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運輸交通省
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高速道路管理室

ベトナム国
高速道路運営維持管理体制強化
プロジェクト

プロジェクト業務完了報告書

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略語

略語	英文	和文
BOT	Build, Operate andTransfer	民間事業者が公共施設等を建設して管理・運営し、事業期間終了後に国や自治体に所有権を委譲する事業方式
C/P	Counterpart	カウンターパート
Cuu Long CIPM	Cuu Long Corporation for Investment, Development and Project Management of Infrastructure	クーロンインフラ投資開発プロジェクト管理会社
CG	Consultative Group Meeting	顧問グループ会議
DRVN	Directorate for Roads of Vietnam	道路総局
ETC	Electronic Toll Collection System	自動料金収受システム
HPC	Ha Noi People's Committee	ハノイ人民委員会
IRI	lnternational Roughness Index	国際ラフネス指数
ITST	Institute of Transport Science and Technology	交通省科学技術研究所
JCM	Joint Coordination Meeting	合同調整会議
JICA	Japan International Cooperation Agency	国際協力機構
LOS	Level of Service	サービスレベル
MOT	Ministry of Transport	運輸交通省
MOPS	Ministry of Public Security	公安省
NEXCO	Nippon Expressway Company Limited	日本高速道路株式会社
O&M	Operation and Maintenance	運営管理
ODA	Official Development Assistance	政府開発援助
OJT	On- the-Job Training	実際の業務を行なう中で必要な知識や技能を身につけさせる研修
PPP	Public Private Partnership	官民連携
R/D	Record of Discussion	政府間技術協力プロジェクト合意文書
PMUTA	Technical Assistance Project Management Unit	技術支援プロジェクト管理ユニット
RRMU	Regional Road Management Unit	地域道路管理局
TG	Technical Group	テクニカルグループ
TECOTEC	Technical Instrument & Consultant Technology JSC	技術設備コンサルティング社
TOC	Table of Contents	目次
TSG	Technical Specification Guidelines	技術指導書
UTC	University of Transport and Communication	交通通信大学
UTT	University of Transport Technology	交通技術大学
VEA	Vietnam Expressway Authority	ベトナム高速道路庁
VEC	Vietnam Expressway Corporation	ベトナム高速道路会社
VEMO	Vietnam Expressway Management Office	ベトナム高速道路管理室
VMS	Variable Message Signs	可変型情報版
WT	Working Team	ワーキングチーム

1 プロジェクトの背景と目的

ベトナム国における高速道路の整備は、資金調達方法の違いによる幾つかの方法[1]が採用されている。そして、高速道路 O&M 業務は、MOT が定める基準・マニュアルに基づき、各高速道路開発者傘下の O&M 機関が実施することになるが、O&M 業務の民間会社への委託についても現在議論されていることから、高速道路 O&M 業務は多様な O&M 機関が実施することが予想される。

今後、幾つかの高速道路の供用が予定されていくことから、多様な O&M 機関が社会の要求を満足するような統一的なサービスレベルで業務が実施できるよう、MOT では高速道路の O&M 基準・マニュアルを整備することが急務となっている。そこで、JICA はベトナム政府（以下「ベトナム」とする。）からの要望に応え、日本の高速道路の先進的な O&M 技術と経験を技術移転するために「高速道路運営維持管理体制強化プロジェクト」（以下「プロジェクト」とする。）を実施した。プロジェクトの上位目標、目的、期待される成果は、表 1.1 に示すとおりである。

表 1.1 プロジェクトの上位目標、目的、期待される成果

項目	内容
上位目標	ベトナムにおける高速道路ネットワークが、適切に運用･維持管理される。
プロジェクトの目的	高速道路の効率的かつ安全な運営維持管理のための枠組み（制度・基準・人員等）が整備される。
期待される成果	- 高速道路の運営・維持管理に関わる制度・基準が策定される。
	- （パイロットプロジェクトとして）一部区間で目標の枠組みに即した運営維持管理が開始される。

[1] ベトナムの高速道路費用は、国家予算、ODA、BOT 及び PPP 方式による民間資金等が使われている。

2 プロジェクト組織

2.1 プロジェクト組織の概要

プロジェクトの組織図は、図 2.1 に示すとおりである。

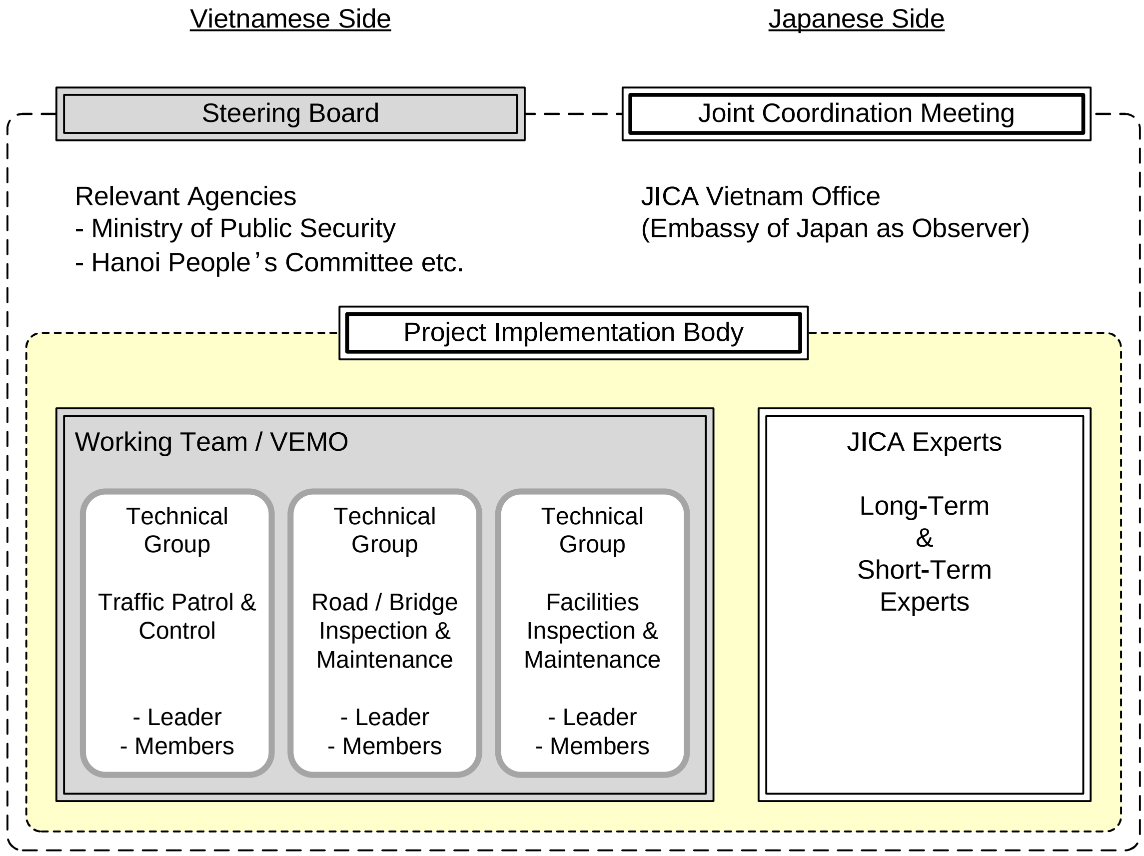


図 2.1 プロジェクトの組織図

2.2 プロジェクトのカウンターパート

ベトナム国運輸交通省 2012 年 7 月 30 日付け「Decision on "Transference of Project Owner and consolidation of the organization and implementation of the JICA funded Technical Assistance Project "Strengthening the O&M system for expressway"」[2]により、プロジェクトのベトナム側実施体制が変更となり、これに合わせて合同調整会議のベトナム側のメンバーも変更となった。すなわち、プロジェクトの実施機関は運輸交通省（MOT）から道路総局（DRVN）に移され、プロジェクトの実施に当たってのワーキング・チームのトップも MOT 計画投資局副局長から DRVN 副局長に変更となった。そして、プロジェクトのカウンターパートは、技術面では DRVN 内にある高速道路管理室（VEMO）、業務管理面では、同様に DRVN 内にある技術支援プロジェクト管理ユニット（PMUTA）が行った。また、運輸交通省内に設立する計画のある高速道路局（VEA）については、

2 MINISTRY OF TRANSPORT, No 1783: / QD-BGTVT, July 30, 2012, DECISION, On "Transference of Project Owner and consolidation of the organization and implementation of the JICA funded Technical Assistance Project "Strengthening the O&M system for expressway"（ANNEX-4 参照）

現在までに設立について政府決定がなされない状況が続いている[3]。

2.3 ステアリング・ボード

ステアリング・ボードの役割は次のとおりである。

- 関連機関との調整
- プロジェクトによる成果物のレビュー、例えば提案される政策、基準・マニュアル、公式資料についての賛同等

2.4 合同調整会議（JCM）

JCM は、MOT 副大臣と JICA ベトナム事務所代表が共同議長を務める。JCM の機能は、次のとおりである。

- プロジェクトの R/D のフレームワークに則り作成されたプロジェクトの年間作業計画の議論と承認
- プロジェクトの年間作業計画と全体的な進捗の達成度の評価
- プロジェクトの実施中に発生した主要な問題についての意見交換と見直し

JCM のベトナム側のメンバーは、上記カウンターパートの変更を受けて表 2.1 のとおり変更となった。

表 2.1 JCM のメンバー

区分	カウンターパート組織
当初	MOT、VEC、関連機関（公安省、ハノイ人民委員会等）
変更後	MOT、DRVN、関連機関（高速道路運営維持管理会社、公安省、ハノイ人民委員会等）

2.5 ワーキングチーム（WG）

ワーキングチームの機能は次のとおりである。

- プロジェクトの活動において日本人専門家との調整
- ステアリング・ボードへのプロジェクト活動の報告

2.6 テクニカルグループ（TG）

プロジェクトの効率的な実施（特に、VEMO の効率的な人材育成、早期の TSG[4]の作成）のために、図 2.1 に示す 3 つのテクニカルグループ（TG）i) Road / Bridge Inspection and Maintenance、ii) Facilities Inspection and Maintenance、iii) Traffic Patrol and Control が設立された。

3 2013 年 7 月 2 日の VEMO の Tuan 室長からのヒアリング結果では、2013 年 8 月に VEA が 20 人規模で DRVN の内局として設置されるとの情報があった。

4 MOT ではプロジェクトで作成する高速道路 O&M 基準・マニュアルを「the Technical Specification Guidelines: TSG」と呼ぶこととした。以下、「TSG」とする。

2.7 日本人専門家

日本人専門家は、表 2.2 に示す各業務を担当し、ベトナム側カウンターパートに対し、プロジェクトの実施において技術的事項について指導、助言を行った。さらに、プロジェクトでは、秘書（1 名）、通訳（英越 1 名、日越最大 3 名）、ローカルコンサルタント（4 名）が業務を支援した。

表 2.2 日本人専門家リスト

担当分野	専門家名
総括／土木保全計画	折笠　幹夫
舗装維持管理	來島　輝武
橋梁維持管理	坂井田　実／横山　博司
施設保全計画	飯村　英紀
電気・通信設備管理	吉沢　敏之
交通・道路管理	松下　安彦
交通管制	石塚　敏浩
機材調達	上橋　信行
業務調整／土木保全計画補助	浦野　一也

3 プロジェクトの内容

3.1 活動

プロジェクトでは、表 3.1 に示す活動を実施した。

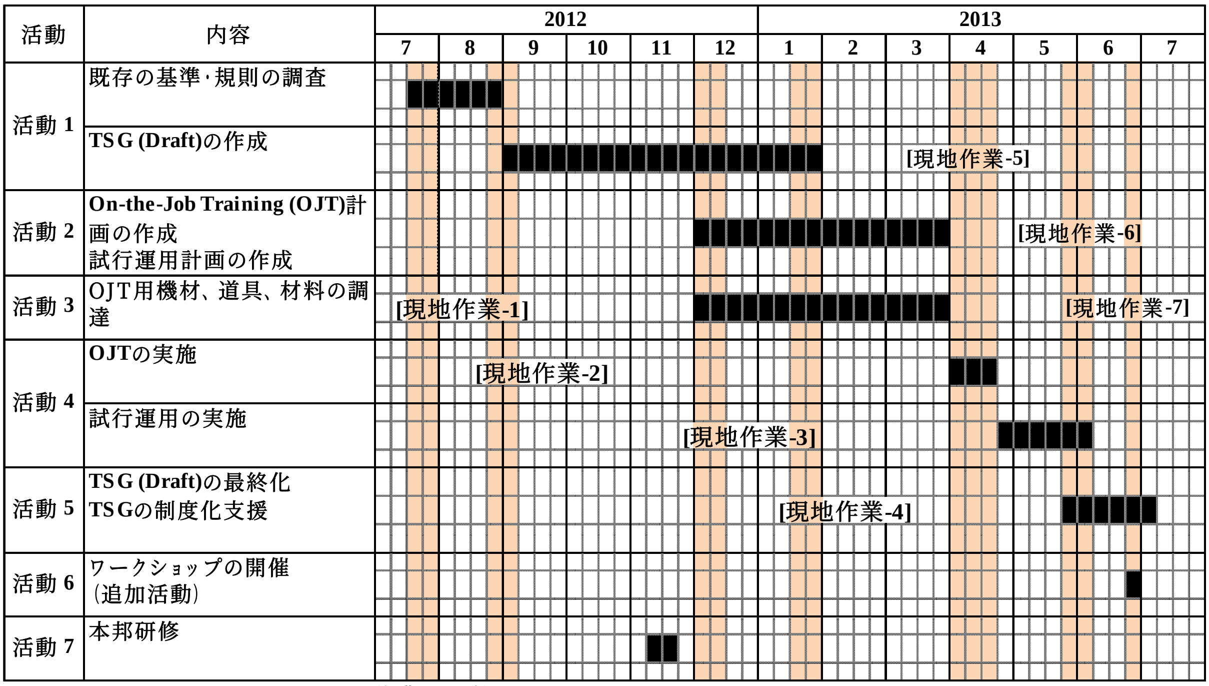
表 3.1 プロジェクトにおける活動

活動	活動	実施期間
活動 1	既存の基準・規則の調査	2012 年 7 月～8 月に実施
	TSG (Draft) の作成	2012 年 7 月～2013 年 1 月に実施
活動 2-1	On-the-Job Training (OJT) 計画の作成	2012 年 12 月～2013 年 3 月に実施
活動 2-2	試行運用計画の作成	
活動 3	OJT 用機材、道具、材料の調達	2012 年 12 月～2013 年 3 月に実施
活動 4-1	OJT の実施	2013 年 4 月に実施
活動 4-2	試行運用の実施	2013 年 4 月～6 月に実施
活動 5	TSG (Draft) の最終化 TSG の制度化支援	2013 年 6 月～7 月に実施
活動 6	ワークショップの開催（追加活動）	2013 年 6 月に実施
活動 7	本邦研修	2012 年 11 月に実施

3.2 スケジュール

上記 7 つの活動は、2012 年 7 月から 2013 年 7 月までの 12.5 か月間の工期内に、表 3.2 に示すスケジュールに沿って実施した。

表 3.2 プロジェクトスケジュール



注-1: [ ] はベトナムでの現地作業の回数を示す。
注-2: 活動 7 は、長期専門家により実施された。

3.3 詳細スケジュール

プロジェクト期間中、日本人専門家は合計 7 回ベトナムに派遣され、表 3.3 に示す各業務を実施した。プロジェクトの前半は、TSG (Draft) の作成、OJT 及び試行運用の計画作成、OJT 実施のための機材調達を行い、プロジェクトの後半は、OJT 及び試行運用の実施、TSG の最終化、TSG の制度化支援を行った。TSG (Draft) の作成と OJT は、日本人専門家が中心となり、ベトナム側カウンターパート及びローカルコンサルタントと共同で実施した。

表 3.3 日本人専門家現地派遣スケジュール

現地作業	時期	期間	日本人専門家の活動
現地作業 -1	2012 年 7 月 22 日 ～ 8 月 4 日	14 日間	- 準備作業 - 既存の基準・規則等の調査
現地作業 -2	2012 年 8 月 26 日 ～ 9 月 8 日	14 日間	- TSG (Draft) の作成
現地作業 -3	2012 年 12 月 2 日 ～ 12 月 15 日	14 日間	- TSG (Draft) の作成 - OJT 計画の作成 - OJT 用の機材、道具、材料の調達
現地作業 -4	2013 年 1 月 20 日 ～ 2 月 2 日	14 日間	- TSG (Draft) の作成 - OJT 詳細計画の作成 - OJT 用の機材、道具、材料の調達状況の最終確認
現地作業 -5	2013 年 3 月 31 日 ～ 4 月 20 日	21 日間	- OJT 用の機材、道具、材料の検収 - T TSG (Draft) を使用して OJT の実施
現地作業 -6	2013 年 5 月 26 日 ～ 6 月 8 日	14 日間	- OJT 及び試行運用の結果による TSG (Draft) の最終化
現地作業 -7	2013 年 6 月 19 日 ～ 6 月 25 日	7 日間	- TSG の制度化支援、ワークショップ

3.4 会議

プロジェクトでは、日本人専門家とベトナム側カウンターパートが活動内容等について調整を行うために、3 種類の会議を定期的に開催した。

3.4.1 合同調整会議（JCM）

JCM は、プロジェクト期間中、2013 年 5 月 7 日に開催された。JCM では、これまでのプロジェクトの活動結果を報告し、さらにプロジェクトで作成した TSG の制度化について議論がなされた。JCM の議事録を ANNEX-3 に添付する。

3.4.2 顧問グループ会議（CG）

CG は、日本人専門家の派遣時に実施した。特に、TSG (Draft) 作成の節目では、VEMO 及び TG の考え方を確認するために開催した。また、OJT 計画作成では、VEMO 及び PMUTA と基本方針を確認し、具体的な OJT の準備を行うために開催した。

3.4.3 定期会議

VEMO 及び PMUTA とのプロジェクトを円滑に推進させるために、会議を定期的に開催し、常にベトナム側の考えを確認しながら作業を進めた。

3.5 報告書及び成果物

3.5.1 報告書

プロジェクトにおいて作成・提出した報告書は、表 3.4 及び表 3.5 に示すとおりである。

表 3.4 報告書の種別（JICA との契約に基づく報告書）

	報告書名	言語	提出時期
1	業務計画書	和文	2012 年 7 月
2	ワークプラン	英文	2012 年 9 月
3	プロジェクト業務進捗報告書	和文 英文	2013 年 4 月
4	プロジェクト業務完了報告書	和文 英文	2013 年 7 月

表 3.5 報告書の種別（JICA との契約によらない報告書）

	報告書名	言語	用途	提出時期
5	Inception Report	英文 越文	関係機関への説明	2012 年 7 月
6	Report	英文 越文	MOT でのキックオフミーティング	2012 年 8 月
7	Kickoff Meeting Between Member of the Technical Groups and JICA Experts	英文 越文	DRVN でのキックオフミーティング	2012 年 8 月
8	On-the-job Training (OJT) and Pilot Implementation Plan (Outline)	英文 越文	PMUTA 及び VEMO への説明	2013 年 2 月
9	On-the-job Training (OJT) Participants List	英文 越文	同上	2013 年 3 月
10	On-the-job Training (OJT) and Pilot Implementation Plan (Details)	英文 越文	OJT オリエンテーション	2013 年 4 月
11	Supplementary Teaching Material	和文 越文	OJT 時の TSG を補完する教材	2013 年 4 月
12	Report of the OJT	英文 越文	OJT 閉講式	2013 年 4 月
13	Comments and Answers to TSG from MOT & DRVN	和文 英文 越文	TG 会議（TSG の最終化を議論）	2013 年 4 月
14	Report	英文 越文	JCM	2013 年 5 月
15	Comments and Answers to TSG from Cuu Long CIPM, VEC and VEC O&M	和文 英文 越文	TG 会議（試行運用結果により TSG の最終化を議論）	2013 年 6 月
16	Workshop Documents	和文 英文 越文	ワークショップでのプレゼンテーション資料	2013 年 6 月

3.5.2 技術協力のための成果物

TSG (Draft) は、OJT の教材として使用するために 2013 年 1 月までに作成し、その後ベトナム側関係機関への意見照会を行い、それらを基に内容の見直しを行い、OJT の実施に合わせて 2013 年 4 月に完成させた。OJT 用 TSG (Draft) は、リング製本とし、4 分野の表紙を色分し 4 分冊にすることで各分野を区別しやすいよう工夫した。

また、TSG は、OJT 及び試行運用の結果、さらに関係機関からのコメントを反映させ最終化を行い、2013 年 6 月に最終版を提出した。TSG は、ベトナム側から持ち運びが便利なようにコンパクトに印刷して欲しいとの要望があり、A5 サイズ、ハードカバーのくるみ印刷として作成し提出した。また、作成した TSG は、ANNEX-5 に添付する。

4 プロジェクトの活動結果

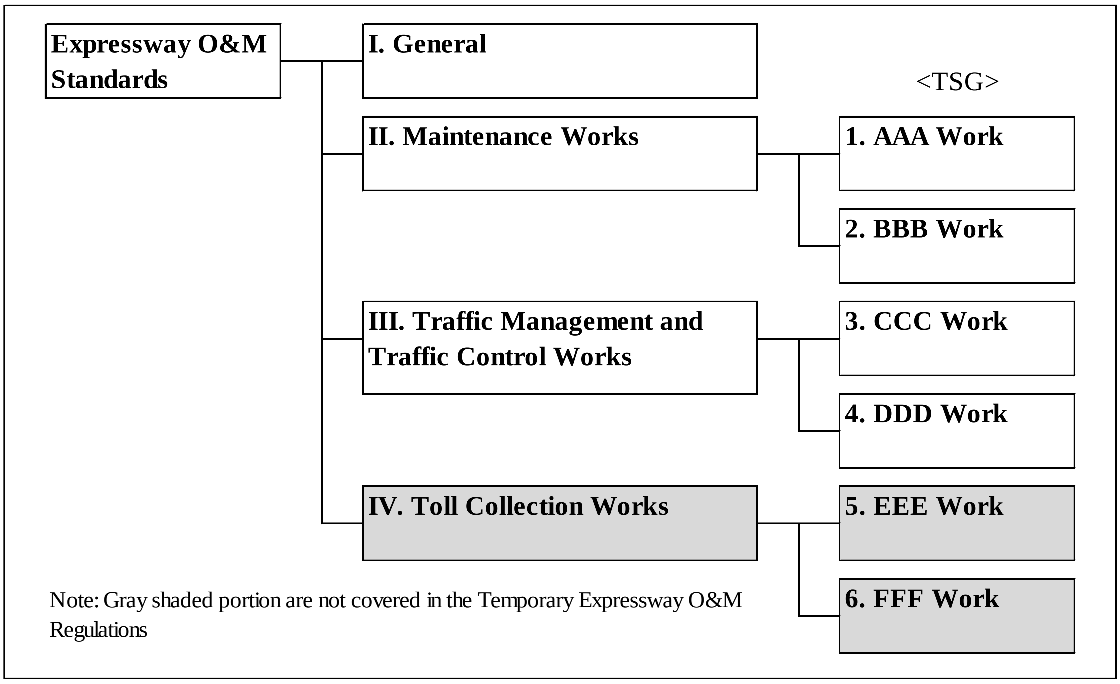
4.1 概要

プロジェクトでは、表 3.2 に示すとおり 7 回の現地作業を実施した。各活動結果は、以下に示すとおりである。

4.2 現在の基準、規則の調査及び TSG (Draft) の作成（活動 1）

4.2.1 O&M 基準と TSG の定義

ベトナムでは、これまでに幾つかの高速道路 O&M 暫定基準（以下「暫定基準」とする。）が発効され、これらをベトナムの高速道路 O&M 基準としている。一般的に、高速道路 O&M 基準は、道路維持管理、交通管理、料金収受の 3 分野に分けられ、さらに各分野は、幾つかの業務分野に細分化される。これらの関係は、図 4.1 に示すとおりである。そこで、TSG は、O&M 業務において、道路及び施設物の損傷状況に合わせた点検、補修方法等を規定し、O&M 基準を補完するための基準と位置付けられる。

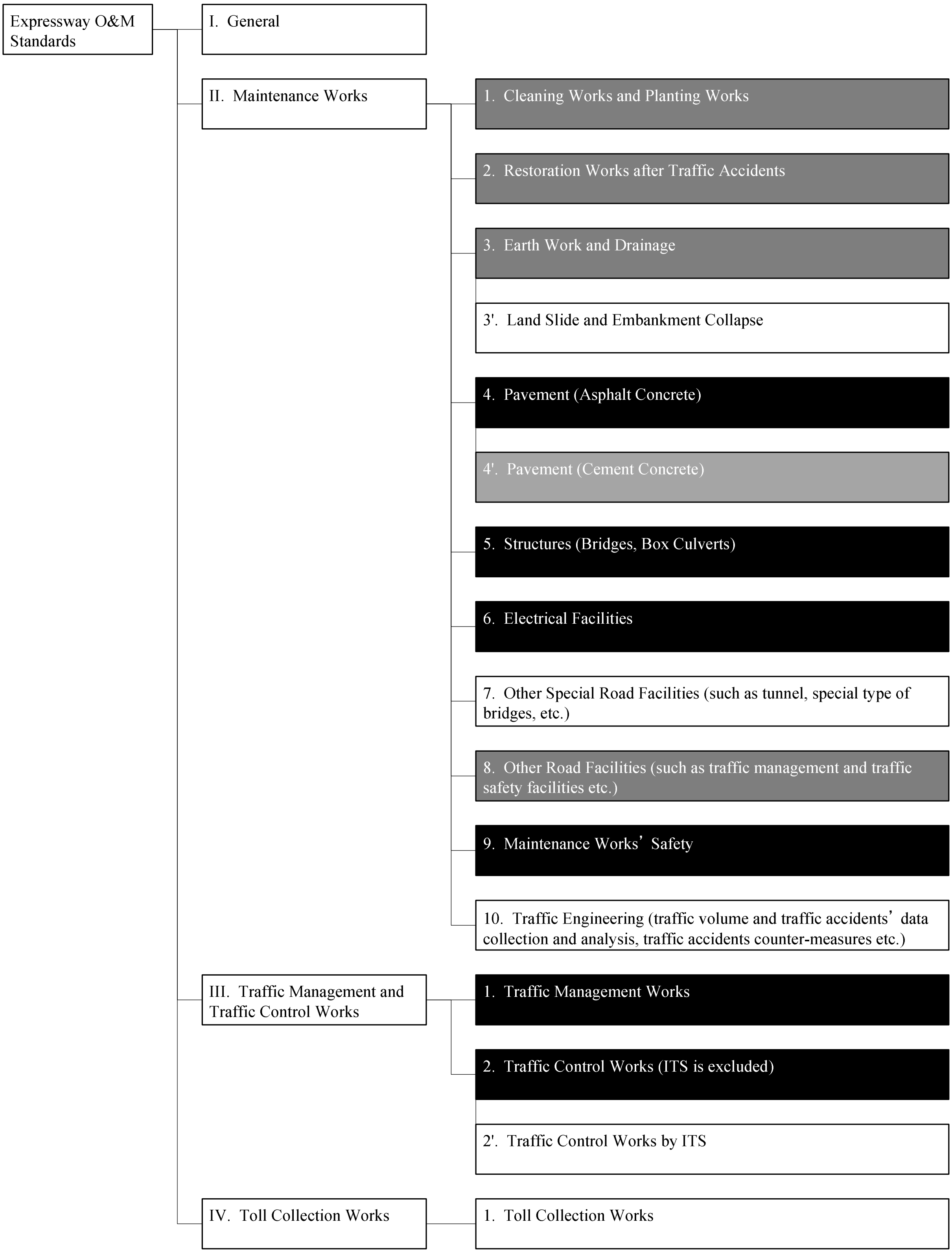


出典: JICA 日本人専門家チーム

図 4.1 O&M 基準と TSG の関係

4.2.2 O&M 基準と TSG の構成

一般的な高速道路 O&M 基準が網羅する項目は、図 4.2 に示すとおりである。上記のとおり、高速道路の O&M 業務は、大きく 3 分野に分けられ、さらに幾つかの業務分野に細分化される。灰色に着色された分野は既に暫定基準で言及しているもの、黒色で着色されている分野はプロジェクトで作成したものを示す。



出典：　日本人専門家チーム
注：　[グレー]･･･既に暫定基準で言及しているものを示す。
[　黒　]･･･プロジェクトで作成したものを示す。

図 4.2　O&M 基準の構成

4.2.3 TSG の目次

TSG の分野ごとの目次は、表 4.1 に示すとおりである。

表 4.1 各分野の TSG の目次

4.2.4 TSG 作成の方法

(1) TSG 作成の基本方針

TSG 作成の基本方針は、次のとおりとした。

- TSG は、既存の暫定基準に基づき作成する。
- 上記暫定基準において言及されていない部分は、ベトナム国の一般道路の基準を参考にする。
- 上記 1 及び 2 においても言及されていない部分は、ベトナム国の高速道路の運営管理に適用できると思われる日本の NEXCO 及び他国の道路機関の基準等を参考にする。

(2) 作成手順

TSG は、表 4.2 に示す作成手順により作成した。

表 4.2 TSG の作成手順

手順	内容	備考
ステップ１	TSG の目次を作成する。	
ステップ２	作成した目次から、日常的な運営管理において使用頻度の高い項目を選定する。	
ステップ３	選定した項目を緊急性の高い順番に並べる。	
ステップ４	TSG は、上記項目の優先順位に沿って、既存基準を改訂すること、新たに作成されることにより作成する。	

4.2.5 作成スケジュール

TSG 作成スケジュールは、3.5.2 章「技術協力のための成果物」 に記述のとおりである。

4.3 OJT 計画（活動 2-1）

4.3.1 研修項目

作成された TSG (Draft) は、今後ベトナムの高速道路 O&M 基準として制定化された後は、国内の統一基準として全国の高速道路 O&M の実践的な業務において使われる。そこで、現在一般道路及び高速道路の O&M 業務に従事する技術者及び将来従事する可能性のある技術者に TSG の内容を具体的に説明すること、さらに TSG に基づく現場での作業方法を指導することは重要である。そこで、プロジェクトではそれら技術者に対し、TSG の内容をより理解させるために、机上での説明だけではなく、現場での実践的な作業も含めた OJT を計画した。

OJT は TSG (Draft) に記載された全ての内容を対象とし、舗装・橋梁・電気施設分野については維持管理サイクルの一連の流れ、交通管理分野については交通パトロール、交通管理業務、異常事象時の対応等、高速道路 O&M 業務において必要不可欠な作業を表 4.3 のとおり計画した。

表 4.3　OJT の研修項目

No.	分野	研修項目	備考
1	舗装維持管理	O&M の点検及び診断方法、補修方法	
2	橋梁維持管理		
3	電気施設維持管理		
4	交通管理	交通パトロール方法、路上作業、交通事故等の緊急時の対応、路上障害物の排除方法	

4.3.2　研修スケジュール

スケジュールの概要は、表 4.4 に示すとおりである。

表 4.4　OJT スケジュールの概要

No.	スケジュール	期間	活動	備考
1	4 月 2 日		オリエンテーション	
2	第 1 週／4 月 3 日～5 日	3 日間	座学	日本人専門家により実施する
3	第 2 週／4 月 8 日～12 日	5 日間	現場研修	〃
4	第 2 週／4 月 15 日～17 日	3 日間	現場研修	〃
5	4 月 18 日		閉講式	

4.3.3　研修生

(1)　研修生の選定

研修生の選定は、PMUTA 及び VEMO が行った。日本人専門家チームは、選定にあたって次の条件を考慮するよう提案した。

- 研修生は技術系職員とし、OJT 全期間参加できること。
- 研修生は、現在道路の O&M 業務に従事している、または将来従事する可能性のある職員であること。
- 研修生は、OJT 後に試行運用を行うことから、現在高速道路の O&M 業務を行っている VEC O&M (VEC) 及び Company 715 (Cuu Long CIPM) の職員が含まれること。

(2)　研修生の人数

分野別の研修生の人数は、表 4.5 のとおり計画した。また、現在実施中の JICA 技術協力プロジェクト「高速道路建設事業従事者養成能力強化プロジェクト」のカウンターパートである UTT (University of Transport Technology) の講師の参加も要請した。

表 4.5　分野別の研修生の人数（計画）

No.	分野	研修種別	研修生数	備考
1	舗装維持管理	座学 現場研修	10	
2	橋梁維持管理	座学 現場研修	10	
3	電気施設維持管理	座学 現場研修	10	
4	交通管理	座学	10	
		現場研修（グループ A）	5	座学に参加する 10 人の研修生は、2 つのグループに分けられる。南部・中部からの研修生は、座学、現場研修が連続できることからグループ A に配置される。
		現場研修（グループ B）	5	

4.3.4　研修概要

分野別の研修計画概要は、それぞれ表 4.6、表 4.7、表 4.8 及び表 4.9 に示すとおりである。

表 4.6　舗装研修の概要

No.	スケジュール	期間	活動	場所
1	2013 年 4 月 3 日～5 日	3 日間	− 座学	− ハノイ市内の Apollo English Center の教室
2	4 月 8 日～12 日	5 日間	− 現場研修	− Vuc Vong の VEC O&M 事務所の会議室 − Cau Gie – Ninh Binh 高速道路
3	4 月 15 日～17 日	3 日間	− 現場研修（研修生自身で主体的に OJT ができるよう日本人専門家が指導する。 − 追加的な講義の実施、研修全体のまとめ	− 〃

表 4.7　橋梁研修の概要

No.	スケジュール	期間	活動	場所
1	2013 年 4 月 3 日～5 日	3 日間	− 座学	− ハノイ市内の Apollo English Center の教室
2	4 月 8 日～12 日	5 日間	− 現場研修（橋梁点検／橋梁補修方法）	− Vuc Vong の VEC O&M 事務所の会議室 − Vuc Vong 及び Liem Tuyen 高架橋 (Cau Gie – Ninh Binh 高速道路)
3	4 月 15 日～17 日	3 日間	− 現場研修（橋梁補修方法）	− Vuc Vong の VEC O&M 事務所の会議室 − VEC O&M 事務所の駐車場

表 4.8　電気施設研修の概要

No.	スケジュール	期間	活動	場所
1	2013 年 4 月 3 日～5 日	3 日間	− 座学	− ハノイ市内の Apollo English Center の教室
2	4 月 8 日～12 日	5 日間	− 現場研修（電気施設の点検方法）	− Vuc Vong の VEC O&M 事務所の会議室 − Vuc Vong IC 周辺 (Cau Gie – Ninh Binh 高速道路)
3	4 月 15 日～17 日	3 日間	− 現場研修（点検結果の評価、補修方法）	− Vuc Vong の VEC O&M 事務所の会議室

表 4.9　交通管理研修の概要

No.	スケジュール	期間	活動	場所
1	2013 年 4 月 3 日～5 日	3 日間	− 座学	− ハノイ市内の Apollo English Center の教室
2	4 月 8 日～11 日 （グループ A）	4 日間	− 現場研修（道路パトロール等）	− Vuc Vong の VEC O&M 事務所の会議室 − VEC O&M 事務所の駐車場 − Cau Gie – Ninh Binh 高速道路
3	4 月 12 日及び 15 日～17 日 （グループ B）	4 日間	− 現場研修（道路パトロール等）	− Vuc Vong の VEC O&M 事務所の会議室 − VEC O&M 事務所の駐車場 − Cau Gie – Ninh Binh 高速道路

4.3.5　費用分担

OJT の各活動におけるベトナム側と日本側とでの費用分担は、カウンターパートとの協議の結果、表 4.10 のとおりとなった。

表 4.10　OJT における費用分担

No.	項目	種別	内容	費用分担	
				ベトナム側	日本側
1	場所	オリエンテーション、閉講式	DRVN 会議室	●	---
		座学	Apollo English Center	---	●
		現場研修	VEC O&M 会議室	---	●
			VEC O&M 事務所周辺	---	●
			Cau Gie – Ninh Binh 高速道路での車線規制	---	●
2	交通機関	現場研修	ハノイ～VEC O&M 事務所間の交通機関	---	●

No.	項目	種別	内容	費用分担	
				ベトナム側	日本側
			VEC O&M 事務所～現場研修箇所間の交通機関	---	●
			道路パトロール車両	---	●
3	座学用教材、機材	教材	TSG	---	●
			副教材	---	●
		機材	PC、プロジェクターetc.	---	●
4	現場研修用機材、道具	機材 etc.	JICA 供与機材	---	●
		道具 etc.	日本人専門家が用意する機材	---	●
			研修生自身が用意する機材	●	---
5	旅費、日当、宿泊費	日当	日本人専門家が研修生に支払う **[注-1]**	---	●
		宿泊費	研修生自身が支払う	●	---
		昼食費	研修生自身が支払う **[注-2]**	●	---
		交通費	研修生自身が支払う **[注-3]**	●	---
6	オリエンテーション及び閉講式費用	コーヒーブレイク	閉講式	---	●
		機材	オリエンテーション及び閉講式	●	●

凡例： ●が負担する側を示す。
注-1: 研修生に支払う日当の金額については、ベトナム政府が定める金額に準拠する。
注-2: 研修期間中の昼食については、研修生自身の負担とする。
注-3: 移動に伴う費用は、日本人専門家チームが用意する交通機関以外は、全て研修生自身の負担とする。

4.4 試行運用計画（活動 2-2）

TSG (Draft) を最終化するためには、作成した TSG (Draft) がベトナム国内の高速道路 O&M の実情に適合しているか、また実際に使用する際に不都合はないか等を確認することが必要である。そこで、OJT に参加した研修生が自分の職場に戻り TSG (Draft) を実際の高速道路 O&M 業務で使用することの試行運用を計画した。

試行運用は舗装、橋梁、電気施設、交通管理の作成した TSG (Draft) を対象とし、試行運用期間中に TSG (Draft) に記載された業務を極力実施し、TSG (Draft) の内容における問題点等を抽出することを目的とした。

試行運用の実施期間は、2013 年 4 月 22 日～6 月 7 日（7 週間）とし、その概要を表 4.11 に示す。

表 4.11　試行運用の概要

No.	スケジュール	期間	活動	備考
フェーズ１	第 4 週／4 月 22 日～第 8 週／5 月 24 日	5 週間	- 試行運用の実施	− OJT に参加した研修生が各自の職場で実施する。
フェーズ２	第 9 週／5 月 27 日～第 10 週／6 月 7 日	2 週間	- 研修生が行った試行運用結果を日本人専門家がレビューする。その結果を基に TSG (Draft) の最終化を行う。	− 日本人専門家及び研究生が共同で実施する。

4.5　OJT 用機材、道具、材料の調達（活動 3）

4.5.1　JICA による供与機材

TSG (Draft) に基づき、OJT 及び実際の O&M 業務において必要となる機材を調達した。それら機材は、OJT の現場研修では実際に使用し、研修生に使用方法等についての指導を行った。調達機材の一覧を A4 フォーム (ANNEX-6) に示す。

4.5.2　現場研修のための道具及び材料

(1)　日本人専門家チームが準備した道具及び材料

現場研修で必要となり、日本人専門家チームが準備した道具及び材料は、表 4.12 に示すとおりである。

表 4.12　日本人専門家チームが準備する道具及び材料

No.	道具、材料	数量	単位
薬品			
1	道具の洗浄用シンナー	1	個
計量器			
2	デジタル計量器	1	個
文房具			
3	名札	83	個
4	ウレタンフォーム用カッター	1	個
5	ホワイトボード（写真撮影用）	5	個
6	ホワイトボードマーカー	16	個
7	ホワイトボード消し板	8	個
8	マグネット	8	個
9	クリップボード（A3 サイズ）	20	個
10	現場研修用チョーク	20	個
11	レーンマーク用テープ（白色） (600m) 100mm×25m	24	個
道具			
12	ヘルメット + 安全チョッキ	10	個
13	手袋	20	個
14	巻尺 (50m)	3	個
15	室内用電気延長ケーブル	4	個
16	コードリール (20m)	1	個
17	赤旗 70x70cm	6	個
日用品			
18	バケツ	6	個
19	水用タンク	1	個
20	ブルーシート (4 × 4m)	1	個
21	ゴミ袋	11	個
22	プレート	2	個
23	スプーン	7	個
24	雑巾	1	Kg
25	ほうき	2	個

(2)　研修生が準備した道具

現場研修のために研修生自身で準備した道具は、表 4.13 に示すとおりである。

表 4.13　現場研修のために研修生自身で準備する道具

No.	道具	使用目的	数量	備考
1	ヘルメット	現場研修	研修生の人数	
2	安全チョッキ	〃	〃	
3	作業服	〃	〃	
4	作業靴	〃	〃	
5	筆記用具	〃	〃	

(3)　VEC O&M からのレンタル機材、人員等

OJT で必要となる機材、実践研修のための交通規制に必要な人員等は、日本人専門家チームの負担とし、VEC O&M からレンタルした。そのため、日本人専門家チームと VEC O&M 間では、表 4.14 に示す内容のレンタル契約を結んだ。

表 4.14　VEC O&M からレンタル道具等

No.	道具	数量	単位	備考
倉庫、教室、機材のレンタル				
1	倉庫（監視員を含む）	1	月	
2	会議室（机、椅子を含む）	32	部屋・日	
3	プロジェクター	32	基・日	
4	ビームリフター (10m ~ 12m) （運転手、燃料を含む）	1	日	
5	ピックアップトラック (1.0 t) （運転手、燃料を含む）	8	日	
6	発電機 (2.4 KVA) （燃料を含む）	8	日	
7	梯子 (7m, 2 段)	8	日	
車線規制作業				
8	Vuc Vong IC～Cao Bo IC 間、車線規制（L=200m）	5	日	
9	Vuc Vong IC 及び Cao Bo IC 料金所、車線規制	3	日	
作業支援のための技術職員派遣				
10	橋梁技術者	5	人・日	
11	電気技術者	4	人・日	
12	交通技術者	2	人・日	
13	電気作業員	4	人・日	
14	作業員	2	人・日	
15	自動車運転手	2	人・日	

4.5.3　OJT 用機材等を保管するための倉庫

調達した機材、道具、材料等は、調達業者 (TECOTEC) により、3 月 20 日～27 日に倉庫に搬入され、日本人専門家チーム（機材調達担当）が PMUTA の立ち会いのもと検収を行った。これら OJT 用機材、道具、材料保管用の倉庫は、表 4.14 に示すとおり VEC O&M の倉庫をレンタルした[5]。

5　倉庫レンタル費用は、4.5.2 章、(3)「VEC O&M からのレンタル機材、人員等」のレンタル契約に含む。

表 4.15　OJT 用機材等保管のための倉庫

倉庫の場所	期間	使用日数	活動
Vuc Vong の VEC O&M 事務所	2013 年 3 月 20 日～3 月 27 日	8 日間	機材の搬送
	2013 年 3 月 28 日～3 月 29 日	2 日間	機材の検収
	2013 年 3 月 30 日～4 月 18 日	20 日間	OJT 実施（座学及び現場研修）

4.5.4　交通管理現場研修用の道路パトロール車両

プロジェクトには、OJT で使用するための道路パトロール車両の調達が含まれていた。そこで、現在 VEC 及び Cuu Long CIPM の高速道路道路管理者が所有する道路パトロール車両を調査し、今後ベトナムの道路パトロール車両として使用される可能性のある車両の仕様を提案した。この提案に基づき、道路パトロール車両を日本から購入することとしたが、ベトナム側の当該車両の仕様に係る詳細検討に時間を要し、OJT の実施時期までに調達が困難であることが判明したため、OJT では日本の道路パトロール車両と同様の車両をレンタルし対応した。その後、JICA ベトナム事務所による道路パトロール車両の調達はキャンセルされ、DRVN へは公文書によりその旨通報された。

4.5.5　調達機材の引き渡し

プロジェクトで調達した機材は、「委託契約等における機材調達・管理ガイドライン　平成 24 年 4 月、独立行政法人国際協力機構調達部」に沿って DRVN に引き渡した。機材の引き渡しの状況は、表 4.16 に示すとおりである。

表 4.16　OJT 用機材の処理状況

No.	機材の処理状況	月日	品目数	確認者
1	供与機材の引き渡し	2013 年 4 月 5 日	11 品目	DRVN PMUTA
2	消耗品の引き渡し	2013 年 4 月 17 日	72 品目	DRVN PMUTA

注：　供与機材は、4 月 8 日～4 月 17 日間実施した OJT で使用した。そこで、OJT 期間中日本人専門家チームは、これら供与機材を DRVN から借用する手続きを行い使用した。

4.6　OJT の実施（活動 4-1）

4.6.1　概要

OJT は、4.3 章「　OJT 計画（活動 2-1）」に沿って実施した。以下に、OJT の実施概要及び分野ごとの実施結果を示す。

(1)　スケジュール

OJT は、表 4.17 のとおり 3 週間実施し、第 1 週目は座学、第 2 週目及び第 3 週目は現場研修を行った。

表 4.17 OJT スケジュールの概要

No.	スケジュール	期間	活動	備考
	4 月 2 日		オリエンテーション	
1	第 1 週／4 月 3 日～5 日	3 日間	座学	日本人専門家により実施される
2	第 2 週／4 月 8 日～12 日	5 日間	現場研修	〃
3	第 2 週／4 月 15 日～17 日	3 日間	現場研修	〃
	4 月 18 日		閉講式	

(2) 研修生の人数

1) 分野別の研修生の人数

分野別の研修生の人数を表 4.18 に示す。UTT からは 6 名の講師が各分野に参加した。

表 4.18 分野別の研修生の人数（実績）

No.	分野	研修種別	研修生数	備考
1	舗装維持管理	座学	15	
		現場研修		
2	橋梁維持管理	座学	15	
		現場研修		
3	電気施設維持管理	座学	8	
		現場研修		
4	交通管理	座学	11	
		現場研修（グループ A）	6	座学に参加した 11 人の研修生は、2 つのグループに分けられる。南部・中部からの研修生は、座学、現場研修が連続できることからグループ A に配置される。
		現場研修（グループ B）	5	

2) 全参加者数

研修には、研修生、PMUTA、日本人専門家、通訳、ローカルコンサルタントが参加し、全体人数は座学で 67 名、現場研修で 70 名に達した。参加者の内訳は、表 4.19 に示すとおりである。

表 4.19　研修参加人員の内訳

研修種別	研修分野		参加者数				
			研修生	**PMUTA**	日本人専門家	通訳&ローカルコンサルタント	合計
座学	舗装維持管理		15	1	1	2	19
	橋梁維持管理		15	1	1	2	19
	電気施設維持管理		8	1	2	2	13
	交通管理		11	1	2	2	16
	合計						**67**
現場研修	舗装維持管理		15	1	3	2	21
	橋梁維持管理		15	1	1	2	19
	電気施設維持管理		8	1	6	2	17
	交通管理	（グループ A）	6	1	4	2	13
		（グループ B）	5	1	4	2	12
	合計						**70（69）**

注：　現場研修の日本人専門家の数には、本業務の日本人専門家の他に NEXCO 中日本及び関連会社からの支援の専門家も含まれる。

(3)　研修場所

1）　座学

座学は、表 4.20 に示すとおり 4 分野が並行して実施したため、1 クラス約 20 名が収容できるスペースを 4 部屋、3 日間準備することが必要であった。そのため、日本人専門家チームは、ハノイ市内の「Apollo English Center」の教室をレンタルし対応した。

表 4.20　座学のための教室

スケジュール	期間	分野	教室数	参加者数	場所	講義室
2013 年 4 月 3 日～5 日 10:00～16:00	3 日間	舗装維持管理	1	19	ハノイ	ハノイ市内 「Apollo English Center」
		橋梁維持管理	1	19		
		電気施設維持管理	1	13		
		交通管理	1	16		
合計			**4**	**67**	**---**	**---**

2）　現場研修

現場研修は、表 4.21 に示すとおり 4 分野が並行して実施したため、1 クラス約 20 名が収容できるスペースを 4 部屋、8 日間準備することが必要であった。そのため、Vuc Vong にある VEC O&M の会議室をレンタル[6]し対応した。

6　当レンタル費用は、4.5.2 章、(3)「VEC O&M からのレンタル機材、人員等」のレンタル契約に含む。

表 4.21　現場研修のための教室

スケジュール	期間	分野	教室数	参加者数	場所	講義室
2013 年 4 月 8 日～12 日 10:00～16:00	5 日間	舗装維持管理	1	21	Vuc Vong	VEC O&M 事務所の 4 つの会議室を使用
		橋梁維持管理	1	19		
		電気施設維持管理	1	17		
		交通管理	1	13		
Total			**4**	**70**		
2013 年 4 月 15 日～17 日 10:00～16:00	3 日間	舗装維持管理	1	21	Vuc Vong	VEC O&M 事務所の 4 つの会議室を使用
		橋梁維持管理	1	19		
		電気施設維持管理	1	17		
		交通管理	1	12		
Total			**4**	**69**		

また、現場研修期間中の分野別の実践研修は、表 4.22 に示す箇所で実施した。

表 4.22　実践研修場所

スケジュール	期間	分野	講義室	実践研修場所	備考
2013 年 4 月 8 日～12 日	5 日間	舗装維持管理	VEC O&M 会議室	- Vuc Vong IC – Cao Bo IC (Cau Gie – Ninh Binh 高速道路)	車線規制を実施
		橋梁維持管理	VEC O&M 会議室	- VEC O&M 事務所周辺 - Vuc Vong IC – Cao Bo IC (Cau Gie – Ninh Binh 高速道路)	-----
		電気施設維持管理	VEC O&M 会議室	- Vuc Vong IC 周辺	-----
		交通管理	VEC O&M 会議室	- VEC O&M 事務所駐車場 - Cau Gie IC～Ninh Binh IC (Cau Gie – Ninh Binh 高速道路)	車線規制を実施
2013 年 4 月 15 日～17 日	3 日間	舗装維持管理	VEC O&M 会議室	- Vuc Vong IC – Cao Bo IC (Cau Gie – Ninh Binh 高速道路)	車線規制を実施
		橋梁維持管理	VEC O&M 会議室	- VEC O&M 事務所周辺	-----
		電気施設維持管理	VEC O&M 会議室	-----	-----
		交通管理	VEC O&M 会議室	- VEC O&M 事務所駐車場 - Cau Gie IC - Ninh Binh IC (Cau Gie – Ninh Binh 高速道路)	車線規制を実施

(4)　実践研修のための車線規制

舗装及び交通管理の実践研修は、実際の高速道路上で行った。そのため、日本人専門家チームは、Cau Gie - Ninh Binh 高速道路において表 4.23 に示す日時に車線規制（1 車線規制、延長約 200m）を行うよう VEC O&M に依頼した[7]。

7　当車線規制費用は、4.5.2 章、(3)「VEC O&M からのレンタル機材、人員等」のレンタル契約に含む。

表 4.23　現場実践研修のための車線規制

スケジュール	分野	期間		車線規制区間	実施者
		午前	午後		
2013 年 4 月 9 日（火）	舗装	10:30～12:00 (1 時間 30 分)	13:30～16:00 (2 時間 30 分)	Cau Gie～ Ninh Binh	VEC O&M
2013 年 4 月 10 日(水)	舗装	〃	〃	〃	〃
2013 年 4 月 11 日(木)	舗装	〃	〃	〃	〃
2013 年 4 月 15 日(月)	舗装	〃	〃	〃	〃
2013 年 4 月 16 日(火)	舗装	〃	〃	〃	〃
2013 年 4 月 17 日(水)	交通管理	〃	-----	〃	〃

(5)　現場研修のための交通機関

現場研修は、Vuc Vong IC に近い VEC O&M の事務所周辺で実施した。そのため、日本人専門家チームは、現場研修参加者の移動のために次の交通機関を準備した。

- ハノイと Vuc Vong（VEC O&M 事務所）間往復の車両
- VEC O&M 事務所から実践研修箇所までの移動用車両
- 交通管理研修で使用する道路パトロール車両

(6)　研修カリキュラム及び教材

研修カリキュラム及び教材は、日本人専門家チームが準備した。研修カリキュラムは、作成した TSG (Draft) とさらに TSG (Draft) の内容を補完するために各日本人専門家が作成した副教材により構成された。

(7)　開講及び閉講

OJT 開始時には、OJT の実施方法等を説明するためのオリエンテーションを実施した。また、終了時には、OJT 全体のまとめとなる閉講式を実施した。閉講式では、OJT に全期間参加した研修生に対し終了証書を授与した。[8]オリエンテーション及び閉講式の内容は、表 4.24 及び表 4.25 に示すとおりである。

8　授与した終了証書と研修生のリストを ANNEX-7 に添付する。

表 4.24　オリエンテーション（4 月 2 日）

No.	進行表	時間（分）	議事次第	発表者
1	10:00～10:30	30	OJT の概要説明	日本人専門家
2	10:30～11:30	60	各分野のオリエンテーション	〃

表 4.25　閉講式（4 月 18 日）

No.	進行表	時間（分）	議事次第	発表者
1	10:00～10:05	5	オープニングスピーチ	PMUTA 部長
2	10:05～10:15	10	DRVN スピーチ	DRVN 副局長
3	10:15～10:25	10	JICA スピーチ	JICA 事務所
4	10:25～10:40	15	OJT 結果報告	日本人専門家
5	10:40～10:55	15	終了証書の授与式	DRVN 副局長
6	10:55～11:00	5	クロージングスピーチ	PMUTA 部長
			コーヒーブレイク	

4.6.2　各分野の OJT 結果

(1)　舗装分野

1）　概要

舗装分野の OJT の概要は、表 4.26 に示すとおりである。また、詳細実施内容は、ANNEX-8 (1) に添付する。

表 4.26　舗装分野の OJT 概要

月日	種別	内容
4 月 3 日（水）	座学	TSG1.1、TSG1.2 の説明
4 月 4 日（木）	座学	TSG1.3、TSG1.4 の説明
4 月 5 日（金）	座学	TSG1.5、TSG1.6 の説明
4 月 8 日（月）	現場実習	計測機器の操作説明、補修作業の概要説明
4 月 9 日（火）	現場実習	わだち掘れ、小段差、ポットホールの調査と評価
4 月 10 日（水）	現場実習	ひびわれの調査と評価
4 月 11 日（木）	現場実習	常温合材による小補修作業､加熱シール材によるひびわれ補修作業
4 月 12 日（金）	現場実習	車上目視による路面評価
4 月 15 日（月）	現場実習	わだち掘れ、小段差、ポットホール、ひびわれの調査と評価
4 月 16 日（火）	現場実習	常温合材による小補修作業､加熱シール材によるひびわれ補修作業
4 月 17 日（水）	現場実習	評価と判定、課題の整理、試行運用実施方法の説明

2）　研修実施における工夫点等

舗装分野の OJT では、表 4.27 に示す工夫等を行った。

表 4.27 舗装分野の OJT における工夫等

概要	No.	内容
説明資料の作成方法	1	- 説明資料は越語と日本語の併記資料を事前に作成し、同時通訳の円滑化を図った。
講義方法	2	- 楽しく、分かりやすい講義となるように資料や説明方法を工夫した。
	3	- 研修生は積極的に授業に参加させたことで、理解も早く進み、臨機応変な応用動作もできた。
機材の使用方法の説明	4	- 使用する資材・機材は、研修生の使用経験が無いため、資料による事前説明と講師による基本操作説明を充実させた。
研修中の安全対策	5	- 交通規制を伴う OJT では、一般の通過車両と研修生の安全を第一に考え、安全対策の充実を最重要項目とした。

3) 研修結果に基づく TSG 最終化への反映

OJT 期間中には、TSG の不具合に関係する重大な意見等は無かった。しかし、短期間の研修であることから、今後は各自の現場で実践を繰り返し、問題点の抽出を継続的に進めて行くことが重要である。

(2) 橋梁分野

1) 概要

橋梁分野の OJT の概要は、表 4.28 に示すとおりである。また、詳細実施内容は、ANNEX-8 (2) に添付する。

表 4.28 橋梁装分野の OJT 概要

月日	種別	内容
4 月 3 日（水）	座学	TSG2.1 の説明
4 月 4 日（木）	座学	TSG2.2 の説明
4 月 5 日（金）	座学	TSG2.3～TSG2.6 の説明
4 月 8 日（月）	点検現場実習	日常点検
4 月 9 日（火）	点検現場実習	定期点検
4 月 10 日（水）	点検現場実習	詳細点検
4 月 11 日（木）	点検現場実習	詳細点検
4 月 12 日（金）	維持補修現場実習	目地シーリング
4 月 15 日（月）	維持補修現場実習	ひび割れ注入
4 月 16 日（火）	維持補修現場実習	断面修復
4 月 17 日（水）	現場実習のまとめ	評価と判定、課題の整理、試行運用実施方法の説明

2) 研修実施における工夫点等

橋梁分野の OJT では、表 4.29 に示す工夫等を行った。

表 4.29　橋梁分野の OJT における工夫等

概要	No.	内容
説明資料の作成方法	1	- TSG の座学解説では、事例写真、図を多く活用したパワーポイント資料を作成して、分かりやすい説明を心がけた。
講義方法	2	- 現場実習（点検、維持補修）実施に当たっては、現場実習前に事例写真、ビデオ、図を用いた資料で分かりやすい説明を心がけた。 - 実習実施後に、必ず実習内容について実施状況写真を入れた資料を作成して、説明する時間を取り実習内容の理解を深めることに努めた。
	3	- 座学、現場実習共に、実習生を含めて議論する時間を多く取るように心がけた。 - 議論の事例は以下である。座学での損傷の説明の折には、実習生の経験を紹介してもらい、議論した。点検実習では、点検で確認された損傷の評価、補修方法などの議論を行った。
講義方法、 実践研修方法	4	- 実習生は、積極的に質問、議論を行い全員協力的であった。 - 座学では、実習生の経験している事例の紹介により、異なる地域と環境で業務を行っている実習生皆で議論ができた。 - 現場実習では、率先して資機材を分担して運び効率の良い作業ができた。片づけも同様で大変に良い実習ができた。
実践研修方法	5	- 維持補修の実施は、実習場所事務所のコンクリート壁などを活用して行い、安全を確保して、必要な補修作業が計画時間内でできるように計画して実施した。
	6	- 現場実習は、実習生が実際に作業する機会を多くするように努めた。
	7	- 実習生、ベトナムのアシスタント技術者 1 名、ベトナムの通訳（英越）1 名のメンバーにより、良いチームワークで研修を実施するように心がけた。 - 実習生の意欲的活動でチームとして良い研修ができた。
研修中の安全対策	8	- 現場実習では、安全な作業に心がけた。 - 作業前の説明で安全作業の注意喚起をするとともに、作業開始前に安全装備の確認を行った。現場実習作業では、適切に休憩時間を取り、その時間を活用してコミュニケーションを行うように努めた。

3）　研修結果に基づく TSG 最終化への反映

OJT 期間中には、TSG 最終化へ反映する事項は無かった。OJT 期間中に、研修生と議論する時間を取ると共に、常に研修内容の反復を心がけたことにより、研修生の TSG の理解が深まったと考える。

(3)　電気施設分野

1）　概要

舗装分野の OJT の概要は、表 4.30 に示すとおりである。また、詳細実施内容は、ANNEX-8 (3) に添付する。

表 4.30 電気施設分野の OJT 概要

月日	種別	内容
4 月 3 日（水）	座学	TSG 説明
4 月 4 日（木）	座学	TSG 説明
4 月 5 日（金）	座学	TSG 説明
4 月 8 日（月）		現場研修準備
4 月 9 日（火）	実習	受配電設備
4 月 10 日（水）	実習	自家発電設備
4 月 11 日（木）	実習	交通規制、道路照明設備
4 月 12 日（金）	実習	道路照明設備
4 月 15 日（月）	座学	点検データ活用方法
4 月 16 日（火）	座学	点検データ活用方法
4 月 17 日（水）	座学	点検データ活用方法

2) 研修実施における工夫点等

電気施設分野の OJT では、表 4.31 に示す工夫等を行った。

表 4.31 電気施設分野の OJT における工夫等

概要	No.	内容
実践研修方法	1	- 測定器を使用した点検により不具合点を見つける実習を行った。 - 日本人の専門家による測定器の取扱説明を実施し、ベトナム研修生のみで測定器を適正に使用できるまで実習をさせた。
	2	- 現地に則した点検チェックリスト及び点検データ記録表を事前に作成し、座学で保全データの管理の重要性を説き、今後の活用方法を説明した。 - その記録表の記載方法について、ベトナム研修生の小班を 3 班編成し、ベトナム人が独自に記録できるまで現地にある測定器で繰り返し説明した。
実践研修方法 研修中の安全対策	3	- 最初は不慣れだったが、要領を得ると効率的な点検を行えるようになった。 - また、安全についても意識がついてきて、日本人が指摘しなくても、安全を考慮して点検するようになった。
研修中の安全対策	4	- 「安全」に対する心構えが足りなかったことから、ヘルメット・安全チョッキにて現場にでることを徹底した。
	5	- 受配電設備については感電の恐れがあることから、検電器や耐電手袋、耐電長靴などを準備して、点検を行ってもらった。
	6	- 交通規制に関して、矢印板やラバーコーンを設置する際は通行車両を確認し、安全を考慮しながら作業を行い、本線上は危険なので、ガードレールの外側に居るように徹底した。

3) 研修結果に基づく TSG 最終化への反映

OJT 期間中には、TSG 最終化へ反映する事項は無かった。しかし、講義時間が 3 日間と限られており、また、研修生にとって全て新しい内容であることから、どの程度理解されたかは不明である。そこで、TSG の作成時から現場の人たちの意見を聞く機会があり、一緒に作成していく機会があればより実践的な TSG になったと思われる。

(4) 交通管理分野

1） 概要

交通管理分野の OJT の概要を表 4.32 に示す。また、詳細実施内容を ANNEX-8 (4) に添付する。

表 4.32 交通管理分野の OJT 概要

月日	種別	内容
4 月 3 日（水）	座学	TSG 説明
4 月 4 日（木）	座学	TSG 説明
4 月 5 日（金）	座学	TSG 説明
4 月 8 日（月）	実習＜Group A＞	基本動作
4 月 9 日（火）	実習＜Group A＞	規制の方法
4 月 10 日（水）	実習＜Group A＞	規制の方法
4 月 11 日（木）	実習＜Group A＞	高速道路上での実習
4 月 12 日（金）	実習＜Group B＞	基本動作
4 月 15 日（月）	実習＜Group B＞	規制の方法
4 月 16 日（火）	実習＜Group B＞	規制の方法
4 月 17 日（水）	実習＜Group B＞	高速道路上での実習

2） 研修実施における工夫点等

交通管理分野の OJT では、表 4.33 に示す工夫等を行った。

表 4.33 交通管理分野の OJT における工夫等

概要	No.	内容
実践研修方法（安全意識）	1	- 現在のベトナムの高速道路は交通量が少ないことから、全体的に、意識が一般道感覚となっている。 - 「高速道路は危険。安全に配慮しながら行動することが重要。」ということを常に意識するよう徹底した。
実践研修方法	2	- 交通管理が容易に理解できるよう座学用教材の動画を日本で作成し、NEXCO 交通管理隊員による実践状況を確認しながら、TSG を説明した。
	3	- 研修生が各職場に戻った後、TSG を説明・実践するには十分な理解が必要。 - 実習においては、研修生を二つのグループに分けた少人数制を採用し、きめ細やかな指導を行った。
	4	- 実習においては、東名高速道路横浜基地に所属する現役の交通管理隊員を講師陣に追加し、日本で最も重交通量区間で活躍する隊員の動きを生で見れるようにした。
	5	- 高速道路本線上の研修は危険を伴うことから、VEC O&M 駐車場において実習を行った。 - その際、高速道路をｲﾒｰｼﾞできるよう、テープによる模擬車線を作成した。
	6	- 各グループ最終日に行った高速道路上での研修では、VEC O&M 駐車場において行った内容についての復習を行った。 - また、退避訓練を全員で行い、高速道路上での受傷事故を防ぐためのスキルを身につけさせた。
	7	- 最初は不慣れだったが、繰り返し基本動作を行うことにより、徐々に動きが良くなっていた。 - また、各職場に戻ってから TSG をしっかりと説明できるように講師陣のデモンストレーションの動画を撮影する等、真剣に受講していた。

概要	No.	内容
	8	- 研修生では無い VEC O&M の交通管理隊員が受講を希望。 - TSG の理解を広げるため、B グループへの参加を認め、同じカリキュラムにて研修を行った。最終日に高速道路本線上の研修では、TSG どおりの規制設置・撤去を、率先して自ら行っていた。

3） 研修結果に基づく TSG 最終化への反映

OJT 期間中には、TSG 最終化へ反映する事項は無かった。しかし、研修生自体は現場従事者が少なかったことから、TSG を適確に理解させるには、現場従事者への研修が必要であると考える。（特別に途中から VEC O&M 交通管理隊員も現場研修に参加した。）

4.6.3 OJT 結果の総合評価

(1) OJT における研修生の理解度等

研修生の選定にあたっては、OJT 全期間（3 週間）参加できることを条件としたことから、研修生の出席率は高く（全分野平均 76%)、大半の研修生が研修全体を受講したこと、さらに OJT のカリキュラムでは最初に座学を設け TSG (Draft) の内容を説明した上で現場研修に移行したことで、研修内容の理解度は高まったと考えられる。

また、舗装、橋梁分野の研修では、研修生の多くが現在一般道路のそれら業務に従事していたことから、一定レベルの維持管理に関する経験・知識を有し、研修時には活発な質問、意見が出されたことから、TSG (Draft) については十分に理解されたと判断できる。一方で、電気施設、交通管理分野については、ベトナムでは新しい分野であり、研修生自身それら業務の経験がほとんど無かったことから、TSG (Draft) の理解度を高めるためには、今後も継続的な研修が必要である。

(2) 研修生へのアンケート調査結果

OJT における研修内容の理解度等を確認するために、OJT 終了後に全研修生に次の項目のアンケート調査を実施した。回答の中から具体的な内容を表 4.34 及び表 4.35 に示す。また、全回答を ANNEX-9 に添付する。

- 問１：OJT の結果を今後の業務においてどのように活用したいか？
- 問２：OJT についての感想等

これによると、多くの研修生は OJT の内容は非常に有意義であり今後の O&M 業務において活用したいと答えている。一方で、TSG の幾つかはベトナムの高速道路に合わないとの回答もあり、今後ベトナム側で制度化するにあたり内容の見直し等の検討も必要と思われる。

表 4.34　アンケート調査結果（問１）

分野	No.	分類	回答
舗装	1	TSG の業務への適用	- 安全かつ円滑な交通を確保するために、ハノイ・ハイフォン高速道路の補修に適用する。
橋梁	2	基準作成	- ベトナムの高速道路の管理・補修のマニュアルを作成するため、参考にする。
	3	TSG の業務への適用	- ベトナムでの高速道路の管理・補修に実際に適用する。 - Thanh Hoa から Thua Thien Hue までの古い橋梁の調査・補修のため、 OJT から習得したことを活用する。 - このコースから勉強したことを参考にして、橋梁、ボックスカルバートの点検計画を立てる。 - 会社が管理している区域における損傷を発見したとき、補修方法を特定、その損傷に応じた補修機材を判断できる。
	4	TSG の組織での活用	- 大学での教育のため：勉強したことを道路建設学部の「橋梁の運営管理及び点検・評価」科目のカリキュラムに追加し、大学での実行の教育内容に入れる。 - 高速道路の維持管理会社との業務の中にも活用する。
施設	5	維持管理計画作成	- ベトナムにおける電気技術インフラを定期的に管理・保守・修理するプロセスを構築する。 - 修理・保守計画を立てる。
	6	TSG の業務への適用	- 適用している既存のプロセスにおいて、不適切な点を訂正する。 - 電気システムを点検・監視するマニュアルとする。 - 道路電気施設の定期点検及び補修する四半期、年次計画を立てる。 - ベトナム道路・高速道路の照明システム管理 に適用する。 - 電気技術インフラを検査・保守する能力を向上する。 - ベトナムの高速道路が日本の高速道路まで成長できるように、このコースから勉強したことをベトナムでの高速道路の管理・補修に活用する。
交通	7	TSG の組織での活用	- 自分がよく訓練し、直接実施部門に教育する。 - 常に自分の機関のメンバーに教育し訓練させる。 - OJT から習得した結果を UTT における道路開拓・管理科目の教育に適用する。もし、将来的に自校に高速道路管理に関する教育を行えば、他の教師に伝達する。
	8	TSG の業務への適用	- 将来に OJT での勉強されたことを毎日の VEC O&M の巡回チームに対し活用する。 - 下記のことを私の仕事に活用する。 ▫ 情報受け取り・取り扱いにおける各機関との間の連携 ▫ それぞれの動作、行動 ▫ 交通管理者との間の連携 ▫ 交通巡回及び交通管理

表 4.35　アンケート調査結果（問２）

分野	No.	分類	回答
舗装	1	TSG の適合性	- 実際的で有効的なコースでしたが、いくつかの点はベトナムでの高速道路に合わないと思う - いくつの機関は適用できないと思う。
	2	習得内容	- 下記のことを勉強になりました ▫ 作業中の安全性 ▫ 道路点検の知識 – 特に仕事の計画立て技術、高速道路の補修に関する技術を取得した。
橋梁	3	TSG の適合性	- TSG は、知識量が多いし、実際的に作成されたものである。但し、いくつかの項目はベトナムに合うために検討する必要がある。 - 日本専門家は真面目に働いていたし、多くの専門知識を持っている方だと感じた。授業の雰囲気は楽しかった。 - 現場でのコースがもっとあれば良いと思う。
	4	習得内容	- 高速道路の管理・補修に関しては新しいことをたくさん勉強になった。
	5	TSG の内容への要望	- 点検すべき項目と点検手順が分かるようになって、定期点検すべき位置と損傷程度を確定することができる。そのことで補修対策をとることできる。 - OJT は座学も現場研修もあったので、自分の仕事のためにいろいろ良いことを勉強できた。 - TSG が出した様式は一般的な様式だが、構造物別様式（伸縮装置、橋台、橋脚、梁構造）があれば使いやすく、まとめやすくなると思う。
施設	6	習得内容	- OJT の内容は実際的な知識があり、人間の安全はいつも第一位にしたコースでした。 - 人間の安全確保と仕事の効果向上のハイテック機材に接近することができた。 - 高速道路の管理・補修に関する知識をたくさん習得できた。その他、日本専門家から仕事中の態度とマナーを勉強になった。 - 日本の高速道路の運用・メンテナンスは詳細で、統一作成されていたものだ。 - この OJT コースはベトナムにとって非常に必要だと思う。 - いろいろ良いことを勉強になった。私は日本専門家の働き方について良い印象を持っている。 - 日本での高速道路の管理・補修の技術を接近し、習得することができた。それらをベトナムの高速道路に活用すると思う。
交通	7	TSG の適合性	- 専門家が高い専門性を持っている方であり、懇切に説明してくれた。 - ベトナムには各部分の役割がはっきりされないので、適用することが難しい。 - 講師と講師補佐は懇切丁寧に指導してくれた。 - 各機材は使いやすいし、仕事に役立つものだ。しかし、台風など厳しい天候に使用するのが難しい。
	8	習得内容	- このコースの知識は私にとって新しく役に立つ知識であり、日本人の専門家は懇切丁寧に教えてくれた。

4.7 試行運用の実施（活動 4-2）

4.7.1 概要

(1) スケジュール

試行運用のスケジュール及びその活動内容は、表 4.36 に示すとおりである。

表 4.36 試行運用の概要

段階	時期	期間	活動	備考
フェーズ 1	2013 年 4 月 22 日～24 日	5 週間	- OJT の結果に基づき、各研修生は実際の高速道路 O&M 業務において TSG を使用する。 - 各研修生は、実際の業務状況から、彼ら自身で TSG の内容をチェックする。	
フェーズ 2	2013 年 5 月 27 日～6 月 7 日	2 週間	- 日本人専門家と研修生は、試行運用結果から TSG の内容を見直す。 - 日本人専門家は、現在高速道路の O&M を実施している VEC O&M および Cuu Long CIPM を訪問する。 - 日本人専門家は、TSG をいかに使われるかを調査する。 - 日本人専門家は、TSG の最終化を行う。	

(2) 試行運用結果

VEC O&M 及び Cuu Long CIPM からの研修生は、試行運用中に実際の業務において TSG (Draft) の活用を行い、表 4.37 に示す結果を残した。これら結果は、TSG の最終化に反映させた。

表 4.37 試行運用結果の概要

フェーズ	試行運用結果の概要
フェーズ 1	- 研修に参加した研修生は、自分の職場に戻り、実際の高速道路の O&M 業務において TSG (Draft) の実践的な活用を行った。 - 実践的から得られた結果は、プロジェクトのデータとして収集し保存した。
フェーズ 2	- 保存したデータは、TSG (Draft) に記載されているデータシートに記入し、日本人専門家に提出した。 - 日本人専門家は、研修生とそのデータについて確認し、TSG の修正が必要な事項については TSG の最終化に反映させた。

4.7.2 各分野の試行運用結果及び総合評価

(1) 舗装分野

試行運用期間中に、VEC O&M 及び Cuu Long CIPM において実施された試行運用結果は、ANNEX-10 (1) に添付する通りである。

これによると、TSG (Draft) に基づく日常点検、定期点検が実施され、その結果も定められた様式に記録として残されている。一方で、特殊な測定機器を用いた定期点検については、測定機器を所有していない理由から実施されていない。また、補修作業については、点検により発見されたポットホールの補修は実施されたが、ひび割れについては同様に補修機械を所有していない理由から実施されていない。以上から、舗装分野の試行運用は、特殊な機械・器具が必要な作業を除いては一通り実施され、その記録も残されていることから、現状で可能な試行運用は十分に実施されたと言える。

この試行運用結果を受け、TSG の最終化に向けたヒアリング調査を行ったが、これらの内 TSG 最終化に係る事項は、表 4.38 に示す通りである。結果として、修正が必要な TSG の不具合は無かった。しかし高速道路の運用期間が短いことから、今後継続的に問題点の抽出に取り組むことが必要である。

表 4.38　　舗装分野の試行運用結果

分類	No.	試行運用後の意見、提案	回答
補修と予算関係	P1	- ポットホールの補修は発生原因により予算を出す部署が異なるので、原因別に整理して欲しい。	- ポットホールは色々な要因が複合的に作用して発生するため、その原因を分類･特定することは困難である。
補修サイクル	P2	- ベトナムでは、ポットホールは発生数と発生密度により補修の対応が異なるので、ベストな補修サイクルを教えて欲しい。	- ベストな補修サイクルは、使える予算や管理レベルにより異なるため、一律に決めることはできない。また管理レベルは、国や地域ごとに決めるものであり、本プロジェクトが提案することはできない。

その他の意見として以下が挙げられたが、ベトナム側にて TSG を早期に制度化するとともに、必要な予算の確保、資機材の調達、TSG の継続運用による現地事情にあった改訂を加えていくこと等が望まれる。

- TSG が制度化されていないため、調査や補修工事が実施できなかった。
- 予算がないため、補修工事が実施できなかった。
- 必要な機器がないため、詳細調査や補修作業ができなかった。
- 運用中の高速道路が開通後あまり時間がたっておらず、TSG を実践できず、TSG の問題点を特定できなかった。

(2)　　橋梁分野

試行運用期間中に、VEC O&M 及び Cuu Long CIPM において実施された試行運用結果は、ANNEX-10 (2) に添付する通りである。

これによると、TSG (Draft) に基づく日常点検、定期点検が実施され、その結果も定められた様式に記録として残されている。その結果によると、コンクリート床版の鉄筋の露出、伸縮装置のボルトの欠損、土砂詰まり等の損傷・不具合が発見されている。また、これら損傷については TSG

(Draft) に基づく損傷の評価も実施され、応急的な補修作業も実施されている。このように、 TSG (Draft) に示される維持管理サイクル作業が実施されたことから、試行運用は適切に実施されたと判断できる。

この試行運用結果を受け、TSG の最終化に向けたヒアリング調査を行ったが、これらの内 TSG 最終化に係る事項は、表 4.39 に示す通りである。これらコメントを受け、TSG の定期点検記録様式を、JICA プロジェクト「Transport Sector Loan for National Road Network Develop」で作成され、現在一般道路の橋梁調査に用いられている書式を参考にして見直し、あわせて関連する TSG 本文も修正した。

表 4.39 橋梁分野の試行運用結果

分類	No.	試行運用後の意見、提案	回答
点検様式	B1	- TSG の定期点検の様式に、現在ベトナムで使用されている一般道路の書式を反映する。	- VEMO から提示された、一般道路の定期点検の書式を TSG に反映する。
	B2	- 【様式 2-4 の記号】損傷の凡例の記号を分かりやすくしてほしい。	- 日本語の略記号であり、ベトナムの基準を参考にした略記号にかえる。
	B3	- 【様式 2-4 の追加】橋台の様式を追加してほしい。	- 橋脚の様式があり、図面を変えることにより適用できる。よって、橋台の様式は追加しない。
点検判定	B4	- 損傷の判定区分と事例をまとめたテキストがほしい。	- 今後点検を実施していく中で作成する課題と判断する。本プロジェクトでは対応しない。
記述内容	B5	- 【様式 2-2 の記載表現】過度な振動は異常な振動の表現がベトナム語の記述として望ましい。	- 変更する。
印刷方法	B6	- TSG の印刷物は携帯できるサイズが望ましい。	- 基本的に印刷製本についてはベトナム側の判断に任せる。（プロジェクトの成果品は A5 版で 50 部作成することを TG 会議で確認した。）

今後は、ベトナム側で TSG を早期に制度化するとともに、継続して運用し、現地の実情にあった改訂を加えていくことが望まれる。

(3) 電気施設分野

試行運用期間中に、VEC O&M 及び Cuu Long CIPM において実施された試行運用結果は、ANNEX-10 (3) に添付する通りである。

これによると、TSG (Draft) に基づき、受配電設備、自家発電設備について、目視点検及び所有している点検器具を用いての日常点検、定期点検が実施され、その結果も定められた様式に記録として残されている。それによると、各設備各検査部位についての点検では、「設備機能 : 良・不良」、「亀裂・損傷 : 有・無」等の結果が残されており、不良箇所については応急的な対応が実施されている。このように、 TSG (Draft) に示される点検、維持管理作業が実施されたことから、試行運用は適切に実施されたと判断できる。

この試行運用結果を受け、TSG の最終化に向けたヒアリング調査を行ったが、これらの内 TSG 最終化に係る事項は、表 4.40 に示す通りである。結果として、修正が必要な TSG の不具合は無かった。

表 4.40 電気施設分野の試行運用結果

分類	No.	試行運用後の意見、提案	回答
点検機器	F1	- 測定器（接地抵抗測定器，絶縁抵抗測定器）がないため全ての点検が実施できない。	- 機能劣化等を事前に把握し予防保全をするには、測定器による点検は必要であると認識しており、TSG が制度化された際には上位機関へ要求して欲しい。
	F2	- 受電引き込み柱の点検するスペース（足場）がないため詳細な部位の点検が実施できない。現状は引き込み柱には足場がないため、引き込み柱上周辺の汚損・損傷確認のみ地上からの目視による。	- 機能劣化等を事前に把握し予防保全をするには、引込柱上のトランスや付属金物、低圧配電盤等の点検は必要であると認識しており、TSG が制度化された際には足場を設置するように上位機関へ要求し、TSG の制度化を早期に進めて欲しい。
その他	F3	- 点検記録写真にホワイトボードを入れ、TSG 点検項目と適・不適の状況を記録している。	- 継続して進めて欲しい。

その他の意見として以下が挙げられたが、今後、ベトナム側にて TSG を早期に制度化するとともに、必要な予算の確保、資機材の調達、独自の OJT 継続、TSG の継続運用により必要な改訂を加えていくこと等が望まれる。

- 点検項目が今までより多くなり、今まで見逃してきた不具合箇所が新たに見つかった。
- 点検しても、予算がないため補修ができない。
- スキルを有する人員が少ないため、点検に時間を要した。
- 研修生が自分の職場に戻り、自らが講師となり周辺の同僚に TSG 及び OJT 実施手法を教え、ベトナム単独の OJT を実施した。教える時間も現業の合間に実施し OJT の体制を作った。

(4) 交通管理分野

試行運用期間中に、VEC O&M 及び Cuu Long CIPM において実施された試行運用結果は、ANNEX-10 (4) に添付する通りである。

これによると、TSG (Draft) に基づく交通管理パトロールが実施され、その巡回記録が定められた様式に記録として残されている。その記録には、巡回中に遭遇した、i) 故障車への救援、ii) タイヤがパンクした車両への救援、iii) 落下物の排除等の事象について適切に処理された記録が残されている。さらに、異常事象時の対応記録として、交通事故の発生状況及びその対処結果についても適切な記録が残されている。このように、 TSG (Draft) に示される交通パトロール、交通管理業務、異常事象時の対応が適切に行われ記録として残されていることから、試行運用は適切に実施されたと判断できる。

この試行運用結果を受け、TSG の最終化に向けたヒアリング調査を行ったが、これらの内 TSG 最終化に係る事項は、表 4.41 に示す通りである。結果として、異常事象対応記録簿に協力機関の状況を付加した。その他、修正が必要な TSG の不具合は無かった。

表 4.41 交通管理分野の試行運用結果

分類	No.	試行運用後の意見、提案	回答
パトロール体制	T1	- TSG では二人以上で巡回することになっているが、Cau Gie – Ninh Binh 高速道路は交通量が少ないので、一人でも可能な状況にある。	- 現在の交通量ではそのように感じるかもしれないが、安全に路上作業を行うには、二人以上での巡回が必要である。
規制機材	T2	- 既存の規制機材が重すぎて、TSG どおりの数の規制機材が設置できない。	- 交通量が増えてきたら、TSG どおりに規制を設置した方が安全である。TSG が制度化された際には、規制機材の更新費用について、上位機関へ要求して欲しい。
旗の使用	T3	- 「旗が無い」、「急に旗に変えるとドライバーが理解できない」という理由から、旗を使用せず、指揮棒を使用した。	- TSG では「指揮棒」の使用を否定していない。「旗」の方が視認性に優れ安全であるので、交通量の増に伴い徐々に「旗」に移行して欲しい。
記録様式	T4	- TSG 様式の『異常事象対応記録簿』に「協力機関の状況」を加えて試行運用を行った。	- TSG 様式の『異常事象対応記録簿』に「協力機関の状況」を付け加える。

その他の意見として以下が挙げられたが、今後、ベトナム側にて TSG を早期に制度化すること、管制センターの設立について必要な協議を行うこと、TSG の継続運用により必要な改訂を加えていくこと等が望まれる。

- 現段階では TSG が MOT の正式認可を受けていないことから、TSG の巡回記録は、試行運用時に使用できなかった。
- HCMC – Trung Luong には管制センターが無い（レッカー管理部が管制の役割をしている）。

4.8 TSG (Draft) の最終化及び TSG の制度化の支援（活動 5）

4.8.1 TSG (Draft) の最終化

(1) TSG (Draft) へのコメント等

作成された TSG (Draft) は OJT の座学の教材として使われた。さらに、OJT に参加した研修生は、自分の職場に戻り実際の高速道路の O&M 業務において TSG (Draft) の試行運用を行った。OJT 及び試行運用に参加した研修生からの意見は 4.7.2 章に記述のとおりである。さらに、現在高速道路の O&M を実施している Cuu Long CIPM (Company 715) 及び VEC (VEC O&M) からは、別途 TSG (Draft) についてのコメントが提出された。（ANNEX-11 (1) 参照）

(2) 最終化の方法

TSG の最終化は、先に提出された MOT 及び DRVN からのコメント（ANNEX-11 (2) 参照）と OJT

及び試行運用において出されたコメントについて、日本人専門家が対応方法を検討し、2013 年 4 月 18 日及び 2013 年 6 月 5 日に開催した TG 会議において、ベトナム側と協議を行い、日本人専門家が提出した対応方法について合意を得て行った。そこで、これら対応方法により TSG を修正し、修正後の TSG はさらに VEMO による内容のチェックを踏まえて最終版の印刷を行った。

4.8.2 TSG の制度化支援

(1) 概要

TSG は、今後ベトナムにおける統一した O&M 基準として使われる。しかし、図 4.2「高速道路 O&M 基準の構成」に示すとおり、高速道路 O&M 基準はプロジェクトで作成した 4 分野の他に O&M 業務全体をカバーしなければならない。そこで、プロジェクトでは関係者が集まる会議等で高速道路 O&M 基準の全体像を示すことを適宜行った。

また、プロジェクトで作成した 4 分野の TSG については、現在の高速道路の O&M 業務においてすぐに適用できることから、早期に制度化を行い実際の現場で使えるようにすべきである。そして、制度化した TSG を実践的に使用し、作業現場での適合性を確認することが重要である。その後は、実際の現場での意見を取り入れながらベトナム側で改訂作業を進め、よりベトナムの状況にあった TSG を完成されることが期待される。

(2) 制度化の方法及びスケジュール

作成した 4 分野の TSG は、2013 年 5 月 7 日に開催した JCM において、MOT のチュオン副大臣から早期に制度化を行うよう MOT 及び DRVN 担当者に指示があった。これを受けて DRVN は、2013 年内を目標に制度化を行うとしている。制度化に向けての進め方は、表 4.42 に示すとおりである。

表 4.42 TSG の制度化方法

段階	時期	内容
ステップ 1	2013 年 6 月	- プロジェクトによる 4 分野の TSG を作成
ステップ 2	2013 年 12 月	- DRVN に立ち上げた WG により高速道路 O&M 全体の TSG を作成している。 - WG のメンバーは、DRVN 及び UTC により構成される。 - TSG は、Maintenance Works 及び Traffic Management and Traffic Control Works の 2 分野となる。 - Maintenance Works にはプロジェクトで作成した舗装、橋梁、電気施設が含まれ、その他の分野は、他国の事例、暫定基準等を参考に作成する。（他分野は、トンネル、鋼橋、斜面対策等） - Traffic Management は、プロジェクトで作成した交通管理を基本として作成する。
ステップ 3	2014 年中頃	- 作成した高速道路 O&M 全体の TSG について関係機関の意見照会を行い、DRVN の基準として発効する。
ステップ 4	2016 年中頃	- DRVN の基準を VEC および Cuu Long CIPM 等の高速道路 O&M で適用し、問題点の抽出を行い、この基準の最終化を行う。
ステップ 5	2015 年以降	- 最終化された DRVN の基準を国内統一基準となるよう MOT に上申する。その後、MOT が国内統一基準として発効する。

注： 上記内容は 2013 年 6 月 18 日に DRVN 科学技術部でのヒアリング結果による

また、ITS については、上記高速道路 O&M 基準とは別に検討が進めら、現在 MOT に WG が作られ次の 5 つの分野についての基準・マニュアルの作成を進められている。

- 可変型情報版（Variable Message Signs: VMS）
- 自動料金収受システム（Electrical Toll Collection System: ETC）
- 交通管制センター（Traffic Management Center）
- 通信システム（Communication System）
- 車重計（Weigh Station）

これら基準・マニュアル作成は、WG メンバーの他にベトナム国内の IT 企業が参加し支援を行っている。これら、基準・マニュアル作成では、ITS 機器の設計基準だけではなく、運用面の基準・マニュアルの作成も目指している。これまで、JICA が行った ITS 調査（SAPI）の報告書は、これら作成の基本となっている。

4.9 ワークショップの開催（活動 6）

今後、高速道路の O&M システムを確立するためには、まだ多くの分野の基準・マニュアルの作成が必要である。さらに、高速道路の O&M 業務の従事者への人材育成が必要不可欠である。そこで、プロジェクトが次のステップに移るために必要となる情報を提供し、ベトナム側が独自に高速道路の O&M システムの確立に向けて進めることができるようワークショップを開催した。

ワークショップのテーマは､｢ベトナムにおける高速道路の O&M システムの確立に向けて｣とし、日本側、ベトナム側双方から次のテーマでプレゼンテーションを行った。なお、日本側のテーマは、JCM において MOT のチュオン副大臣が今後日本に支援をお願いしたいと述べた事項から選定した。

- ベトナム側 : i) 高速道路の O&M の現況と計画
- 日本側 : i) 高速道路整備及び O&M のための財源、ii) 高速道路 O&M のためのデータベースシステム整備、iii) 高速道路 O&M における ITS の活用

ワークショップの概要を ANNEX-12 に添付する。

4.10 本邦研修（活動 7）

高速道路の実践的な O&M 体制を理解し、TSG (Draft) の作成を効率的に行うために、本邦研修が実施された。本邦研修は、2012 年 11 月に 10 日間実施され、TG メンバーから 10 名が選抜され参加した。また、プロジェクトの NEXCO 中日本所属の日本人専門家は研修の講師として、本邦研修に参加した。

5 プロジェクト実施上の課題、創意工夫、教訓（プロジェクトの運営、実施方法）

5.1 課題

プロジェクトを通じて生じた課題は、表 5.1 に示すとおりである。

表 5.1 課題

No.	項目	内容
1	プロジェクトのカウンターパートについて	- 業務実施上のカウンターパートは、技術面は VEMO、行政面は PMUTA と二つに分かれ、プロジェクトの実施において窓口が 2 つあり、どちらがプロジェクトの各業務の担当となるのか不明なところがある。そこで、プロジェクトの実施においては窓口を一本化して、その窓口機関がプロジェクトを調整することが好ましい。
2	TSG の作成方法について	- DRVN が運営管理する道路には高速道路は存在せず、プロジェクトで作成した TSG の技術面において、実務を理解している技術者がいない。そこで、プロジェクトの実施においては、これら実務を熟知している機関、技術者の参加が必要であった。
3	TSG の制度化について	- 現在、高速道路の運営管理を行っている VEC 及び Cuu Long CIPM は MOT の傘下の組織で、DRVN の組織ではない。そこで、プロジェクト作成した TSG を高速道路の運営管理において使われるためには、MOT の基準として発効されることが必要である。

5.2 創意工夫

プロジェクトにおいて行った創意工夫は、表 5.2 に示すとおりである。

表 5.2 創意工夫

No.	項目	内容
1	TSG の作成方法と今後の改訂	- TSG の作成は、ベトナム国の高速道路暫定基準を基に、そこに不足する内容については、ベトナム国の一般道路の維持管理基準、その他の国の基準等を参考に記述した。 - しかし、ベトナム国では電気施設の基準、交通管理の基準については、これまで十分な記述がなく、これら分野については、日本の高速道路の基準・マニュアルを多く準用した。 - そこで、今後作成した TSG を実際の O&M 業務で活用し、不具合等がある場合には、ベトナムの実態に合わせて改訂を行うことが必要となる。
2	TSG の作成方法	- 今後の改訂作業は、ベトナム国政府自身で行うこととなることから、今回の TSG の作成においては、設置した TG と常に連携し、TSG の作成の節目ごとに適切に打ち合わせを行った。 - それにより、TGs のメンバーが、TSG の作成過程を把握しできるようにし、将来の改訂作業の流れを理解できるようにした。
3	TSG の内容	- TSG の内容については、実際の高速道路の O&M 業務を行っている現場の作業員が適切に実施できるよう、より具体的に分かりやすく記述した。

また、OJT の実施計画において留意した事項は、表 5.3 に示すとおりである。

表 5.3 留意事項

No.	項目	内容
1	OJT の研修生の選定	- 作成された TSG (Draft) は、上記のとおり高速道路の O&M 業務に従事する実務者が活用できるものであることから、OJT のメンバー選定においては、現在 O&M 業務の従事者、将来の従事予定者とした。 - 特に､現在高速道路の O&M 業務を行っている VEC 及び Cuu Long CIPM の技術者の多くの参加を促した。
2	OJT 用機材の選定	- OJT 用の機材の調達においては、極力ベトナム国内で調達できるものを基本と考えた。 - それは、今後作成した TSG に基づき O&M 業務を行うが、各高速道路会社がそれら機材を容易に調達できなければならないからである。 - 最終的に OJT 用機材 87 品目中 16 品目のみ日本等から輸入することとなった。

5.3 教訓

プロジェクトを通じて得られた教訓は、表 5.4 に示すとおりである。

表 5.4 教訓

No.	項目	内容
1	経験知識の TSG の反映	- 現在、ベトナム国の高速道路は Cau Gie – Ninh Binh 及び HCMC – Trung Luong の 2 路線のみ供用中で、運営管理者も VEC 及び Cuu Long CIPM のみである。 - さらに、これら高速道路の運営管理期間も短く、それら業務経験も浅い。そこで、今回作成した TSG も、これら供用中の高速道路の経験知識は反映されていない。
2	経験知識の蓄積	- 今後は、これら運営管理会社では、運営管理についてのノウハウの蓄積は必要不可欠である。 - また、多くの熟練した技術者の育成も必要である。
3	人材育成の方法	- 技術者の育成については、現在 UTT (University of Transport Technology) をカウンターパートとして実施中の「JICA 高速道路建設事業従事者養成能力強化プロジェクト」と連携を十分に図るべきである。
4	高速道路 O&M システムの確立と人材育成の方法	- 今後の基準、マニュアル作成、改訂、さらに人材の育成については、官（MOT、DRVN）、民（高速道路会社）、学（UTC、UTT、ITST 等）が共同して実施していく体制作りが重要である。 - そのためには、現在の VEMO を発展させる VEA を早期に発足させ､さらに VEA は DRVN 傘下ではなく､MOT の下部組織として、全高速道路会社を所掌する位置付けとすることが重要である。

6 プロジェクト目標の達成度

6.1 現在のプロジェクト目標の達成度

プロジェクト目標は次のとおりである。

- 高速道路の効率的かつ安全な運営維持管理のための枠組み（制度・基準・人員等）が整備される。

上記目標が達成するためには、プロジェクトでは下記の成果を残す。

- 高速道路の運営・維持管理に関わる制度・基準が策定される。
- （パイロットプロジェクトとして）一部区間で目標の枠組みに即した運営維持管理が開始される。

プロジェクトでは、高速道路の O&M 業務を実施するために必要となる基準・マニュアルの全体像を示し、その中において重要で緊急性の高い 4 分野を選び TSG の作成を行った。さらに、作成した TSG を基に、OJT 及び試行運用を行い、高速道路の O&M 業務従事者の人材育成を行った。そこで、プロジェクトの目標とする事項は実行した。しかし、作成した TSG の範囲が限定されていること、OJT 及び試行運用への参加人数が限られていることから、これらを拡大していくことが必要となる。

6.2 今後プロジェクト目標を達成するために必要となる活動

プロジェクトでは、今後ベトナムにおいて高速道路の運営管理システムをどのように確立していくのかについて、道筋を作ることができたと考える。そこで、プロジェクトの成果を基に、今後ベトナム側で行うことが必要となる活動として、次のことが考えられる。

- プロジェクトで作成した 4 分野の TSG を制度化し、実際の高速道路の O&M 業務で使えるようにする。
- 実際の高速道路の O&M 業務で 4 分野の TSG を使い、ベトナム高速道路の実情に適合するよう TSG を改訂する。改訂にあたっては、高速道路の O&M 業務従事者の意見を反映させることが重要である。
- 4 分野の TGS も含めた全体の TSG を作成する。同様に制度化を行う。
- ベトナム国内の高速道路会社において、統一した全体の TSG が使われるようにする。
- 全体の TSG に基づき、高速道路 O&M 業務従事者の人材育成を行う。

以上を実施することで、今後供用が予定される幾つかの高速道路で、予想される多様な O&M 実施機関による O&M 業務が、社会の要求を満足する統一的なサービスレベルで実施できるようになる。

O&M 基準、マニュアルの整備は、O&M 業務の積み重ね、それら経験を基に作成し、さらにその後改訂を進めるべきである。

O&M 基準、マニュアル等の作成を担当する行政組織では、基準、マニュアル等を専属で担当する部署を設けることが必要である。その組織は、常に現場の実態を把握し、その実態に適合する基準、マニュアルになるよう改訂をすることが必要である。

7 上位目標の達成に向けての提案

現在ベトナムで供用中の高速道路には、それぞれの供用に合わせて制定された暫定基準がある。しかし、現在の暫定基準は、O&M 業務が広範囲にわたるにもかかわらず、概念的で全分野がカバーされていない。従って、現在の暫定基準では O&M 業務全般を行うのには不十分である。

そこで、プロジェクトでは、高速道路の O&M 業務の基本となる重要性の高い 4 つの分野のみ TSG を作成したが、6 章で述べたとおり、プロジェクト目標である「高速道路の運営管理での効率的で安全なフレームワークの確立」のためには、高速道路の O&M 業務全般にわたる基準・マニュアル等を整備することが必要である。そこで、プロジェクトで作成した 4 分野の TSG を参考にして、今後ベトナム人技術者の手により全分野の基準、マニュアルの整備を進められることを期待する。そこで、今後どのように基準・マニュアル等を整備していくべきかを以下に提案する。

7.1 基準・マニュアルの種別

7.1.1 一般的な基準・マニュアルの種別とヒエラルキー

日本における一般的な基準・規定・マニュアル等の種別とヒエラルキーを整理すると、表 7.1 のとおりとなる。

表 7.1 基準・マニュアル等の種別とヒエラルキー

ヒエラルキー		内容	制定機関	備考
法律	Act	国会の決議を経て制定される法規範。	国会	
命令	Cabinet Order, Ordinance of the Ministry, Rule	国会の決議を経ないで、行政官庁が制定する法規範。	各行政機関	
国家 基準・規格	National Standard	主務大臣が制定する。	各行政機関	JIS (Japanese Industrial Standards) 等
セクター基準	Sector Standards	各行政官庁が制定する。	各行政機関	
仕様書	Specifications	企業や規制団体や軍事組織によって私的に作成される。	各関係機関	
要領 マニュアル	Guidelines / Manuals	企業や規制団体や軍事組織によって私的に作成される。	各関係機関	

出典： 日本人専門家チーム

7.1.2 道路分野の基準等基準・マニュアルの種別とヒエラルキー

表 7.1 にならい日本の道路、高速道路に関する基準・規定・マニュアル等の種別とヒエラルキーを整理すると、表 7.2 のとおりとなる。

表 7.2　道路・高速道路の基準・規定・マニュアル等の種別とヒエラルキー

ヒエラルキー		具体的な基準等名	内容	制定する機関
法律	Act	道路法 等	道路の根幹を定める。	国会
省令	Ordinance of the Ministry	道路構造令 道路維持管理基準[注]	道路構造の基準値を定める。 道路の維持管理の基準値を定める。	国土交通省
施行細則	Rules for Operation	道路構造令の施工細則 等	上記基準の解説をする。	国土交通省
示方書	Sector Standards	道路橋示方書 コンクリート標準示方書 等	道路の建設にあたっての施工基準値を定める。	国土交通省
仕様書	Specifications	土木工事共通仕様書 等	各建設工事の施工条件を規定する。	高速道路会社
マニュアル等	Manuals / Guidelines	各種設計、施工要領、マニュアル 等	各建設工事の施工基準値、施工方法を示す。	高速道路会社
基準	Norm	土木工事積算基準 等	各建設工事の積算の方法を示す。	国土交通省／高速道路会社
附則 細目表	Supplementary Provisions, Schedule	土木工事積算単価表 等	上記積算のための各単価、歩掛を示す。	国土交通省／高速道路会社

出典：　日本人専門家チーム
注：　現在、道路維持管理基準は各道路管理者がそれぞれで決定し業務を行っているが、国土交通省は、道路の維持管理に関する基準を法令で位置付ける方針を決めた。
（http://www.kensetsunews.com/?p=12362、2013/05/13）

7.1.3　ベトナムの道路分野における基準・マニュアル等

現在までにベトナムで制定されている道路、高速道路に関する基準・規定・マニュアル等の種別とヒエラルキーを整理すると表 7.3 のとおりとなる。

表 7.3　ベトナムの道路分野における基準・マニュアル等

No	種別/分類	発効年月日	文書種別	機関	文書番号	件名
1	[C] [III]	16/8/1997	Circular	MOF	53/TC/TCT	Guiding the procedure for collection, payment and management of the fee for ensuring inland waterway traffic order and safety
2	[B] [IV]	20/12/2001	Decision	MOT	4393/2001/QĐ-BGTVT	Promulgating 22TCN237-01 Standard of rules and road signs Regulations of Road Signs: Traffic regulation of traffic lane management for maintenance works on opened traffic road etc..
3	[B] [IV]	28/5/2003	Decision	MOT	1527/2003/QD-BGTVT	promulgating 22TCVN306-03 on Technical Standards for Road Routine Maintenance Technical Standards for Road Routine Maintenance
4	[C] [II]	3/6/2002	Decree	GOV	57/2002/ND-CP	Detailing the implementation of the ordinance on charges and fees

No	種別/ 分類	発効年月日	文書種別	機関	文書番号	件名
5	[C] [III]	19/7/2004	Circular	MOF	76/2004/TT-BTC	Instruction for collection, remittance, management and usage of fee, charges in road transportation
6	[C] [III]	21/5/2007	Circular	MOF	53/2007/TT-BTC	Instructions for collection, payment and usage of fees levied on driving test
7	[I]	13/11/2008	Law		23 / 2008 / QH2	Road Traffic Law
8	[A] [III]	4/1/2010	Report	PMU My Thuan	15/PMUMY-TCB	Approval of the Plan for Temporary Management of HCMC- Trung Luong Expressway (Phase 1) (adjusted, supplemented to Report 5196/PMUMT-TCB dated December 25th 2009)
9	[A] [III]	20/1/2010	Decision	MOT	181/QD-BG TVT	Approving the Plan for Management Organization, temporary Operation of HCMC- Trung Luong Expressway
10	[A] [III]	21/1/2010	Decision	MOT	195/QD-BG TVT	Temporary Regulation on Management & Operation over Ho Chi Minh City – Trung Luong Expressway
11	[B] [IV]	19/4/2010	Circular	MOT	10/2010/TT-BGTVT	Road Maintenance Routine Standards
12	[C] [III]	28/7/2010	Ministerial Decision	DRVN	1270/QD'-TCDBVN	On the promulgation of “Regulations for authorization of power and responsibility of DRVN in the management of investment into repairs conducted in the National Highway system, with the usage of economic road fund and revenues collectible from ferry fee
3	[A] [III]	24/12/2010	Decision	MOT	3641/QD-BGTVT	Temporary Regulation on Organization, Management, Operation of Thang Long Boulevard
13	[A] [III]	17/2/2011	Decision	MOT	266/Qd-BG TVT	Temporary Regulation on the Maintenance of Ho Chi Minh City- Trung Luong Expressway
14	[C] [III]	28/4/2011	Resolution	HCMCPC	03/2011/NQ-HDND	Adjustment of road charges at toll gate of Binh Trieu 2 Bridge
15	[A] [III]	28/10/2011	Decision	MOT	2451/QD-BGTVT	Temporary Regulation on Management and Operation over Cau Gie – NH21 Section of Cau Gie – Ninh Binh Expressway
16	[A] [III]	28/10/2011	Decision	MOT	2452/QD-BGTVT	Management and Operation Plan over Cau Gie – NH21 Section of Cau Gie – Ninh Binh Expressway

出典： 日本人専門家チーム
種別： [A] 高速道路の O&M、[B] 一般道路の O&M、[C] 道路の建設、維持管理のための財源
分類： [I] Act、[II] Ordinance of the Ministry、[III] Rules for Operation、[IV] Sector Standards、[V] Specifications、[VI] Manuals / Guidelines、[VI] Norm、[VII] Supplementary Provisions, Schedule
出典： 「ベトナム・高速道路における運営維持管理事業案件形成調査報告書」経済産業省、平成 22 年（2010 年）3 月、P 3-17、Technical Standard on Road Maintenance Issued Pursuant to Decision No. 1527/2003/QD-BGTVT, May 28,2003 (Vietnam Transport Sector Study Task 5 Proposal for National Road Maintenance Program, JICA Feb. 2010 (P3-18)) から引用

7.2 高速道路 O&M 基準・マニュアル作成の基本的な考え方

7.2.1 日本とベトナムとの基準・マニュアルの比較

ベトナムでは表 7.3 のとおり道路・高速道路に関する基準・マニュアル等は数多く制定はされているが、まだ十分とは言えない。そこで、どのような基準・マニュアルが不足しているかを把握するために、日本とベトナムとの基準・マニュアルを表 7.4 のとおり比較した。

表 7.4 ベトナムと日本との基準・マニュアルの整備状況の比較

ヒエラルキー		具体的な基準等名		ベトナムの基準・マニュアルの現状
		日本の基準等	ベトナムの基準等（表7.3のMOT文書種別）	
法律	Act	道路法等	[I] Law	道路全体を規定する法律がない。
省令	Ordinance of the Ministry	道路構造令 道路維持管理基準	[II] Decree	体系だった道路に関する基準がない。
施行細則	Rules for Operations	道路構造令の施工細則 等	[III] Circular / Decision	〃
示方書	Sector Standards	道路橋示方書 コンクリート標準示方書		
仕様書	Specifications	土木工事共通仕様書 等	[IV] Circular / Decision	〃
マニュアル等	Manuals / Guidelines	要領、マニュアル 等		
基準	Norm	土木工事積算基準等	基準は設けられている。	データの更新がなされていない。高速道路のものがない。
附則 細目表	Supplementary Provisions, Schedule	土木工事積算単価表 等		

出典： 日本人専門家チーム

7.2.2 ベトナムの基準・マニュアルの整備において必要なこと

ベトナムの基準の特色は、日本のようにヒエラルキーが明確ではなく、一つの規定の中に基準、マニュアルが全て書かれていることが特色である。そこで、今後ベトナム高速道路の基準等を整備するためには、表 7.4 にある基準・マニュアルのヒエラルキーを整理し、各基準においてどのような内容について記述すべきかを決定することが重要である。そこで、今後高速道路の O&M 基準・マニュアルを整備するにあたり、どのように整備すべきかを表 7.5 のとおり提案する。また、表 7.5 に示す提案に沿った基準・マニュアル作成の基本方針、作成内容を以下に示す。

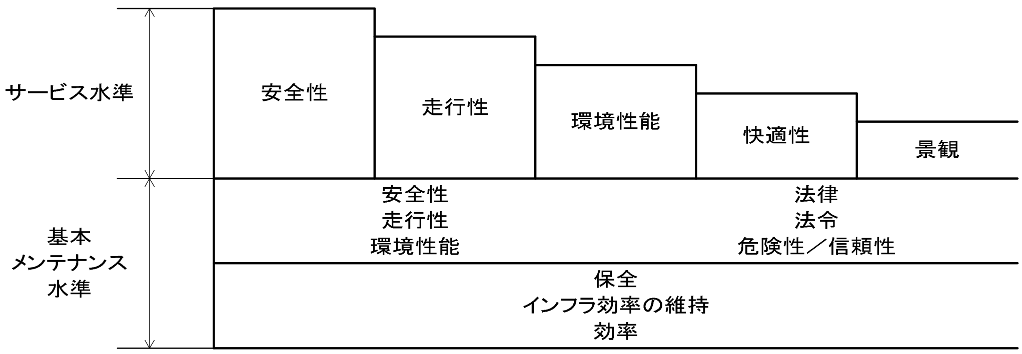
表 7.5　高速道路 O&M に関する基準・マニュアルの種別と内容

種別	基準・マニュアル名	内容	制定機関	備考
省令	高速道路O&M基準	ベトナム国の状況に適合する「サービス水準」を設定することで作成される。	各行政機関（MOT）	
要領マニュアル	高速道路O&Mマニュアル（技術指導書）	高速道路O&M業務の点検・作業の基準、規則・方法を示す。高速道路O&Mのすべての分野について作成することが必要となる。	各関係機関（各高速道路会社）	プロジェクトで作成したTSGに相当する。

7.2.3　基準・マニュアル作成にあたっての基本方針

(1)　高速道路が具備すべき性能と社会的要求

高速道路管理者の O&M 業務での目安になるものが「基本メンテナンス水準」と「サービス水準」である。「基本メンテナンス水準」とは、社会的要求として高速道路が果たすべき役割、すなわち基本的な性能水準である。一方、「サービス水準」とは、それぞれの道路管理者がそれぞれの道路にふさわしい性能を保持するための目標水準である。「基本メンテナンス水準」と「サービス水準」との関係を図 7.1 に示す。 ただし、「基本メンテナンス水準」と「サービス水準」との間に明確な境界はなく、一般的に「基本メンテナンス水準」と「サービス水準」を合わせて「サービス水準」として使用することも多い。



出典：　「高速道路の保全管理技術」中日本ハイウェイ・エンジニアリング東京、平成 20 年 12 月、P11 から引用

図 7.1　高速道路に課せられる社会的要求

(2)　基準とマニュアルの関係

一般的に、国が定める基準では、高速道路が上記の「Level of Basic Maintenance」を確保できるよう各分野において最低限の基準を設定し、それを各高速道路管理会社に遵守させる。一方、各分野の詳細な作業規則・マニュアル等については、上記の「Level of Service」を確保するよう、各高速道路の特色を考慮し、各高速道路会社が作成し、O&M 業務に使用する。また、これら各高速道路が作成する作業規則・マニュアル等については、国は各高速道路会社が高速道路で適切に O&M が実施できるかどうかを判断し、承認を与えることが必要である。

7.2.4 国が定める O&M 基準

(1) 高速道路の O&M 基準で規定すべき性能種別

「サービス水準」（「Level of Basic Maintenance」と「Level of Service」を合わせたもの）は、道路構造物及び舗装路面の状態により大きく左右される。すなわち、設定では、交通量、交通の質、交通事故の発生状況、道路構造物の点検頻度に関わる道路構造、路面状況等が大きく影響する。そこで、「サービス水準」としてどのような性能を規定するのかを、大きく 5 つの分類（安全性、走行性、環境性能、快適性、景観）に分けて具体的な設定事例も合わせて表 7.6 に示す。

表 7.6 規定すべき性能種別と「サービス水準」の設定事例

種別	内容	「サービス水準」の設定事例
安全性	指定された速度範囲で走行し、安全に目的地に到達できること	事故件数、事故率
		路面評価基準：わだち掘れ量（25mm）、スベリ摩擦係数（0.25）、縦断方向凸凹（8mプロファイル90(PrI)）、ひび割れ率（20%）、ポットホール寸法（径20cm）
走行性	旅行時間の損出を減らしたり、防いだりして道路利用者の利便性を確保すること	通常時の走行速度80km/hrを確保する
		交通量ピーク時でも60km/hrを可能とする
		いかに渋滞を発生させないようにするか（渋滞延べ時間）
環境性能	高速道路からの有害な影響を無くす、減らしたりすること	道路交通による騒音を制限する
		道路交通により発生する有害物質を減少させる
		振動、光、悪臭等（空気、土壌、水）の影響を減少させる
快適性	快適で走り易さの程度	道路利用者へのストレス、運転動作へのマイナスを緩和する
		IRIが指標
景観	道路利用者及び道路周辺住民の人たちに、高速道路の楽しさ・利便性の魅力を感じてもらうこと	道路利用者からの評価
		道路周辺住民からの評価

出典： 「高速道路の保全管理技術」中日本ハイウェイ・エンジニアリング東京、平成 20 年 12 月、P12～P13 から引用

(2) 高速道路 O&M 基準に要求される内容

基本的に、国が定める高速道路 O&M 基準は、表 7.6 に示す「サービス水準」の設定事例に沿って、ベトナム国の状況に適合する「サービス水準」の設定を示すことで作成される。各高速道路会社は、作成された O&M 基準に基づき、O&M 業務を実施し、定期的にその Performance の結果を報告する。国は、それら各高速道路会社からの報告を確認し、各高速道路が適切な水準で管理していることを確認することができる。

7.2.5 高速道路会社が定めるマニュアル

(1) ベトナム国の高速道路 O&M の暫定基準

現在、ベトナム国において定められている高速道路 O&M 暫定基準は、これまで述べた O&M 基準及びマニュアルの両方を兼ね備えたものとなっている。そこで、現在の暫定基準がどのような内容となっているのかを表 7.7 に示す。

表 7.7 O&M 暫定基準が網羅する内容

項目	細目	内容	業務分野
O&Mに関する技術的指示	1) 高速道路の運営	高速道路の点検、パトロール、交通量測定	交通管理
	2) 高速道路の清掃作業	中央分離帯・標識・防護柵の清掃、植栽の管理・草刈り、交通事故現場の清掃、路面障害物の除去	道路維持管理
盛土、橋梁の維持管理ガイドライン	1) 排水系統、盛土、舗装の点検及び評価	排水系統、盛土、舗装の点検及び評価 付属施設の点検及び評価（技術的評価基準）	道路維持管理
	2) 橋梁、カルバート、その他構造物の点検及び評価	橋梁、カルバート、その他構造物の品質評価の状況調査としての点検及び評価（技術的評価基準）	道路維持管理
	3) 排水系統、盛土に関する維持管理作業	排水系統、盛土に関する一般的な損傷、日常、緊急的な維持管理作業、定期維持管理作業	道路維持管理
	4) アスファルト舗装に関する維持管理作業	アスファルト舗装に関する一般的な損傷,、日常的な維持管理作業、定期維持管理作業	道路維持管理
	5) コンクリート舗装に関する維持管理作業	コンクリート舗装に関する一般的な損傷、日常的な維持管理作業、定期維持管理作業	道路維持管理
	6) 付属施設に関する維持管理作業	付属施設に関する一般的な損傷、日常、緊急的な維持管理作業	道路維持管理
	7) 構造部材の維持管理、補修	構造部材に関する一般的な損傷、日常的な維持管理作業、定期維持管理作業	道路維持管理
	8) その他の構造物に維持管理、補修に関する技術的ガイドライン	その他の構造物に関する一般的な損傷、日常的な維持管理作業、定期維持管理作業、道路照明に関する維持管理作業	道路維持管理
	9) 付属施設の交通事故による損傷の補修		交通管理
	10) 維持管理作業中の交通規制と工事中の安全対策	工事中の安全対策、工事中の交通規制方法	交通管理
	11) 路上での維持管理作業中の路上作業者と交通安全対策	路上での維持管理作業中の路上作業者の交通安全対策、交通安全の保証	交通管理
O&M に関する技術ノーム	1) O&Mに関するノームの整備		—
	2) 適用する規則		—
	3) 点検、運営に関するノーム	点検、運営に関する技術ノーム、作業の構成	—
	4) 道路、橋梁、その他付属物の維持管理、補修のためのノーム	総則、技術ノームの内容	—

出典：「Decision: Temporary Regulation on the Maintenance of Ho Chi Minh City - Trung Luong Expressway」 Minister of Transport, 17 February 2011 に基づき作成

(2) 高速道路 O&M マニュアルに要求される内容

O&M 暫定基準は、表 7.7 に示すとおり高速道路の維持管理における点検・補修・清掃作業及び交通管理に関する事項を全体的に網羅はしているが、各項目において、頻度・体制等に関してはほとんど記載されておらず、作業内容についても具体的な記述がない[9]。そこで、今後全般にわたり作成することが必要となる O&M マニュアルについては、道路維持管理、交通管理（緊急時の対応を含む）については不足する事項を追記すること、さらに現在記述のない料金収受については新たに記述することが必要となる。そこで、表 7.8 に、新たに作成する O&M マニュアルはどのような内容を網羅すべきかを日本の高速道路会社が保有する基準、要領等との比較の上で示す。

表 7.8 O&M マニュアルが網羅すべき内容

業務分野	項目	日本の高速道路会社が保有する基準、要領等	O&M基準で記載が必要な事項
道路維持管理	点検	道路（舗装）点検要領	頻度、体制、点検内容
		構造物点検要領	同上
	作業監理	道路維持修繕要領	具体的な作業監理方法
		構造物修繕要領	同上
	工事監理	施工監理要領	具体的な施工監理方法
交通管理	交通規制	交通パトロール業務要領	具体的なパトロール方法
		交通規制手順要領	交通規制の種別、規制方法
	無線	無線通信要領	通信方法、機器の操作・整備方法
緊急時対応	交通事故	交通事故対応要領	各機関の役割、作業内容
		路上作業中交通事故対応要領	同上
	異常時	自然災害、異常気象時の交通規制基準	交通規制基準値、作業内容
料金収受	料金収受	料金収受業務要領	具体的な料金収受の方法
		料金収受点検要領	機器の運用・操作・整備方法
O&M基準とは別に整備すべき高速道路に関する基準、要領等			
工事仕様書		道路維持管理作業仕様書	契約基準に基づく仕様書
		施設物維持管理作業仕様書	同上
高速道路設計基準	設計要領	道路本体、舗装、排水溝	高速道路全体を設計するための要領
		橋梁、カルバート、トンネル等構造物	同上
		道路付属物（交通安全、交通管理）	同上
		施設物（建物、電気施設、通信施設）	同上
		植栽	同上

出典： 日本人専門家チーム

9 「ベトナム・高速道路における運営維持管理事業案件形成調査報告書」経済産業省、平成 22 年（2010 年）3 月、P3-38 から引用

7.3 O&M 基準及びマニュアル（TSG）の作成方法

今後ベトナム国では、図 4.2 に示すような全般的な高速道路 O&M 基準及びマニュアル（TSG）を作成することが必要である。作成にあたっては、プロジェクトでの作成方法と同様に、現在の暫定基準を基本とし、不足する分野についてはベトナム国の一般道の O&M 基準、他国の高速道路 O&M 基準・マニュアルを参考とすべきである。また、マニュアルの内容については、より具体的に現場の作業員が確実に作業を実施できるよう分かりやすく、より具体的に記述することが必要である。

ところで、プロジェクトでは、4 つの分野の TSG の作成にあたっては上記のとおり既存の暫定基準を基本としたが、記述が概念的で、内容が不十分なところが多かったことから、結局は多くの部分を日本の NEXCO の O&M マニュアルを準用している。また、作成した TSG (Draft) は、4 月～5 月に 3 週間の OJT、その後 5 週間の試行運用において使用し、それらの結果を踏まえて TSG の最終化を行った。

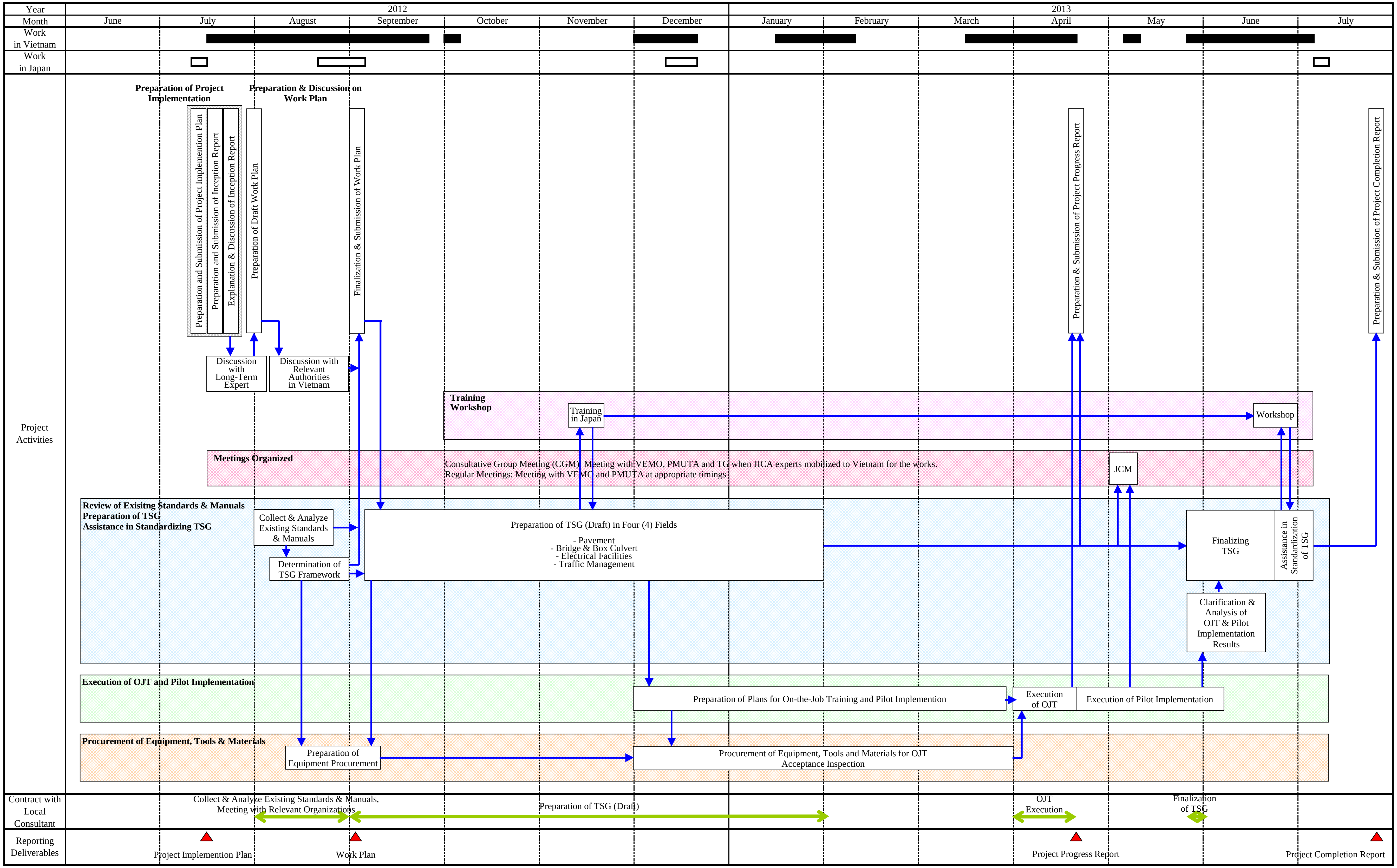
そこで、今後作成される基準、マニュアル（TSG）は、DRVN / MOT が、全体を横並びに比較し整合性を図り、また試行運用等を経て、基準、マニュアル（TSG）として不適切なものがないかどうか確認することが求められる。また、それらについては、適切な時期に O&M 基準として制度化することが重要である。

これまで述べたとおり、4 つの分野の TSG を作成しプロジェクトは終了するが、これで高速道路 O&M の基準・マニュアルが完成したわけではない。今後は高速道路全般にわたる O&M 基準・マニュアルを整備すること、さらにプロジェクトで作成した TSG についても、ベトナムの実態により適合するよう改訂を行うことが求められる。そこで、これら業務は、プロジェクト実施中に示した O&M 基準・マニュアル作成方法を参考にベトナム人技術者の手により確実に実施されることが望まれる。

添付資料

ANNEX-1

業務フローチャート


Year
2012
2013
Month
June
July
August
September
October
November
December
January
February
March
April
May
June
July
Work in Vietnam
Work in Japan
Project Activities
Preparation of Project Implementation
Preparation & Discussion on Work Plan
Preparation and Submission of Project Implemention Plan
Preparation and Submission of Inception Report
Explanation & Discussion of Inception Report
Preparation of Draft Work Plan
Finalization & Submission of Work Plan
Discussion with Long-Term Expert
Discussion with Relevant Authorities in Vietnam
Preparation & Submission of Project Progress Report
Preparation & Submission of Project Completion Report
Training Workshop
Training in Japan
Workshop
Meetings Organized
Consultative Group Meeting (CGM): Meeting with VEMO, PMUTA and TG when JICA experts mobilized to Vietnam for the works.
Regular Meetings: Meeting with VEMO and PMUTA at appropriate timings
JCM
Review of Exisitng Standards & Manuals
Preparation of TSG
Assistance in Standardizing TSG
Collect & Analyze Existing Standards & Manuals
Determination of TSG Framework
Preparation of TSG (Draft) in Four (4) Fields
- Pavement
- Bridge & Box Culvert
- Electrical Facilities
- Traffic Management
Finalizing TSG
Assistance in Standardization of TSG
Clarification & Analysis of OJT & Pilot Implementation Results
Execution of OJT and Pilot Implementation
Preparation of Plans for On-the-Job Training and Pilot Implemention
Execution of OJT
Execution of Pilot Implementation
Procurement of Equipment, Tools & Materials
Preparation of Equipment Procurement
Procurement of Equipment, Tools and Materials for OJT
Acceptance Inspection
Contract with Local Consultant
Collect & Analyze Existing Standards & Manuals, Meeting with Relevant Organizations
Preparation of TSG (Draft)
OJT Execution
Finalization of TSG
Reporting Deliverables
Project Implemention Plan
Work Plan
Project Progress Report
Project Completion Report

ANNEX-2

専門家派遣実績（要員計画）

Assignment Schedule Provided

	Assignment	Name (Sex)	Company	Grade	Year	2012						2013							Total (days)	Person / Month	
					Month	7	8	9	10	11	12	1	2	3	4	5	6	7		Vietnam	Japan
Work in Vietnam	Team Leader / Civil Works Maintenance Plan	ORIKASA Mikio (Male)	Dainichi Consultant Inc.	2	Actual	15	(69)	2 21 (1)	2		2 (21) 22	13 (28)	9	17 (35)	20	5 (7) 11	26 (42)	6	203	6.77	
	Pavement Inspection & Maintenance	KIJIMA Terutake (Male)	Dainichi Consultant Inc. (Supporting Staff)	3	Actual	22 (14)	4 26 (14)	8			2 (14) 15	(14)	2	31	(21) 20		26 (14) 8		91	3.03	
	Bridge Inspection & Maintenance	SAKAIDA Minoru YOKOYAMA Hiroshi (Male)	Dainichi Consultant Inc.	3	Actual	22 (14)	4 19 (14)	1			2 (14) 15	20 (14)	2	31	(21) 20		26 (14) 8		91	3.03	
	Facility Inspection & Maintenance	IIMURA Hideki (Male)	NEXCO Central	4	Actual	22 (14)	4 26 (14)	8			2 (14) 15	20 (14)	2	31	(21) 20		26 19 (14) 8	25(7)	98	3.27	
	Electricity / Communication Facility	YOSHIZAWA Toshiyuki (Male)	NEXCO Central (Supporting Staff)	4	Actual	22 (14)	4 26 (14)	8				20 (7)	26	31	(21) 20		26 (14) 8		70	2.33	
	Traffic Management (Patrol)	MATSUSHITA Yasuhiko (Male)	NEXCO Central	4	Actual	22 (14)	4 26 (14)	8			2 (11) 12	17 (17)	2	31	(21) 20		26 19 (14) 8	25(7)	98	3.27	
	Traffic Control	ISHIDUKA Toshihiro (Male)	NEXCO Central (Supporting Staff)	4	Actual		26 (14)	8			2 (7) 8	20 (14)	2	31	(21) 20		26 (14) 8		70	2.33	
	Procurement Specialist	KAMIHASHI Nobuyuki (Male)	Dainichi Consultant Inc. (Supporting Staff)	4	Actual		12 (7) 18				2 (7) 8			25 (14)	7				28	0.93	
	Coordinator / Civil Works Maintenance Plan (Assistant)	URANO Kazuya (Male)	Dainichi Consultant Inc.	5	Actual	15 (21)	4												21	0.70	
						Subtotal (in Vietnam)											Actual			25.66	
Work in Japan	Team Leader / Civil Works Maintenance Plan	ORIKASA Mikio (Male)	Dainichi Consultant Inc.	2	Actual	11 (3) 13												8 (2) 9	5		0.17
	Procurement Specialist	KAMIHASHI Nobuyuki (Male)	Dainichi Consultant Inc. (Supporting Staff)	4	Actual	8/20-8/24 (5) 8/27-8/31 (5)	9/3-9/7 (5) 12/10-12/14 (5) 12/17-12/19 (3)												23		0.77
						Subtotal (in Japan)											Actual				0.94
						Total											Actual			26.60	

▲ Project Implemention Plan ▲ Draft Work Plan ▲ Work Plan ▲ ▲ Project Progress Report ▲ ▲ Draft Project Progress Report ▲ ▲ Draft Project Completion Report Project Completion Report

Legend: [black bar] Work in Vietnam; [white bar] Work in Japan; [hatched bar] Work paid by the Company

ANNEX-3

JCM 議事録

2013/5/9

高速道路運営維持管理体制強化プロジェクト
JCM の議事録

【概要】
日時：２０１３年5月7日　１４：００～
場所：ベトナム国交通運輸省本省Ａ第７会議室
主な出席者：ベトナム国　MOT　チュオン副大臣、DRVN　ビン副局長　他
JICA ベ事務所　長瀬次長、戸室、タイハー
JICA 専門家　折笠、村田

【議事概要】
＜ビン副局長の説明＞
・高速道路維持管理関連の新政令については、これまでに骨格を作成し、MOT にすでに承認をいただいている。本年７月を目標に素案を MOT に提出する予定としていたが、時期を前倒しし、本年 5 月 20 日に素案を MOT に提出すべく準備をすすめている。特に、維持管理関連については特に必要性が高いことから、他の分野とは切り離して先行して提出したいと考えている。
・これまでカメラシステムをファップバン周辺に設置して、高速道路の交通状況のデータを収集することを予定していたが、RR3 の維持管理、ファップバンーカウゼーの照明の管理は DRVN からハノイ市に移管されており、設置協議等に時間を要することが想定されるとともに、設置後の維持管理の困難が予想されることから、カメラシステムは設置しないこととしたい。

＜チュオン副大臣の意見＞
・本プロジェクトは充実した成果がでている
・ベトナムでは２０１５年までにあと 300km の高速道路が供用を開始する予定である。
今後多くの業者、セクターが維持管理に参画することになると考えられるが、それらの主体が活用・準拠できる基準、マニュアルの整備が求められている。
・当面優先的すべきは、高速道路維持管理関連の政令の制定である。あわせて、詳細な通達の発出である。
・DRVN はＪＩＣＡチームの実行した成果をよく精査し、正式な基準案を作成してほしい。

＜チュオン副大臣からの要請＞
・本プロジェクトで作成している舗装、橋梁等のガイドラインについてはより具体化していってほしい
・（高速道路維持管理に関する）基準・規格の全体像を整理してほしい

・現在、北部ＩＴＳセンター（リージョナルセンター）の整備についてＪＩＣＡの支援を受けるべく交渉中であり、維持管理に関する活動をその活動とつなげていってほしい。

・（高速道路に関する）データベースを構築してほしい。

・DRVN が中心となって、多くの人が受講できる人材育成プログラムを考えてほしい。

・必要予算の算出の方法を整理してほしい。３～５年に１度の点検等を本成果のガイドラインに沿って実施した場合を想定し、1km あたりにいくら程度の維持管理予算が必要であるか概略で取りまとめてほしい。特にこの点についてはＪＩＣＡに支援していただきたい。

・維持管理業者の要件を整理してほしい

・地方部の道路における照明の必要性について整理してほしい

・中央帯に設置される防眩板の設置基準について整理してほしい

・本プロジェクトで作成したＴＳＧをカウゼーーニンビン区間に導入してはどうか。

＜長瀬次長の回答＞

・本技術協力プロジェクトは今年の７月までであり、残り期間は大変限られており、協力できる部分は限られると思われるが、プロジェクトの期間内で協力できるところは協力する。

・まずは、本プロジェクトの成果を活用いただきたい。

＜戸室さんからの回答＞

（MOT 出席者から TSG が 4 分野しかなく、ITS 等他の分野が未整備であるとの意見に対して）

・ITS に関連するガイドラインについては、本プロジェクトでは作成していない。現在協力について協議中の北部リージョナルセンターの整備にあわせて、ＩＴＳに関する運営維持管理ガイドライン（案）の作成が必要と整理されれば、協力内容にふくめることは可能であると考えている。

（村田専門家作成）

MINISTRY OF TRANSPORT
DIRECTORATE FOR ROADS OF VIETNAM
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Hanoi, May , 2013

IMPLEMENTATION REPORT ON PROJECT FOR STRENGTHENING OPERATION AND MAINTENANCE SYSTEM FOR EXPRESSWAY

(up to April 2013)

I. PROJECT INFORMATION:

Project Owner: DRVN (referring to the Decision 1366/QD-BGTVT dated June 13th 2012, VEMO under MOT was former project owner)

Duration: Estimated from 8/2011 to 7/2013 (24 months)

Total capital: USD 2.394.000.

Main objectives: (according to R&D between MOT and JICA dated May 25th 2011)

+ Establishment of an effective and safety framework for expressway operation and maintenance.

+ Personel training and capacity building for Vietnam expressway management organizations for the effective expressway management, operation and maintenance.

The project outputs include:

a. Output 1: Preparation of master plan, principal scheme for expressway operation and maintenance.

b. Output 2: To prepare the expressway operation and maintenance manual

c. Output 3: To execute trial maintenance works at some expressway sections

d. Output 4: Personnel training for expressway operation and maintenance; Capacity building for VEMO

Besides, MOT issued Decision 271/QD-BGTVT dated February 13th approving this investment project with 04 outputs.

II. PROJECT IMPLEMENTATION:

- On June 13th 2010, MOT issued Decision 1366/QD-BGTVT on transferring the Technical Assistance "Project for Strengthening Operation and Maintenance System for Expressway" funded by JICA, on July 13th 2010, MOT issued Decision 1783/QD-BGTVT on changing the Project owner and strengthening organization of Technical Assistance "Project for Strengthening Operation and Maintenance System for Expressway" funded by JICA;

- On June 29th 2012, DRVN issued Decision 1079/QD-TCDBVN on assigning tasks on the management of Technical Assistance "Project for Strengthening Operation and Maintenance System for Expressway".

- On August 15th 2012, DRVN issued Decision 1355/QD-TCDBVN on establishment of Working Groups of Technical Assistance "Project for Strengthening Operation and Maintenance System for Expressway".

By the end of April 2013, the outcomes are as follows:

- **Output 1:** Preparation of master plan, principal scheme for expressway operation and maintenance:

In September, 2012, VEMO requested to clarify and JICA Expert replied that this content was not in the scope of this project. During the implementation, JICA Expert was twice requested and sumitted the comments for Draft of New Decree on Expressway Management, Operation and Maintenance. Until now, JICA Expert considers this as one project activities.

- **Output 2:** Preparation of 04 draft of manuals on expressway O&M:
  - Manual for inspection/ maintenance of asphalt concrete pavement;
  - Manual for inspection/ maintenance of bridge;
  - Manual for inspection/ maintenance of facilities (lighting system, power system for other electrical equipment, radio communication);
  - Manual for traffic management, patrol and control (no ITS) and incident handling.

Outcome:

- The first draft of 04 manual was completed by the end of January 2013.
- 09 units have commented and the Consultant organized a meeting to explain for those comments and summarize the result of OJT (output 2) in the afternoon of April 18th 2013.
- Final draft: as planned, will be prepared after the pilot implementation (after June 7th 2013 to the end of the project).

- **Output 3:** Execution of OJT and trial O&M on some expressway sections, which includes 2 steps:
  - Step 1: Lessons on the content of 4 manuals (in the class) and training on site on Cau Gie-Ninh Binh: 02/4/2013 - 18/4/2013 (about 3 weeks): completed.

There are 42/40 trainees from 12 organizations, units.

- Step 2: Execution of pilot implementation on 2 expressways under management (Ho Chi Minh-Trung Luong and Cau Gie-Ninh Binh from 22/4 to 25/5/2013); review and evaluation by Japanese expert (from 27/5 to 7/6/2013): will be conducted.

+ DRVN issued an official letter No.1543/TCDBVN-VPDCT dated April 17th 2013 to instruct VEC O&M and Company 715 to execute the pilot implementation on Cau Gie-Ninh Binh and HCM-Trung Luong; VEC and RRMU VII are requested to supervise the execution.

- **Output 4:** Human resource training for expressway operation and maintenance; Capacity building for VEMO.

- Training in Japan: completed, from 11/11/2012 to 23/11/2012, there are 9 attendences which are officials from DRVN and MOT.

- In June 2013: Project plans to install 02 cameras for traffic monitoring at Phap Van interchange (01 camera on Phap Van-Cau Gie, 01 camera on Ring Road 3). This system will be maintained for 01 month. The purpose of this system is to bring to VEMO the basic knowledge of traffic condition on expressway and how to handle the incidents: will be conducted.

III. PROPOSAL – RECOMMENDATION

1, Outcome 4- Regarding the installation of 02 cameras for for traffic monitoring at Phap Van interchange (01 camera on Phap Van-Cau Gie, 01 camera on Ring Road 3)

Because Ring Road 3 and the lighting system of Phap Van-Cau Gie have been handed over to Hanoi People's Committee, if cameras are installed on these sections, we must request for the approval of Hanoi Transportation Department, and it may be difficult to maintain the system. Moreover, on Phap Van-Cau Gie-NH1, there is one camera system of Hai Chau Corporation in cooperation with Road and Railway Traffic Police Bureau; and on Cau Gie-Ninh Binh, VEC's camera mornitoring system is now under construction and will be used for pilot implementation.

Recommend to revise as follows:

- To use the data of Cau Gie-Ninh Binh from May 15th to June 15th for training, and it is not necessary to install 2 cameras as planned. JICA Expert has the same opinion.
- Target trainees: the purpose of this system is to give the basic knowledge of traffic condition on expressway and how to handle the incidents so the target trainees should be organizations, units which will be responsible for expressway/road management, namely: Transport Infrastructure and Safety Department (DRVN), RRMU II (Traffic Management Department, Safety Department), VEC, VEC O&M.

2, The content of Draft of TSG is qualified to be upgrade to Standard. We would like to propose that upgrading the Draft to Standard, which can be issued officially and applied in actual management and operation, should be added as one task of this project. Implementation method: using Project capital for Editorial Board, Check and Acceptance Boar d, meeting, printing (this proposal is in accordance with MOT's Notice No.516/TB-BGTVT dated September 05th 2012).

However, according to JICA Expert, it is difficult to use ODA fund for these activities.

The end of report

ANNEX-4

プロジェクトのカウンターパートの変更を示す公文書

MINISTRY OF TRANSPORT

SOCIALIST REPUBLIC OF VIETNAM
Independence -Freedom - Happiness

N° 1783: / QD-BGTVT

Hanoi, July 30, 2012

DECISION

On "Transference of Project Owner and consolidation of the organization and implementation of the JICA funded Technical Assistance Project "Strengthening the O&M system for expressway"

THE MINISTER OF TRANSPORT

- Pursuant to the Decree 51 /2008/ND-CP on 22.4.2008 issued by the Government, regulating the functions, tasks, powers and organizational structure of the MOT;
- Pursuant to the Decree 131/2006/ND-CP on 9.11.2006 issued by the Government, regulating the management and usage of Official Development Assistance fund ;
- Pursuant to the Circular 04/2007/TT-BKH on 30.7.2007 issued by the MPI, providing the instructions for the management and usage of Official Development Assistance fund ;
- Pursuant to a Memorandum of Understanding signed on 25/5/2011 between JICA Chief Representative of Vietnam and the Ministry of Transport;
- Pursuant to Official Letter dated 17.11.2011 from JICA on the statement about the implementation of the TA project "Strengthening the O&M system for expressway";
- Pursuant to the Decision 271/QD-BGTVT on 13.02.2012 of MOT on approving technical assistance project "Strengthening of O&M system for the expressway funded by JICA "; and 892/QD-BGTVT dated 24.4.2012 on transference of the VEMO to DRVN and the Decision 1366/QD-BGTVT dated 13.6.2012 on the transference of TA project "Strengthening the O&M system for expressway" funded by JICA.
- Having reviewed the request of the DRVN specified in the Document 1950/TCDBVN-VPDCT dated 29.5.2012 on the transference of the Project to DRVN, and the 2743/TCDBVN-TCCB dated 16.7.2012 on the establishment, and consolidation of the working groups for JICA funded Project "Strengthening the O&M system for expressway";
- Upon the request of the Planning & Investment Division (DRVN)

Hereby DECIDES

Article 1. To transfer the Project Owner of the JICA funded Technical Assistance Project "Strengthening the operation and maintenance system for the expressway" with VEMO to DRVN. Other actions will follow the Decision 271/QD-BGTVT dated 13.2.2012 issued by MOT.

Article 2. Adjustment is made in the technical Working Group for "Strengthening the O&M system for expressway" which was established after Decision 265/QD-BGTVT issued on 17.2.2012 by MOT to be relevant to Decision on the Project transference 1366/QD-BGTVT issued by MOT, in which Mr. PHAM QUANG VINH, the vice Director General of DRVN will to be the Group Leader in replacement for Mr. LE ANH TUAN, the vice Director of Planning & Investment Division. The other actions will follow the Decision No. 265/QD-BGTVT issued by MOT on 17.2.1012.

DRVN, therefore, is assigned to establish working groups to work in partnership with the Project consultants and to implement the Project as required by Memorandum of Understanding signed on 25/5/2011 between JICA Chief Representative of Vietnam and the Ministry of Transport.

Article 3. This Decision shall take effect from the date of signing.

Article 4. The Heads of Divisions, Planning & Investment, Infrastructure, Finance, Science & Technology, DRVN and heads of agencies and concerned units are responsible for the implementation of this Decision ■

Recipients :
- As specified in Article 4;
- Minister of Transport (reporting);
- MPI; MOF; State Bank of Việt Nam;
- Treasury, central and local banks
- Archives in Clerk Office, Planning & Investment

signed by
VICE MINISTER
on behalf of
MINISTER

NGUYEN NGOC DONG

ANNEX-5

Technical Specification Guidelines (TSG)

ANNEX-5 (1)

TSG (English)

Directorate for Roads of Vietnam Japan International Cooperation Agency

The Project for Strengthening Operation and Maintenance System for Expressway in Vietnam

TECHNICAL SPECIFICATION GUIDELINES FOR OPERATION AND MAINTENANCE OF EXPRESSWAYS

Vietnam Expressway Management Office

JICA Experts Team

JUNE 2013

Preface

The expressway network is a key constituent in the national road system. The Decision 356/QD-TTg dated 02/25/2013 of the Prime Minister approving the adjustment of Vietnam road development master planning for duration 2020 - 2030 determines the rapid development of expressway network, expected to reach 2,018 km in length by 2020.

The organization, management, operation and maintenance of expressways, in accordance with the objectives set out in the Law on Road Traffic, are to ensure constant traffic, safety, and shortening of travelling time. This is a heavy responsibility, but perceived as the honor by the Directorate for Roads of Vietnam.

Understanding the importance and significance of the management, operation and maintenance of expressways, the Ministry of Transport of Vietnam and the Japan International Cooperation Agency (JICA) have discussed and agreed on the realistic actions. Accordingly, the two-year technical cooperation Project "Strengthening of Operation and Maintenance of the Expressway" has been successfully implemented in the Directorate for Roads of Vietnam (July 2011- July 2013). An important outcome of the project is to develop "the Technical Specification Guidelines" for Operation and Maintenance of the expressway with the 4 main sections as in the followings;

- Technical Specification Guidelines for inspection and maintenance of pavement.
- Technical Specification Guidelines for inspection and maintenance of bridge & culvert.
- Technical Specification Guidelines for inspection and maintenance of electrical facilities (lighting system, power supply for other equipment, and radio system for communication).
- Technical Specification Guidelines for traffic magement (excluding ITS).

The groups of Japanese and Vietnamese authors would like to thank the leadership, the efficient coordination of the Vietnam Ministry of Transport, the Japan International Cooperation Agency (JICA), the Directorate for Roads of Vietnam and other related organizations and individuals, who have prepared all the best favorable conditions for this Guidelines to be compiled with quality, and timely accomplishment.

Regards,

Mr. Vu Anh Tuan,
Chief Officer of Vietnam Expressway Management Office

Directorate for Roads of Vietnam **Japan International Cooperation Agency**

The Project for Strengthening Operation and Maintenance System for Expressway in Vietnam

SECTION 1

TECHNICAL SPECIFICATION GUIDELINES FOR INSPECTION AND MAINTENANCE OF PAVEMENT

Vietnam Expressway Management Office
JICA Experts Team

JUNE 2013

Table of Contents

1 Pavement (Asphalt Concrete)

1.1 Outline

1.1.1 Functional Requirements for Pavements

Pavements need to satisfy such major functional requirements as safety, comfort and economy. The performance needs meeting the respective functional requirements. To achieve safety, high skid resistance and visibility of pavement markings are required. Comfort is greatly affected by smoothness. Besides, smoothness also affects safety and economy that is represented by the vehicle mileage.

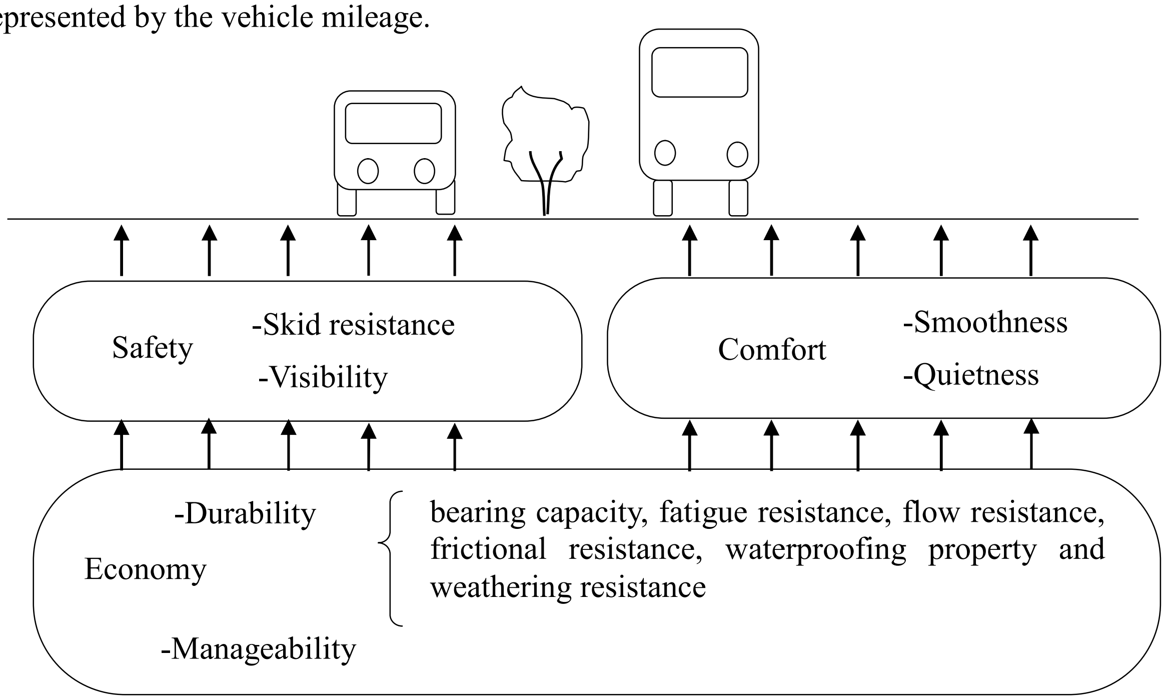


Figure 1.1-1 Functional Requirements for Pavements

1.1.1.1 Safety

Major performance requirements for pavements for safe travel on expressways are skid resistance and visibility. Skid resistance is required in the transverse and longitudinal directions. Transverse skid resistance affects the maneuverability of vehicles that is affected by lateral wind forces and transverse slope. Longitudinal skid resistance on the other hand governs the braking and stopping of vehicles. Skid resistance varies according to the pavement material used and road roughness. Selecting appropriate materials is therefore necessary.

Visibility function ensures drivers of good recognition on lane markings and vehicles ahead. Loss of visibility greatly deteriorates safety. The visibility of lane markings is important particularly at night and at the time of a rain. In order to prevent the deterioration of visibility, it is necessary to provide pavements with appropriate surface drainage systems.

1.1.1.2 Comfort

Among the performance functions required for comfortable travel on expressways, smoothness and quietness provided by pavements are important.

Smoothness affects the comfort of vehicle occupants and governs the comfort and fatigue of the driver. The results of existing studies show that there is a close correlation between the comfort of vehicle occupants and road smoothness. Smoothness offered by road pavement is also related to economy in terms of vehicle mileage and the length of time to repair. In order to achieve a high level of smoothness, it is necessary to select homogeneous materials with sufficient bearing capacity, flow resistance and frictional resistance, and appropriate method for construction work.

Quietness is evaluated in terms of the noise to which the driver and roadside residents are subjected to. The noise of a vehicle is composed of the mechanical noise released from the engine and exhaust system, vehicular noise produced by the body and driving systems and tire noise made at the interface between the tire and road surface. Pavement smoothness (longitudinal roughness) is related to vehicular noise and surface roughness is related to tire noise.

1.1.1.3 Economy

Pavements are civil engineering structures, which get damaged while they are in service, and if they are repaired from time to time, their life cycle can be more prolonged. When considering the economy of pavement, therefore, it is important not only to minimize the costs required at the initial construction or during maintenance and repair but also to consider the costs required over a long period of time. It is necessary to make the most economical decision through taking into account all the costs accruable to the construction work over time.

From an economic viewpoint, durability and maintainability (ease of management) count as important performance requirements for pavements.

Durability is required to ensure the serviceability of pavements that is designated in the initial stage. The performance factors of pavements related to durability are bearing capacity, fatigue resistance, flow resistance, frictional resistance, waterproofing property and weathering resistance.

Maintainability is meant to be a function that facilitates the management of pavements including maintenance and repair. As more expressways are constructed and more pavements become ready for service, the percentage of maintenance and repair cost increases in proportion to overall expressway improvement cost. It is therefore necessary to develop efficient maintenance and repair plans and to minimize maintenance and repair work.

1.1.2 Damage to Pavements and Its Causes

Asphalt pavements suffer fatigue failure due to repeated traffic loading and to the deterioration or aging of the asphalt mixture, or serviceability deterioration owing to the flow of mixtures or friction. Damage to asphalt pavements is largely classified into functional and structural types of damage.

1.1.2.1 Functional Damage

Functional damage is not attributable to the reduction of strength of pavement structure and includes rutting and surface cracking. The damage stays at the surface layer in most of the cases. Unless appropriate repair is made immediately, the damage frequently penetrate the base course and below under certain local and traffic conditions.

The major types of functional damage to pavements include rutting, cracking and the deterioration of skid resistance. The progression of those damages induce the deterioration of traveling performance of vehicle in terms of safety and comfort.

1.1.2.2 Structural Damage

Structural damage is attributable to the reduction of structural strength of the pavement body like cracking due to the deterioration of bearing capacity of the base or sub grade. It is necessary to consider the repair even of the base and sub grade.

Damage related to pavement structure is caused by strength deterioration under repeated loading, insufficient pavement thickness and material strength, strength deterioration in the base or sub grade due to frost heave, etc. Rutting and cracking, which are functional types of damage in the initial stage, may also cause structural damage if they are left unattended for a long period of time.

Structural damage is frequently induced by strength reduction in lower layers such as the base and sub grade and by the penetration of damage to lower layers. It is necessary to select the optimal repair method based on the results of structural surveys of pavements.

1.1.2.3 Types of Damage to Asphalt Pavements

Typical types of damage to asphalt pavements are described below.

1.1.2.3.1 Rutting

Rutting means uneven and rough surface in the transverse direction caused by the heavy repetitive traffic loads. Rutting is caused either by the flow of asphalt mixture or friction.

Rutting due to the flow of asphalt mixture cracking

1.1.2.3.2 Cracking

Cracking is caused by the deterioration or aging of mixture or by structural factors. Both factors affect the durability of pavements. If it is left unattended, cracking expands and develops. Infiltration of storm water promotes cracking and is likely to lead to structural damage.

1.1.2.3.3 Deterioration of Smoothness

Smoothness is deteriorated by the local settlement of road surface due to cracking or the development of potholes, insufficient roller compaction in the backfill of the structure during construction, or residual settlement in soft-ground areas. Smoothness greatly affects the driver’s comfort.

Deterioration of smoothness due to settlement in the front and rear of the structure

Pothole

1.1.2.3.4 Potholes

Potholes are small holes created on the road surface. The causes of potholes include the leakage of oil from vehicles and poor mixing of asphalt mixture. If potholes are left unattended, damage develops because of the infiltration of storm water or other factors and structural damage may be induced.

1.1.2.3.5 Bumps

Bumps are created by vertical displacement of road surface at the connection between the bridge joint and pavement surface or along a buried object, and affect the comfort of vehicle occupants.

A bump at a bridge joint.

The types and states of damage to asphalt pavements, the area or location of damage and damage classifications are listed in Table 1.1-1.

Table 1.1-1 Types of damage to asphalt pavements 1

(damage state, area or location, damage classification)

<table>
<tr><th colspan="2" rowspan="2">Type of damage</th><th rowspan="2">State of damage</th><th rowspan="2">Area or location damage occurred</th><th colspan="2">Damage classification</th></tr>
<tr><th>Functional</th><th>Structural</th></tr>
<tr><td rowspan="2">Rutting</td><td>Rutting due to the flow of asphalt mixture</td><td>Consolidation and lateral movement of asphalt mixture or settlement at lower layers</td><td>Mainly on vehicle swept paths along heavy traffic routes in warm areas</td><td>○</td><td>○</td></tr>
<tr><td>Rutting due to friction</td><td>Abrasion on vehicle swept paths</td><td>In snowy and cold areas</td><td>◎</td><td></td></tr>
<tr><td rowspan="7">Cracking</td><td>Cracking due to the deterioration of bearing capacity of the base and sub grade</td><td>Linear cracks developing to hexagonal</td><td>Mainly on vehicle swept paths</td><td></td><td>◎</td></tr>
<tr><td>Cracking due to the deterioration or aging of asphalt mixture</td><td>Hexagonal</td><td>Cracking occurring on vehicle swept paths progressing to the entire pavement.</td><td>○</td><td>○</td></tr>
<tr><td>Cracking due to uneven settlement</td><td>Linear (longitudinal, transverse or irregular)</td><td>Around the structure, at joints made as a result of the widening of lanes, at cut/fill boundaries, etc.</td><td></td><td>◎</td></tr>
<tr><td>Cracking due to thermal stress cracking</td><td>Linear (transverse). At nearly regular intervals.</td><td>In cold areas and in the areas with large variations of temperature</td><td>○</td><td>○</td></tr>
<tr><td>Cracking at construction joints</td><td>Linear (longitudinal or transverse)</td><td>At construction joints</td><td>◎</td><td></td></tr>
<tr><td>Reflective cracking</td><td>Liner (longitudinal or transverse)</td><td>On concrete slabs and in cases where cement stabilization is applied</td><td></td><td>◎</td></tr>
<tr><td>Top-down cracking</td><td>Linear (longitudinal) to reticular</td><td>On vehicle swept paths</td><td>○</td><td>○</td></tr>
<tr><td rowspan="3">Deterioration of smoothness</td><td>Longitudinal irregularities and settlement</td><td>Longitudinal irregularities with a relatively long wavelength</td><td>In soft grounds, in the backfill of the structure and near a buried object</td><td></td><td>◎</td></tr>
<tr><td>Corrugations</td><td>Ripple-like folds on the surface</td><td>Near the toll gate and in congested sections</td><td>○</td><td>○</td></tr>
<tr><td>Depressions and swells</td><td>Local depressions and swells</td><td>In parking areas and in congested sections</td><td>○</td><td>○</td></tr>
<tr><td rowspan="6">Others</td><td>Potholes</td><td>Holes created on pavement surface. Occurrences of abrasion of aggregates and hexagonal cracking</td><td>In cracked sections, poor-drainage sections and sections subjected to raveling by tire chains</td><td>○</td><td>○</td></tr>
<tr><td>Deterioration of skid resistance coefficient</td><td>freezing and polishing</td><td></td><td>◎</td><td></td></tr>
<tr><td>Bump</td><td>Vertical surface displacement or irregularities</td><td>At expansion joints on bridges and in the backfill of a structure</td><td>○</td><td>○</td></tr>
<tr><td>Pumping</td><td>Outflow of water and fine particles of sub grade materials., often accompanied by cracking.</td><td>At spots with cracking or abrasion on the base layer or below</td><td></td><td>◎</td></tr>
<tr><td>Raveling</td><td>Separation of surface mortar</td><td>Mainly on vehicle swept paths</td><td>◎</td><td></td></tr>
<tr><td>Cutback due to oil leakage</td><td>Scattered aggregates. Potholes.</td><td>At accident sites and in parking areas</td><td>◎</td><td></td></tr>
</table>

Legend Damage classifications ◎: Highly likely incidence.
○: Potential .incidence

1.1.2.4 Main Causes and Mechanisms of Damage

The causes and mechanisms of typical damage to asphalt pavements are described below.

1.1.2.4.1 Rutting

Rutting is a transverse surface irregularity created by wheels. Rutting is caused either by the flow of asphalt mixture or by friction.

Conceivable external causes of rutting due to the flow of asphalt mixtures are the rise of pavement surface temperature in the summer and the concentration of heavy vehicles on specific lanes. The mechanical properties of asphalt mixtures are greatly affected by binder properties. Asphalt mixtures behave like an elastic body at low temperature but they behave like a viscos-elastic body at high temperature. At high temperature, asphalt mixtures are vulnerable to deformation under heavy vehicles. Deformation mostly remains permanently. Permanent deformations are accumulated further as wheels pass the same position. One of the internal factors of the rutting attributable to the flow of asphalt mixtures is the flow resistance of asphalt mixtures. Flow resistance is affected by the amount of asphalt, asphalt penetration and the grain size of the mixture. Measures to increase flow resistance are listed below.

- Minimize the amount of asphalt as long as an optimum amount is secured.
- Use hard asphalt.
- Use coarse graded materials for mixtures and increase the amount of coarse aggregate.

Rutting caused by the flow of asphalt mixture Rutting caused by friction

The external cause of rutting by friction is the travel of vehicles equipped with tire chains or spike tires. A conceivable internal factor is the frictional resistance of asphalt mixtures. Frictional resistance is reduced by the following factors.

- Inadequate density due to insufficient compaction
- Inadequate amount of asphalt
- Low hardness of aggregate

1.1.2.4.2 Cracking

Cracking occurs in a varying manner according to the cause or pavement structure. Cracking is roughly divided into linear and planar types. Linear cracking is generally considered to occur in the initial stages and mostly belongs to functional damage. Planar cracking usually occurs as linear cracking and develops with the lapse of time into structural damage.

The most important external cause of cracking is traffic loading. Cracks are caused by the tensile stress created by traffic loading (an external force).

If the asphalt mixture is assumed to be an elastic body, it is deformed by an external force as shown in Figure 1.1-2, and compressive and tensile stresses occur at the top and bottom edges of the mixture respectively. Asphalt mixtures with the tensile strength approximately one-tenth of compressive strength have extremely low resistance to tension. Excessive loads cause the tensile strain on the bottom surface of the asphalt layer to exceed the limit resulting in cracking. Pavements are designed to maintain a mechanical balance. Once the balance is lost, an excessive-deflection induced deformation causes cracking, due to a rapid increase in traffic volume, overloaded heavy-duty vehicles and uneven bearing capacity of roadbed;

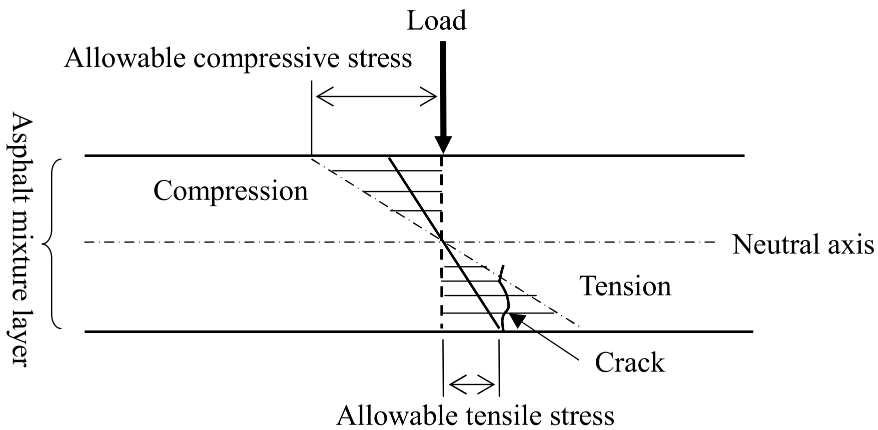


Figure 1.1-2 Tensile Stress of Asphalt Mixture

The internal causes of cracking include the amount and hardness of asphalt. Mixtures with a large amount of asphalt and of fine-graded type are highly resistant to cracking. Mixtures with a small amount of asphalt and of course-graded type are vulnerable to cracking. The hardness of asphalt is affected by thermal degradation during the manufacturing of mixtures. Temperature should therefore be controlled appropriately.

Planar cracking Reflective cracking
(develops into a structural failure) (at the end of an approach slab)

1.1.2.4.3 Deterioration of Smoothness

The deterioration of smoothness, in the broad sense, refers to the longitudinal and transverse directions, however, it generally means longitudinal irregularities. For smoothness, a standard value is defined at the completion of construction. Smoothness remains satisfactory in the initial stages of service but deteriorates with the lapse of time. The deterioration frequently occurs with other types of damage such as cracking and surface settlement due to the development of potholes. Bumps and corrugations also lead to the deterioration of smoothness. These phenomena cause the deterioration of smoothness of a short wavelength.

The deterioration of smoothness in soft grounds or in the backfill of a structure induces poor smoothness of a relatively long wavelength in numerous cases. The phenomenon is attributable to the slow progress of residual settlement, which is caused mainly by poor soil stabilization during construction or insufficient compaction of backfill materials.

Deterioration of smoothness due to surface settlement with the development of cracking

Deterioration of smoothness due to differential settlement near a transverse structure

The types of damage to asphalt pavements, the area or location of damage and main causes are listed in Table 1.1-2.

Table 1.1-2 Types of damage to asphalt pavements 2

(area or location of damage and main causes)

Type of damage		Area or location damage occurred	Main causes
Rutting	Rutting due to the flow of asphalt mixture	Mainly on vehicle swept paths along heavy traffic routes in warm areas	Travel of heavy-loaded vehicles, congestion and inappropriate mixtures
	Rutting due to friction	In snowy and cold areas	Abrasion by tire chains or other materials
Cracking	Cracking due to the deterioration of bearing capacity of the base and sub grade	Mainly on vehicle swept paths	Strength deterioration in the base or sub grade
	Cracking due to the deterioration or aging of asphalt mixture	Cracks occurring at vehicle swept paths, progressing to the entire pavement.	Thermal degradation during the manufacturing of mixtures and aging by ultraviolet rays
	Cracking due to differential settlement	Around the structure, at joints made as a result of the widening of lanes, at cut/fill boundaries, etc.	Differential settlement due to the consolidation of a fill
	Cracking due to thermal stress cracking	In cold areas and in the areas with large variations of temperature	Shrinkage due to temperature decrease
	Cracking at construction joints	At construction joints	Poor spreading and compaction
	Reflective cracking	On concrete slabs and in cases where cement stabilization is applied	Cracks in the base and sub grade
	Rutting	At wheel tracks	Tensile strain on the pavement surface created by heavy vehicles
Deterioration of smoothness	Longitudinal unevenness and settlement	In soft grounds, in the backfill of the structure and near a buried object	Differential settlement due to the consolidation of a fill, difference in residual settlement rate and insufficient compaction
	Corrugations	Near the toll gate and in congested sections	Uneven bearing capacities of the base and sub grade and loading at vehicle start-up and stopping.
	Depressions and swells	In parking areas and in congested sections	Poor application of prime coat or tack coat
Other	Potholes	At cracked sections, poor-drainage sections, sections subjected to raveling by tire chains	Developing cracks, poor quality of mixtures and insufficient compaction
	Deterioration of skid resistance coefficient		Leaks of asphalt constituent and polished aggregate
	Bump	At expansion joints on bridges and in the backfill of a structure	Settlement due to insufficient compaction of base, sub grade and mixtures and differential ground settlement
	Pumping	In sections with cracking or spalling on the base layer or below	Cracking or spalling on the base layer or below
	Raveling	Mainly on vehicle swept paths	Shortage or hardening of asphalt
	Cutback due to oil leakage	At accident sites and in parking areas	Cutback due to oil leakage

1.1.3 Need (Lifecycle Costs) for and Objectives of Pavement Protection

1.1.3.1 Maintenance and Repair and Serviceability

For economical and efficient maintenance and repair, it is important to appropriately and systematically comprehend the driving performance in such terms as safety and comfort, and the serviceability of pavements.

Serviceability means the bearing capacity and surface properties of pavements at a given point of time. The serviceability of pavements declines with the development of damage due to the accumulation of traffic volumes. Serviceability declines gradually, while necessary maintenance work (e.g. sealing the cracks and patching) is carried out to keep the serviceability of pavement at a certain level. Then, repair (overlaying by cutting or partial replacement) work is done at a certain point of time to restore serviceability greatly. Serviceability is restored upon pavements repair. Serviceability, however, starts declining due to the accumulation of vehicle traffic load at the point when the repaired pavement commence service. When the pavement fails, all the layers are replaced and serviceability is restored to the level at the time when it was initially constructed. Thus, the life cycle of pavements is restarted with cyclic repairs. A concept of the life cycle of a pavement from a viewpoint of maintenance and repair is shown in Figure 1.1-3.

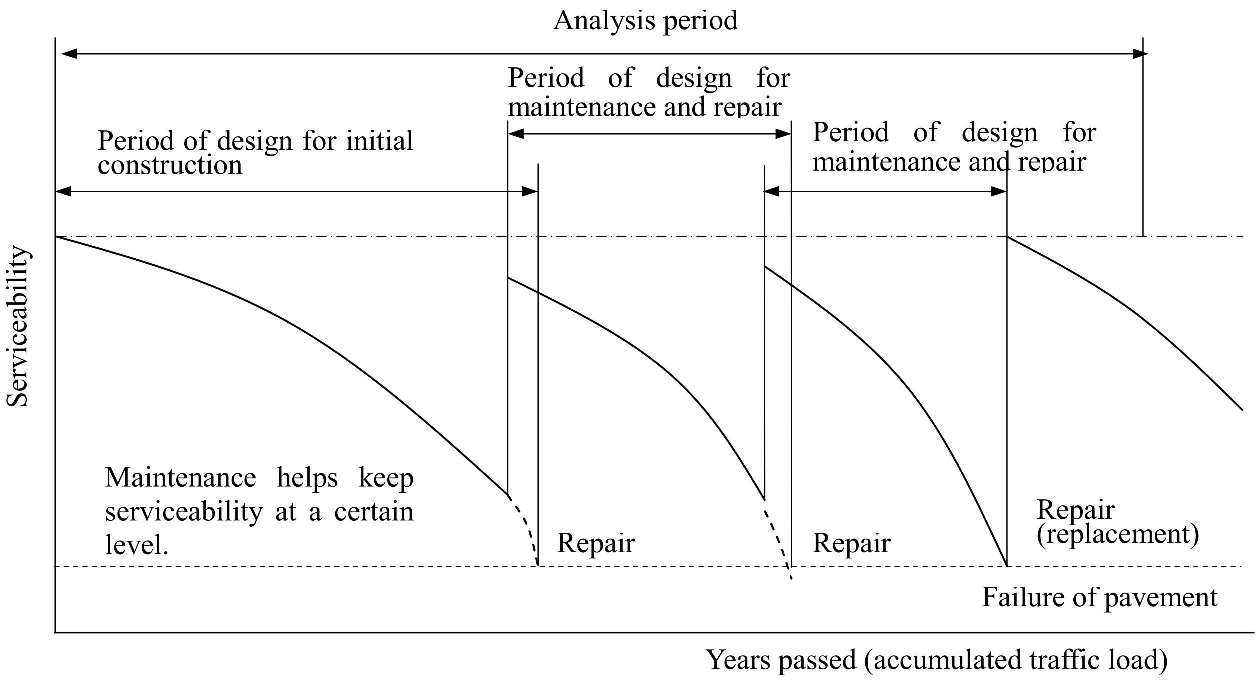


Figure 1.1-3 Concept of Life Cycle of Pavement and Maintenance and Repair

1.1.3.2 Need for and Objectives of Preventive Maintenance

The economy of maintenance and repair should be evaluated not only counting the costs required for maintenance and repair but also the subsequent costs of maintenance and repair incurred continuously and the benefit and cost of road users (such as the travel time reduction and the period of congestion). The concept of lifecycle cost counts the combined sum total of initial construction, maintenance and repair costs, in order to manage pavements most economically.

Potholes and cracks, which are functional damage in the initial stages of occurrence, develop into structural damage if they are left unattended. Structural damage requires much higher costs of surveys and repair than those of functional damage. Daily protective maintenance activities including inspections, investigations, maintenance and repair constitute an important effort for minimizing the lifecycle cost.

It is therefore important to accumulate and analyze the records of inspections, investigations, maintenance and repair to develop repair plans for minimizing the lifecycle cost.

1.1.4 Definition of Maintenance and Repair

Maintenance and repair are appropriate treatments applied for specific damage to pavements to achieve the following goals.

- To secure the durability of pavements and keep the pavement structure functional
- To ensure vehicular maneuverability on the road surface and provide safety and comfort
- To prevent roadside environmental degradation ascribable to pavements

Pavements are subjected to external forces such as the traffic loads and weather conditions. They suffer from aging to yield degraded serviceability. The smooth vehicular travel is gradually affected adversely. In order to prevent such problems, it is important to constantly grasp the surface condition and take appropriate maintenance and repair measures at appropriate time.

Pavements are maintained and repaired to keep their serviceability at a certain level. Maintenance aims at keeping or slightly upgrading the serviceability of pavements, however, structural enhancement is not intended. Examples include the filling the cracks in pavements with sealing materials and the patching of potholes and partially settled spots.

On the other hand, repair is made to improve the structural strength of pavements, thus restoring serviceability to a large extent, such as, overlaying, surface cutting and overlaying and partial replacement are conceivable.

Maintenance or repair is conducted at an appropriate timing in view of the development of damage. Maintenance and repair are classified as described below based on the timing.

- At each time damage is discovered during a patrol, measures should be taken urgently.
- In cases where damage develops gradually but no structural enhancement is required, measures may be taken on a timely basis when the damage reaches a certain limit.
- In cases where damage develops gradually and cross-sectional design is required, long-term measures should be applied based on a plan.

Conducting maintenance or repair work at a wrong timing may cause the damage to pavements to develop, resulting in a great increase in maintenance or repair costs. It is therefore important to control the development of damage (extending the service life by maintenance) in the initial stages of damage to minimize the progress of damage. In order to implement maintenance or repair method based on a plan, an appropriate timing of maintenance or repair should be determined based on the results of cost performance analysis in view of the lifecycle cost.

1.1.5 Workflow of Maintenance and Repair

Workflow from surface inspection to maintenance and repair is shown in Figure 1.1-4. Pavements maintenance and repair works are conducted in that sequence. Inspections are conducted daily and regularly. Emergency measures are taken immediately for the damage that requires urgent or temporary work. Whenever maintenance or repair is required, the scale and causes of the damage is evaluated through investigations, and appropriate maintenance or repair methods are selected, designed and implemented. The results are recorded. In conducting maintenance and repair work, the workflow is followed.

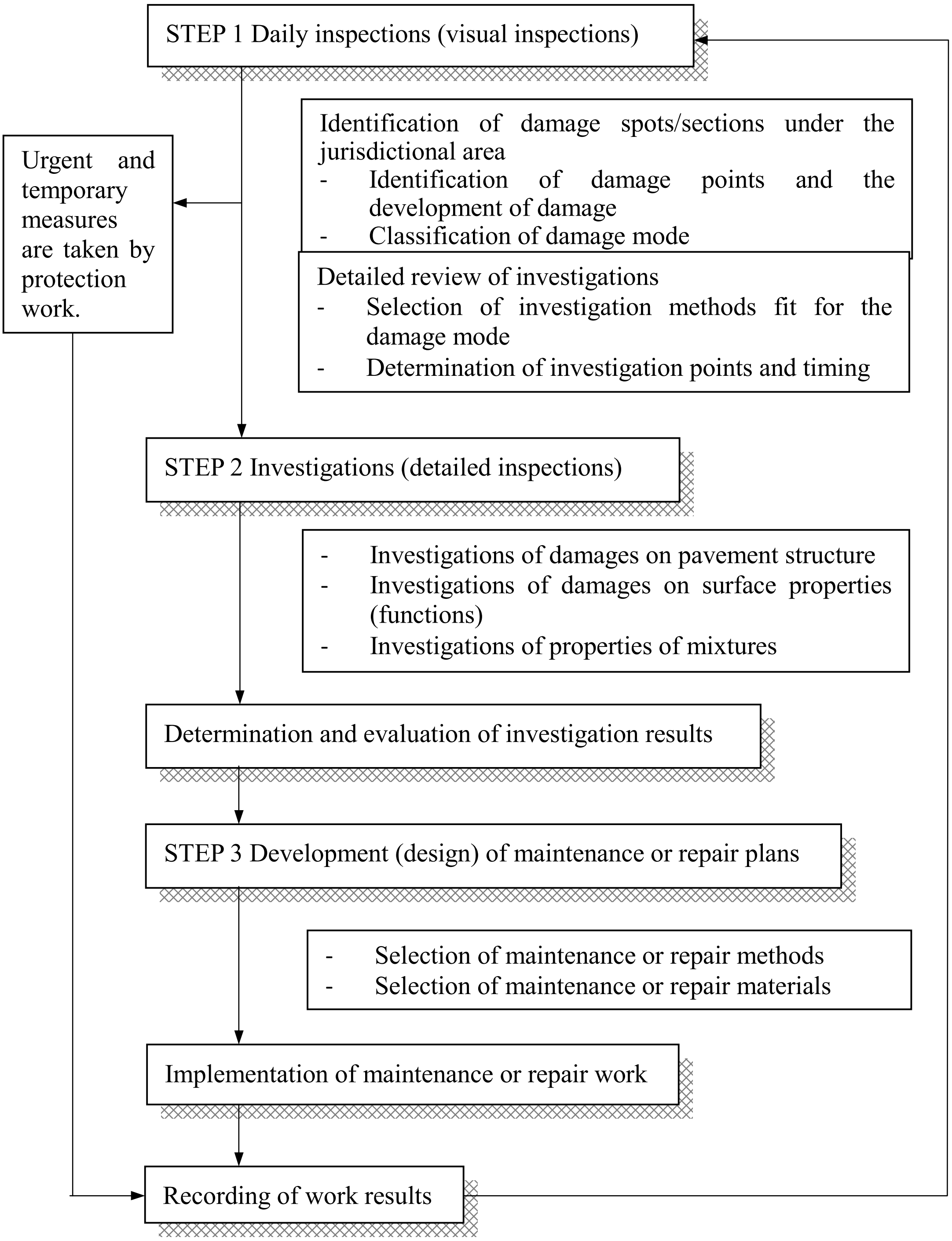


Figure 1.1-4 Workflow of maintenance and repair

Maintenance or repair is composed of three phases - planning maintenance or repair throughout the road, developing plans for implementation in selected sections and implementing the plans.

For maintaining or repairing the entire road network, plans are developed for the entire road network by dividing all the routes in the sections under control into units of sections, comparatively evaluating serviceability of each unit and prioritizing the units accordingly. For the damage that is found to require urgent measures during regular or daily inspections, however, suitable construction methods should empirically be determined and maintenance or repair works should be implemented immediately.

For performing maintenance or repair work, rational implementation plans are to be established by conducting necessary investigations, targeting the sections prioritized to be maintained or repaired in planning the entire road network plan. When determining suitable sections of maintenance or repair, an appropriate length should be established in view of the traffic conditions and other factors.

Visual inspections are conducted first in the investigations in individual sections. If implementing maintenance or repair methods is considered adequate as a result of visual inspections, it is possible to dispense with detailed identification of the state of damage or the identification of design conditions. In the case where repair is required, however, it is desirable to grasp the state of damage in detail or to grasp design needs.

For appropriate maintenance and repair of pavements, records should be made available on a successive basis including pavement inventory and database to explicitly present the history of maintenance and repair.

1.2 Inspections and Surveys

1.2.1 Types and Frequencies

Inspections are classified into daily inspections conducted daily, Routine inspections done periodically and emergency inspections that are made in emergency as during an abnormal weather. Detailed surveys are conducted as required based on the results of inspections. The desirable frequencies and methods of respective inspections are listed in Table 1.2-1.

Table 1.2-1 Guidelines for Frequencies and Methods of Inspections

Type	Frequency of inspection	Method of inspection
Daily inspections	Daily	Visual inspection
Routine inspections	Monthly or once in several months	Visual inspection
	Yearly or once in several years	Detailed surveys using instruments
Emergency inspections	In emergency like during an abnormal weather	Visual inspection

1.2.2 Daily Inspections

Daily inspections are required for managing the pavements appropriately and in a systematically well-planned manner. In daily inspections, surface conditions are visually observed in inspection vehicles. In cases where detailed confirmation is required, the condition is confirmed while the inspection vehicle is parked on the shoulder. The results of daily inspections serve as a basis for conducting appropriate detailed surveys and for establishing appropriate maintenance or repair plans. It is therefore important in daily inspections to record the conditions in the locations where an incidence of abnormality is detected.

Response to pavement damage in the initial stages of occurrence greatly affects subsequent damage progression. Therefore, daily inspections play an important role to discover pavement damage in early stages. In the case where temporary repair is made in particular, subsequent progress of damage should closely be monitored. In daily inspections, records of time-based changes and the mode of damage are to be organized.

It is important to make use of the results of daily inspections to establish survey and construction plans for fundamental repair.

Table 1.2-2 shows a reference table in determining the damages versus the criteria employed in daily inspections. Potholes, voids, stripping and cracks causing serious damage require immediate repair work for the purpose of extending the service life at the damage spot.

Table 1.2-2 Criteria for Assessment of Damages

Type of deformation	Criteria for Assessment	Remarks
Potholes, voids and stripping	Surface stripping exceeds the surface layer thickness and is wider than a 20-cm-diameter area on the surface.	The deformation occurs suddenly after a rainfall.
Upheaval (Bumps)	Great bumps at the connections on a structure cause the loss of control of steering wheel and considerable bouncing of the vehicle. The bump exceeds 20 mm at the connection on a bridge, or 30 mm at the connection on a transverse structure or at the cut/fill boundary.	Bumps at the joints of concrete pavements are included.
Rutting	Ruts of more than 25 mm on the road surface cause the loss of control of steering wheel and considerable bouncing of the vehicle.	Large quantities of water splash during a rainfall.
Cracking	Cracks on the surface are likely to lead to potholes and stripping. Large cracks with a cracking ratio of more than 20% occur that lead to the deformation in the pavement.	
Longitudinal irregularities and subsidence	Large longitudinal irregularities and settlements adversely affect the comfort of vehicle occupants.	
Local deformations and voids	Local deformations and voids on the surface cause the loss of control of steering wheel and considerable bouncing of the vehicle.	
Depression	Local surface poodle is observed each time rain falls.	
Raveling	The ejection of fine particles is found on the surface. Hexagonal cracks also occur.	This is highly likely to be structural damage.
Corrugations	Ripple-like folds with a depth of more than 30 mm exist on the surface.	
Breakage at joints	Breakage at joints and projections on the surface are found.	Concrete pavements

Reference: NEXCO - Inspection Procedure for Protection (Structures)

Table 1.2-3 Daily Inspection Form for road patrol (reference)

Affiliated Unit：____________________ Patroller：____________________

Range of road patrol：__________ ～ __________ Date of performance：____________________

Date and time of inspection	**Location, chain age, place where damages and/or violations are spotted**	**Climate condition (sunny, rainy, cloudy, foggy, stormy), sudden incidents, nature of newly detected incidents and/or violations (attached drawing shows location and sizes)**	**Solution, on-site measures taken and results**	**Comments and notes by senior officer who receives the report. His /her Signature**	**Comments by Patroller**

※ Instructions

The purpose and requirements

1) Road patrol diary aims at recording to promptly detect damages, violations for quick fixing. This document is kept in files at the affiliated agencies.
2) The road patroller while on duty must record the condition of roads, bridges, buildings and safety corridors.
3) Leadership will check the contents of logbook/ dairy and provide instructions for solutions / processes, and undersign his/her authorization.
   Inspector checks the daily journal entry and directs the counter measures.
   Leadership of departments of RRMUs or the provincial Transportation Department checks on a monthly basis and provides instructions.
4) Every month, every quarter logbooks /diary of road patrol must be submitted to Commission of Acceptance.
5) Road Patrol Diary is the product of the patroller. The dairy is the foundation to assess partially the quality, performances and management practices of management unit. And from the results, it is to make a rational maintenance and repair plan.

Content for inspection and records

1) Pavement: Check for potholes, mud sink ... or not. If so, record the location and percentage (%, m2 ...).
2) Curb: Check to ensure whether the location is not flat, filled with rocks ... or not
3) Longitude trench: Check if it is backfilled with stone, or damaged affecting the drainage ... or not
4) The clearance of wild trees, and weeds
5) Traffic Safety System: Check for damaged, lost or stolen parts.
6) The road: Check for damage or subsidence ... or not
7) Check for violating road safety or
8) Traffic safety: When traffic accidents happen, write in road diary of patrol and recommendations for fixing and road rehabilitation, and to report to the agency within the day.
9) To monitor the implementation of the road works, if there is a problem, immediately notify the inspector/patroller.
10) Description of road cleanliness condition

1.2.3 Routine inspections

By Routine inspections, the general surface damage or changes thereof identified by daily inspections are evaluated regularly and quantitatively. Routine inspections are conducted at intervals of several months or years according to the conditions at the site. Routine inspections include inspections by repeated implementation of simple manual methods and detailed surveys using measurement equipment.

1.2.3.1 Routine inspections by Repeated Implementation of Simple Methods

This type of survey is positioned at the midpoint between daily inspections and detailed surveys. It is difficult to quantitatively grasp the changes in damage by daily inspections. In selecting the locations where detailed surveys are required, identifying the time-based changes at damage points is important. In order to supplement daily inspections, therefore, visual inspections are made regularly by inspectors aboard an inspection vehicle and how the vehicle occupants feel is inspected every month or once in several months.

Heavy vehicles generally run on nearside lanes where vehicles travel at relatively low speed. The damage to pavement is therefore more outstanding on nearside lanes than on passing lanes. Routine inspections are therefore limited to the evaluation made on a vehicle running on the nearside lane. Inspections are to detect the rutting and cracking, and the smoothness is accessed if driving is free from bumps. The rating is defined as good (no entry in the table), poor (represented by a triangle) or very poor (represented by an “x”). Inspections are made at every passage of 1 km. If possible, however, inspections should be conducted at passage of 100 m (Figure 1.2-1). A vehicle running at a speed of 60 km/hr. takes approximately six seconds to pass a distance of 100 m, which is sufficient to determine and enter the rating. To assist recording, markings are required in the field at intervals of 100 m.

Simplified items and methods as described above enable easy quantitative identification of changes. Accumulated survey results provide information for determining the location and timing of detailed surveys.

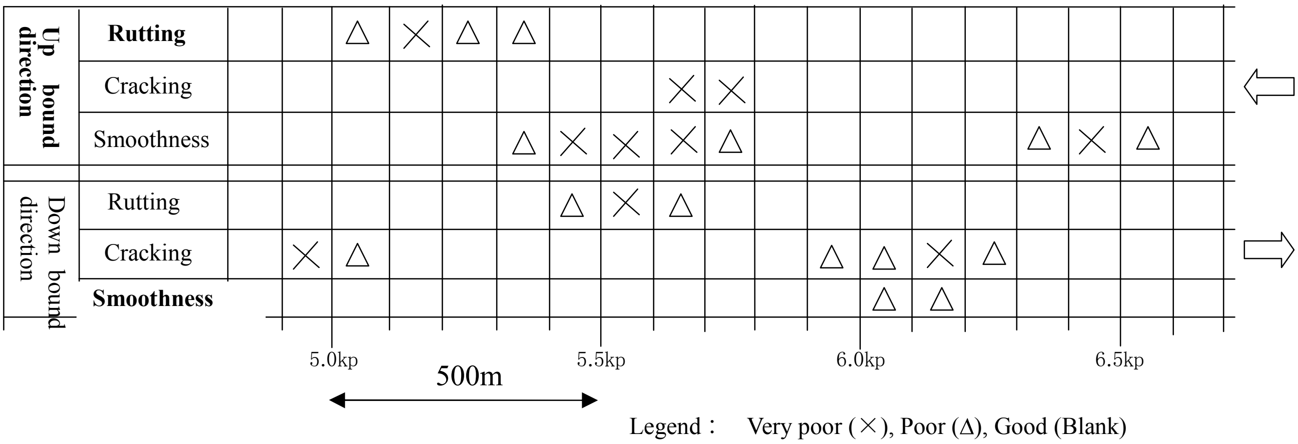


Figure 1.2-1 Examples of records of Routine inspections by simple methods

1.2.3.2 Routine inspections Using Measurement Equipment

In the case where the spots are found with a heavy damage that develops quickly as a result of daily inspections and of 1.2.3.1 above, the degree of damage is identified more accurately by detailed surveys using measurement equipment. The spots that are preliminarily considered important should be selected roughly once a year for detailed surveys using measurement equipment. The items for which Routine inspections are desirable and the frequencies of surveys are listed in Table 1.2-3.

Table 1.2-3 Items and Frequencies of Routine inspections

Inspection item	Frequency of inspections		Remarks
	Routine inspections by simple methods	Routine inspections using measurement equipment	
Rutting	Monthly	Annually	
Cracking	Monthly	Annually	
Deterioration of smoothness	Monthly	Annually	Bumps are included

Routine inspections using measurement equipment should be conducted on all the lanes throughout the route on a regular basis. In the case where measurement takes much time, however, the range of detailed surveys should be narrowed down by repeatedly implementing simple methods, and detailed Routine inspections should be conducted using measurement equipment.

1.2.4 Emergency Inspections

Emergency inspections are conducted to identify the extent and severity of adverse impacts on pavements whenever there are incidences of an abnormal weather occurs or a chemical substance spillovers. It is important to conduct emergency inspections at the occurrence of incidence, while securing the safety of inspection engineers. Otherwise, the possibility of secondary damage to inspection engineers increases.

In emergency inspections, surface conditions are visually monitored by inspectors aboard an inspection vehicle. If detailed verification is required, the conditions should be verified while the inspection vehicle is parked on the shoulder. Whenever an abnormal condition is discovered, the responsible organizations should be notified, followed by dispatched specialized inspection organization's conduct of detailed surveys for corrective actions.

The severity of the emergency incidence that require emergency inspections should be identified in advance. For predicting incidence of abnormal weather, the installation of observation equipment such as rain gauges and seismographs is a prerequisite. For surveying the wash-out of chemicals, the chemical substances that are distributed in Vietnam should be identified in advance. For reference, some of the reference values for conducting emergency inspections on Japanese expressways are listed in Table 1.2-4.

Table 1.2-4 Some of the reference values for emergency inspections in Japan (for reference)

Event requiring inspections	Reference values for emergency inspections	Remarks
Abnormal rainfall	A continuous rainfall of 220 mm or more and an hourly rainfall of 50 mm or more	Rain gauges installed at fixed points are used.
Earthquake	A measured seismic intensity of 4.5 or higher	Seismographs installed at fixed points are used.

Reference: NEXCO Central - Disaster Inspection Guidelines

1.2.5 Detailed Surveys (Surface Conditions, Structures and Mixtures)

1.2.5.1 Survey Methods for Respective Purposes

The methods of surveys that are required to evaluate different types of performance of asphalt pavements are shown in Table 1.2-5. Visual surveys are regarded as simple surveys in daily, regular and emergency inspections. Other surveys than visual surveys correspond to detailed surveys.

Table 1.2-5 Major asphalt pavement survey methods for respective purposes

Survey item		Survey method
Load bearing capacity	Capacities of base and sub grade	Measurement of settlement and deflection
	Fatigue-induced cracks on bottom surface	Visual surveys, sketches and photography
	Low-temperature cracks	Visual surveys, sketches and photography
	Fatigue-induced cracks on the surface	Visual surveys, sketches and photography
	Frost heave	Visual surveys, sketches and photography
	Seismic capacity	Visual surveys, sketches and photography
	Traffic volume	Measurement of daily and accumulated traffic volumes
Safety of travel	Skidding	Measurement of the depth of texture and skid resistance coefficient
	Texture	Visual surveys and surface roughness
	Abrasion (wear and rutting)	Visual surveys and measurement of transverse profile
	Bumps	Visual surveys and measurement of bumps
Comfort of vehicle occupants	Longitudinal irregularities and roughness	Visual surveys and measurement of smoothness and longitudinal profile
	Bumps	Visual surveys and measurement of bumps
Durability of surface layer	Durability of asphalt	Visual surveys, core sampling and cut and cover surveys
	Spalling	Visual surveys, core sampling and cut and cover surveys
	Scattering of aggregate	Visual surveys, core sampling and cut and cover surveys
Strength of asphalt mixtures		FWD (falling weight deflect meter) surveys, core sampling and cut and cover surveys
Bearing capacities of base and sub grade		FWD surveys, plate loading tests and in-situ CBR(California bearing ratio) tests

Reference: Japan Society of Civil Engineers - Standard Specifications for Pavements

1.2.5.2 Survey Methods for Respective Types of Damage

In the surveys of pavement damage, it is necessary to identify the causes by analogy based on the mode of damage, and to select survey methods fit for the damage. Surveys include the surveys to obtain the bearing capacity of the pavement body, surface property surveys for identifying the reduction of functional damage and the surveys to obtain the properties of mixtures. The typical survey and test methods for evaluating the damage to asphalt pavements are listed in Table 1.2-6.

Table 1.2-6 Major asphalt pavement survey methods by type of damage

Type of damage		Type of survey: Structural	Type of survey: Road surface	Type of survey: Mixtures	Major survey methods fit for evaluation
Rutting	Rutting due to the flow of asphalt mixture		○	◎	Measurement of rutting and core sampling (properties of mixtures, spalling in lower layers and waterproofing property)
	Rutting due to friction		◎		Measurement of rutting
Cracking	Cracking due to the deterioration of bearing capacities of base and sub grade	◎	○	○	Measurement of cracking, measurement of deflection (FWD) and load bearing tests (in-situ CBR tests)
	Cracking due to the deterioration of asphalt mixtures		○	◎	Measurement of cracking ratio and check of properties of collected asphalt (penetration and softening point)
	Cracking due to differential settlement	○	○		Visual measurement of cracks and load bearing tests (in-situ CBR tests)
	Cracking due to thermal cracking		○	◎	Measurement of cracking ratio and check of properties of collected asphalt (ductility and brittle point)
	Cracking at construction joints		○		Visual measurement of cracks
	Reflective cracking	○	○	○	Measurement of cracking ratio, measurement of deflection (FWD) and properties tests (collected asphalt and mixtures)
	Top－down cracking		○	◎	Measurement of cracking ratio, measurement of deflection (FWD, core sampling and measurement of properties of collected asphalt (penetration and softening point)
Deterioration of smoothness	Longitudinal irregularities and settlements	◎	○	○	Measurement of IRI (International Roughness Index), measurement of deflection (FWD) and load bearing tests (in-situ CBR tests)
	Corrugations, depressions and swells		○	◎	Measurement of IRI and core sampling (amount of asphalt)
Other	Potholes		○	○	Measurement of diameter and depth, visual observation (material segregation and spalling of mixtures) and core sampling (density)
	Deterioration of skid resistance coefficient		◎	○	Measurement using British pendulum testers, dynamic friction testers or skid measurement vehicles.
	Bumps		◎		Measurement of bumps using leveling cords
	Pumping	◎	○	○	Partial cutting (cracks at lower layers), measurement of deflection (FWD) and core sampling (spalling at lower layers)
	Raveling		○	◎	Visual observation (stripping) and core sampling (density)
	Cutback due to oil leakage		○	○	Confirmation of the range and property tests (collected asphalt and mixtures)

Legend) Survey methods ◎ : Surveys required for detailed identification
○ : Surveys required to generally grasp pavement damage conditions

Reference: NEXCO - Design Guidelines (pavements)

1.2.5.3 Survey Levels

The levels of surveys are listed in Table 1.2-7. Detailed surveys should be made appropriately to identify the damage to pavements in detail. Surveys are generally conducted at levels 1 through 4 in numerous cases. The higher the level of survey, the more detailed information is obtained. Level-1 basic surveys should be made in any case. In level-2 surveys, the degree of damage is evaluated quantitatively. Level 3 is conducted in the case where further investigations are required. Level-4 investigations are intended to investigate the causes in detail.

Table 1.2-7 Items and levels of surveys of damage

Survey item	Level of survey			
	Survey level 1	Survey level 2	Survey level 3	Survey level 4
Rutting	Visual observation	Rutting	Core sampling, Deflection, Extraction and property tests	Testing of dynamic stability of cut samples, Cut and cover tests
Cracking	Same as above	Cracking ratio, Crack width	Core sampling, Deflection, Extraction and property tests	Cut and cover tests
Smoothness	Same as above	Smoothness		
Potholes	Same as above			
Bumps	Same as above	Depth of bump		
Other	Same as above			

Reference: Japan Road Association, Manual for Asphalt Pavement

1.2.6 Road Surface Survey Methods by Damage Type

Road surface surveys cover such items as rutting, cracking, smoothness and bumps. The survey methods are described in detail below.

1.2.6.1 Rutting

1.2.6.1.1 Measurement of Rutting with Leveling Cords

A leveling cord was set as a reference (Figure 1.2-2). The line that links the inside ends of lane marks on both sides was defined as a reference height. In order to eliminate the margin of error due to a swell over the reference height, pieces of wood of several centimeters with the same thickness were placed. Measurements were taken at intervals of 20 cm or less. The transverse shape was measured in millimeters using a scale. The method is easy to use but may involve errors according to the person in charge of measurement. No mechanical records can be stored.

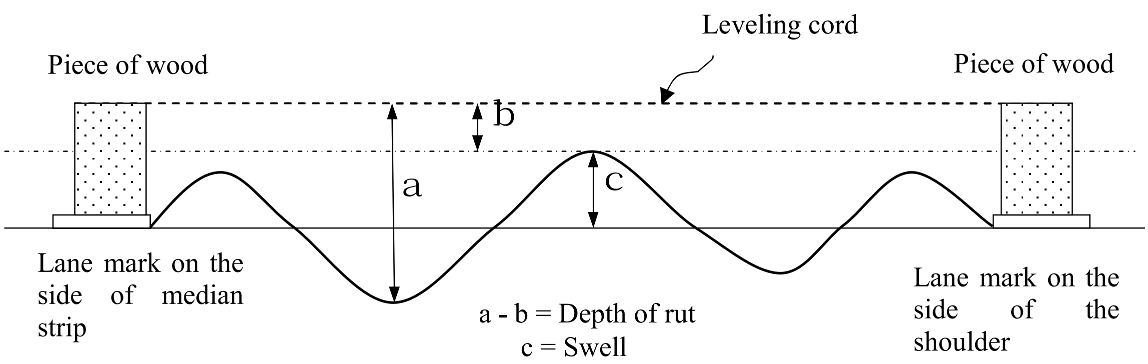


Figure 1.2-2Measurement of rutting with leveling cord

1.2.6.1.2 Method of Measurement Using Transverse Profile Meter

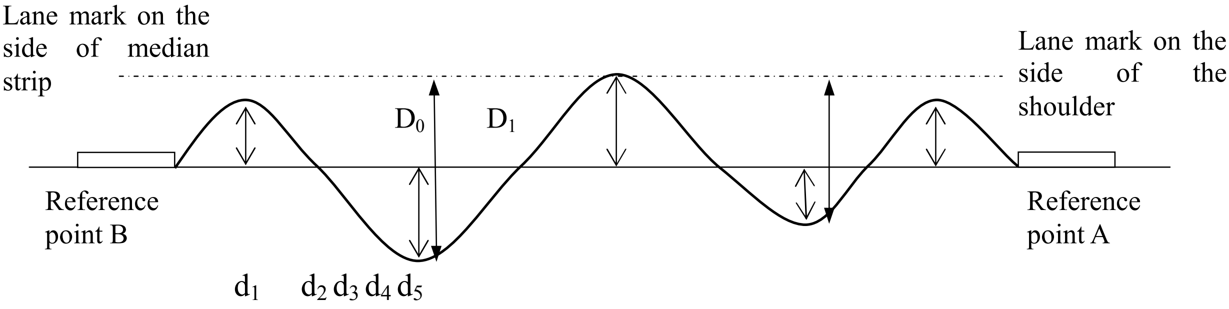
This method involves the mechanical recording of a transverse profile while moving along a beam (straight scale). The transverse profile meter is set so as to straddle the lane marks on both sides. Then, a scale is used to adjust the heights at both ends at the same level using adjustment screws. A waveform recorder is moved on the beam to record the transverse profile. The method requires much time for transport and assembly but enables mechanical recording of data.

Measuring rutting using a transverse profile meter

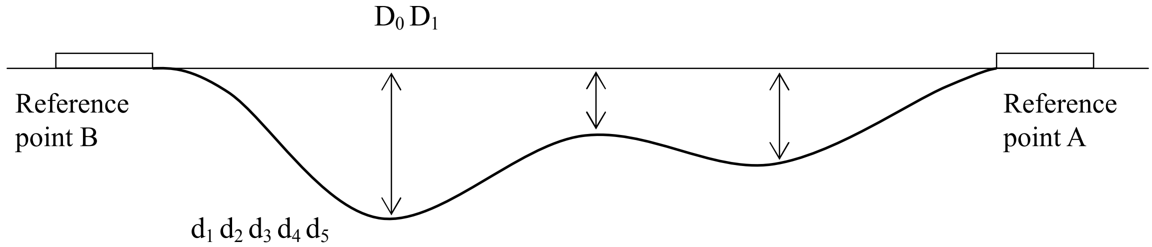
1.2.6.1.3 Calculation of the Results of Rutting Measurement

The results of measurement d1 through d5 are calculated in millimeters in each cross section Figure 1.2-3. The larger of D0 and D1 is defined as the depth of rut in the measurement cross section.

Example of rutting due to the flow of asphalt mixture



Example of rutting due to friction



Reference: NEXCO, NEXCO Testing Methods

Figure 1.2-3Definition of rut depth

1.2.6.2 Cracking

1.2.6.2.1 Methods for Measuring Cracks Using Sketches

Lanes are closed and plan views of areas where cracking occurred are developed using sketches. A two-dimensional diagram composed of meshes is prepared in advance. The lane width is divided into four and meshes are created at longitudinal intervals of 1 m. In order to make sure that cracks of 1 mm or larger are captured, cracks on the road surface are marked with a chalk before recording. Then, cracks are recorded on the preliminarily developed 2D diagram. At the same time, the locations of cracking are photographed. It is desirable that three to five people conduct surveys to minimize errors. The method enables accurate identification of the occurrence of cracks but requires much time. The method should therefore be used to a limited extent on roads that carry heavy traffic because there is a risk of traffic congestion.

1.2.6.2.2 Organization of the Results of Measurement of Cracks

Cracks are classified as described below when measurements are made using meshes.

Planar cracking means two or more cracks in a mesh. Linear cracking means only one crack in a mesh. Patching is applied in an area not wider than 100m^2 at any point except in places where large-scale replacement is done or a bump is removed. The areas actually patched are recorded.

Cracks are measured on asphalt pavements. The mesh size is set at 1 m times a quarter of the lane width. The cracking ratio is calculated by the following equation.

Cracking ratio (%) = Area of meshes with planar cracking (m^2) + area of meshes with linear cracking (m^2) x 0.3 + area of patching (m^2) x 1/area of study section (m^2)

Cracking ratio is calculated by the above equation based on the results listed in Table 1.2-8 Surface Cracking Survey Sheet based on sketches. Cracking ratios are obtained every 100 meters of lane length in principle.

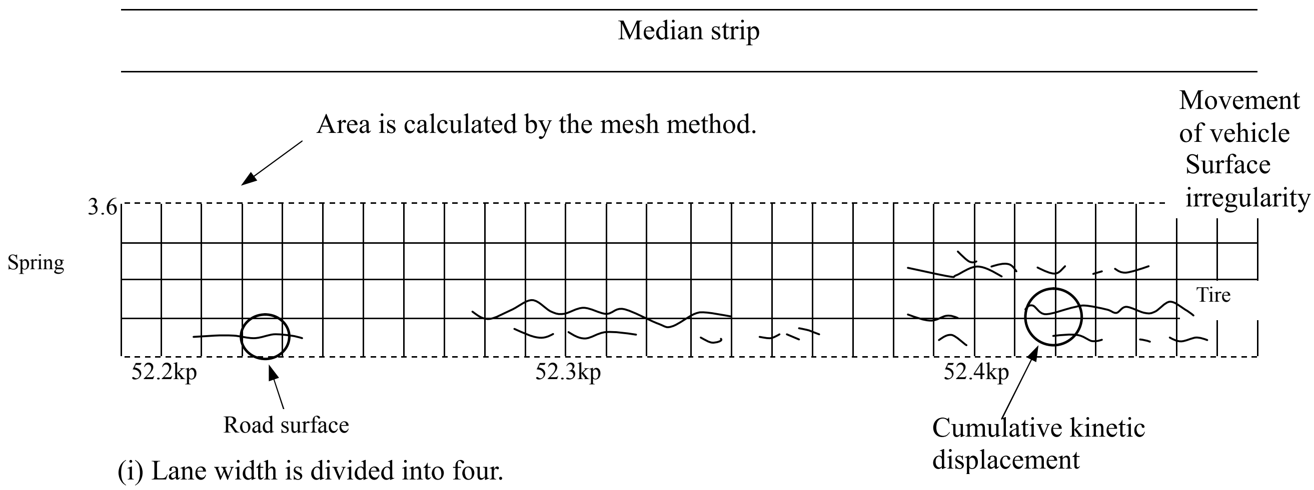
Table 1.2-8 Surface cracking survey sheet based on sketches (for reference)

<table>
<tr><td colspan="2">Name of administration office</td><td></td><td colspan="3">Date when the road is in service</td><td></td><td>Date of survey</td><td colspan="2"></td></tr>
<tr><td>Survey section</td><td>Up bound or down bound route</td><td colspan="2">Kp ～ kp</td><td colspan="2">Width</td><td>m</td><td>Site condition</td><td colspan="2">Fill, cut or bridge</td></tr>
<tr><td rowspan="2">Type of crack (check the applicable type)</td><td>Linear cracking</td><td></td><td colspan="3">Maximum crack width</td><td>mm</td><td rowspan="2">Type of lane (check the applicable type)</td><td>Nearside lane</td><td></td></tr>
<tr><td>Planar cracking</td><td></td><td colspan="3">Maximum crack width</td><td>mm</td><td>Passing lane</td><td></td></tr>
<tr><td colspan="10">Evaluation of cracked area</td></tr>
<tr><td>Person who made evaluation</td><td colspan="3">1</td><td>2</td><td>3</td><td>4</td><td>5</td><td colspan="2">Average (m^2)</td></tr>
<tr><td>Linear cracking (m^2)</td><td colspan="3">Mesh×1.0×0.9 *×0.3 **</td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Planar cracking (m^2)</td><td colspan="3">Mesh×1.0×0.9</td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>Total (m^2)</td><td colspan="3"></td><td></td><td></td><td></td><td></td><td colspan="2"></td></tr>
</table>

* A quarter of lane width

** Correction factor for linear cracking

Plan view of the points of cracking



(i) Lane width is divided into four.

(ii) Meshes are placed along the road alignment at intervals of 1 m from the 100-m kilopost.

Photographs are attached

Distance traveled

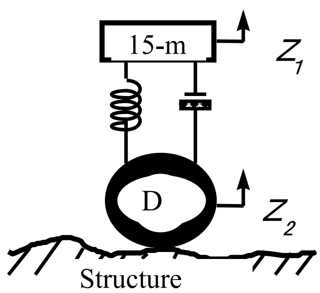
Reference: NEXCO, NEXCO Testing Methods

1.2.6.3 Method of Measuring Smoothness

The International Roughness Index (IRI) is generally used for evaluating smoothness. The IRI was first advocated in 1986 by the International Bank for Reconstruction and Development (World Bank), which then requested the University of Michigan Transportation Institute to build the evaluation index. The relatively new index enables the evaluation of a wide variety of surface from rough through smooth surfaces.

The longitudinal profile of surface is measured at intervals of 250 mm or less by any method and the collected data is analyzed by “Road Ruff”, an IRI analysis program.

The IRI is expressed as the value (mm/m) obtained by dividing by the distance traveled the cumulative kinetic displacement due to the vertical vibration in the case where a quarter-car simulation model travels on the surface on which data was collected. The quarter-car simulation model is composed of tire and spring elements (Figure 1.2-4) and behaves like an actual vehicle. The evaluation method is beneficial as it quantitatively shows the behavior. Higher IRI indicates greater vertical movement of the vehicle and poorer smoothness (ride quality). There is no international standard for the length in which the IRI should be measured. The IRI is measured at intervals of 200 m on the expressways in Japan.



$IRI = \Sigma \Delta Z / L$

- $Z' = Z_1 - Z_2$
- $\Delta Z = |Z'_i - Z'_{i+1}|$

- $\Sigma \Delta Z$: Approach to the structure
- L: Ex-Joint
  Joint in a bridge
- Z_1: Two-meter leveling
- Z_2: Dm

Figure 1.2-4Quarter-car simulation model for calculating IRI

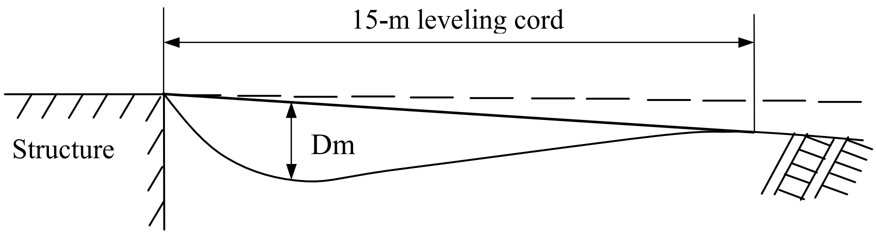
Longitudinal profiles required for calculating the IRI can be measured most accurately by level surveys. The survey method, however, requires much labor. IRI measuring vehicles shown below are therefore generally used in numerous cases.

IRI measuring vehicle: Dainichi Consultant Inc.

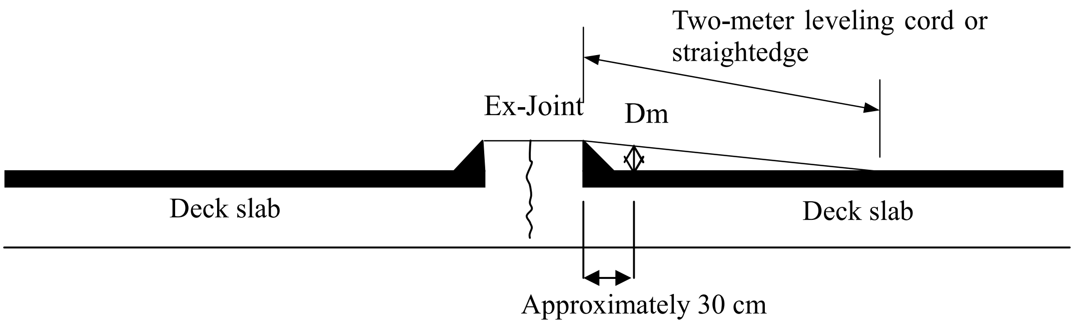
1.2.6.4 Method of Measuring Bumps

Leveling cords are used to measure bumps at the approach to a structure or at the joints on a bridge. Bumps are generally measured in the outside wheel path (OWP) in principle. Measurements are made at the approach to a structure or at the joints on a bridge to obtain the difference in level (maximum depth of settlement) at the locations shown in Figure 1.2-5. Leveling is adopted in the case of settlement with the length of transition exceeding 15 m at the approach to a structure. The results of leveling are organized using the bump survey sheet shown in Table 1.2-9.

Approach to the structure



Joint in a bridge



* Measurements are made using a 2-m leveling cord in the outer wheel path.

Figure 1.2-5 Method of measuring bumps

Table 1.2-9 Bump survey sheet (for reference)

Measurement point: approach to a structure ／ joint in a bridge Date of measurement Measurement made by

Structure	KP Up bound/ Down bound route	Lane	Settlement measured (cm)																						Maximum settlement (cm)	Remarks
			Distance	m	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	m 15.0		
○○ bridge	KP Up/Down	Travel/ Passing	OWP		1.8	2.2	2.4	2.5	2.8	3.1	3.9	4.6	4.9	5.2	4.6	4.0	3.7	3.3	3.1	2.5	1.8	1.3	0.6		5.2	
	KP Up/Down	Travel/ Passing	OWP																							
	KP Up/Down	Travel/ Passing	OWP																							
	KP Up/Down	Travel/ Passing	OWP																							
	KP Up/Down	Travel/ Passing	OWP																							
	KP Up/Down	Travel/ Passing	OWP																							
	KP Up/Down	Travel/ Passing	OWP																							

OWP: outside wheel path

1.2.6.5 Other Survey Methods

1.2.6.5.1 Method of Measuring Skid Resistance Coefficient

Skid resistance may be measured using the British portable tester or dynamic friction tester. For high-speed measurement in a wide area, skid resistance measurement vehicles are used. Skid resistance deteriorates due to bleeding or polishing. Functions are seldom restored by repair work.

Skid resistance measurement vehicle
；Nippon Expressway Research Institute Co. Ltd.

1.2.6.5.2 Road Surface Measurement Vehicles

In the case where a limited number of roads are serviceable and carry a relatively small volume of traffic, road surface is surveyed manually while lanes are closed to traffic. With the increase of the road length to be administered and of the traffic volume, road surface measurement vehicles are used that enable high-speed measurement for greater safety of workers and higher work efficiency. The development of road surface measurement vehicles was launched in Japan around 1985 for use on expressways. At present, road surface conditions are measured throughout the routes on all expressways in Japan at intervals of two to three years.

A high-speed road surface measurement vehicle used by NEXCO Central is shown below. The vehicle can simultaneously measure rutting, cracking and the IRI at any speed up to 100 km/hr. It is also technically capable of making three-dimensional evaluation of road surface at high density (at longitudinal intervals of 0.5m and transverse intervals of 0.1 m) using GPS and inertial measurement unit (IMU).

High-speed road surface measurement vehicle「Road Tiger」
；Central Nippon Highway Engineering Tokyo Co. Ltd.

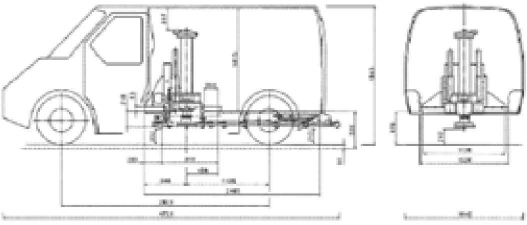
1.2.7 Methods of Surveying Pavement Structure

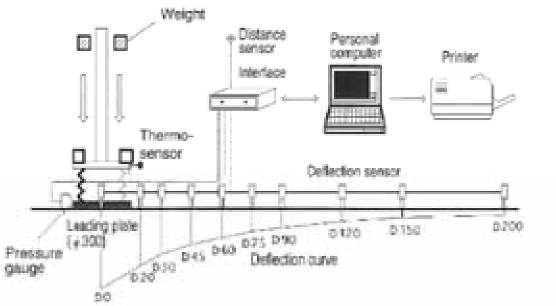
1.2.7.1 Surveys of Layers of Pavement

Structural damage frequently reaches the base course or sub grade. It is therefore important to start visual monitoring at the point when abnormal conditions are observed on the surface. The construction conditions for the base and sub grade should be identified based on the materials prepared in the initial stages of construction.

For evaluating the soundness of pavement structure, the degree of deflection is measured using a falling weight deflect meter (FWD). FWD measures the degree of deflection using multiple sensors that occurs on the surface when the surface is subjected to an impact produced by a falling weight. Dropping the weight at multiple points for measuring deflection causes the pavement to deflect around the points of loading. The shape and degree of deflection reflect the condition in the pavement. Evaluating the values of measurements enables the assessment of the soundness of the pavement.

In cases where no soundness of the pavement structure can be fully evaluated, core sampling or cut and cover surveys are adopted. Such a measure enables the verification of changes in thickness and material properties of layers constituting the pavement, load bearing capacity of the base, groundwater level and other parameters.





FWD（Falling Weight Deflect meter）
；Central Nippon Highway Engineering Nagoya Co. Ltd.

1.2.7.2 Surveys of Mixtures

Cores are sampled and the mixture materials and properties are surveyed in order to select the repair method or verify the degree of deterioration of mixtures. The tests fit for evaluation vary according to the mode of damage. Surveys should therefore be planned only after the state of damage to the pavement to be studied has been fully identified. Survey plans need to be developed that are suitable for the mode of damage based on Table 1.2-6.

1.2.7.3 Information Obtained in Surveys

Asphalt pavements are damaged by various factors such as the deterioration due to heavy traffic, aging with the lapse of time and changes in mixture property owing to water infiltration. It is therefore necessary to estimate the causes of damage based on the information obtained in various tests and to take necessary corrective measures. The types of surveys of pavement structures and mixtures, and the results of surveys are listed in Table 1.2-10.

Table 1.2-10 Methods of Surveying Pavement Structures and Survey Results

	Type of survey	Results of survey (information obtained)	Remarks
Pavement structure	In-situ CBR test	Load bearing capacity of base and sub grade	
	Measurement of the degree of deflection	Strength and load bearing capacity of layers of the pavement	FWD
	Core sampling	Deformation of layers, range of damage, properties of materials and mixtures, waterproofing property, density, bond between aggregate and asphalt, etc.	
	Cut and cover surveys	The same parameters as listed above, and load bearing capacity of base course, dynamic stability, moisture state of bed and sub grade, etc.	
Mixtures	Penetration and softening point	Deterioration and aging of asphalt	Asphalt extraction tests
	Ductility	Cracking resistance	Asphalt extraction tests
	Brittle point	Susceptibility to deformation at low temperature	Asphalt extraction tests
	Density (void ratio)	Susceptibility to flow of asphalt	
	Dynamic stability	Flow resistance	
	Grain size and amount of asphalt	Property as an asphalt mixture	
	Immersion tests	Waterproofing property of mixture	

1.3 Diagnosis and Maintenance and Repair Plans

1.3.1 Evaluation and Determination

Selecting sections or spots where maintenance or repair are required, prioritization, selecting methods of maintenance work, and the timing of implementation is determined based on the results of various surveys.

The targeted goals of maintenance and repair are defined as the status at which level the pavement conditions are recovered by maintenance or repair works. The target goals have been set as shown in Table 1.3-1 so as to maintain the road surface at a certain level, thus maintain road conditions satisfactory.

Table 1.3-1 Target Goals for Maintenance or Repair

Rut (mm)	Cracking ratio (%)	Difference in level including settlement (mm)		Smoothness (IRI) (mm/m)	Skid resistance coefficient (μV)
		Connection to the bridge	Connection to the transverse structure		
25	20	20	30	※(3.5)	※(0.25)

Reference: NEXCO, Design Procedure (pavement)

Operational guidance in using the above goals

- Smoothness index will not be evaluated in terms of IRI for the time being. Smoothness will be evaluated using the target level for the difference in level including settlement. Improvement works have yet reported to be implemented on expressways by the reason of the degraded skid resistance. For the time being, therefore, IRI and skid resistance coefficient will not be employed to trigger maintenance and repair.
- Potholes, depressions, twists and other local deformations on the surface should be repaired immediately based on the results of visual inspections rather than setting the target level for maintenance or repair because they usually demand urgent response.
- No target goals will be set for structural surveys or for the properties of mixtures because pavement damages are induced by multiple factors. Evaluation will be made in principle through comparison with those pavements of sound sate. It is therefore important to make evaluations based not only on the survey results but also observation of external conditions including the traffic and weather, road structure, spring water and geology, coupled with observations on the point of damage.

1.3.2 Maintenance or Repair Plans

Maintenance or repair ensures the performance of asphalt pavements during their service life and reduces pavements' life cycle costs. Appropriate maintenance or repair is therefore important. In planning maintenance or repair work, the areas that require corrective measures are prioritized based on the results of evaluation and rating of the pavement. Then, appropriate corrective work and implementation time are determined in high-priority areas. The above process is implemented for each road network and for respective projects. Compatibility should be achieved between the maintenance or repair plans in the network and in the project. Table 1.3-2 lists basic considerations in maintenance or repair planning.

Table 1.3-2 Basic Considerations in Maintenance or Repair Planning

Road network (maintenance or repair plans throughout the road network)	Project (maintenance or repair design in areas of implementation)
—	Initial design conditions
Pavement configuration (thickness)	Pavement configuration (thickness and material property)
Traffic volume	Traffic volume and axle load (wheel load)
History of maintenance and repair	History of maintenance and repair
Surface conditions	Surface property and mixture property
—	Load bearing capacity and strength of each layer

On asphalt pavements, their weaknesses are likely to surface during a rain in particular and the damage develops rapidly. When a damage is discovered, therefore, measures should be taken on a timely basis. Whether actions are taken in the initial stages of damage or not has a great bearing upon the rate of subsequent progression of damage. Repair such as patching and the application of crack seals should be made diligently in the early stages. Early repair is the key to the elimination of future large-scale repair.

1.3.2.1 Identification of Design Conditions

When selecting the repair method, designing the cross section to be repaired or selecting the material, design parameters such as load bearing capacity, pavement structure, property of pavement materials and traffic conditions should be identified quantitatively as required. It is also desirable to confirm the design conditions at the time of initial construction and the history of maintenance and repair. The objective is to help make appropriate decisions.

- Load bearing capacity and pavement structure

  Evaluating the load bearing capacity and pavement structure enables the determination of whether the damage is structural or functional. Estimating the value required for overlay sectional design also becomes possible. Whenever the degree of deflection is found to be extraordinarily higher than usual, it often turns out that the sub grade has insufficient load bearing capacity. In those instances, cut and cover surveys need to be implemented. The depth of layers in which damage prevails and the load bearing capacity of the sub grade are measured to collect data required for identifying the range of layers that requires repair and for designing the cross section.

- Properties of pavement materials

  For asphalt mixtures, the grain size, amount of asphalt and asphalt property are investigated. Water content and penetration are investigated in the base and sub grade. The material properties of asphalt mixtures are frequently investigated mainly in the case where the damage is determined to be of functional type. Then, identifying the asphalt mixture material properties enables appropriate selection of repair materials.

- Traffic loads

  Pavements are also damaged in numerous cases as cyclic loading exceeding the design traffic volume or excessive traffic loads act, breaking the equilibrium between the traffic load and the pavement structure. In the case of sectional design in the repair of structural damage in particular, it is desirable to identify not only the sub grade design conditions but also the traffic loads for appropriate sectional design. In the case of functional damage, grasping the extent of traffic load is also important.

- Design conditions at the time of initial construction and history of maintenance and repair

  The design conditions when the pavement was initially constructed are important at the time of sectional design during the repair of structural damage. The history of maintenance and repair is useful when selecting the repair method or the range of repair.

1.3.2.2 Selection of Repair Method

Major maintenance methods include the injection including patching, surface treatment and local replacement. The appropriate method is selected based on the survey results and repair plans. Major repair methods are replacement, local replacement, leveling, cutting and overlaying, and overlaying. Selection should be made carefully based on the survey results and repair plans. Major maintenance and repair methods for asphalt pavements are outlined in Figure 1.3-1 and Table 1.3-3.

The horizontal axis indicates the characteristics of functional and structural measures. The vertical axis indicates the range of layers with applicable measures. The maintenance or repair measures at the upper right are more of structural character and cover all the layers of the pavement. Those at the lower left on the other hand are functional measures and cover only the surface and base layers. Some of the functional measures are taken mainly under urgent conditions. The measures positioned in the left of the figure are more of urgent character.

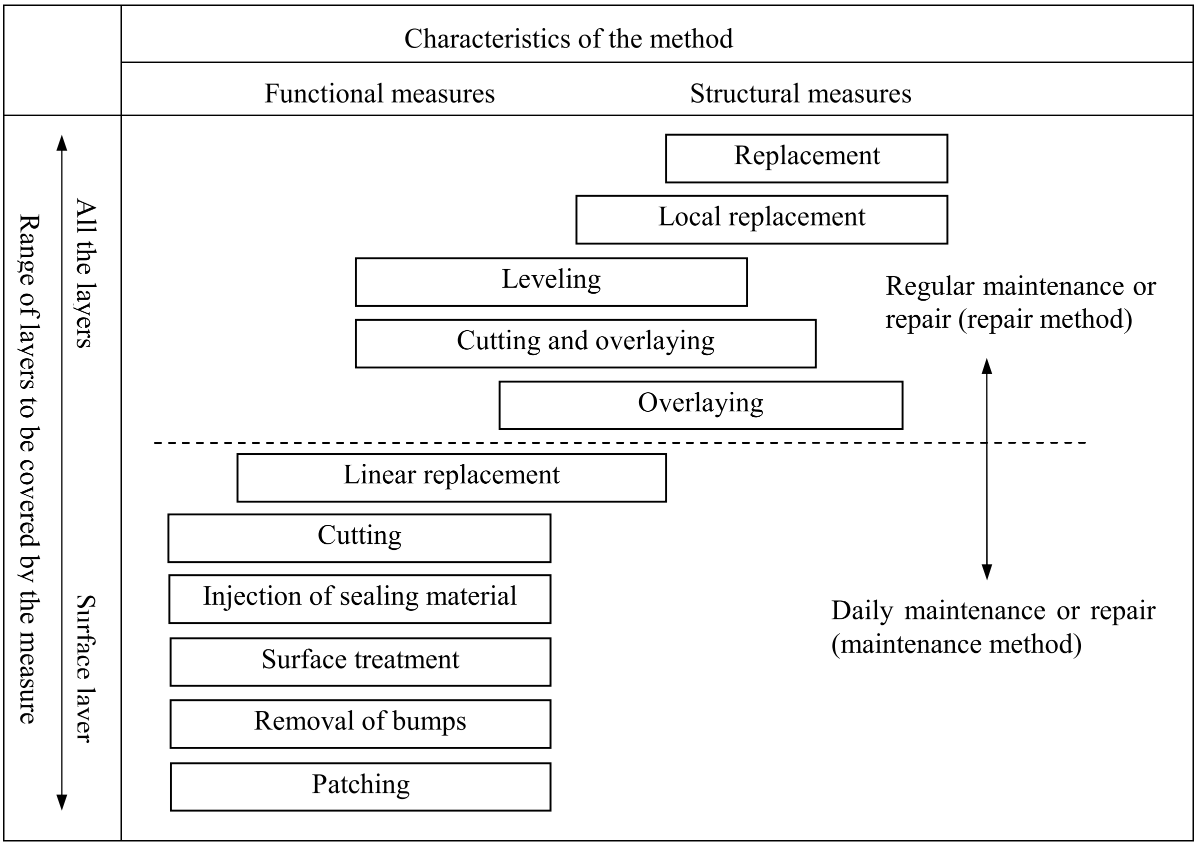


Figure 1.3-1 Major asphalt pavement maintenance and repair methods

Table 1.3-3 Outline of major maintenance and repair methods for asphalt pavements

Method	Outline
Replacement	The base course or part of the base course of an existing pavement is replaced. The sub grade may be replaced or the sub grade or base course may be stabilized in some cases.
Local replacement	In the case where the local damage to an existing pavement is determined to be great and no other method is expected to repair the damage, local replacement is done from the surface layer, base layer or base course. The method is frequently applied together with cutting and overlaying or overlaying in the areas where great cracking occurred locally.
Leveling	Modifications are made longitudinally by laying additional mixtures in longitudinal depressions on the surface produced by differential settlement. In planning, considerations should be given for guaranteeing the adequate height of safety fence, securing the drainage capacity and selecting appropriate regulation methods.
Cutting and overlaying	Existing asphalt mixture layers are removed by cutting, and the surface or base layer of the existing pavement is replaced.
Overlaying	Hot asphalt mixtures with a thickness of 3 cm or more are laid over an existing pavement. At locally faulty points, if any, replacement should be made first. If overlaying is adopted, the influences on the clearance gauge or the structures at the surface should be examined.
Linear replacement	The pavement is replaced along linear cracks. Only the hot asphalt mixture layers are replaced.

Method	Outline
Cutting	Bumps on the surface are removed by cutting to eliminate irregularities or the difference in level. The method is often implemented as a preliminary measure before overlaying or surface treatment.
Injection of sealing material	Joint fillers are injected into relatively wide cracks. Injection materials include emulsified, cutback and resin types. Various materials are used according to the width or depth of the crack.
Surface treatment	A sealing layer with a thickness of 3 cm or less is applied over the existing pavement using materials other than hot asphalt mixtures. The seal coat, slurry seal or resin-type seal method is available.
Patching and removal of the difference in level	Potholes, depressions and irregularities are temporarily filled. For filling, hot asphalt mixtures or cold mixtures using bituminous or resin binder are employed.

Considerations during the selection of the maintenance or repair method are described below.

- Types and causes of damage

  To which layer corrective measures are required is examined based on the results of inspections and detailed surveys. High degree of cracking or deflection needs particular attention because there is a high possibility of structural damage. In the case where serious rutting is found, caused by the flow of asphalt, removal of the layer is necessary that caused the rutting.

- Planar scale of damage

  It is necessary to determine whether the scale of damage is local or occurring at a wide area. Methods are chosen fitting to the scale of damage.

- Timing of maintenance or repair

  An appropriate timing should be determined considering the progression of the damage and the weather conditions.

- Roadside conditions

  The restrictions imposed by the roadside environment including the height of the existing pavement and houses in the vicinity should be examined.

- Traffic conditions

  It should be determined whether or not the cross section of the existing pavement is adequate under the present traffic conditions.

1.4 Maintenance and Repair Work

1.4.1 Major Daily Maintenance and Repair Work

Pavements are treated either by maintenance or repair. Maintenance is not intended for fundamental restoration from the damage to the pavement but only for the maintenance of serviceability of the pavement by temporary measures. The asphalt pavement maintenance measures include patching, injection of sealing materials, surface treatment, cutting and linear replacement. No discussions will be made here on surface treatment because there have been no cases of application of the method on expressways.

1.4.1.1 Patching (removal of the difference in level)

In patching, potholes, bumps, local cracks and depressions are temporarily filled with asphalt mixtures. The objective is to control the deterioration of load bearing capacity due to water infiltration and to improve ride quality on a temporary basis. A simple method is for embedding asphalt mixtures or other materials direct into the fault without applying any pre-treatment. In another method, faulty areas are removed by cutting and backfilled with asphalt mixtures. The former is adopted in the case where urgency is required. Patching is applied either by hot mixing or by colt mixing.

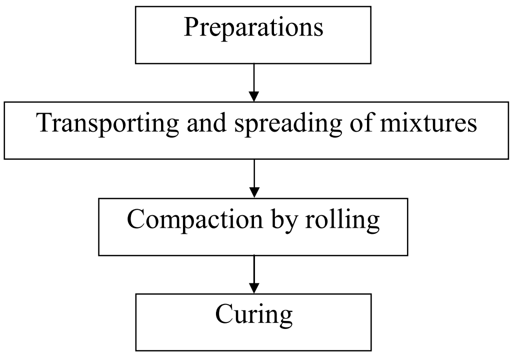


Figure 1.4-1 Flow of Patching Steps

1.4.1.1.1 Patching by Hot Mixing

In the patching by hot mixing, potholes, bumps and depressions are temporarily filled with hot asphalt mixtures. The method is fit for the maintenance or repair of roads that carry heavy traffic of large vehicles because it provides excellent bond with the existing pavement and high durability and stability. For the hot asphalt mixtures used by the method, materials similar to those used on the existing pavement should basically be adopted.

- Preparatory work

  Damaged and faulty sections are removed using a concrete cutter and their shape is trimmed. When repairing small areas such as potholes, no cutting is required. Then, dust and mud in or around the cut face are removed. Then, a tack coat is laid on the bottom and side surfaces. The excess tack coat staying in depressions are wiped off with a cloth or by other means.

- Transport and spreading of mixtures

  Only a small amount of mixture is generally used. The mixture is covered with membranes during the transport to prevent temperature drop. The mixture is spread so that the finished level may be approximately one centimeter higher than the road surface surrounding the faulty spot, taking into account of settlement after the commencement of service.

- Compaction by rolling

  Small road rollers or plate compactors are used for compaction.

- Curing

  The surface is cured until it becomes possible to touch with a hand.

- Matters to be taken care of

  In the above patch work, the point to be repaired needs to be cleaned and a wet surface needs to be completely dried. The work should be carried out quickly to obtain the designated compaction temperature. Heating by burners should be minimized even where necessary.

1.4.1.1.2 Patching by Cold Mixing

The method of patching by cold mixing can be implemented at the room temperature. It is easy to implement and is therefore adopted in emergency. The method is inferior to the hot mixing method in initial stability and durability, and moreover, it needs the period of curing.

- Preparatory work

  Similar pretreatment is done to that in the method by hot mixing.

- Spreading of mixture

  Aggregate mixture is wrapped in bags. The mixture is spread so that the finished level may be approximately one centimeter higher than the road surface surrounding the faulty spot, counting the magnitude of settlement after the commencement of service.

- Compaction by rolling

  Small road rollers or plate compactors are used for compaction.

- Curing

  The road should not be put into service until the moisture and solvent of the bituminous material vaporize.

- Considerations

  The method is temporarily applicable on roads that carry heavy traffic of large vehicles if urgency is demanding.

1.4.1.2 Injection of a Sealing Material

The sealing material injection method involves the injection of an asphalt-type sealing material or a resin-type sealing material into cracks, which is applicable at room temperature. The method is adopted to temporarily suppress the deterioration of load bearing capacity due to water infiltration. The objectives of the method are to extend the service life of the pavement and to reduce the cost of pavement maintenance and repair.

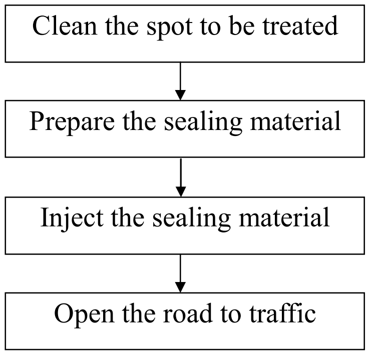


Figure 1.4-2 Flow of injection of a sealing material

1.4.1.2.1 Injection of an Asphalt-type Sealing Material

The method is used to treat the pavement by injecting a hot-mixed sealing material. Hot-mixed sealing materials are highly cohesive, adhesive and elastic, so they are well adaptive to swelling and shrinkage. Asphalt-type sealing materials are more cohesive than resin-type sealing materials that are described later. They are therefore suitable for cracks with a relatively large width of five to ten millimeters.

- Cleaning the spot to be treated

  The faulty spot is cleaned by blowing off the dust or mud in cracks using compressed air. The loosened areas around the crack are removed.

- Preparation of the sealing material

  The sealing material is melted by heating.

- Injection of the sealing material

  The sealing material is poured into the crack and made to penetrate into the crack using a U-shaped tool. Excess material is scraped off with a tool and the surface is cast. Sand is spread as required to prevent the adhesion to tires.

- Opening of the road to traffic

  The road is put into service after confirming that the sealing material has fully hardened.

- Considerations

  A wet surface is fully dried by heating with a burner before injection.

1.4.1.2.2 Injection of a Resin-type Sealing Material That Hardens at Room Temperature

The method is used to treat the pavement by injecting a resin-type sealing material that hardens at the room temperature. The sealing material hardens quickly and even at low temperature. Thus the material provides high workability including flexibility and traceability along the crack. The method is therefore applicable to narrow cracks of 5 mm or less.

- Method of patching

  The method similar to that for asphalt-type sealing materials is used. No preparation of a sealing material is, however, required.

- Considerations

  When the sealing material penetrates and cause settlement, additional volume of material is injected again according to the degree of settlement. Resin-type sealing materials are generally more costly than the asphalt type. They should be used within the designated working life. A wet surface should completely be dried by heating with a burner or other device before injection.

1.4.1.3 Cutting

Cutting is used to scrape off the projections on the uneven or irregular pavement surface. Bumps are scraped off using machines to restore the surface shape. The method is often adopted as a preparatory work before surface treatment or overlaying.

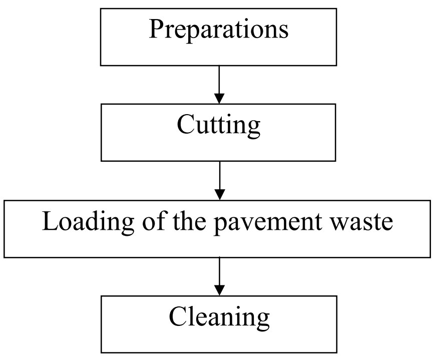


Figure 1.4-3 Flow of Cutting

- Preparations

Drainage basins are protected prior to surface cutting to prevent them from being clogged with the materials produced by cutting.

- Cutting

  Bumps are scraped for the designated thickness using surface cutters. Sufficient amount of water is sprinkled during cutting to control the production of dust during operation.

- Loading of the pavement waste

  The pavement waste produced by cutting is loaded on dump trucks using loading machines for transport to designated sites.

- Cleaning

  Road sweepers are used to completely clean the surface while sprinkling water to control the production of dust.

- Considerations

  The method is a temporary measure. On the surface where rutting due to the flow of asphalt or corrugations cause problems, therefore, irregularities are likely to recur early. The irregularities that developed in a short time in particular are highly likely to recur.

1.4.1.4 Linear Replacement

In linear replacement, the pavement is replaced along linear cracking. The method is generally applied only to asphalt mixture layers including the layers stabilized with bituminous materials.

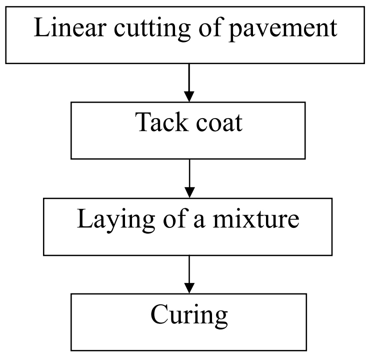


Figure 1.4-4 Flow of Linear Replacement

- Linear cutting of pavement

  The faulty sections with linear cracks are cut off. For cutting, a cutter is placed along the crack and the section is scraped off with a breaker or backhoe.

- Tack coat

  The cut spot is cleaned with a compressor and cured by evenly spreading emulsified asphalt using an engine sprayer. Then, the cut surface in the existing asphalt mixture layer is also fully coated with emulsified asphalt using a brush.

- Laying of a mixture

  A hot mixture is manually spread and compacted using a small vibratory roller or tire roller. Joints should be carefully compacted because the joints are likely to be compacted poorly, resulting in weak points.

- Curing

  The pavement is cured until the surface temperature drops below 50°C before opening the road to traffic.

1.4.2 Regular Maintenance and Repair Work

A type of regular maintenance or repair is the repair work. In the case where a pavement has been greatly damaged and keeping the surface under a structurally and functionally excellent condition is difficult, fundamental treatment is applied to the pavement through repair work.

Asphalt pavement repair methods include overlaying, cutting and overlaying, replacement and local replacement. All are more costly than maintenance.

The damage to pavements is caused by various factors. The repair method should therefore be adopted based on the materials including various survey results. The planar scope of the damage, timing of repair, and traffic and roadside conditions need to be examined carefully.

1.4.2.1 Overlaying (leveling)

In overlaying, an asphalt mixture layer is laid over the existing pavement. The method is applied in the case where the damage is expected to progress throughout the pavement in the near future or the pavement structure has become insufficient to carry ever increasing traffic. The method provides the following benefits.

- Increase in the load bearing capacity of the pavement or restoration of the load bearing capacity of a damaged pavement
- Functional restoration of surface smoothness or skid resistance
- Provision of additional functions

The thickness of the layer laid by the method is generally three to five centimeters unlike the thickness of carpet coat (applied by surface treatment) of 1.5 to 2.5 cm. Leveling is applied for restoring from functional damage in the areas subjected to differential settlement, however is not intended for structural reinforcement. In leveling, longitudinal modifications are made by laying new binders over depressions in the longitudinal direction.

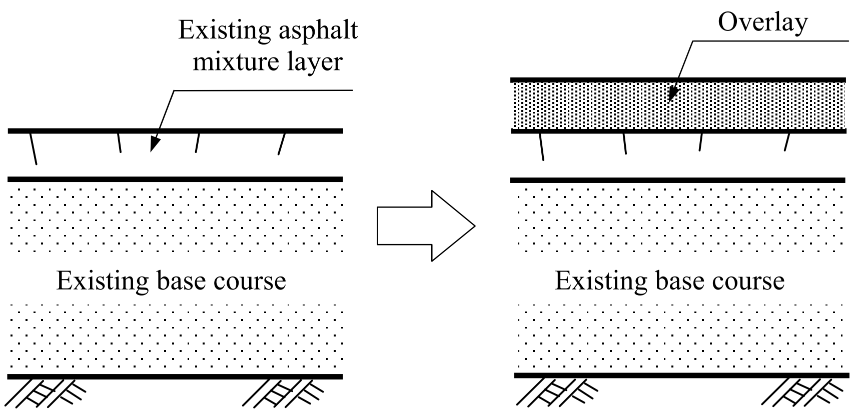


Figure 1.4-5 Conceptual View of Overlaying

The thickness of overlay is designed either by a method using the California Bearing Ratio (CBR) or by a method using deflection. Overlaying is a simple method for reinforcing the pavement structure that enables the improvement of layer equivalency factor by increasing pavement thickness. For adoption, it should be noted that the surface elevation increases and that the causes of damage have yet to be removed fundamentally.

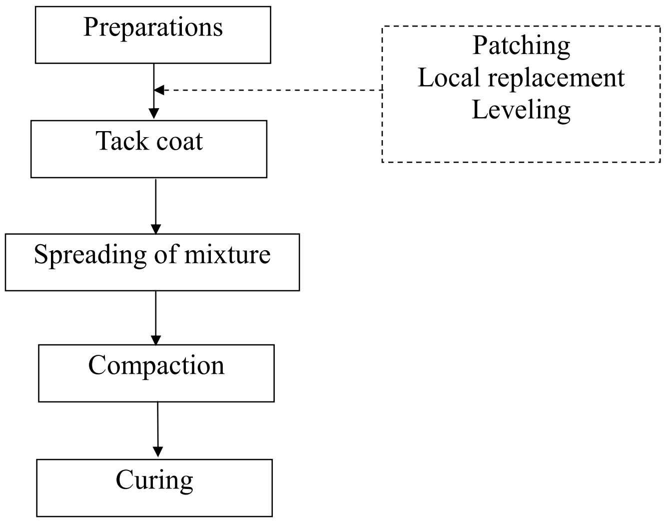


Figure 1.4-6 Flow of Overlaying

- Preparatory Work

  In the case where there are damaged areas or irregularities on an existing pavement, patching, leveling, local replacement or other measure is taken according to the condition before overlaying. For overlaying, the surface is cleaned, dust or mud is removed and a tack coat is applied. In leveling, cutting is required for a depth of approximately 20 mm for connection to secure the minimum pavement thickness at the end.

- Tack coat

  A designated amount of emulsified asphalt is evenly spread using distributors or other devices. At the end point of cutting, spreading is done manually or using simple pump spreaders. Care should be exercised to prevent emulsified asphalt from staying on the existing surface.

- Spreading of a mixture

  The mixture is usually spread using asphalt finishers, or manually in areas where no finishers can be used. The mixture is spread so as to achieve the designated thickness after compaction. If it starts raining while spreading the mixture, spreading should be suspended. The mixture that has been spread should be compacted quickly and finished.

- Compaction

  The mixture that has been spread is compacted so as to obtain the designated density. Compaction generally starts with joint compaction and proceeds to the primary and secondary compaction and ends with finishing.

  The primary compaction is done by two-time trips, or a back-and-forth trip, of a 10- to 12-ton roller. Compaction is carried out at the highest temperature possible as long as no hair crack occurs. The compaction temperature is generally 110 to 140°C. In order to prevent the mixture from adhering to the roller, a small amount of water may be sprayed thinly over the surface using an atomizer.

  For the secondary compaction, eight- to 20-ton tire rollers or six- to 10-ton vibratory rollers are generally used. Compacting the mixture by tire rollers improves the interlocking of aggregates owing to the force of compaction as under traffic loading, and is expected to achieve a uniform density in the depth direction. Using vibratory rollers with appropriate loading, frequency of vibration and amplitude produces the designated degree of compaction in smaller numbers of times of rolling than using tire rollers. The secondary compaction is generally carried out at 70 to 90°C.

  Finishing is done to correct irregularities or eliminate roller marks. Tire rollers or road rollers should travel back and forth once. In the case where vibratory rollers are used for secondary compaction, tire rollers should preferably be employed for finishing. No roller should stay for a long time on the just-finished pavement.

- Curing

  The pavement is cured until the surface temperature drops below 50°C before opening the road to traffic.

- Considerations

  Overlaying is suitable for controlling relatively moderate cracks that occur on the pavement surface. In the case of the occurrence of numerous cracks that are likely to reach the base course or sub grade, replacement is preferable. After the completion of the leveling work, it is necessary to secure the adequate height of safety fence and the drainage capacity.

1.4.2.2 Cutting and Overlaying

Cutting and overlaying work involves the cutting of part of the existing asphalt mixture layer followed by overlaying. The repair method - cutting and overlaying- has recently been implemented most because it eliminates the need of increasing the surface elevation and wide availability of high-performance cutters. In cutting and overlaying work, unlike overlaying work, surface cutters are adopted. Surface cutters are classified into wheeled-type and crawler-type devices according to the mode of travel. Surface cutters equipped with a loading machine are generally used.

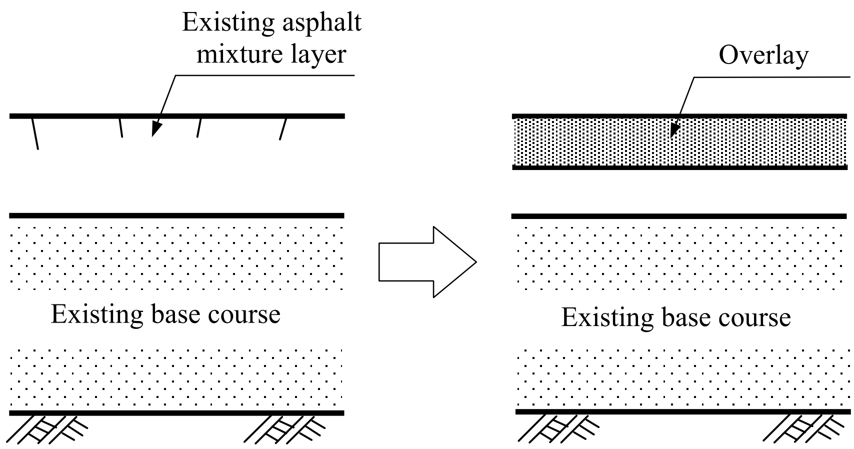


Figure 1.4-7 Conceptual View of Cutting and Overlaying

Cutting the surface and loading the pavement waste

↓

Cleaning

↓ ← Elimination of the difference in level

Tack coat

↓

Spreading of mixture

↓

Compaction

↓

Curing

Figure 1.4-8 Flow of Cutting and Overlaying

- Cutting the surface and loading the pavement waste

  Cutting the existing surface is generally done by using surface cutters. The areas around cutting should be separated by cutting with concrete cutters. The pavement waste produced by cutting is transported to the designated places on trucks.

Cutting and loading of the pavement waste

Cleaning

- Cleaning

  The debris produced by cutting is completely removed while spraying water to prevent drifting. It should be make sure that no debris is left in the ditches created by cutting.

- Tack coat

  Construction is carried out as in overlaying. In cutting and overlaying, care should be exercised to prevent the emulsified asphalt that constitutes the tack coat from staying in the ditches created by cutting.

Tack coat

Tack coat (treatment at the edge)

- Spreading of mixture

  The spreading work is implemented as it is done in overlaying.

- Compaction

  The compaction work is implemented as it is done in overlaying.

- Curing

  The curing work is carried out as in overlaying.

Spreading

Primary compaction by a road roller

Secondary compaction by a tire roller

1.4.2.3 Replacement

In replacement, the existing pavement is partly or fully removed and a new pavement is constructed. The method is implemented in cases where the pavement has been seriously damaged and the damage has reached the sub grade or base course, or where the surface has a limited elevation. The types of damage to which the method is applied include the deterioration of the load bearing capacity of sub grade or base course and the rutting and cracking ascribable to settlement. The pavement is replaced from the surface to the layer with considerably deteriorated strength. In the case where the base course has suffered from the deterioration of load bearing capacity, the pavement is replaced using excellent materials or is stabilized.

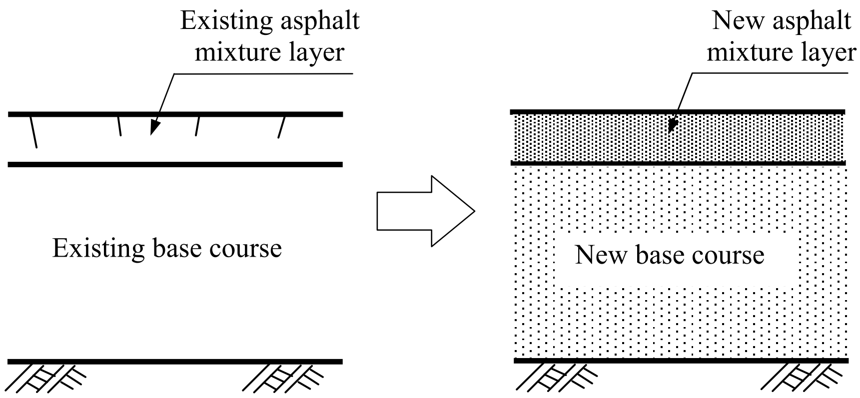


Figure 1.4-9 Conceptual View of Replacement

Demolishing an existing pavement and transporting the pavement waster using a shovel loader.

Laying a prime coat on a lower base course using an engine sprayer.

Preparations
↓
Demolition of existing pavement and transport of the pavement waste
↓
Construction of a lower base (granular lower base)
↓
Prime coat
↓
Construction of an upper base (base stabilized with bitumen)
↓
Tack coat
↓
Construction of surface and base layers

Figure 1.4-10 Flow of Replacement

- Preparations

  The points of replacement (e.g. start and end points and longitudinal joints) are specified explicitly.

- Demolition of the existing pavement and transport of the pavement waste

  The edge of the area to be replaced is cut to the designated depth by a cutter. The existing asphalt mixture is pulled up with a cutter or breaker and fragmented. The existing asphalt mixture that has been fragmented with a shovel loader or backhoe is loaded on dump trucks and transported to designated places. The sub grade is to be treated carefully so as to finish it as smooth as possible.

- Construction of a sub-base (granular sub-base)

  Irregularities on the cut surface are corrected using a bulldozer or grader while confirming the elevation of finished sub grade. The base course materials delivered by dump trucks are spread by bulldozers. Compaction is done using a road roller or a tire roller. The edge is corrected manually and carefully compacted with a rammer or other equipment.

- Prime coat

  A designated amount of emulsified asphalt is spread evenly with an engine sprayer and cured. When spreading, protection is provided using concrete panels or other materials to prevent the emulsion from drifting.

- Construction of a base course (base stabilized with bitumen)

  Construction is carried out as in overlaying.

- Tack coat work

  Emulsified asphalt is evenly spread with a distributor and is cured. When spraying the emulsion, protection is provided using concrete panels or other materials to prevent the emulsion from drifting.

- Construction of wearing course and binder course

  Construction is carried out by the same manner as is done in overlaying. When the binder course temperature drops to approximately 50°C, the tack coat works and the wearing course work are undertaken. The work is done as in overlaying. When the wearing course surface temperature drops to approximately 50°C, the pavement is opened to traffic. Then, pavement markings are placed using dedicated machines by a separate work.

1.4.2.4 Local Replacement

Local replacement of the wearing course, binder course or sub-base is one of the measures employed when the existing pavement is greatly damaged locally by cracking or other factors and suffered from structural damage as revealed by the preliminary survey... The method may sometimes be implemented in areas that suffered serious local damage before overlaying or "cutting and overlaying" is implemented.

Small cutter

Loading the pavement waste using a shovel loader

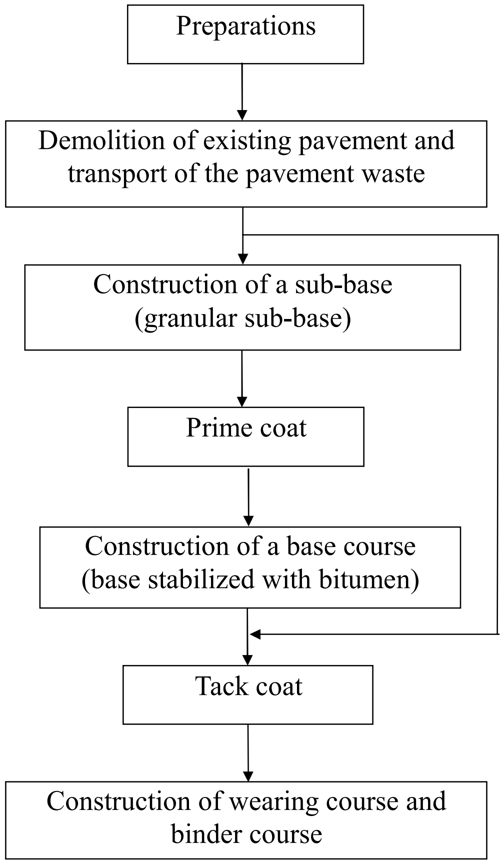


Figure 1.4-11 Flow of Local Replacement

- Preparatory work

  The points of replacement (e.g. start and end points and longitudinal joints) are to be marked.

- Demolition of existing pavement and transport of the pavement waste

  The edge of the area to be replaced is cut to the designated depth by a cutter. The existing asphalt mixture is pulled up with a small cutter or breaker and fragmented. The existing asphalt mixture that has been fragmented with a backhoe or shovel loader is loaded on dump trucks and transported to designated places.

- Construction of a sub-base

  Irregularities on the cut surface are corrected manually or using a backhoe while confirming the elevation of finished sub grade. The base course materials that are delivered by dump trucks are spread manually or using a backhoe. Compaction is done carefully with a rammer or plate compactor.

- Prime coat

  A designated amount of emulsified asphalt is spread evenly with an engine sprayer and is cured. When spreading, protection is provided using concrete panels or other materials to prevent the emulsion from drifting.

- Construction of a base course (base course stabilized with bitumen)

  The mixture is spread manually and compaction is done carefully using a rammer or plate compactor to construct the upper base.

- Tack coat work

  A designated amount of emulsified asphalt is spread evenly with an engine sprayer and cured. When spreading, protection is provided using concrete panels or other materials to prevent the emulsion from drifting.

- Construction of wearing course and binder course

  The binder course mixture is manually spread, and carefully compacted using a rammer or plate compactor to construct the binder course. Then, a tack coat is applied. The surface layer (wearing course) mixture is manually spread, and carefully compacted using a rammer or plate compactor to construct the surface layer. Pavement markings are placed with a line marker. When the pavement surface temperature drops to approximately 50°C, the pavement is opened to traffic.

- Considerations

  Local replacement is prone to cause settlement after the road is opened to traffic. Careful compaction is required in construction. Settlement is likely to occur at the edge in particular. It is therefore desirable to place the finished surface of the surface layer approximately 0.5 cm higher than the existing pavement. When two or more layers are constructed, the overlapping of joints should be avoided and the upper layers should be removed with a wider margin to facilitate compaction (Figure 1.4-12).

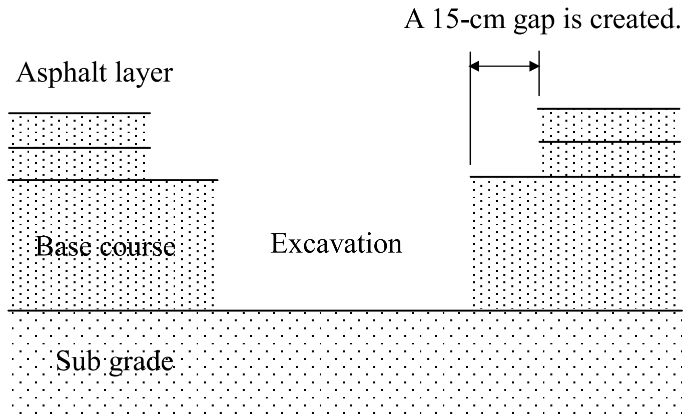


Figure 1.4-12 An indicative sample cross section of excavation in local replacement work

1.4.3 History of Maintenance and Repair

Keeping the records of maintenance or repair is important in assessing and establishing future maintenance or repair plans. Activities of surveys, planning, design, implementing maintenance and repair, evaluation, and research on pavements are interconnect each other. It is therefore desirable to make sure that valuable data is accumulated not only during construction but also during maintenance or repair. Table 1.4-1 gives a sample sheet for recording maintenance or repair work.

Table 1.4-1 Format for recording maintenance or repair work

Date of maintenance or repair		Route	
Site		Chainage/ Milestones	～ (up bound, down bound)
Type of damage		Severity of damage	Severe, medium, small
Method of maintenance or repair			
Load bearing capacity of sub grade		Design traffic volume	
Cross section and materials used	Status Before maintenance or repair		Status After maintenance or repair
Special note	＊Enter particulars concerning the preliminary surveys, materials used, etc.		
General view of the site			

1.4.4 Recommendations for Construction

Asphalt pavements require timely and adequate provision of maintenance or repair after the commencement of service. Timely assessment on present status of structure, performance decline, safety and the applicability of new technologies is mandated to make a decision on implementing maintenance and repair. In the above assessment, consulted are records during construction and maintenance and repair. It is also necessary to continuously improve the technology for design, construction and maintenance or repair by analyzing life cycle costs. The records of maintenance and/or repair, together with inspection and survey records, are statistically processed for use to predict future performance of the pavement at the site. It is important to use the records so as to track them back to the design method at the time of construction.

1.5 Traffic Safety Measures

1.5.1 Traffic Safety Measures

Traffic safety measures are important during the inspection, survey or maintenance or repair work on expressways because other passenger vehicles travel in the vicinity at high speed during the work. Traffic safety measures on expressways under different conditions are described in this section.

1.5.1.1 Basic Matters Observed on Duty

1.5.1.1.1 Safe Driving

- The driver on duty should be fully aware that he or she is one of the road administrators and strictly observe rules of driving safely.
- Vehicle occupants should make sure to wear the seatbelt while traveling.
- The patrol or maintenance vehicles should have marked visible from other passenger vehicles.

1.5.1.1.2 Clothes, Equipment and Health Management

- Work clothes should be worn that enable easy movement.
- Specified protective equipment such as helmets, safety vests, safety shoes and whistles should be worn or carried.
- Health conditions should be checked before tasked to duty work and the work should be suspended in case of bad health.

1.5.1.1.3 Parking and Stopping

- Hazard lights should be turned on while parking or stopping the vehicle.
- Full attention should be paid to other passenger vehicles when accelerating or decelerating.
- The vehicle should park in an area with a wide shoulder that provides good visibility as much as possible.
- Front tires should be directed sidewards, away from the traffic flow to prevent the vehicle from entering the lane when it is bumped rear-ended.

1.5.1.1.4 Traffic Control

- Traffic is controlled to ensure the safety of the work yard and workers.
- Securing visibility by other passenger vehicles is important.
- The installation of traffic control equipment should be commenced at the upstream end.
- The removal of traffic control equipment should be commenced at the downstream end.

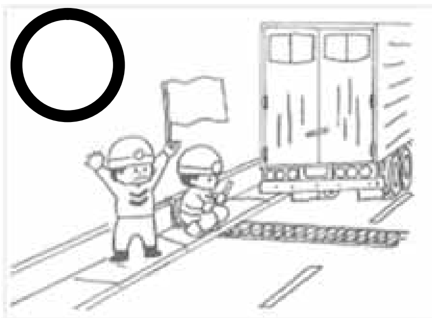
1.5.1.1.5 Work in Sections under Traffic Control

- It should be made sure that an inspector watches the behavior of other passenger vehicles.
- Workers should not work with their back turned to other passenger vehicles.
- Workers should not get out of the demarcated control area without due reasons while at work.

1.5.1.2 Traffic Safety Measures during Inspection or Survey

1.5.1.2.1 General

- Inspections and surveys should be conducted by at least two workers.
- One of the workers should command the attention of other passenger vehicles using a flag or other tool and secure the safety.
- The vehicle at work should be provided with markings and have its yellow revolving light turned on for differentiation from other vehicles.



One of the workers should be on the watch.

1.5.1.2.2 Considerations in Daily Inspections

- Visual inspections at a low speed should basically be conducted while traveling not on the passing lane but on the nearside lane.
- When an unusual spot is encountered, the vehicle should park on the shoulder after confirming safety, and an inspection should be made.
- In cases of emergency, safety should be secured at the site and the headquarters should be notified immediately for assistance.

1.5.1.2.3 Precautions to be taken in Routine inspections and Detailed Surveys

- Surveys using measurement equipment should be conducted while exercising due care to prevent the inspection/survey vehicle on duty from getting out of the lane closed to traffic.

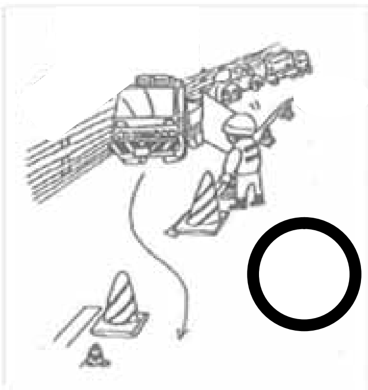
- It should be made sure that a separate inspector is deployed not to fail to confirm safety while others are preoccupied with inspection or survey.

1.5.1.2.4 Precautions to be taken in Emergency Inspections

- Emergency inspections should be conducted under the condition where the safety of the inspectors is fully guaranteed to prevent occurrence of secondary disasters.
- On-board visual verifications should be made at the lowest speed possible, so that serious damage is likely to be detected on the surface.
- When an unusual condition is detected, safety should be secured at the site and the headquarters should be notified immediately for help.

1.5.1.3 Traffic Control and Safety Measures during Maintenance or Repair Work

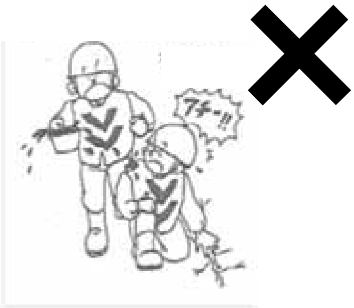
- An inspector should be assigned at the entrance/exit of the area closed to traffic to prevent the other vehicles from entering the area.
- Workers should work face to face with other passenger vehicles while working near an adjacent lane.

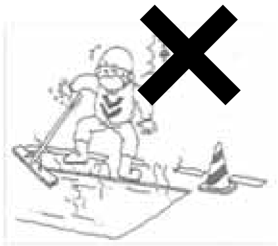


An inspector should be assigned at the entrance/exit to the area closed to traffic.

Worker should work face to face with other passenger vehicles.

- When handling hot crack sealing materials and pavement mixtures, protection should be provided against burn.
- When a cutter or breaker is used for cutting, concrete panels or other materials should be used to prevent broken pieces from spreading.



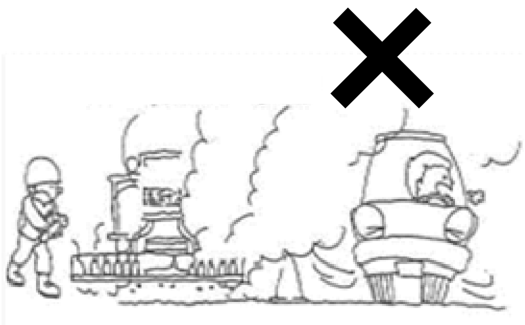


When handling hot materials, burn prevention measures should be taken.

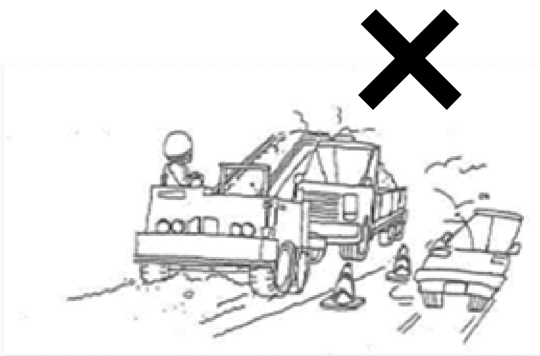
Protection should be applied to prevent the spreading of broken pieces.

When a heated cutter is used, the impacts of considerable smoke on other passenger vehicles should be minimized.

- When loading cutting waste, care should be paid to prevent the heavy machinery from getting out of the closed lane and to control the spreading of broken pieces.

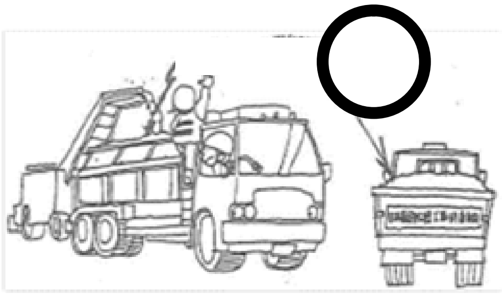


Considerable smoke causes accidents.

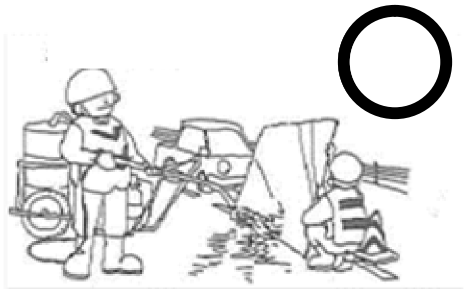


The spread of cutting waste should be strictly prohibited.

- The debris loaded on a dump truck for transport should be covered with a membrane to prevent spreading.
- When spreading bituminous materials, concrete panels should be installed to prevent the materials from spreading over other passenger vehicles.

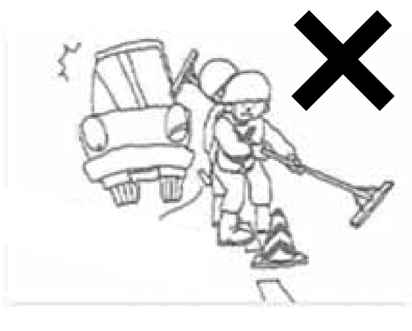


Loaded debris is covered with a membrane to prevent spreading.



The spreading of materials is prevented with concrete panels.

- In laying pavement mixtures by manual labor, an inspector should be assigned to prevent workers from getting out of the closed lane.
- When multiple heavy machines are used for work, an inspector should be assigned to prevent their mutual accidental contact.



Care should be exercised to prevent the extrusion of equipment from the work yard.

Accidental contact of heavy machines should be prevented.

1.5.2 Installations for Traffic Safety Measures

Necessary installation required to secure safety for duty maintenance workers engaged in inspections, surveys and maintenance or repair on expressways, are described. Those installations are to assure workers' safety from while other passenger vehicles traveling at high speed in the vicinity and inviting passengers' attention to the work in progress.

1.5.2.1 Installations for Controlling Traffic

- Arrow board

  Arrow boards should be installed near the upstream end of the area closed to the traffic to construct a taper. Boards should basically be placed at an interval of 20 m and eleven boards should constitute a taper for a length of 200 m. Arrow boards should sufficiently be heavy enough not to be blown away and sufficiently light enough to be carried easily.

Arrow board

Rubber corn

- Rubber cones

  Rubber cones should be placed along lane markings at intervals of 10 to 20 m to separate the closed and controlled work area from the vehicle travel zone. The length of installation distance should be determined according to the range of work. Rubber cones, like arrow boards, should be sufficiently heavy enough not to be blown away and sufficiently light enough to be carried easily.
- Traffic control vehicles

  The traffic control vehicle should be located near the arrow board at the upstream end to identify the work site and protect the work space. The vehicle should preferably show arrows and be equipped with a rotating light to identify the work site.
- Regulatory markers

  Regulatory markers should be installed to notify passenger vehicles of traffic control. Specifics and the positions of installation should be determined through the consultation with the road administrator.

1.5.2.2 Equipment for Traffic Safety during Work

- Flags

  Inspectors wave flags to invite attention of passenger vehicles traveling in immediate adjacency of the closed lane.

- Work Clothes and equipment to be carried on

  Workers should dress themselves so that they can move easily. They should wear a helmet to protect their head from flying objects. They should wear a safety vest to make themselves highly visible at long range. They should work in feet protection safe shoes other than slippers to ensure alertness and protection from heavy objects. Workers should carry a whistle for announcing danger over a long distance.

1.6 An Addendum: Maintenance or Repair of Concrete Pavements

Concrete pavements are more durable but also more costly than asphalt pavements. Concrete pavements have another drawback as compared with asphalt pavements. They require much time and cost for repair. Concrete pavements are, therefore, generally constructed in a tunnel or near the toll gate where repair work involves difficulties.

1.6.1 Types of Damage to Concrete Pavements

Damage to concrete pavements, like that of asphalt pavements, is classified into functional and structural types of damage. The types and states of damage to concrete pavements, and the main causes of damage are listed in Table 1.6-1.

Table 1.6-1 Types of Damage to Concrete Pavements

Type of damage		State of damage	Major causes	Damage classification	
				Functional	Structural
Wear	Raveling	Wear by tire chains	Wear by tire chains	◎	
	Polishing and scaling	Scaled road surface	Abrasion of rough-finished surface, use of soft aggregate and freezing and thawing	◎	
Cracking	Cracks in corners and longitudinal and transverse cracks	Cracks in the corners of a slab, and longitudinal and transverse cracks	Inadequate structure or functions of joints, insufficient slab thickness, differential ground settlement and fatigue failure	○	○
	Cracks near a transverse structure	Cracks near a transverse structure	Differential settlement of the structure and base course, and stress concentration because of the structure	○	○
	Map cracks	Crack expansion in a grid pattern	Development of cracking		◎
Deterioration of smoothness	Deformation	Longitudinal irregularities	Differential ground settlement	◎	
Damage to joints	Damage to joint materials	Protrusion of joint materials	Aging of joint plates, extrusion of joint materials and pumping of base course materials	◎	
	Damage to the edge of joint	Cracking at joints	Inadequate structure or functions of joints	◎	
Other	Difference in level	Irregularities near a structure and difference in level on a slab	Differential ground settlement, and inadequate functions of dowel bars and tie bars.	◎	
	Blowup and crushing	Swelling of the slab at joints	Inadequate structure or functions of joints		◎
	Swelling of the slab		Insufficient thickness of the layer for controlling frost heave		◎

Legend Damage classifications ◎ : This classification is highly likely to be applicable.
○ : Either classification is likely to be applicable.

Reference: NEXCO, Design Protocol (pavement)

1.6.2 Main Causes and Mechanism of Damage (Concrete Pavements)

Main causes of concrete pavements are attributable to the concrete slab itself, to the base course or sub grade, or to such external factors as the traffic and the weather conditions after the commencement of service.

On concrete pavements, cyclic traffic loading, changes in pavement temperature or other factors cause fatigue failure, which then induces damage. The breakage at joints or expansion of cracks deteriorates serviceability and causes damage. The damage to concrete pavements similar to that of asphalt pavements include cracking, difference in level and wear. In contrast, breakage at joints and buckling occur only on concrete pavements. On continuous steel-reinforced concrete pavements, cracking is not treated as damage but is taken as a defect in structural design. The damage to concrete pavements should be assessed in terms of various work types designed for pavements.

1.6.3 Major Survey Methods by Type of Damage (Concrete Pavements)

The typical survey and test methods for evaluating the damage to concrete pavements are listed in Table 1.6-2.

Table 1.6-2 Major concrete pavement survey methods by type of damage

Type of damage		Major survey methods fit for evaluation
Wear	Raveling	Measurement of the extent of rutting
	Scaling	Visual verification of scaling Strength verification by sampling
Cracking	Cracks in corners Longitudinal and transverse cracks	Verification of cracking by visual inspections or other means Measurement of deflection by FWD (Falling Weight Deflect meter)
	Cracks near a transverse structure	Verification of cracking by visual inspections or other means Measurement of deflection by FWD
	Map cracks	Verification of cracking by visual inspections or other means
Deterioration of smoothness	Deformation	Measurement using IRI (International Roughness Index)
Damage to joints	Damage to joint materials	Verification of quality of joint materials
	Damage to the edge of joint	Visual verification of scaling Measurement of deflection by FWD
Other	Degradation of skid resistance coefficient	Measurement using BPT (British Pendulum Tester), DFT (Dynamic Friction Tester) or a slip measurement vehicle
	Difference in level	Measurement of deflection by FWD and cut and cover
	Blowup and crushing	Measurement of deflection by FWD and cut and cover
	Swelling of the slab	Measurement of deflection by FWD and cut and cover

Reference: NEXCO, Design Procedure (pavement)

Measuring deflection using FWD enables the evaluation shown in Table 1.6-3. The FWD method is effective for evaluating the damage to and the soundness of concrete pavements.

Table 1.6-3 Items of Structural Evaluation of Concrete Pavements Using FWD

Evaluation item	Survey area	Parameter	Remarks
Distribution of loads on the concrete slab	Center	Curvature and flexural stiffness	The lower the curvature or the higher the flexural stiffness, the better.
Bearing capacity of base course	Center and at the edge of joint	Total deflection	The lower the deflection, the better.
Load transfer at joints or in cracked areas	At joints and cracked areas	Transfer coefficient of deflection	The higher the transfer coefficient of deflection, the better.
Existence of voids	Center and cracked areas at joints	Comparison of relative deflection	Voids are suspected in cases where relative deflection of the concrete slab is large despite no cracks observable on the slab.

Reference: NEXCO, Design Protocol (pavement)

1.6.4 Evaluation and Determination and Repair Planning (Concrete Pavements)

Concrete pavements are evaluated and rated by the same manner as described in “1.3.1 Evaluation and Determination” and in “1.3 Diagnosis and Maintenance and Repair Plans”.

There have been fewer cases of maintenance or repair of concrete pavements than those of asphalt pavements. Owing to concrete pavements’ high durability, no methods have yet been established for design and construction for maintenance or repair of concrete pavements. In the repair planning for concrete pavements, therefore, materials and methods for maintenance or repair should be selected considering the state of damage and construction conditions at the site.

1.6.5 Maintenance and Repair Methods (Concrete Pavements)

The maintenance and repair methods that have been applied to concrete pavements versus the types of damage are listed in Table 1.6-4.

Table 1.6-4 Maintenance and Repair Methods for Concrete Pavements

Mode of failure / Maintenance or repair method		Breakage at joints		Cracking		Difference in level	Wear					Structural damage (in cases where slab removal is required)
		Joint materials	Near the joint	Cracks not reaching the bottom surface of slab	Cracks reaching the bottom surface of slab		Raveling (rutting)	Polishing (slipping)	Scaling	Pothole	Voids under the slab	
Sealing and filling		○	○	○	○							
Patching			○						○	○		
Local replacement			○		○							
Local replacement that creates new joints					○							
Stitching using bars					○							
Leveling						○						
Cutting						○	○					
Jacking up						○						
Surface treatment	Thin layer pavement							○				
	Chipping with a scribbler, or by shot blast or water jetting							○				
	Cutting							○				
	Longitudinal and transverse grooving							○				
	Chemical treatment and high-pressure jet							○				
Overlaying	Asphalt mixtures				○		○	○				
	Cement concrete (SFRC)						○					
Cutting and overlaying	Cement concrete (SFRC)						○					
Injection											○	
Replacement	Asphalt pavements											○
	Concrete pavements											○
	Precast slabs											○

Reference: NEXCO, Design Protocol (pavement)

The concrete pavement maintenance and repair methods are outlined below.

- Sealing and filling

  Filling or injecting asphalt, cement or resin materials fill into cracks or joints.

- Patching

  The method involves the removal of existing pavement material in an area affected by cracking or other damage using a cutter, proper treatment of cut face and the repair with cement or resin materials.

- Local replacement

  Local replacement is applied in cases where cracks penetrated into the slab thickness near a joint or cracks occurred in corners.

- Local replacement creating new joints

  In cases where a crack fully crosses the lane at the center of the slab, a new joint is created in the cracked area and local replacement is applied.

- Stitching with bars

  The method is implemented in cracked areas or at joints with deteriorated load transfer capacity. Reinforcement is applied by installing connection materials that are cut in rectangular (e.g. D22 deformed reinforcing bars of 700 mm) and materials are also injected into the cracks.

- Leveling

  The method is used in the case where the lower layers of the slab are sound and suffer little deflection. The difference in level is removed using asphalt mixtures. Thin layers are applied, so care should be exercised to prevent the drop of mixture temperature and to apply adequate tack coating.

- Cutting

  An area where the difference in level occurred is cut to correct the difference. Care should be exercised to verify the soundness of the slab and when treating the area with defective edges created by cutting.

- Jacking up

  In the case where the difference in level accompanies voids under the slab, the voids are filled to remove the difference in level by jacking up.

- Surface treatment

  The method is employed to restore the skid resistance on the surface. Surface treatment includes re-grooving, thin film pavement, and cleaning by shot blast or water jetting.

- Overlaying

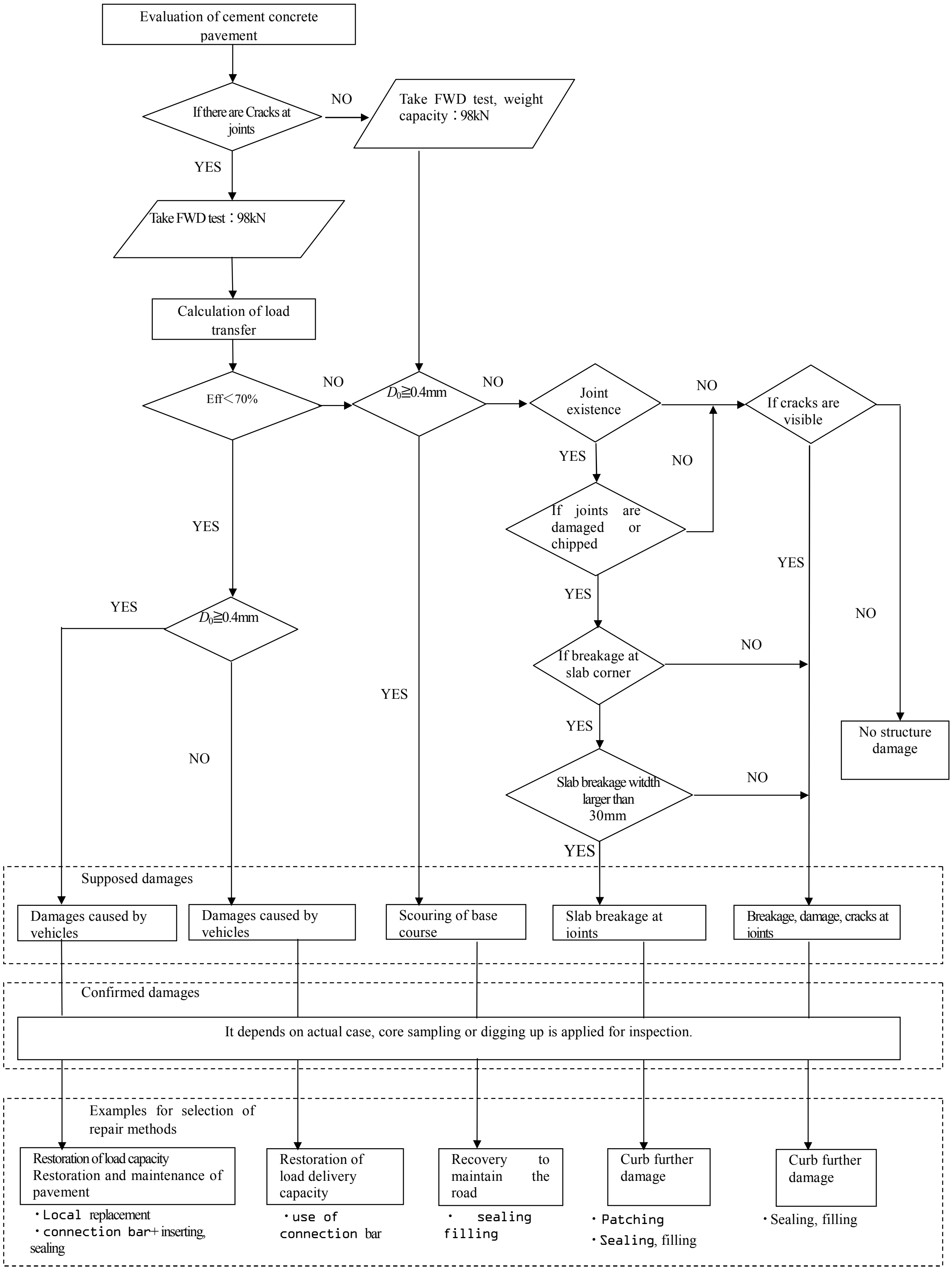
  The method uses either asphalt or cement mixtures. Asphalt mixtures are used more frequently because of the ease of construction and cost performance. Breakage is prevented and development of damage is preliminarily controlled by connecting slabs by stitching using bars or by injecting into moderate cracks.
- Cutting and overlaying

  The method is the same as cutting and overlaying on asphalt pavements. Full attention should be paid to varying capacity of cutting machinery according to the difference in material strength and also to the effects of cutting on wire mesh.
- Injection

  The method is implemented to fill the voids created between the concrete slab and base course and to push up the slab that subsided to the original level. Asphalt- and cement-type injection materials are generally available.
- Replacement

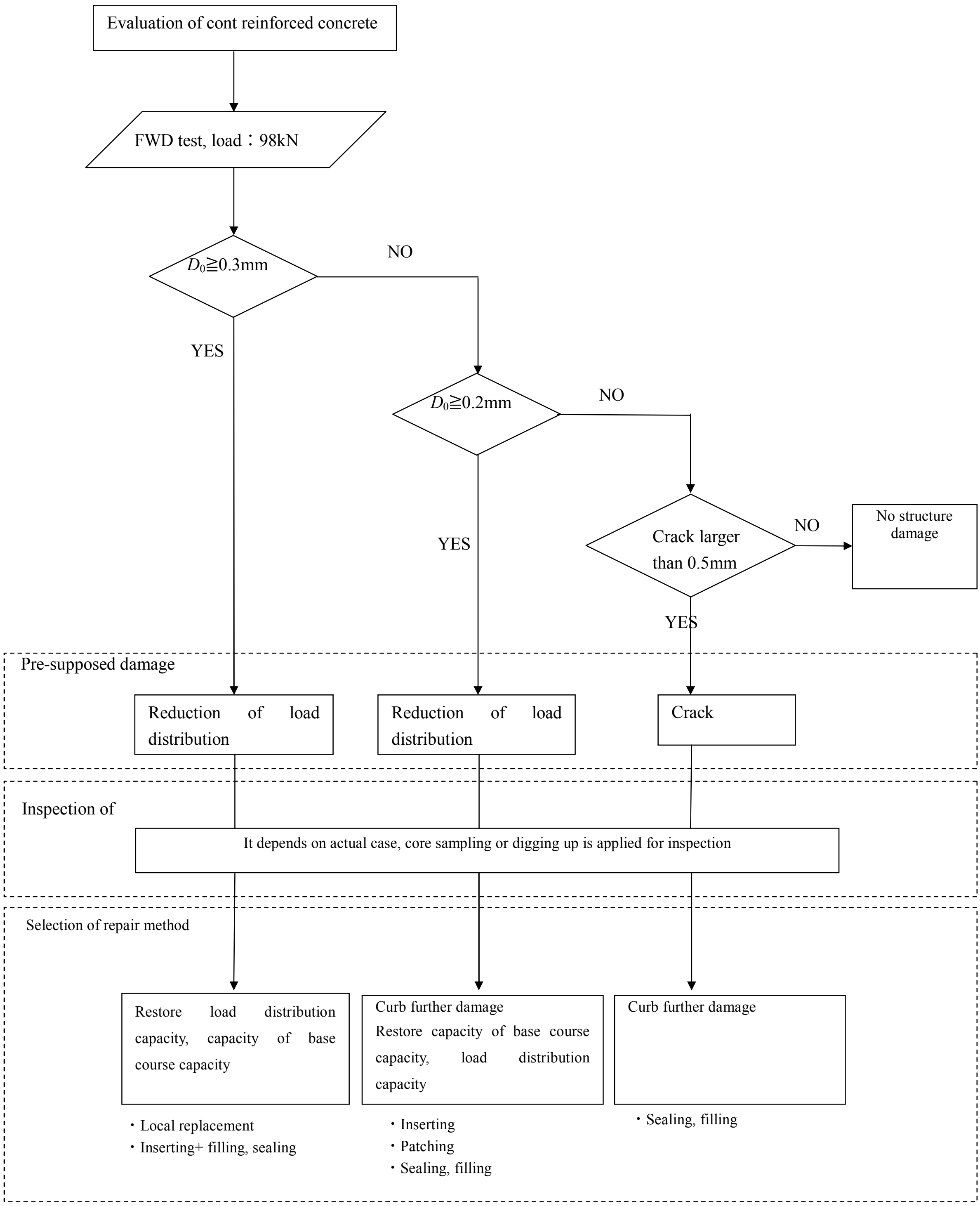
  Replacement is used for repair in cases where the existing concrete slab has been seriously damaged and no other methods are applicable such as maintenance and overlaying.

Cases of maintenance and repair on concrete pavement occurs less than on asphalt concrete pavement. It is due to the high durability of cement concrete pavement, currently there is no design and construction method for maintenance and repair of cement concrete pavement. Thus, for the repair and maintenance of cement concrete pavement, it is advised to select from the reference maintenance and repair in the diagram below. In planning the cement concrete pavement fixing, materials and repair methods are selected, based on a review of on-site damage conditions for rational maintenance and repair.



Reference: NEXCO, Design Protocol (pavement)

Table 1.6-1 Consideration of repair method (cement concrete pavement)



Reference: NEXCO, Design Protocol (pavement)

Table 1.6-2 Consideration of repair method (continuous reinforced concrete)

Directorate for Roads of Vietnam Japan International Cooperation Agency

The Project for Strengthening Operation and Maintenance System for Expressway in Vietnam

SECTION 2
TECHNICAL SPECIFICATION GUIDELINES FOR INSPECTION AND MAINTENANCE OF BRIDGE & CULVERT

Vietnam Expressway Management Office
JICA Experts Team

JUNE 2013

Table of Contents

2 Road Structures (Bridges, Box Culverts)

2.1 General

In implementing operation and maintenance works for structures on expressway, it is quite important that expressway operator shall formulate maintenance programs and properly carry out the maintenance activities in order to ensure satisfactory performance of road structures during expected service lives with experienced personnel and appropriate organization.

Terminologies used in this Chapter are defined in Table 2.2-1:

Table 2.1-1 Terminologies used for Maintenance Work of Road Structures

Terminology	Definitions
Maintenance Work	All the technical activities conducted so as to ensure the required level of service in structural performances during service lives.
Performance of Structures / Elements	Capacities to perform the required functions pursuant to the purposes and requirements.
Durability	Resistance to the reduction in performance capacities with time due to degradation of materials in structures under the specified service conditions.
Safety	No adverse effects to the lives / properties of road users and surrounding residents is required of the performance.
Inspection	All activities to investigate defect / damage on overall structures and structural elements for subsequent assessment.
Daily Inspection	Visual inspection conducted during daily patrol for early detection of defect / damage.
Routine Inspection	Inspection routinely conducted with visual observation and tools / equipment in order to maintain the structures in sound conditions.
Emergency Inspection	Inspection to check the safety of road structures when structures will be or were suffered from such disasters as earthquake, typhoon and heavy rain, and/or when defects and damage were found.
In-Depth Inspection	Inspection to obtain additional detail information, which is not available from daily / routine inspections.
Deterioration	General term of initial defect, damage and degradation.
Initial Defect	Defects such as crack / cold joint in concrete structure or welding crack in steel structure occurred during construction or immediately after construction. Defects observed after construction may be included if such defects are considered due to construction work activities.
Damage	Deterioration occurred within short period of time due to earthquake and collision with vehicles / vessels, not with time. Fatigue damage with external repetitive forces, though occurred for extended period of time, may be included. “Damage” will sometimes be used with the same meaning of “deterioration” in a broad sense.
Degradation	Various functions in the structure / element are degraded with time.
Repair	Measures taken to remove adverse effects to a third party and to restore / improve aesthetic appearance / landscape and durability. Included improvement of load-carrying capacity to a level the structure holds at the time of construction completion.
Reinforcement	Measures to increase load-carrying capacities to or greater than a level that such structures hold at the time of construction completion.
Life Cycle Cost	Total cost including all the costs for planning, design, construction, maintenance during service life and replacement (demolish cost included).
Primary Element	An element designed to carry the loads applied to the structure as determined from an analysis.
Secondary Element	An element in which the stress is not normally evaluated in the analysis.

2.1.1 Performance Requirements for Road Structures

Performance requirements for road structures shall be clearly defined prior to the maintenance activities.

(1) Performance requirements for typical road structures inspected are safety, serviceability, effects to a third party, aesthetic appearance / landscape and durability.

(2) Safety for the fracture of structural element, fatigue fracture and the overall stability of structure shall be inspected.

(3) Serviceability shall ensure comfort on use of structures by road users and surrounding residents as well as satisfactory levels of required performance for structures.

(4) Effects to a third party shall include injury to road users due to spalling of cover concrete and noise to the surrounding residents due to vehicle passage.

(5) Aesthetic appearance / landscape shall consider the degradation of performance to harmony with surrounding environments due to dirt / rust stain on surface and cracks.

(6) Durability on road structures shall be checked on four (4) performance requirements: safety, serviceability, effects to a third party, and aesthetic appearance / landscape.

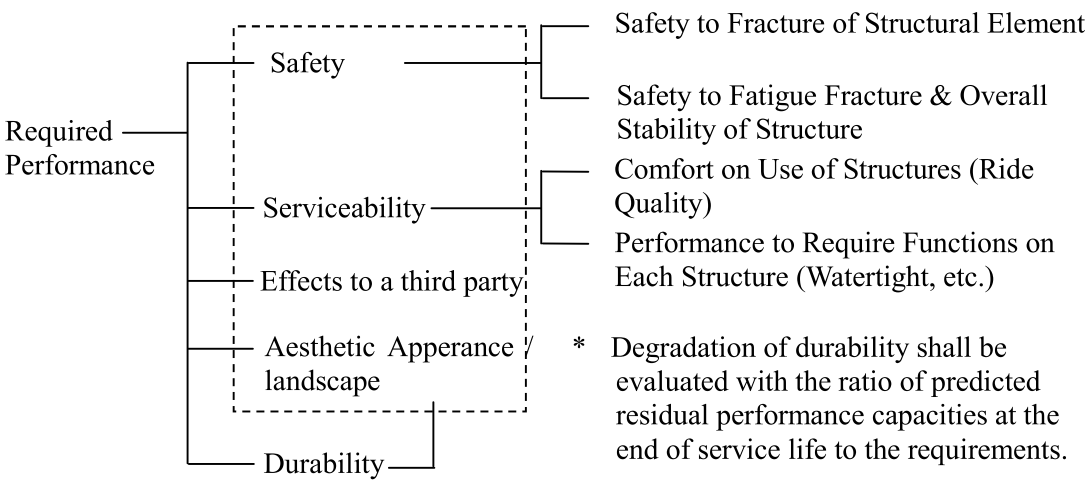


Figure 2.1-1 Classification on Performance Requirements

Expressway shall satisfy high performance requirements in providing smooth, safe and convenient traffic conditions even with high traffic volume under the inclement weather. Structures on expressway shall therefore satisfy the following requirements:

(1) Smooth transition between approach embankment and bridge / box culvert;

(2) Deflection of a structure within permissible limit.

(3) Stable structures with sufficient strength under any unforeseen conditions;

(4) No stagnation of water on the surface of bridge deck slab and box culvert;

(5) Free from inundation and overflow during floods with good drainage system;

(6) Structures shall be regularly monitored so that any defects / damage can be detected, evaluated, and appropriate measures taken so as to ensure required strength.

2.1.2 Evaluation on Soundness of Road Structures

Soundness of structures on expressway shall be evaluated on the followings:

a) Deflection of beam structures;

b) Lateral displacement and settlement of bridge abutments and piers;

c) Rate of deterioration with time on concrete elements, rate of corrosion on steel elements;

d) Dimensions and defect / damage conditions of parapet / railing on bridge and box culvert;

e) Current working performance of expansion joints and differences in level at expansion joints;

f) Dimensions of bridge bearings, current movement and rotation capacities;

g) Damage on the drainage system;

h) Cracks, locations of defect / damage, differences in level and flexural deformation on bridge beams, abutments and piers;

i) Riverbed scour and riverbank erosion.

2.1.3 Causes of Damage to Structures

Descriptions are given on major causes of damage to road structures.

2.1.3.1 Substructure

2.1.3.1.1 Scope of Application

This Clause shall apply to concrete abutments and piers, bridge foundations and such ancillary works as foundation protection, retaining walls and revetments.

2.1.3.1.2 Defect / Damage to Substructure

Typical defect / damage on substructures are described in Table 2.1-2.

Table 2.1-2 Typical Defect / Damage to Substructure

Defect / Damage
- Crack or damage on pier concrete due to collision of debris, vessels and vehicles; - Crack or damage on bearing seats; - Crack due to shrinkage and thermal effects on mass concrete; - Delamination at construction joint, deficiency between precast concrete element and cast-in-place concrete element; - Degradation with time and defect / damage on concrete in wetlands and water level variations. - Abrasion of pier concrete due to water flow; - Debris, rubbish or dirt sediment on abutments and piers after the floods; - Dirt / water stagnation on bearing seat.

Defects and damage on each type of structure are summarized in Table 2.1-3.

Those on abutments and piers are largely categorized into two (2) types: the ones on surfaces, and the ones on overall structures such as settlement or displacement.

For bridge foundations, defects and damage visually identified are listed.

For ancillary works, defects and damage resulting in loss of safety of overall structures are included in the Table.

Table 2.1-3 Defect / Damage to be Inspected by Type of Structure

Type of Structure	Defect / Damage to be Inspected
Abutment, Pier	(1) Crack, (2) Scaling / Delamination, (3) Rebar Exposed, (4) Void, Honeycomb, (5) Water Leakage, (6) Free Lime, (7) Rust Stain, (8) Degradation / Discoloration, (9) Settlement, (10) Displacement
Foundation	(1) Settlement, (2) Displacement, (3) Settlement, (4) Undermining
Ancillary Work	(1) Crack, (2) Scaling / Delamination, (3) Water Leakage, (4) Free Lime, (5) Rust Stain, (6) Settlement, (7) Displacement

Table 2.1-4 gives the descriptions on defects and damage to substructures.

Table 2.1-4 Description of Defect / Damage on Substructure to be Inspected

Damage	Descriptions
(1) Crack	Tension stresses, arisen from materials used, service environments, structural features and external forces, cause cracks on monolithic concrete elements.
(2) Scaling / Delamination	Cover concrete is dropped off or delaminated due to expansion of corroded steel reinforcement, internal stress in concrete, poor construction joint and so on.
(3) Rebar Exposed	Steel reinforcement in concrete is exposed due to scaling / delamination of concrete or poor construction.
(4) Void, Honeycomb	Deficiency due to insufficient filling / compaction of concrete in construction stage.
(5) Water Leakage	Water arisen out of road surface and backfilling materials flows out from the construction joints, cracks forming through element depth, expansion joints, structural joints such as isolation / contraction joints and deficiencies in drainage system.
(6) Free Lime	Lime contents exudate with water from construction joints or cracks forming through element depth and dried on concrete surface.
(7) Rust Stain	Rust on concrete surfaces effluxes from construction joints or cracks due to corrosion of steel reinforcement in concrete.
(8) Degradation, Discoloration	Degradation in performance of concrete will occur primarily due to chemical reactions. Discoloration on concrete surface will occur with chemical reactions.
(9) Settlement	Abutments, piers, bridge foundations and ancillary structures are settled.
(10) Displacement	Abutments, piers, bridge foundations or ancillary structures are displaced or inclined. Wing walls, retaining walls or revetments are displaced ahead
(11) Scour	Abutments on riverbank or piers in water may be subject to scour on pile caps / foundations due to water flow.
(12) Undermining	Bridge foundation is exposed / undermined.

2.1.3.2 Superstructure (Concrete Bridge)

2.1.3.2.1 Scope of Application

This Clause shall apply to the reinforced / pre-stressed concrete beams / girders on superstructures.

2.1.3.2.2 Defect / Damage on Concrete Superstructure

Defects and damage on concrete superstructures are described in Table 2.1-5.

Table 2.1-5 Typical Defect / Damage on Bridge Deck

Element	Defect / Damage
Reinforced Concrete / Pre-stressed Concrete Beam Structures	Cracks due to water leakage and surrounding environments, degradation with time, shrinkage, temperature change and shortage of curing time.
Bridge Deck Slab	Deformation on asphalt concrete, cracks on cement concrete, rupture in waterproofing

With steel reinforcements in concrete, defect / damage on concrete bridges will need a large scale of repair / reinforcement works if steel reinforcements are seriously corroded. Concrete bridges may have less durability due to poor construction or may be degraded at high rate of progress with severe ambient weather conditions.

Defect / damage to be inspected on concrete bridges are summarized by types of structures in Table 2.1-6.

Table 2.1-6 Defect / Damage by Types of Structures

Type of Structure	Defect / Damage
Reinforced Concrete	(1) Crack, (2) Water Leakage / Stagnation, (3) Free Lime, (4) Scaling / Delamination, (5) Rebar Exposed, (6) Rust Stains, (7) Degradation / Discoloration, (8) Excessive Deflection, (9) Abnormal Sound, (10) Excessive Vibration, (11) Extreme Big / Small Girder End Gap, (12) Settlement, (13) Displacement
Pre-stressed Concrete	(1) Crack, (2) Water Leakage / Stagnation, (3) Free Lime, (4) Scaling / Delamination, (5) Rebar Exposed, (6) Rust Stains, (7) Degradation / Discoloration, (8) Rupture of Steel, (9) Excessive Deflection, (10) Abnormal Sound, (11) Excessive Vibration, (12) Extreme Big / Small Girder End Gap, (13) Settlement, (14) Displacement

Visual inspection is of great importance to identify defect / damage on overall structures or on expansion joints, bearings, railings and substructure wherever accessibility is ensured, thereby contributing to the estimate of local defect / damage on other structural elements.

Table 2.1-7 describes defect / damage on overall bridge structures visually observed.

Table 2.1-7 Descriptions of Defect / Damage on Bridge Structures

Defect / Damage	Descriptions
(1) Excessive Deflection	Unfavorable upward / downward deflections on bridge beams / deck slabs due to creep and shrinkage in concrete, or shortage of pre-stressing forces given.
(2) Abnormal Sound	Gaps or ruptures at girder ends or element joints cause rattle noise. Poor connections or abrasion at element joints cause squeak noise.
(3) Excessive Vibration	Visually or sensibly observed excessive vibration of structures.
(4) Extreme Big / Small Girder End Gap	Collision with girder ends, abutment ballast walls, stoppers and expansion joints due to extreme small girder end gaps. Extremely big girder end gap.
(5) Settlement	Bridge supports such as bridge bearings, piers and abutments are settled.
(6) Displacement	Abutments and piers are inclined or laterally displaced.

All the defect / damage on structural elements will not be immediate harms to overall bridge structures. However, progressive defect / damage, which may cause subsequent serious problems, shall be identified at an earlier stage so that current degree of deterioration can be evaluated.

Table 2.1-8 describes defect / damage on bridge structural elements.

Table 2.1-8 Descriptions of Defect / Damage on Bridge Elements

Defect / Damage	Descriptions
(1) Crack	Tension stresses, arisen from materials used, service environments, structural features and external forces, cause cracks on monolithic concrete elements.
(2) Water Leakage	Water mainly arisen out of road surface flows out from the construction joints, cracks forming through element depth, expansion joints and deficiencies in drainage system.
(3) Free Lime	Lime contents exudate with water from construction joints or cracks forming through element depth and dried on concrete surface.
(4) Scaling / Delamination	Cover concrete is delaminated due to expansion of corroded steel reinforcement, internal stress in concrete, poor construction joint and so on.
(5) Rebar Exposed	Steel reinforcement is exposed due to scaling of cover concrete or poor construction.
(6) Rust Stain	Rust on concrete surfaces effluxes from cracks due to corrosion of steel reinforcement in concrete.
(7) Degradation / Discoloration	Degradation in performance of concrete will occur primarily due to chemical reactions. Discoloration on concrete surface will occur with chemical reactions.
(8) Corrosion	Steel elements in the air or in concrete are oxidized and rusted.
(9) Rupture of Steel	Such factors as poor grouting in ducts, chloride damage, carbonation, seepage water from cracks cause rupture of pre-stressing tendons or anchorage removal.

2.1.3.3 Ancillary Works

Typical defects and damage on ancillary works are given in Table 2.1-9.

Table 2.1-9 Typical Defect / Damage on Ancillary Works

Element	Defect / Damage on Ancillary Works
Bridge Expansion Joint	Damage on block out materials (concrete), clogging with soils or hard materials, rupture of rubber strip, rupture of drainage trough, dropping the bolts off, loosening of nuts at anchor bolts.
Bridge Bearing	Dirt on bridge bearing, bulging / deformation / cracks in elastomeric bearings, difference in level, cracks / rupture in PTFE plates, cracks in grouting materials, corrosion on steel bearing base plates, losses of functions in rotation and horizontal displacement.
Drainage System	Clogging with soils or rubbish in drain boxes and outlets, cracks or rupture in pipes, disconnection of pipe joints, losses of joints and attachments.
Bridge Parapet / Railing, Median Strip	Bend on steel railing or posts, cracks or rupture in concrete due to vehicle collision, corrosion in steel railings or posts, dropping off the bolts at post connections, welding cracks, cracks or ruptures in foundation grouting.

2.1.3.3.1 Bridge Bearing

2.1.3.3.1.1 Scope of Application

This Clause shall apply to the steel and elastomeric bridge bearings.

2.1.3.3.1.2 Defect / Damage on Bridge Bearing to be inspected

Defects and damage to be inspected on bridge bearings are summarized in Table 2.1-10.

Table 2.1-10 Defect / Damage on Bridge Bearing to be Inspected

Element	Type	Defect / Damage
Bridge Bearing	Steel Bridge Bearing	(1) Deficiency on Steel, (2) Deficiency on Attachments, (3) Corrosion, (4) Deficiency on Bearing Seat Concrete / Mortar, (5) Excessive Big / Small Gap, (6) Abnormal Sound, (7) Sediment of Dirt or Soils
	Elastomeric Bridge Bearing	(1) Degradation on Elastomer, (2) Deficiency on Attachments, (3) Corrosion, (4) Deficiency on Bearing Seat Concrete / Mortar, (5) Excessive Big / Small Gap, (6) Sediment of Dirt or Soils

2.1.3.3.1.3 Attentions on Defect / Damage to Bridge Bearing

Inspection shall, in principle, be conducted on 100% number of bridge bearings, however, at difficultly accessible places, it is advised to conduct the incorporated inspection by means of observing other bridge elements. In implementing the inspection, attention shall be given to the followings:

(1) Actual movement at horizontally movable bearing or girder end gaps shall be checked and evaluated in consideration of air temperature at time of inspection;

(2) Difference in levels shall be carefully checked at expansion joint where bearing seat mortar is deteriorated or ruptured;
(3) Difference between guided direction and horizontally moving direction, arisen from variable width or curved bridge decks, may cause defect / damage or abnormal sound;
(4) Bridge bearings with uplift forces are prone to defects and damage;
(5) Corrosion of bridge bearings is mainly due to sediment of dirt / soils or water leakage from expansion joints;
(6) Bridge bearing seat mortar will be deteriorated with water leakage;
(7) Wherever horizontal movement and rotation functions are degraded on steel bearings, sole plates are prone to welding cracks.

2.1.3.3.2 Bridge Expansion Joint

2.1.3.3.2.1 Scope of Application

This Clause shall apply to plug seal, strip seal, cushion seal, steel finger joints and modular joint system.

2.1.3.3.2.2 Defect / Damage on Bridge Expansion Joint to be inspected

Defects and damage on bridge expansion joints are summarized in Table 2.1-11.

Table 2.1-11 Defect / Damage on Bridge Expansion Joints to be Inspected

Location Inspected	Defect / Damage
Expansion Joint	(1) Rubber or Steel, (2) Sealing Material, (3) Finger / Sliding Plates, (4) Welding at Finger / Sliding Plates, (5) Seal / Strip / Cushion Rubber, (6) Loosening or Rupture of Anchor Bolts, (7) Cover Cap for Anchor Bolt
In the Vicinity of Joints	(1) Sealing Material, (2) Opening of Gap
Block out Materials	(1) block out Materials, (2) Construction Joints between Expansion Joints and block out Materials, (3) Construction Joints between Expansion Joints and Pavement Materials
Difference in Level	(1) Construction Joints between Expansion Joints and block out Materials, (2) Construction Joints between Expansion Joints and Pavement Materials
Girder End Gap	(1) Opening of Girder End Gap
Water Leakage	(1) Water Leakage from Joints, (2) Drainage Materials, (3) Water Leakage from Curbs
Abnormal Sound	(1) Abnormal Sound at Vehicle Passage

2.1.3.3.2.3 Attentions on Defect / Damage to Expansion Joints

Defects and damage on expansion joints may give discomfort ride quality to vehicles as well as unfavorable adverse effects to bridge structures. It is therefore necessary to give careful attentions and provide more frequent maintenance works on expansion joints and vicinities. Causes of defects and damage will mainly be the repetitive impacts with wheel loads. Such causes will also result in defects and damage on bridge bearing, bridge deck and substructures. Hence, careful attention shall also be given to the vicinities of expansion joints when inspection is implemented.

- Differences in level at expansion joints are caused by fracture of bearing seat mortar, breakage / depression of bearings and rupture of bearing seats.

Wherever extraordinary defects and damage are observed, it is suspected that the lateral displacement / settlement of substructures or settlement of approach embankment arises. In such cases, immediate investigation shall be conducted to recognize the causes.

Expected extraordinary defects and damage on expansion joints are as follows:

(1) Extreme movement or difference in level at girder ends;

(2) Abnormal sound without any reasons;

(3) Defects or damage due to fire or earthquake;

(4) Early detection of similar defects or damage at repair portions.

2.1.3.3.3 Bridge Parapet / Railing

2.1.3.3.3.1 Scope of Application

This Clause shall apply to the reinforced concrete parapet / curb and steel railing.

2.1.3.3.3.2 Defect / Damage on Bridge Parapet / Railing to be inspected

Defects and damage caused on bridge parapets / railings are summarized in Table 2.1-12.

Table 2.1-12 Defect / Damage on Bridge Parapet / Railing to be Inspected

Element	Defect / Damage to be Inspected
Reinforced Concrete Parapet / Curb	(1) Crack, (2) Water Leakage / Free Lime, (3) Scaling of Cover Concrete, (4) Spalling, (5) Rebar Exposed / Corroded
Steel Railing	(1) Deformation / Deficiency (due to vehicle collision), (2) Corrosion

2.1.3.3.4 Drainage System

2.1.3.3.4.1 Scope of Application

This Clause shall apply to drain inlets, drain pipes and attachments installed on bridge structures.

Drainage system shall perform its roles properly to drain the water out of the bridge deck to the specific outlets. Lacking of proper functions may cause damage to vehicles on bridge deck, corrosion or deterioration on bridge structures and adverse effects to a third party under the bridge deck. Careful attention shall, therefore, be given to the performance of required functions during the inspection.

2.1.3.3.4.2 Defect / Damage on Drainage System to be inspected

Table 2.1-13 and Table 2.1-14 give defect / damage to be inspected and descriptions of such defect / damage for drainage system.

Table 2.1-13 Defect / Damage on Drainage System to be Inspected

Element	Defect / Damage to be Inspected
Drain Inlet	(1) Deficiency, (2) Corrosion, (3) Clogging, (4) Deformation, (5) Deficiency / Corrosion on Fittings, (6) Deficiency on Drain Grates
Drain Pipe	(1) Deficiency, (2) Corrosion, (3) Clogging, (4) Disconnection / Unfit, (5) Deformation, (6) Water Leakage
Attachment	(1) Deficiency, (2) Corrosion, (3) Deformation

Table 2.1-14 Descriptions of Defect / Damage on Drainage System

Defect / Damage	Descriptions
(1) Deficiency	A part or all of drain inlets, drain pipes and attachments are missing.
(2) Corrosion	Steel elements are corroded.
(3) Clogging	Malfunction of drainage due to clogging in drain inlets and pipes.
(4) Disconnection / Unfit	Drain pipe joints are disconnected. Drain pipes are unfitted from attachments.
(5) Deformation	A part or all of drain inlets, drain pipes and attachments are deformed.
(6) Water Leakage	Water leakage is observed due to failure of drain pipe or loosening of joints.
(7) Deficiency on Drain Grates	Drain grates are broken, corroded or missing.

2.1.3.3.5 Seismic Structures

2.1.3.3.5.1 Scope of Application

This Clause shall apply to anchor bars, concrete blocks and end cross beams of bridge deck.

2.1.3.3.5.2 Defect / Damage to be inspected

Defects and damage on seismic structures are described in Table 2.1-15. Wherever water leakage is observed at end cross beams, it is expected corrosion of anchor bars has occurred. Attention shall be paid to treat the rust stains on structures.

Table 2.1-15 Defect / Damage on Seismic Structures to Be Inspected

Structure	Defect / Damage
End Cross Beam	(1) Crack, (2) Scaling, (3) Rebar Exposed, (4) Free Lime
Concrete Block	(1) Crack, (2) Scaling, (3) Rebar Exposed, (4) Free Lime, (5) Rust Stain from anchor bars

2.1.3.4 Culvert

2.1.3.4.1 Scope of Application

This Clause shall apply to box culvert and pipe culvert.

2.1.3.4.2 Defect / Damage on Culvert

Defects and damage caused on reinforced concrete culverts shall follow the specifications described in 2.1.3.1.

2.1.4 Necessity and Purposes of Maintenance Work for Road Structures

Maintenance work comprises inspection, formulation of maintenance program and maintenance activities, and shall be implemented so as to ensure safe road and to prevent adverse effects to a third party. Inspection is to collect fundamental data on existing structures in order to recognize current conditions and to implement scheduled repair / reinforcement works. Formulation of maintenance program and maintenance activities will be carried out with a view to ensure the required level of service, to minimize life-cycle cost and to minimize economic losses due to closure of expressway for repair / reinforcement works. Proper actions shall be taken to repair / replace defects and damage with appropriate measures before serviceability limit state is reached.

Specific roles on maintenance work for road structures are given as follows:

1) To ensure safe road and to prevent adverse effects to a third party through early detection of defects and damage;
2) To formulate mid- or long-term maintenance program by means of identifying deterioration conditions and properly recognizing rate of deterioration progress;
3) To ensure soundness of road structures for an extended period of time by assessing current defects / damage and properly evaluating the soundness.

In implementing the inspections, attention shall be paid not only to recognize current defects and damage, but also to understand the conditions of relevant structures, traffic conditions, roadside environment and previous incidents arisen out of road structures.

Maintenance program shall be formulated to ensure the required level of performance during the expected service life. Evaluation of inspection results, subsequent measures, and record-keeping shall properly be implemented.

2.1.5 Maintenance Work Flow for Road Structures

2.1.5.1 Major Maintenance Work Flow

As in Figure 2.1-2, maintenance work for road structures comprises assessment procedures including inspection, estimate of deterioration models, prediction of deterioration progress, evaluation of rate of current performances and judgment of necessity of measures, measures taken from the assessment results and record-keeping. Expressway operator shall formulate maintenance program in order to properly implement the maintenance activities.

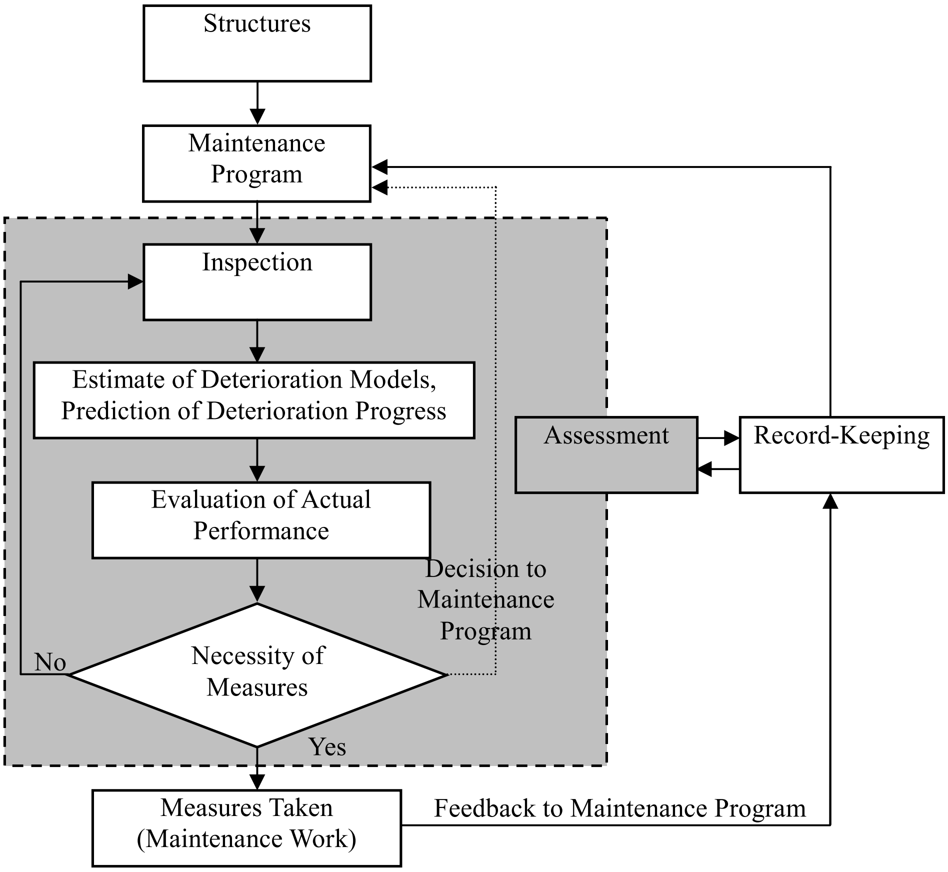


Figure 2.1-2 Major Maintenance Work Flow

2.1.5.2 Standard Intervals for Inspection and Maintenance Work

Standard intervals of inspection and maintenance work shall consider the previous inspection results, current conditions of structures, surrounding environments and service conditions.

(1) Inspections on structures shall consider the purposes of subsequent actions taken;

(2) Initial inspection shall be made so as to identify the initial conditions of structures;

(3) Daily and routine inspections shall be conducted in order to recognize the changes in structural conditions;

(4) Special and emergency inspections shall consider the purposes of such inspections;

(5) Daily and routine inspections shall follow the inspection intervals, items and methods specified in the maintenance program. When it is judged necessary to identify the detail conditions of structures from the inspection results, in-depth inspection shall be carried out.

(6) Whenever emergency measures are judged necessary from the inspection results, such measures shall immediately be taken.

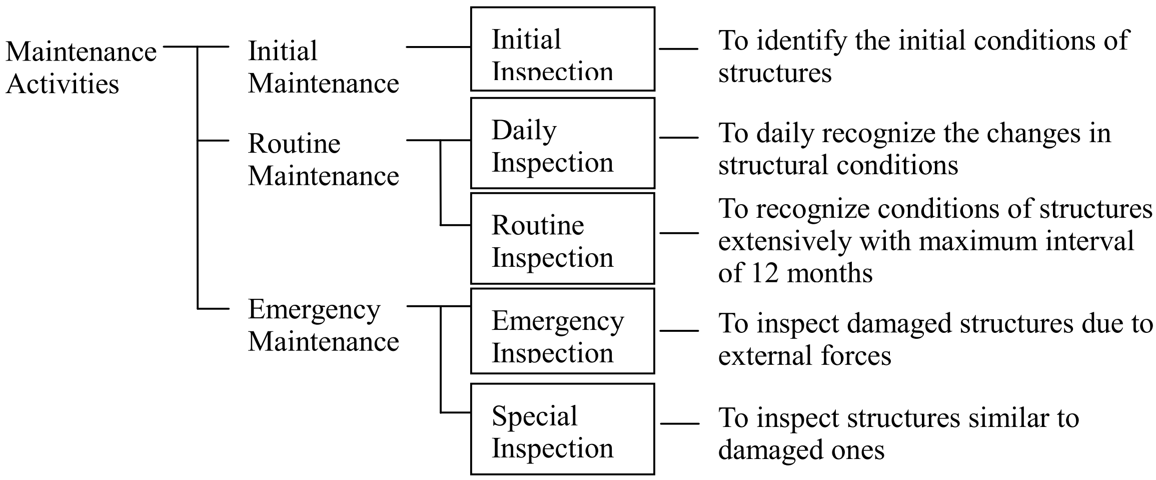


Figure 2.1-3 Types of Inspection

2.1.5.2.1 Daily Inspection

Table 2.1-16 Standard Intervals for Daily Inspection

Type of Inspection		Intervals	Traffic Volume, V
Safety Patrol		4 days / 2 weeks	V < 25,000 vehicle / day
		5 days / 2 weeks	25,000 ≤ V < 50,000 vehicle / day
		6 days / 2 weeks	50,000 ≤ V < 80,000 vehicle / day
		7 days / 2 weeks	80,000 vehicle / day ≤ V
Inspection of Defects / Damage	Monitoring	As required.	
	General Inspection	As required.	

For safety patrol, in addition to onboard inspection, direct visual inspection shall be conducted from outside of patrolling vehicles with maximum 6 month interval inspection.

2.1.5.2.2 Routine Inspection

Maximum inspection interval is 12 months.

2.1.5.2.3 In-Depth Inspection

(1) Maximum inspection interval of 60 months where adverse effects to traffic safety or a third party is expected.

(2) Maximum inspection intervals of 120 months for other places.

2.1.5.2.4 Emergency & Special Inspections

Emergency inspections shall be carried out wherever structures are in question in functioning required performance due to such accidental loads as a large-scale earthquake and typhoon, collision with vehicles and vessels, and fire.

Special inspections shall be implemented on structures similar to the ones with large scale defects and damage in other locations or under similar conditions.

2.2 Inspection

2.2.1 Daily Inspection

2.2.1.1 Items to be Inspected

Daily inspection is implemented to detect defect / damage on structures through daily patrol so that safe road transport and prevention of adverse effects to a third party are ensured. The early detection of defect / damage ensures maintained sound road conditions and enables the formulation of appropriate plans for emergency measures and repair.

It is to visually or sensibly detect the defect / damage on road structures from patrol vehicles only for the structures observed from the expressway.

Items to be inspected by daily inspection are given in Table 2.2-1. For pavement on road structures, it is described in Chapter 1.

Table 2.2-1 Defect / Damage to Be Visually or Sensibly Observed with Daily Inspection

Items to be Inspected	Defect / Damage Observed
(1) Discoloration / Stain on Concrete	● Presence and extent of water / free lime ● Presence and extent of water leakage ● Presence and extent of rust stain
(2) Rebar Exposed / Corroded	● Concrete cover of reinforcement steel, number and location of rebar exposed, degree of corrosion
(3) Deflection / Deformation of Structures	● Excessive deflection, displacement, settlement
(4) Bridge Expansion Joint	● Difference in level, damage on finger plate
(5) Bridge Railing / Curb	● Deformation, damage
(6) Drainage System	● Water stagnation, clogging with soils in drain inlet, damage on drain pipe, water leakage from drain pipe
(7) Rupture of Pre-stressing Tendons	● Projection of pre-stressing tendons on deck slab and cross beams due to rupture

2.2.1.2 Evaluation of Defect / Damage

Results of daily inspection are recorded in Forms 2-1, -2, -3, -4 in the Inspection Report.

Extent of defect / damage shall be evaluated with the criteria in Table 2.2-4 – Table 2.2-14 for each structure, and each defect / damage is classified into one of the following 4 categories in Table 2.2-2.

Table 2.2-2 Evaluation Category for Each Defect / Damage (Daily Inspection)

Level of damage		Level of priority	
Code	Description	Code	Description
A	Good (No defect / damage, or minor defect / damage are observed)	Normal	
B	Average. (Sound functions of a structure are maintained, even with defect / damage. Progress of defect / damage needs to be monitored periodically)	Normal It needs later inspection and continuous monitoring.	
C	High. Defect / damage may endanger the safety of traffic, safety of a third party or stability of the structure, and needs the study of measures.	T	Low (not much impact on the structure stability. Immediate counter-measures may not be needed.)
		C	High (much impact on the structure stability. Immediate counter-measures are needed.)
D	Emergency. Extraordinary defect / damage may cause traffic accidents, danger to a third party or collapse of the structure, and needs urgent measures.	C	High (great impact on the structure stability. Immediate counter-measures are certainly needed.)
		K	Emergency

2.2.1.3 Inspection Methods

Daily inspection is implemented with visual observation by naked eyes, cameras, and/or binoculars, and on-board sensible observation.

On-board observation is implemented to detect the damage of bridge expansion joints, excessive deflection and vibration of bridge girders / beams, and is effective for direct measurement of serviceability.

Wherever serious defect / damage categorized as C or D, which may result in danger to road transport or a third party, are observed, direct visual inspection or hammering test shall be carried out from outside of patrolling vehicles. Such results shall be recorded with digital cameras and in Daily Inspection Record Form.

Photographing is implemented in two forms: close-range view to identify the type and extent of defect / damage, and distant view to identify the location in a structure. Close-range view shall include crack gauge, convex and/or measuring poles, if possible.

2.2.2 Routine Inspection on Concrete Structures

2.2.2.1 Items to be Inspected

Routine Inspection is implemented using the binoculars or access on foot.

If necessary, Routine Inspection can be conducted with visual inspection, hammering, and simple measurement tools through access to the structure using special equipment. Degradation, defect / damage, initial defect of elements are investigated in detail on overall structure.

Items and descriptions to be inspected in routine inspection are given in Table 2.2-3.

Table 2.2-3 Typical Items to Be Inspected in Routine Inspection

Type of Defect / Damage	Descriptions
Overall Deterioration	Excessive deflection, abnormal sound, excessive vibration, excessive big / small girder end gap, displacement
Initial Defect	Cracks, air voids, honeycomb
Degradation	Cracks, free lime, rust stain, scaling / delamination, spalling, rebar exposed / corroded
Degradation (Pre-stressing Tendons)	Corrosion and rupture of pre-stressing tendons
Deterioration due to External Loads	Cracks
Water Leakage, Water Stagnation	Water leakage, water stagnation
Deterioration on Ancillary Works	Defect / damage on bridge bearing and expansion joints, drainage system

2.2.2.2 Evaluation of Defect / Damage

Results of routine inspection as well as evaluation of defect / damage are recorded in Form 2-1 – 2-5, 2-7, 2-8 of Routine Inspection Record Sheet. Wherever no inspection is implemented due to impossible access or it is difficult to evaluate, such reasons shall be recorded in “Remark” with the reasons for no evaluation.

Extent of defect / damage shall be evaluated with the criteria in Table 2.2-4 – Table 2.2-14 for each structure, and each defect / damage is classified into the following 4 categories in Table 2.2-2.

Whenever defect / damage, which need urgent measures, are found at the routine inspection, such defect / damage shall be recorded in Form 2-3 and reported. These defect / damage are also recorded in Form 2-7, since they need urgent measures for a short period of time after detection.

Table 2.2-4 Evaluation Criteria (Pre-stressed Concrete Bridge 1 / 2)

Structure	Type of Structure	Element / Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation		
						D	C	B
Bridge	Pre-stressed Concrete Bridge	Pre-stressed Concrete Girder	Overall Deterioration*	Excessive Deflection	Girders or slab beams are deformed upward or downward due to concrete creep or shrinkage, or excessive or short pre-stressing force.	Extraordinary excessive deflection is observed on girder or slab beam.	Deflection of girder or slab beam is observed to the extent it is visually confirmed.	—
				Abnormal Sound	Rattle noise due to gap or rupture at member joints at the time of vehicle passage or creaking noise due to defect or abrasion at member joints is observed.	—	Abnormal sound is observed at the time of vehicle passage.	—
				Excessive Vibration	Excessive vibration is visually or sensibly observed.	—	Excessive vibration is visually or sensibly observed.	—
				Excessive Big / Small Girder End Gap	Adjacent girder ends, girder and abutment, stoppers or expansion joint plates are collided or at an extraordinary distance.	—	Girder end gap is closed or excessively opened.	Excessive bigger or smaller girder end gap is detected compared to design value.
				Settlement	Uneven settlement between bridge bearings or supports (piers / abutments) is observed.	Due to uneven settlement of supports, reduction in load carrying capacity is observed on bridge deck.	Due to uneven settlement of supports, reduction in load carrying capacity is suspected on bridge deck.	Slight settlement is observed on bridge deck.
				Displacement	Abutment or pier is inclined or laterally displaced.	Bridge deck is largely displaced.	Bridge deck is slightly displaced.	—
			Water Leakage, Water Stagnation	Water Leakage	Concrete surface is wet due to water seepage through construction joint, filling of opening or crack, or due to water leakage from drainage system or expansion joint.	—	Water leakage is observed at all times irrespective of weather conditions. Water leakage is observed at the joints of segments.	Water leakage or water stain is observed after rain.
				Water Stagnation	Water is entered into crossing points of members or inside the box girder and stagnated.	—	Water stagnation is observed irrespective of weather conditions.	Water stagnation is observed after rain.
			Initial Defect	Crack	Fracture due to tension stresses caused mainly by materials used or construction workmanship such as dry shrinkage. Cracks around pre-stressing tendons or anchorage plates will be evaluated by corrosion or fracture of tendons.	—	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Air Void, Honeycomb	Air voids or honeycombs may present in concrete due to poor concrete works. Voids may be remained in pre-stressing tendon duct due to poor grouting works.	—	A large scale of air voids or honeycombs are observed. Voids are observed in pre-stressing tendon ducts due to poor grouting works.	Air void or honeycomb is observed.

* Wherever overall deterioration such as excessive deflection, abnormal sound and excessive vibration is observed, immediate in-depth inspection shall be implemented.

Table 2.2-4 Evaluation Criteria (Pre-stressed Concrete Bridge 2 / 2)

Structure	Type of Structure	Element / Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation		
						D	C	B
Bridge	Pre-stressed Concrete Bridge	Pre-stressed Concrete Girder	Degradation on Concrete	Crack	Fracture in concrete due to tensile stress mainly arisen from environmental conditions in use (chloride damage, etc.). Cracks around pre-stressing tendons or anchorage plates will be evaluated by corrosion or fracture of tendons.	—	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Free Lime	Lime contents exudate with water from construction joints or cracks forming through element depth and dried on concrete surface. Free lime around pre-stressing tendons or anchorage plates will be evaluated by corrosion or fracture of tendons.	—	Exudate of water and/or free lime is extensively observed.	Exudate of water and/or free lime is locally observed.
				Rust Stain	Rust arisen due to corrosion of reinforcement steel is flowed out with water from cracks in concrete. Rust stain around pre-stressing tendons or anchorage plates will be evaluated by corrosion or fracture of tendons.	—	Rust stain is remarkably observed.	Rust stain with water leakage is locally observed due to corrosion of reinforcement steel.
				Scaling / Delamination / Spalling	Scaling or delamination of concrete surface due to swell of corroded steel in concrete, internal stress in concrete or poor construction joint. Scaling / delamination around pre-stressing tendons or anchorage plates will be evaluated by corrosion or fracture of tendons.	—	A large scale of scaling or delamination is extensively observed. Scaling or delamination is scattered.	Scaling or delamination is locally observed.
				Rebar Exposed / Corroded	Reinforcement steel in concrete or in the air is corroded.	Loss of section of reinforcement steel is extensively observed.	Reinforcement steel is exposed and seriously corroded.	Reinforcement steel is locally exposed or corroded.
				Discoloration	Concrete element is deteriorated mainly due to chemical reaction and discolored on surface.	—	Discoloration is observed on concrete surface with cracks.	Discoloration is locally observed on concrete surface.
			Degradation on Pre-stressing Tendons *	Rupture of Pre-stressing Tendon	Pre-stressing tendon in concrete or in the air is corroded. Pre-stressing tendon is fractured due to corrosion.	Pre-stressing tendon is fractured or extruded.	Pre-stressing tendon is corroded. Cracks, free lime, rust stain, scaling / delamination or spalling is observed along the pre-stressing tendon. Block out material at anchorage plate has crack, free lime, rust stain, scaling / delamination or spalling.	—
			Deterioration due to Structural Features and External Forces	Crack	Fracture in concrete due to tensile or compressive stress mainly arisen from structural features or external forces.	Descriptions are given in Table 2.2-5 (evaluation criteria by pre-stressed concrete element).		

* In-depth inspection shall be implemented whenever water leakage and/or free lime are observed at pre-stressing tendons.

Table 2.2-5 Evaluation Criteria (Cracks by Locations of Pre-stressed Concrete Girder)

Structure	Type of Structure	Element / Location		Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation		
							D	C	B
Bridge	Pre-stressed Concrete Bridge	Pre-stressed Concrete Girder	At End Support	Deterioration due to Structural Features or External Forces *	Crack	Fracture in concrete due to tension or compression stress arisen from structural features or external forces.	Vertical or diagonal cracks are observed around the support line.	—	—
			At Intermediate Support				Vertical cracks are observed on a girder.	—	—
			At the Center of a Span				Vertical cracks are observed at lower flange of a girder.	—	—
			At the Quarter of a Span				Diagonal cracks are observed on a girder web.	—	—
			Joint of Segment				Cracks are observed along the segment joint.	—	—
			At Anchorage				Progressive cracks are observed at anchorage plates of pre-stressing tendons.	—	Dead crack is observed around pre-stressing tendon anchorage plates.
			At the Notch				Diagonal cracks at the notch are observed.	—	—

* Immediate in-depth inspection shall be implemented when deterioration due to structural features or external forces is observed.

Table 2.2-6 Evaluation Criteria (Concrete Deck Slab)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation		
						D	C	B
Bridge	Concrete Deck Slab	Concrete Deck Slab	Initial Defect	Crack *	Fracture in concrete due to tensile / compressive stress mainly arisen from materials used or construction workmanship.	Cracks with free lime and/or rust stain are extensively observed. Loss of section of reinforcement steel is suspected.	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Air Void, Honeycomb *	Air voids or honeycombs may present in concrete due to poor concrete works.	—	A large scale of air voids and/or honeycombs are observed.	Air voids and/or honeycomb are observed.
			Degradation	Crack *	Fracture in concrete due to tensile / compressive stress mainly arisen from environmental conditions in use.	Cracks with free lime and/or rust stain are extensively observed. Loss of section of reinforcement steel is suspected.	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Free Lime	Lime contents exudate with water from construction joints or cracks forming through element depth and dried on concrete surface.	—	Exudate of water and/or free lime is extensively observed.	Exudate of water and/or free lime is locally observed.
				Rust Stain	Rust arisen due to corrosion of reinforcement steel is flowed out with water from cracks in concrete.	—	Rust stain is remarkably observed. Rust stain from pre-stressing tendons or anchorage plates is observed.	Rust stain with water leakage is locally observed due to corrosion of reinforcement steel.
				Scaling / Delamination / Spalling *	Scaling or delamination of concrete surface due to swell of corroded steel in concrete, internal stress in concrete or poor construction joint.	—	A large scale of scaling or delamination is extensively observed. Scaling or delamination is scattered.	Scaling or delamination is locally observed.
				Rebar Exposed / Corroded *	Reinforcement steel in concrete or in the air is corroded.	Loss of section of reinforcement steel is extensively observed.	Reinforcement steel is exposed and seriously corroded.	Reinforcement steel is locally exposed or corroded.
			Water Leakage	Water Leakage	Concrete surface is wet due to water seepage through construction joint, filling of opening or crack, or due to water leakage from drainage system or expansion joint.	—	Water leakage is observed at all times irrespective of weather conditions.	Water leakage or water stain is observed after rain.

* Wherever precast reinforced concrete panel is used as form of deck slab concrete casting, it is not possible to detect such defect / damage as cracks on bridge deck slab by visual inspection and/or hammering test. Free lime or rust stain may be the clue for detection of defect / damage.

Table 2.2-7 Evaluation Criteria (Substructure)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation D	Evaluation C	Evaluation B
Bridge	Substructure	Substructure	Initial Defect	Crack	Fracture in concrete due to tensile / compressive stress mainly arisen from materials used or construction workmanship.	Cracks with free lime and/or rust stain are extensively observed. Loss of section of reinforcement steel is suspected.	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Air Void, Honeycomb	Air voids or honeycombs may present in concrete due to poor concrete works.	—	A large scale of air voids and/or honeycombs are observed.	Air voids and/or honeycomb are observed.
			Degradation	Crack	Fracture in concrete due to tensile stress mainly arisen from environmental conditions in use (chloride damage, etc.).	—	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Free Lime	Lime contents exudate with water from construction joints or cracks forming through element depth and dried on concrete surface.	—	Exudate of water and/or free lime is extensively observed.	Exudate of water and/or free lime is locally observed.
				Rust Stain	Rust arisen due to corrosion of reinforcement steel is flowed out with water from cracks in concrete.	—	Rust stain is remarkably observed.	Rust stain with water leakage is locally observed due to corrosion of reinforcement steel.
				Scaling / Delamination / Spalling	Scaling or delamination of concrete surface due to swell of corroded steel in concrete, internal stress in concrete or poor construction joint.	—	A large scale of scaling or delamination is extensively observed. Scaling or delamination is scattered.	Scaling or delamination is locally observed.
				Rebar Exposed / Corroded	Reinforcement steel in concrete or in the air is corroded.	Loss of section of reinforcement steel is extensively observed.	Reinforcement steel is exposed and seriously corroded.	Reinforcement steel is locally exposed or corroded.
				Discoloration	Concrete element is deteriorated mainly due to chemical reaction and discolored on surface.	—	Discoloration is observed on concrete surface with cracks.	Discoloration is locally observed on concrete surface.
			Settlement, Displacement	Settlement	Overall substructure, bridge foundation or ancillary works are settled.	Overall substructure, bridge foundation or ancillary works are largely settled.	Overall substructure, bridge foundation or ancillary works are settled to a small extent.	—
				Displacement	Overall substructure, bridge foundation or ancillary works are displaced or inclined. Wing walls or riverbanks are horizontally displaced.	Overall substructure, bridge foundation or ancillary works are largely displaced.	Overall substructure, bridge foundation or ancillary works are displaced to a small extent.	—
			Water Leakage	Water Leakage	Concrete surface is wet due to water seepage through construction joint, filling of opening or crack, or due to water leakage from drainage system or expansion joint.	—	Water leakage is observed at all times irrespective of weather conditions.	Water leakage or water stain is observed after rain.
			Scour, Exposure	Scour	Abutments facing the river water or piers in the river may be subject to scour around footing / pile cap or bridge foundation.	Footing or caisson is exposed to the level exceeding the design consideration due to scour or riverbed degradation Wing walls on abutment are remarkably scoured.	Footing or caisson is exposed due to scour or riverbed degradation Wing walls on abutment are scoured.	—
				Exposure	Bridge foundation is exposed.	Bridge foundation is remarkably exposed.	Bridge foundation is exposed to a small extent.	—

Table 2.2-8 Evaluation Criteria (Bridge Bearing 1 / 2)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation		
						D	C	B
Bridge	Bridge Bearing	Steel Bridge Bearing	Deterioration on Bridge Bearing	Degradation on Bridge Bearing	Such degradation with time as cracks and deformation is observed on bridge bearing.	Load carrying function is impaired due to compressive failure of such vertical load carrying elements as upper bearing, lower bearing and base plate.	Due to abrasion of sliding / rolling elements, an up-and-down motion is observed. Slight deterioration such as cracks is observed on vertical load carrying elements.	Reduction in functions of displacement and rotation is observed.
				Defect / Damage on Bridge Bearing	Defect / damage due to such short-term events such as earthquake are observed on bridge bearing.	Load carrying function is impaired due to compressive failure of such vertical load carrying elements as upper bearing, lower bearing and base plate. Bearing plates are / may be in danger to be removed from the pot or derailed from lower bearing.	Slight deterioration such as cracks is observed on vertical load carrying elements.	Reduction in functions of displacement and rotation is observed.
				Corrosion on Bridge Bearing	Degradation on surface coating, corrosion, loss of section or fracture is observed on bridge bearing.	Due to serious corrosion, vertical load carrying function is impaired. Bearing plates are / may be in danger to be removed from the pot or derailed from lower bearing.	Due to corrosion, reduction in vertical load carrying capacity is observed.	Due to corrosion, reduction in functions of displacement and rotation is observed.
			Deterioration on Attachments	Defect / Damage on Attachments	Degradation with time such as cracks and deformation is observed. Defect / damage due to such short-term events such as earthquake are observed on attachments	–	Rupture of set bolts. Deterioration of side block, etc. Rupture of side block bolts. Anchor bolts are ruptured and extruded.	Loosening of set bolts, side block bolts and/or nuts used for anchor bolts are observed.
				Corrosion on Attachments	Degradation on surface coating, corrosion, loss of section or fracture is observed on attachments.	–	Loss of section is observed due to corrosion.	Attachments are corroded with deterioration of surface coating.
			Deterioration on Bridge Bearing Seat Mortar / Concrete	Defect / Damage on Bridge Bearing Seat Mortar / Concrete	Degradation with time or defect / damage due to earthquake is observed on bridge bearing seat mortar / concrete.	Due to deterioration of bridge bearing seat mortar / concrete, vertical load carrying function is impaired.	Cracks and voids are observed on bridge bearing seat mortar / concrete.	Small cracks or scaling are observed on bridge bearing seat mortar / concrete.
			Excessive Big / Small Girder End Gap	Excessive Big / Small Girder End Gap	Adjacent girder ends, girder and abutment, stoppers or expansion joint plates are collided or at an extraordinary distance.	Load carrying function is impaired due to remarkable displacement of upper and lower bridge bearings.	Actual displacement is reached to the maximum permissible level. (Stopper hits to the wall)	Actual displacement exceeds the design requirement.
			Abnormal Sound	Abnormal Sound	Rattle noise due to gap or rupture at member joints at the time of vehicle passage or creaking noise due to defect or abrasion at member joints is observed.	–	A large volume of sound is generated.	A sound is generated from a bridge bearing.
			Sediment of rubbish / soils	Sediment of rubbish / soils	Sediment of rubbish or soils adversely affect to bridge bearing and its attachments.	–	Bridge bearing is buried under rubbish and soils.	Rubbish and soils are sediment around bridge bearing.
			Water Leakage	Water leakage from drainage system	Bridge bearing is wet due to water leakage from drainage system or expansion joint.	–	Bridge bearing is wet at all times irrespective of weather conditions.	Bridge bearing is wet after rain.

Table 2.2-8 Evaluation Criteria (Bridge Bearing 2 / 2)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation		
						D	C	B
Bridge	Bridge Bearing	Elastomeric Bridge Bearing	Deterioration on Bridge Bearing	Degradation on Bridge Bearing	Such degradation with time as cracks and deformation is observed on bridge bearing.	Vertical load carrying capacity is impaired due to compressive failure of elastomeric bearing.	Cracks, swell, shearing and/or tear off are observed on overall elastomeric bearing.	Cracks, swell, shearing and/or tear off are locally observed on elastomeric bearing.
				Defect / Damage on Bridge Bearing	Defect / damage due to such short-term events such as earthquake are observed on bridge bearing.	Vertical load carrying capacity is impaired due to compressive failure of elastomeric bearing.	Cracks, swell, shearing and/or tear off are observed on overall elastomeric bearing.	Cracks, swell, shearing and/or tear off are locally observed on elastomeric bearing.
				Corrosion on Bridge Bearing	Degradation on surface coating, corrosion, loss of section or fracture is observed on steel elements of bridge bearing.	—	Steel elements are corroded.	Upper / lower bridge bearing are corroded.
			Deterioration on Attachments	Defect / Damage on Attachments	Degradation with time such as cracks and deformation is observed. Defect / damage due to such short-term events such as earthquake are observed on attachments	—	Rupture of set bolts. Deterioration of side block, etc. Rupture of side block bolts. Anchor bolts are ruptured and extruded.	Loosening of set bolts, side block bolts and/or nuts used for anchor bolts are observed.
			Deterioration on Bridge Bearing Seat Mortar / Concrete	Corrosion on Attachments	Degradation on surface coating, corrosion, loss of section or fracture is observed on attachments.	—	Loss of section is observed due to corrosion.	Attachments are corroded with deterioration of surface coating.
				Defect / Damage on Bridge Bearing Seat Mortar / Concrete	Degradation with time or defect / damage due to earthquake is observed on bridge bearing seat mortar / concrete.	Due to deterioration of bridge bearing seat mortar / concrete, vertical load carrying function is impaired.	Cracks and voids are observed on bridge bearing seat mortar / concrete.	Small cracks or scaling are observed on bridge bearing seat mortar / concrete.
			Excessive Big / Small Girder End Gap	Excessive Big / Small Girder End Gap	Adjacent girder ends, girder and abutment, stoppers or expansion joint plates are collided or at an extraordinary distance.	Load carrying function is impaired due to remarkable displacement or falling out of a girder from the bearing.	Actual displacement is reached to the maximum permissible level. (Stopper hits to the wall)	Actual displacement exceeds the design requirement.
			Abnormal Sound	Abnormal Sound	Rattle noise due to gap or rupture at member joints at the time of vehicle passage or creaking noise due to defect or abrasion at member joints is observed.	—	A large volume of sound is generated.	A sound is generated from a bridge bearing.
			Sediment of rubbish / soils	Sediment of rubbish / soils	Sediment of rubbish or soils adversely affect to bridge bearing and its attachments.	—	Bridge bearing is buried under rubbish and soils.	Rubbish and soils are sediment around bridge bearing.
			Water Leakage	Water leakage from drainage system	Bridge bearing is wet due to water leakage from drainage system or expansion joint.	—	Bridge bearing is wet at all times irrespective of weather conditions.	Bridge bearing is wet after rain.

Table 2.2-9 Evaluation Criteria (Bridge Expansion Joint)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation		
						D	C	B
Bridge	Bridge Expansion Joint	Steel Finger Plate Joint Cushion Seal Type Elastomeric Joint	Deterioration on Expansion Joint	Defect / Damage on Expansion Joint	Degradation with time or defect / damage due to earthquake is observed on expansion joints.	Cracks on face plate, defect or swell in welding is observed. Loss of anchor bolts and nuts is observed.	Loss of elastomeric material is observed.	—
			Deterioration on Blockout Material & Asphalt Plug Seal Material	Defect / Damage on block out Material & Asphalt Plug Seal Material	Degradation with time or defect / damage due to earthquake is observed on expansion joints.	—	Gap is observed between block out material and bridge deck, or between plug seal material and asphalt pavement material. Cracks are observed on block out material or plug seal material.	—
			Difference in Level	Difference in Level	Roughness or difference in level is observed at or in the vicinity of the expansion joint.	Vehicles are out of control or violently bounded at abutment due to remarkable difference in level. 20mm or greater difference in level is observed at abutment. 30mm or greater difference in level is observed at crossing structure or at boundary of cut / fill area.	Difference in level at abutment is 10mm or greater and less than 20mm. Difference in level at crossing structure or at boundary of cut / fill area is 10mm or greater and less than 30mm.	—
			Water Leakage	Water leakage	Water leakage from expansion joint affects adversely to other bridge elements.	Water leakage is observed even with small rains, and gives adverse effects to bridge bearings and bridge structures.	Water leakage is observed.	—
			Abnormal Sound	Abnormal Sound	Abnormal sound is generated at times of vehicle passage.	—	Abnormal sound is generated at times of vehicle passage.	—
			Excessive Big / Small Girder End Gap	Excessive Big / Small Girder End Gap	Girder end gap is excessively small or extraordinarily opened.	—	Girder end gap is closed or extraordinarily opened.	Girder end gap is smaller or bigger compared to design requirement.

Table 2.2-10 Evaluation Criteria (Bridge Railing and Curb)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation D	Evaluation C	Evaluation B
Bridge	Bridge Railing & Curb	Concrete Parapet, Bridge Railing and Curb	Initial Defect	Crack	Fracture in concrete due to tensile / compressive stress mainly arisen from materials used or construction workmanship.	Cracks with free lime and/or rust stain are extensively observed. Loss of section of reinforcement steel is suspected.	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Air Voids, Honeycomb	Air voids or honeycombs may present in concrete due to poor concrete works. Voids may be remained in pre-stressing tendon duct due to poor grouting works.	–	A large scale of air voids or honeycombs are observed.	Air void or honeycomb is observed.
			Deterioration due to Degradation	Crack	Fracture in concrete due to tensile stress mainly arisen from environmental conditions in use (chloride damage, etc.).	–	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Free Lime	Lime contents exudate with water from construction joints or cracks forming through element depth and dried on concrete surface.	–	Exudate of water and/or free lime is extensively observed.	Exudate of water and/or free lime is locally observed.
				Rust Stain	Rust arisen due to corrosion of reinforcement steel is flowed out with water from cracks in concrete.	–	Rust stain is remarkably observed.	Rust stain with water leakage is locally observed due to corrosion of reinforcement steel.
				Scaling / Delamination / Spalling	Scaling or delamination of concrete surface due to swell of corroded steel in concrete, internal stress in concrete or poor construction joint.	–	A large scale of scaling or delamination is extensively observed. Scaling or delamination is scattered.	Scaling or delamination is locally observed.
				Rebar Exposed / Corroded	Reinforcement steel in concrete or in the air is corroded.	Loss of section of reinforcement steel is extensively observed.	Reinforcement steel is exposed and seriously corroded.	Reinforcement steel is locally exposed or corroded.
				Discoloration	Concrete element is deteriorated mainly due to chemical reaction and discolored on surface.	–	Discoloration is observed on concrete surface with cracks.	Discoloration is locally observed on concrete surface.
			Deterioration due to Structural Features and External Forces	Crack	Fracture in concrete due to tensile or compressive stress mainly arisen from structural features or external forces.	Due to extraordinary cracks, spalling and/or compressive failure in concrete are observed.	Though extraordinary cracks are observed, broken pieces of concrete are not dispersed.	Cracks are locally observed.
		Steel Bridge Railing	Deterioration due to Degradation	Corrosion	Steel elements in the air are corroded.	Losses of sections on primary steel elements are observed.	Steel elements are extensively corroded.	Steel elements are locally corroded.
			Deterioration due to Structural Features and External Forces	Deformation, Damage	Permanent deformation and damage caused due to vehicle collision and earthquake.	No required function is performed due to serious damage on primary elements with cracks and deformation.	Malfunction of primary elements is observed due to cracks and deformation.	Slight cracks and deformation are observed on primary elements.
				Loosening and Loss of Bolts / Nuts	Loosening or losses of bolts and nuts on connections between posts and railings are observed.	Posts and railings are in danger of dropping off due to losses of bolts and nuts.	Posts and railings are still remained, though bolts / nuts are lost.	Bolts / nuts are still remained, though they are loosened.

Table 2.2-11 Evaluation Criteria (Drainage System)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation D	Evaluation C	Evaluation B
Bridge	Bridge Surface Drainage Facilities	Drain Box	Deterioration on Drain Box	Deficiency, Corrosion, Deformation and Loss of Drain Box	Deterioration such as deficiency, corrosion, deformation and loss is observed on drain box.	With overflow even at time of small rain and deterioration on drain box, adverse effects are given to a third party or to bridge structure / bridge bearing	Drain box is not properly functioned due to deterioration.	Slight deterioration is observed on drain box.
Bridge	Bridge Surface Drainage Facilities	Drain Box	Deterioration on Drain Cover	Defect, Corrosion and Deformation of Cover	Deterioration such as deficiency, corrosion and deformation is observed on drain cover.	—	Extraordinary deterioration is observed on drain cover and/or attachments.	Drainage function is not well performed due to deterioration on drain cover and attachments.
Bridge	Bridge Surface Drainage Facilities	Drain Box	Sediment of Rubbish and Soils	Clogging with Soils	Clogging with soils is observed in drain box.	Drainage function is impaired due to clogging with soil in drain box, thereby resulting in overflow and adverse effects to a third party, bridge structure and bridge bearing.	Water stagnation is observed on bridge surface due to improper function of drainage system.	Though water stagnation is observed on bridge surface for a short period of time, drainage function is ensured.
Bridge	Bridge Surface Drainage Facilities	Trough on Expansion Joint	Deterioration on Trough	Deficiency, Corrosion, Deformation and Loss of Trough	Deterioration such as deficiency, corrosion, deformation and loss is observed on trough.	With overflow even at time of small rain and deterioration on trough, adverse effects are given to a third party or to bridge structure / bridge bearing.	Trough is not properly functioned due to deterioration. Extraordinary deterioration is observed on attachments.	Slight deterioration is observed on trough.
Bridge	Bridge Surface Drainage Facilities	Trough on Expansion Joint	Sediment of Rubbish and Soils	Clogging with Soils	Clogging with soils is observed in trough.	Drainage function is impaired due to clogging with soil in trough, thereby resulting in overflow and adverse effects to a third party, bridge structure and bridge bearing.	Water stagnation is observed on bridge surface due to improper function of trough.	Though water stagnation is observed on bridge surface for a short period of time, drainage function is ensured.
Bridge	Bridge Surface Drainage Facilities	Drain Pipe	Deterioration on Pipe	Deficiency, Corrosion, Deformation and Loss of Pipe	Deterioration such as deficiency, corrosion, deformation and loss is observed on drain pipe.	With overflow even at time of small rain and deterioration on drain pipe, adverse effects are given to a third party or to bridge structure / bridge bearing.	Drain pipe is not properly functioned due to deterioration. Extraordinary deterioration is observed on attachments.	Slight deterioration is observed on drain pipe.
Bridge	Bridge Surface Drainage Facilities	Drain Pipe	Deterioration on Joint	Corrosion, Deformation and Loss of Joint	Deterioration such as corrosion, deformation and loss is observed on drain pipe joint.	Water leakage is observed from the opened joints, thereby resulting in defect / damage to bridge structure and bridge bearing.	Drain pipe is not properly functioned due to deterioration of joints.	Though water leakage is observed, drainage function is ensured.
Bridge	Bridge Surface Drainage Facilities	Drain Pipe	Sediment of Rubbish and Soils	Clogging with Soils	Clogging with soils is observed in drain pipe.	Drainage function is impaired due to clogging with soil in drain pipe, thereby resulting in overflow and adverse effects to a third party, bridge structure and bridge bearing.	Water stagnation is observed on bridge surface due to improper function of drain pipe.	Though water stagnation is observed on bridge surface for a short period of time, drainage function is ensured.

Table 2.2-12 Evaluation Criteria (Earthquake-Resistant Devices)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation D	Evaluation C	Evaluation B
Bridge	Earthquake-Resistant Devices	Earthquake-Resistant Devices	Deterioration on Concrete Elements	Degradation / Damage on Concrete Elements	Deterioration such as crack, scaling, delamination and rebar exposed is observed.	Extraordinary deterioration such as cracks and scaling / delamination is observed. Load carrying capacity is thereby reduced.	Deterioration such as cracks is observed. It may cause reduction in load carrying capacity.	Slight deterioration such as cracks is observed.
			Deterioration on Steel Elements	Corrosion on Anchor Bars	Anchor bars are corroded.	With the anchor bars corroded, rust stain is extraordinarily observed.	Rust stain is observed due to corrosion of anchor bar.	—

Table 2.2-13 Evaluation Criteria (Inspection Platform)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation D	Evaluation C	Evaluation B
Bridge	Inspection Platform	Inspection Platform	Deterioration on Platform	Deficiency, Corrosion and Deformation on Steel Platform	Deterioration such as deficiency, corrosion and deformation is observed on steel platform including slab, ladder steps and attachments.	—	Required function is extraordinarily impaired due to deterioration on inspection platform such as deficiency, corrosion and deformation.	With the deterioration on platform, required function is not well performed.
				Deficiency and Scaling / Delamination on Concrete Platform	Deterioration such as deficiency, scaling / delamination is observed on concrete platform including slab and ladder steps.	—	Required function is extraordinarily impaired due to deterioration on inspection platform such as deficiency, scaling / delamination.	With the deterioration on platform, required function is not well performed.
			Deterioration on Railing	Deformation and Deficiency on Railing	Deficiency and/or deformation are observed on railing.	—	With the deficiency and/or deformation on railing, working on platform is in danger.	With the deficiency and/or deformation on railing, attention shall be paid in working on platform.

Table 2.2-14 Evaluation Criteria (Culvert)

Structure	Element	Location	Type of Defect / Damage	Defect / Damage	Descriptions of Defect / Damage	Evaluation D	Evaluation C	Evaluation B
Culvert	Reinforced Concrete Culvert	Reinforced Concrete Culvert	Overall Deterioration	Displacement	Culvert is inclined, rotated or displaced.	—	Culvert is largely displaced, and is not properly functioned for vehicle passage and water flow.	Culvert is displaced to some extent.
				Settlement, Scour	Foundation may be scoured due to water flow.	—	Water stagnation is observed in culvert due to extraordinary settlement. A large scale of difference in levels between culvert and approach road is observed due to extraordinary settlement. Wing walls are seriously scoured.	Due to settlement, culvert is not properly functioned for water flow. Wing walls are scoured.
				Unusual Joint	Functions such as water stops and smooth passage of vehicles are not well performed due to irregularity in longitudinal line between adjacent segments.	—	Due to gap, opening and difference in level between adjacent segments, water stops may be dropped off.	Gap, opening and/or difference in level are observed.
			Initial Defect	Crack	Fracture in concrete due to tensile stress mainly arisen from materials used or construction workmanship (dry shrinkage, etc.)	—	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Air Void, Honeycomb	Air void and honeycomb may be remained in concrete due to poor concrete works.	—	A large size of air voids and honeycombs present in concrete.	Air voids and honeycombs present in concrete.
			Deterioration due to Degradation	Crack	Fracture in concrete due to tensile stress mainly arisen from environmental conditions in use (chloride damage, etc.).	—	Cracks, resulting in reduction of durability, are observed.	Small cracks, which may slightly lead to the reduction in durability, are observed.
				Free Lime	Lime contents exudate with water from construction joints or cracks forming through element depth and dried on concrete surface.	—	Exudation of water and/or free lime is extraordinarily observed.	Exudation of water and/or free lime is locally observed.
				Rust Stain	Rust arisen due to corrosion of reinforcement steel is flowed out with water from cracks in concrete.	—	Rust stain from steel reinforcement is extraordinarily observed.	Rust stain from steel reinforcement is locally observed.
				Scaling / Delamination / Spalling	Scaling, delamination or spalling of concrete surface due to swell of corroded steel in concrete, internal stress in concrete or poor construction joint.	—	A large scale of scaling or delamination is extensively observed. Scaling or delamination is scattered.	Scaling or delamination is locally observed.
				Rebar Exposed / Corroded	Reinforcement steel in concrete or in the air is corroded.	Loss of section of reinforcement steel is extensively observed.	Reinforcement steel is exposed and seriously corroded.	Reinforcement steel is locally exposed or corroded.
				Discoloration	Concrete element is deteriorated mainly due to chemical reaction and discolored on surface.	—	Discoloration with cracks is observed on concrete surface.	Discoloration is locally observed on concrete surface.
			Deterioration due to Structural Features and External Forces	Crack	Fracture in concrete due to tensile or compressive stress mainly arisen from structural features or external forces.	Progressive cracks in the direction of road / water flow are observed with free lime and rust stain. Loss of section of reinforcement steel is suspected.	Cracks in the direction of road / water flow are observed with free lime and rust stain.	Cracks in the direction of road / water flow are observed.
			Sediment of Rubbish and Soils	Sediment of Rubbish and Soils	Water stagnation is observed in culvert due to sediment of rubbish and soils.	—	Drainage function is extraordinarily impaired. Water stagnation is observed in culvert.	Drainage function is not well performed.

2.2.2.3 Inspection Methods

Routine inspection is implemented with visual inspection and hammering test. When defect / damage are detected, measurement of extent of defect / damage is conducted using the simple tools.

Such inspection is carried out from bridge surface and under the bridge. Wherever the access is difficult, scaffolds, vehicular lift, boat or under-bridge inspection vehicle is used.

Wherever defect / damage endanger the stability of a structure or safety of a third party, such extent or conditions are recorded in detail and immediately reported to the road operator.

2.2.3 In-Depth Inspection on Concrete Structures

To fully detect and evaluate the extent of defect / damage by routine inspection is beyond its capability.

Wherever it is difficult to estimate or predict the extent of defect / damage using the evaluation criteria in Clause 2.2.2.2, detail data shall be collected through in-depth inspection. Types of defect / damage requiring in-depth inspection and data to be collected are given in Table 2.2-15.

Table 2.2-15 Defect / Damage Requiring In-Depth Inspection and Data to Be Collected

Defect / Damage Requiring In-Depth Inspection		Data to be Collected
Settlement and Displacement		Settlement
Extraordinary Deformation		Deflection of a girder, inclination of a pier, compressive strength, elastic modulus
Cracks along Reinforcement Steel, Scaling / Delamination of Cover Concrete	Carbonation	Carbonation depth, quantity of rust, corrosion cracking
Cracks along Reinforcement Steel, Rust Stain, Section Loss of Concrete / Rebar	Chloride Damage	Chloride ion content, quantity of rust, corrosion cracking
Expansion Crack (Restriction Direction, Alligator Pattern)	Alkali-Silica Reaction	Expansion rate
Latticed Crack, Free Lime	Fatigue	Crack density, deflection

In the in-depth inspection, concrete compressive strength, carbonation depth and chloride ion content are usually investigated. Concrete compressive strength is used for evaluation of load carrying capacity, and carbonation depth and chloride ion content are to predict the timing of concrete defect / damage and rebar corrosion. These data can be obtained with comparative ease.

Descriptions and testing methods are given below.

2.2.3.1 Concrete Compressive Strength

Concrete compressive strength, as well as soundness of pre-stressing tendons and reinforcement steels in concrete, is one of the important factors in order to evaluate load carrying capacity of a structure.

Rebound hammer method is simple and frequently used. This is a convenient method, as the concrete compressive strength can be estimated on site, however, depending on the concrete surface, some cases could not be accurately estimated, and thus, concrete surface should be taken into consideration. Concrete compressive strength is estimated lower on concrete with scaling / delamination of cover concrete, honeycomb or uneven surface. When concrete compressive strength inside the structure or more precise strength is needed, drilled core method is used. Unconfined compressive strength test is made on test specimen taken with drilled core method in accordance with such appropriate specifications as ASTM or BS.

2.2.3.2 Carbonation Depth in Concrete

Reinforcement steels in concrete is in a high level of alkalinity and is protected against corrosion by passive state film. However, in a carbonated concrete, reinforcement steels are subject to corrosion. Measurement of carbonation depth will help to predict the rate of corrosion of reinforcement steels.

Drill powder method is simple and commonly used for carbonation depth measurement on concrete structures in operation.

Carbonation depth is assessed using a 1% solution of phenolphthalein indicator that appears pink in contact with alkaline concrete with pH values in excess of 9 and colorless at lower levels of ph. The powder from drill holes is sprayed or allowed to fall on indicator-impregnated paper.

When drilled core or concrete chipping surface is sprayed with a 1% solution of phenolphthalein, difference in color indicates the carbonation depth.

2.2.3.3 Chloride Ion Content

Chloride ion in concrete will deteriorate the reinforcement steels. Such chloride ions are contained in concrete during construction or penetrated into concrete from salt spray when a structure is constructed at the seashore.

In excess of chloride ion content of 1.2 kg / m3 at reinforcement steel, it is considered in corrosive environment. Distribution of chloride ion content in depth will be used for prediction of deterioration for structures in corrosive environment.

Potentiometric titration method is commonly used for chloride ion content measurement.

2.2.3.4 Crack Investigation

In a cracked concrete, corrosion factors such as water and oxygen as well as carbon dioxide expediting carbonation are penetrated into concrete with ease, thereby resulting in corrosion of reinforcement steels and pre-stressing tendons.

Crack pattern sketch will be prepared only for cracks visually detected. Rate of deterioration will be identified through comparison with previously prepared sketch.

2.2.3.4.1 Preparation of Crack Pattern Sketch

Cracks with surface width of 0.2mm or greater will be recorded in Form-2-5 with surface width, length, location, extent and pattern.

2.2.3.4.2 Measurement of Crack Surface Width and Depth

Crack surface width is measured at perpendicular direction to crack direction using the crack scale. It is noted crack surface width is not uniform in a continuous crack.

In a continuous crack, only the range with its surface width of 0.2 mm or greater will be recorded. Representative width of such a crack shall be the maximum width in a crack.

Crack depth measurement is carried out by ultrasonic wave method or drilled core method.

Ultrasonic wave method is to survey the concrete quality and crack depth by measuring the propagation velocities in concrete.

Drilled core method is to take the core with a crack from the structure and measure its depth. Before taking a core, colored ink shall be injected into a crack in order to observe its depth with ease.

2.2.4 Emergency and Special Inspections

2.2.4.1 Inspection Items

2.2.4.1.1 Emergency Inspection

Emergency inspection is implemented to members or locations of a structure damaged due to such natural disasters as a large scale earthquake, typhoon and floods, collision with vehicles or vessels, and fire. Such inspection will be implemented at a high risk of work conditions. Special attention shall therefore be given to ensure the safety of inspection staff and to promptly complete such inspection.

Defect / damage on member or location of a structure for each event are given in Table 2.2-16. Other types of defect / damage than those described in Table 2.2-16 causing the collapse of a structure or endangering the safety of traffic shall also be inspected as necessary.

Table 2.2 16 Items to Be Inspected for Emergency Inspection

Event	Member / Location	Description of Defect / Damage
Large-Scale Earthquake	Girder End (Bridge Bearing)	Rupture of bridge bearing
		Rupture of bolts
		Girder dropped out of the bridge bearing
		Attachments of earthquake-resistant devices
	Bridge Deck	Damage on girder end due to displacement of substructure
		Damage due to collision between ballast wall and girder end
	Substructure	Cracks at bridge bearings
		Cracks resulting in shear failure
		Deformation / deficiency of bridge railing and curb
		Excessive big / small girder end gap
Typhoon, Flood, Collision	Bridge Deck	Defect / damage due to collision with debris
		Defect / damage due to collision with heavy equipment
		Defect / damage due to collision with vehicles
		Defect / damage due to collision with vessels

2.2.4.1.2 Special Inspection

Wherever any deterioration are found on a structure due to unexpected types of defect / damage or extraordinary deteriorations, not resulting in serious incidents, are observed, special inspection will be implemented on members / locations of a similar structure, which may have same types of deteriorations.

Inspection items for special inspection are those in routine inspection. However, for a structure requiring detail investigations such as prediction of deterioration, in-depth inspection shall be implemented.

2.2.4.2 Evaluation on Defect / Damage

In emergency inspection, defect / damage shall be evaluated with criteria used for routine inspection.

However, in case of degradation, new types of defects / damages, new criteria should be created and based for evaluation.

2.2.4.3 Inspection Methods

2.2.4.3.1 Emergency Inspection

In emergency inspection, safety shall initially be ensured against collapse of a structure through remote visual inspection, followed by direct visual inspection and hammering test using simple tools.

Where a structure seems to be inclined, settled or displaced, survey tools shall be used for measurement.

2.2.4.3.2 Special Inspection

Special inspection shall be implemented not only with visual inspection and hammering test, but also with non-destructive equipment and chipping method as required.

On structures designed and constructed with similar design standards and materials, as-build documents are useful for inspections. Such documents, as well as differences in environmental conditions, shall therefore be carefully investigated.

2.2.5 Record-Keeping System

The inspection staff shall record the inspection results in the prescribed forms and report to the road operator. Records of such inspection results shall be kept in a proper manner and be available whenever necessary.

(1) Results of inspection conducted to recognize the conditions of a structure are important as the database for formulation of inspection plans, measures to be taken and so on.

(2) In case emergency measures are taken on defect / damage found during the inspection, such measures shall be recorded. Evaluation results, after the measures are taken, shall also be recorded and reported.

(3) Digital camera shall be used to record the defect / damage. Such electronic data shall be kept in a proper manner.

(4) Records shall be kept during the operation period of a structure.

2.2.5.1 Record-Keeping Forms

As the results of inspection are precious database for efficient and effective maintenance activities, such results shall be kept in order of inspection date and compiled in Inspection Record Form (Form 2-1) for each structure.

2.2.5.2 Record of Inspection Results

Form of inspection results to be used for each type of inspection is summarized in Table 2.2-17.

Organization of inspection, defect / damage with sketch map, evaluation, selection of measures and measures taken shall be recorded in these Forms.

Table 2.2-17 Inspection Forms used for Each Type of Inspection

No of Form	Title of Form	Type of Inspection: Initial Inspection	Daily Inspection: Safety Patrol	Daily Inspection: Inspection: Monitoring	Daily Inspection: Inspection: General Inspection	Routine Inspection A B	In-Depth Inspection	Descriptions
Form 2-2	Form of Records for Daily Inspection, Routine Inspection Type-A		○	○		○		To record the route of inspection and defect / damage found at the site.
Form 2-3	Records of Defect / Damage Found in Daily Inspection & Necessary for Urgent Measures	○	○	○	○	(○)	(○)	To record the defect / damage found in daily inspection and/or requiring unguent measures for reporting.
Form 2-4	Monthly Summary Sheet of Inspection, Evaluation and Measures Taken		○	○	○			To summarize, on a monthly basis, the inspection, evaluation and measures taken for defect / damage requiring measures for a short period of time after detection.
Form 2-5	Inspection Records - Photographing	○			○	○	○	To summarize the photographs for defect / damage for each structure.
Form 2-6	Defect / Damage Map	○			○	○	○	To sketch the details of defect / damage for each structure.
Form 2-7	Annual Summary Sheet of Inspection, Evaluation and Measures Taken					○	○	To summarize, on an annual basis, the inspection, evaluation and measures taken defect / damage not requiring urgent measures for a short period of time after detection.

2.3 Assessment and Maintenance Program

Incidents arisen from defect / damage on structures will cause serious losses of economical benefits due to closure of expressway to traffic and losses of human lives.

However, since the rate of progress of degradation with time is generally slow and no urgent measures are required at time of detecting the signs of defect / damage, prompt preparation and implementation of measures will not be taken. In addition, it is well known that the greater the extent of defect / damage on structures, the bigger the cost for reinstatement, repair and reinforcement and losses of economical benefit due to closure to traffic. Under such circumstances, in order to use the existing structures effectively and efficiency, scheduled maintenance activities shall be implemented.

Defect / damage on structures shall be checked by inspection activities, recorded and evaluated in accordance with evaluation criteria in 2.2.2.2. Evaluation criteria are developed based on the extent of risks to road users and a third party due to each defect / damage.

To prevent troublesome in taking the measures for each defect / damage on an individual basis, grouping shall be made so that defect / damage within some range of rate of degradation can be repaired at the time, as in Table 2.3-1.

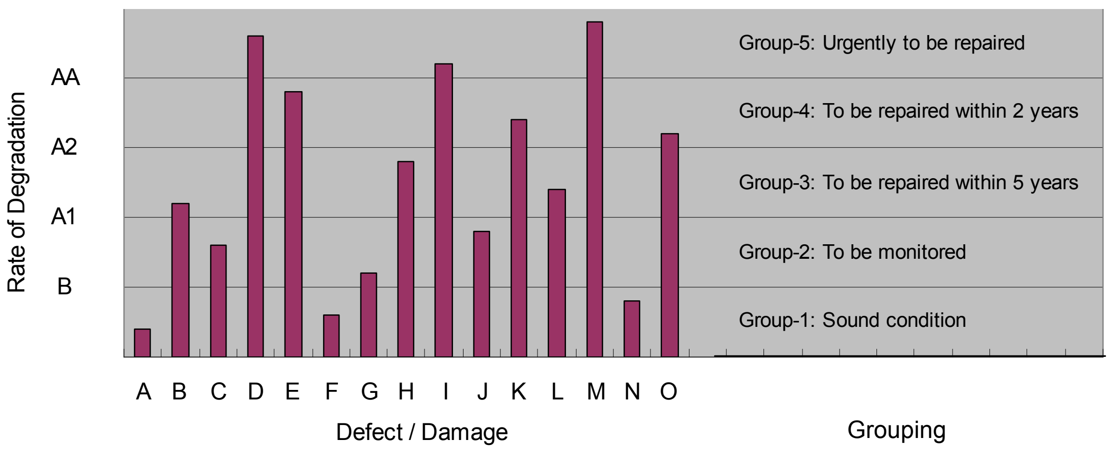


Table 2.3-1 Grouping of Defect / Damage for Efficient Measures

Therefore, with the inspection results on defect / damage and predicted economic losses considered, efficient maintenance program shall be developed. Scheduled inspection and repair works shall subsequently be implemented in accordance with the developed maintenance program.

2.3.1 Assessment based on Inspection Results

Information on types and deterioration levels of defect / damage on structures obtained from inspection activities shall be recorded and used for formulation of maintenance program. In the maintenance program, if it is judged defect / damage is categorized into D and C, such structures shall be basically repaired. However, defect / damage, which need low cost of repair for its ease of work, as indicated in 2.4.1.1 - 2.4.1.3, shall immediately be repaired after detection at times of daily inspection.

Defect / damage categorized into D, which will probably result in serious incidents, need urgent repair works within several days to several months after detection. It is supposed that these defect / damage are drastically degraded from the previous inspection to most recent inspection times, or have not been detected for an extended period of time with some reasons.

Defect / damage categorized into C will probably be degraded to the extent of category D within several months to ten years after detection. Depending on urgency, these will be categorized into T or C of Group C within approximate 3 years.

Deterioration of structures is generally progressed at the following four (4) stages:

(1) Dormant Stage: Though deterioration is not visually observed on surface, factors of deterioration are accumulated and/or microscopic change in materials is generated. It is categorized into A.

(2) Initiation Stage: Though deterioration is not visually observed on surface, it is progressed inside the structure. It is categorized into B.

(3) Acceleration Stage: Signs of deterioration can be visually observed. Deterioration is explicitly progressed. It is categorized into T of group C.

(4) Deterioration Stage: Such required functions as load carrying capacity are evidently degraded. It is categorized into priority C in group C and/or D for its urgency.

Degradation characteristics depend on structural types / forms, surrounding environments and traffic conditions on them. Such degradation characteristics as rate of degradation progress can be identified by means of statistical processing of previous inspection data classified by defect / damage type and surrounding environments. In order to implement the maintenance activities on structures more effectively, it is of great importance to assess the prioritization of repair on each defect / damage in consideration of degradation characteristics as well as integrated effect to overall structural stability by deteriorated members and effect to road network by defect / damage on structures.

2.3.2 Maintenance Program

It is well known that preventive maintenance, which implements repair works in an earlier and proper time with periodical inspection, understanding of defect / damage conditions and prediction of deterioration, is superior to breakdown maintenance with a large-scale repair works conducted immediately after detecting serious defect / damage, in order to keep the structures in sound conditions for an extended period of time and minimize the maintenance cost.

So as to prepare effective and efficient maintenance program, several types of maintenance scenarios shall be developed in consideration of the following:

(1) Several levels of repair work;

(2) Repair method and its cost for each level of repair work;

(3) Prediction of rate of degradation.

With the above, the following procedure shall be taken for development of maintenance program.

1. Basic maintenance scenario shall be determined through cost comparison among several maintenance scenarios;
2. Interval of repair work and its cost shall be assumed for each structure;
3. Based on the above (2), necessary budget for all the target structures in maintenance program shall be summed for a period of maintenance program. It will be recognized uneven budget is required for every year (a lot of budget for a year, small budget for another year).
4. Whenever necessary budget is concentrated for the year, budget leveling will be made by means of shifting the time of repair works for such year to the period of subsequent three (3) years.
5. Appropriate manuals including maintenance procedures shall be prepared after the maintenance program is developed.

2.4 Maintenance Works

2.4.1 Daily Maintenance Work

Daily maintenance work on structures shall be implemented to ensure safe and comfortable expressway with the removal of causes endangering the safety of vehicle travelling and to extend the intervals of large-scale repair works and/or improvement works with prompt and appropriate measures on detected defect / damage for slow progress of deterioration.

Activities implemented for daily maintenance works are described below. Water stagnation on road surface and defect / damage on bridge expansion joints may endanger the safety of road users. Defect / damage on bridge railings caused by vehicle collision may also lose the function preventing vehicles from falling off the bridge. Such deterioration as cracks on bridge deck / substructure concrete, leakage of surface water to girder ends and corrosion of steel elements will result in reduction of load carrying capacity if prompt and appropriate measures are not taken.

2.4.1.1 Bridge Drainage System

Clogging of drain boxes / pipes will cause water stagnation on road surface and may result in loss of steering wheel control or danger of vehicles travelling on adjacent / oncoming traffic lanes by splashed water. Covers dropped on traffic lane out of drain boxes will also result in serious accidents due to loss of steeling wheel control of vehicles travelling on such covers or hitting of covers to vehicles on adjacent / oncoming traffic lanes.

Such defect / damage on bridge drainage system shall immediately be repaired.

2.4.1.2 Bridge Expansion Joint

Wherever fracture of face plates or removal of part of expansion joint is observed, appropriate measures shall promptly be taken to prevent accidents. Defect / damage on bridge expansion joint resulting in uneven road surface shall be temporarily repaired with filling of bituminous mixtures or collection of scattered pieces / parts, and shall be replaced with sound ones as prompt as possible.

Figure 2.4-1 Temporary Filling with Bituminous Mixtures

Difference in level between block out material and adjacent pavement will be discussed in Chapter 1.

Surface water flowing to both ends of expansion joints shall be stopped at curbs with such appropriate measures as sealing materials along with backup material. However, such materials are subject to degradation with ease or were inappropriately installed at construction stage. So as to delay the deterioration progress on bridge bearings and substructures, it is quite important to execute appropriate water stop works at curbs using the sealing materials.

Figure 2.4-2 Inappropriate Water stop Works at Both Ends of Expansion Joint

Figure 2.4-3 Proper Water stop Works at Both Ends of Expansion Joint

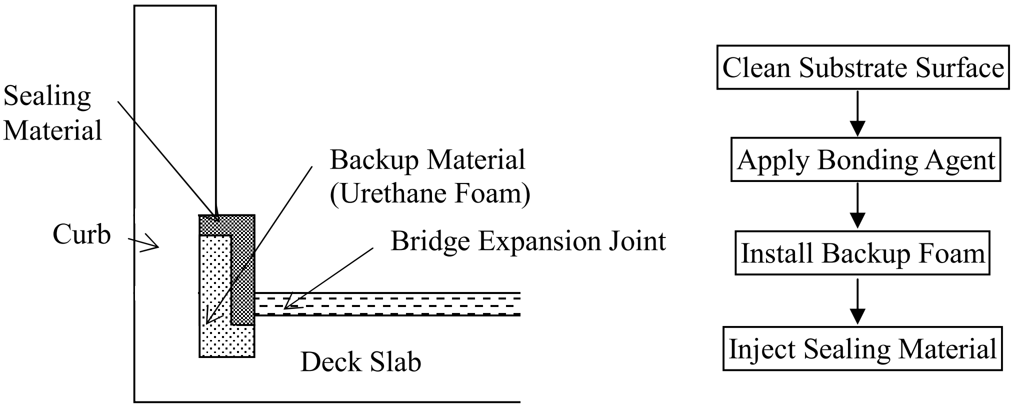


Figure 2.4-4 Guide for Water stop Works at Both Ends of Expansion Joint

2.4.1.3 Concrete Structure

Cracks will usually occur on concrete structure due to various actions as drying shrinkage. Cracks allow such deterioration factors as water and oxygen to penetrate into concrete and expedite the reduction in load carrying capacity of a structure. Wherever the crack with its surface width exceeding 0.2mm is detected, prompt measures shall be taken.

Due to expansion of corroded reinforcement steel, cracks will occur inside the concrete and cause spalling of cover concrete. In such a case, spalled concrete shall be restored properly after application of corrosion inhibitor on exposed reinforcement steels in order to prevent exposure of inside concrete to deterioration factors.

2.4.1.3.1 Crack Repair Method

Crack repair shall be carried out with low-pressure injection method at slow rate of injection so that materials can be injected completely to the crack. Injection material shall be of epoxy resin for the crack with small surface width.

Though several types of injection machine / gun are used for crack injection, hereby described is the cylinder type which can inject comparatively large amount of resin material with ease.

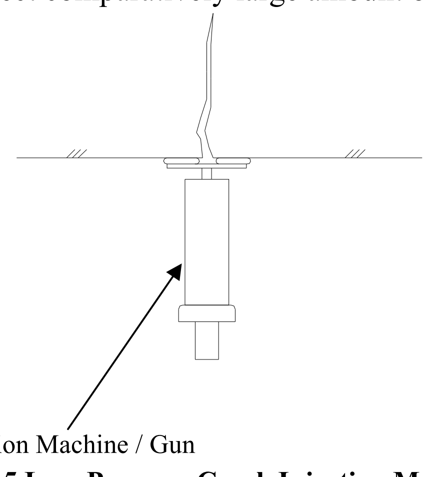
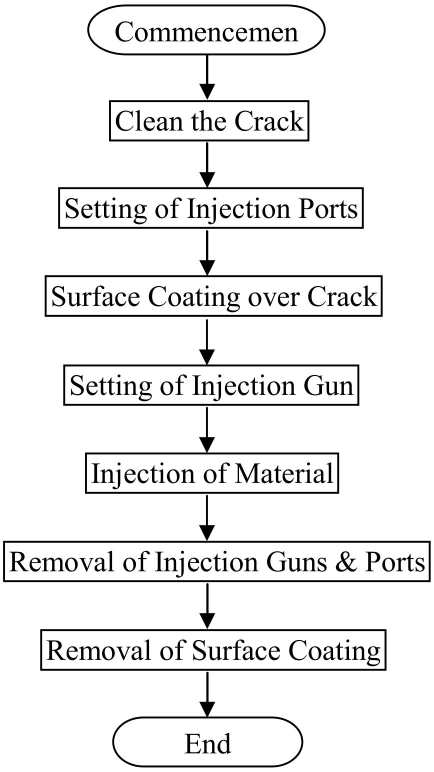


Figure 2.4-5 Low-Pressure Crack Injection Method



Note:
Injection material may be clogged in crack due to the removal of its moisture caused by dry crack surface. It is necessary to dampen the crack through injection of water in it.

Figure 2.4-6 Work Flow for Crack Injection

2.4.1.3.2 Restoration of Section of Element

Plaster work is preferred for small scale of restoration work for concrete structure.

Concrete scaling or delamination is caused by shortage of concrete cover to reinforcement steel with poor concrete work or such severe environments as water leakage. It is therefore required to prevent deterioration factors from penetrating into concrete. After the preparation of substrate surface and application of corrosion inhibitor on reinforcement steels are properly executed, polymer-cement material is injected for restoration.

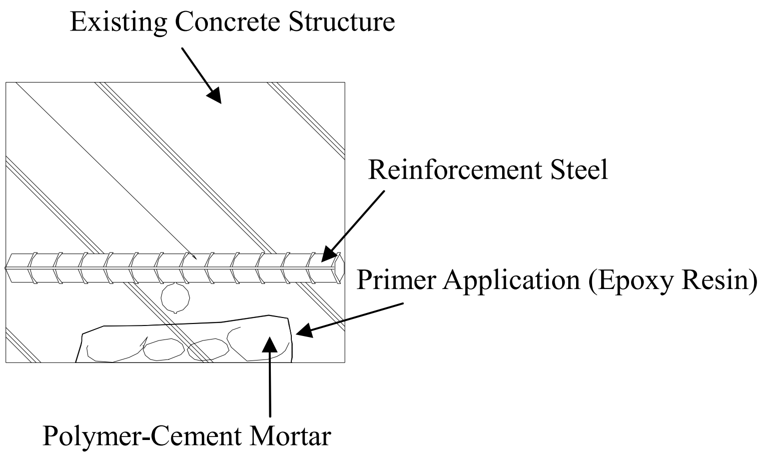
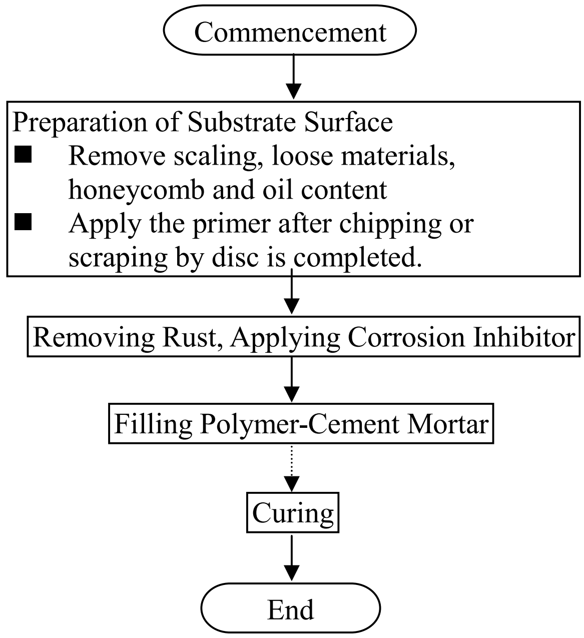


Figure 2.4-7 Method of Restoration of Element Section



Note:
1. Defect / damage shall be completely removed with chipping work followed by surface preparation with blasting and application of corrosion inhibitor on surface of reinforcement steel.
2. For surface preparation, removal of scaling, crack, honeycomb as well as portions containing large amount of chloride ions shall be conducted as much as possible.
3. No defect / damage shall be given to sound portions.

Figure 2.4-8 Work Flow for Restoration of Element Section

2.4.1.4 Removal of Soil Deposits on / around Steel Element, Surface Coating on Steels

2.4.1.4.1 Bridge Bearing

Whenever steel bridge bearings are corroded, rust shall be removed with wire brush or grinder as much as possible. Prior to surface coating, steel surface shall be free from oil, moisture and/or substances, and shall be dry. Surface coating material shall be of zinc-rich paints.

Corrosion on bridge bearing is caused with stagnation of water from bridge expansion joint. Corrosion of steel elements is expedited with moisture retained in soil deposits and/or dust around bridge bearing. Even without corrosion on bridge bearing, it is needed to remove soil deposits and dust from the bridge bearing seat as well as to improve water stop function at bridge expansion joint.

2.4.1.4.2 Bridge Railing

Such slight defect / damage as scratch on surface coating shall be repaired on prepared steel surface free from dust, oil and substances. Surface coating material shall be of quick drying repair paint for ordinary steel surface and of zinc-rich paint for plated surface.

Whenever it is difficult to implement surface coating at site, appropriate measures shall be taken to carry out surface coating in a factory or to replace deteriorated steel element, with the traffic safety ensured during such work.

2.4.2 Routine Maintenance Work

Defect / damage, evaluated as C, caused by degradation with time shall be repaired under the routine maintenance work program. Primary repair works are to improve load carrying capacity of concrete elements and to recover the serviceability of ancillary works.

A lot of modern repair technologies have been developed day by day with improved effects. Hereby described are several types of repair technologies with special attentions for the work.

2.4.2.1 Concrete Structure

Repair works on concrete structures are for cracks, scaling / spalling and corrosion of reinforcement steel and pre-stressing tendon. For routine maintenance work, repair technologies for the crack with large surface width and extensive scaling / spalling of concrete are discussed.

2.4.2.1.1 Crack Repair Method

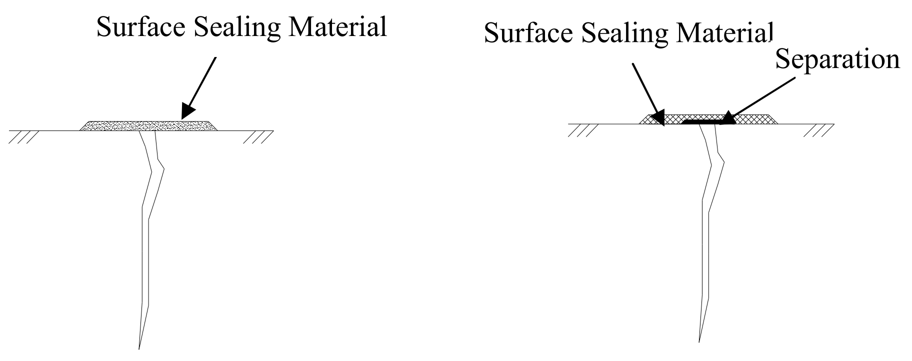
Hereby discussed are such repair techniques as surface sealing method and routing & patching method for cracks with variation in surface width.

2.4.2.1.1.1 Surface Sealing Method

A crack with comparatively small and variable surface width due to progressive degradation and live loads is sealed with flexible sealing materials or joint filling materials. Sealing material shall be of elastic waterproofing agent or polymer cement paste for small variation in its width, and shall be of flexible material for large variation in its surface width.

Procedure for surface sealing work shall be as follows:

(1) Concrete surface along the crack shall be roughed with such tools as wire brush.
(2) Remove the substances followed by cleaning with water and drying the surface.
(3) Filling the air voids on concrete surface with putty.
(4) Seal the crack surface with appropriate materials.



(a) Small Variation in Crack Surface Width (b) Large Variation in Crack Surface Width

Figure 2.4-9 Surface Sealing over Crack

2.4.2.1.1.2 Routing & Patching Method

Routing with V- or U- grooving followed by patching is implemented for cracks with 0.5mm or larger surface width in concrete without corrosion of reinforcement steels.

Concrete surface is grooved with V- or U-shape in approximately 10mm width along a crack. Such grooving is filled with such repair materials as sealing material, flexible epoxy resin or polymer cement mortar.

Routine Repair

Daily Repair

(a) Small Variation in Crack Surface Width (b) Large Variation in Crack Surface Width

Figure 2.4-10 Routing & Patching Method

2.4.2.1.2 Restoration of Section of Element

For the bridge deck with thin cover concrete, extensive restoration of concrete is implemented with filling of non-shrinkage mortar or pneumatically applied polymer cement mortar.

Defect / damage on substructures with thick cover concrete will be chipped followed by surface preparation, application of primer on substrate surface and corrosion inhibitor on reinforcement steels, and casting concrete.

2.4.2.1.2.1 Filling of Mortar

Forms shall be set to ensure the required dimensions and concrete cover to reinforcement steels, and be completely filled with joints between sheathings by sealing materials. Non-shrinkage mortar or high-performance polymer cement mortar are then filled by pressure pump.

Figure 2.4-11 Filling of Non-Shrinkage Mortar

2.4.2.1.2.2 Pneumatically Applied Polymer Cement Mortar

Polymer cement mortar is pneumatically applied to concrete surface with dry-mix or wet-mix system. Wet-mix system is to pump out the premixed mortar and apply to the concrete surface. On the other hand, dry-mix system is to pump out such materials as cement, sand and admixture to the nozzle, to add water at nozzle and to apply to the concrete surface. Each system uses exclusive equipment for application.

Figure 2.4-12 Pneumatically Applied Polymer Cement Mortar

2.4.3 Repair Works on Bridge Accessories

Replacement of all or part of components used will be carried out for bridge accessories.

2.4.3.1 Bridge Expansion Joint

Defect / damage on bridge expansion joint, directly degrade the safety of vehicle travelling, shall urgently be repaired. A large scale repair work such as replacement of whole expansion joint needs at least restriction of traffic lane(s). Therefore, in order to prevent degradation of service level on whole of expressway network, emergency measures are temporarily taken, followed by permanent maintenance works on expansion joints for selected areas during the periods with low traffic volume.

Repair works will be implemented with the following methods, considering the extent of defect / damage, impacts to the socioeconomic activities by closure of traffic lane(s), ease of repair works and safety during the work.

- Repair for Damaged Portions

  Face plates damaged will be partially repaired or replaced with new ones. Trough attached to the expansion joint will be replaced.

- Replacement of Whole Bridge Expansion Joint

  Whole of damaged expansion joint will be replaced with same type or different type of joint.

- Replacement of Block out Materials

  Block out materials used will be replaced.

Special attention shall be paid on safety management with traffic control, since such works are implemented very close to vehicles travelling at high speed.

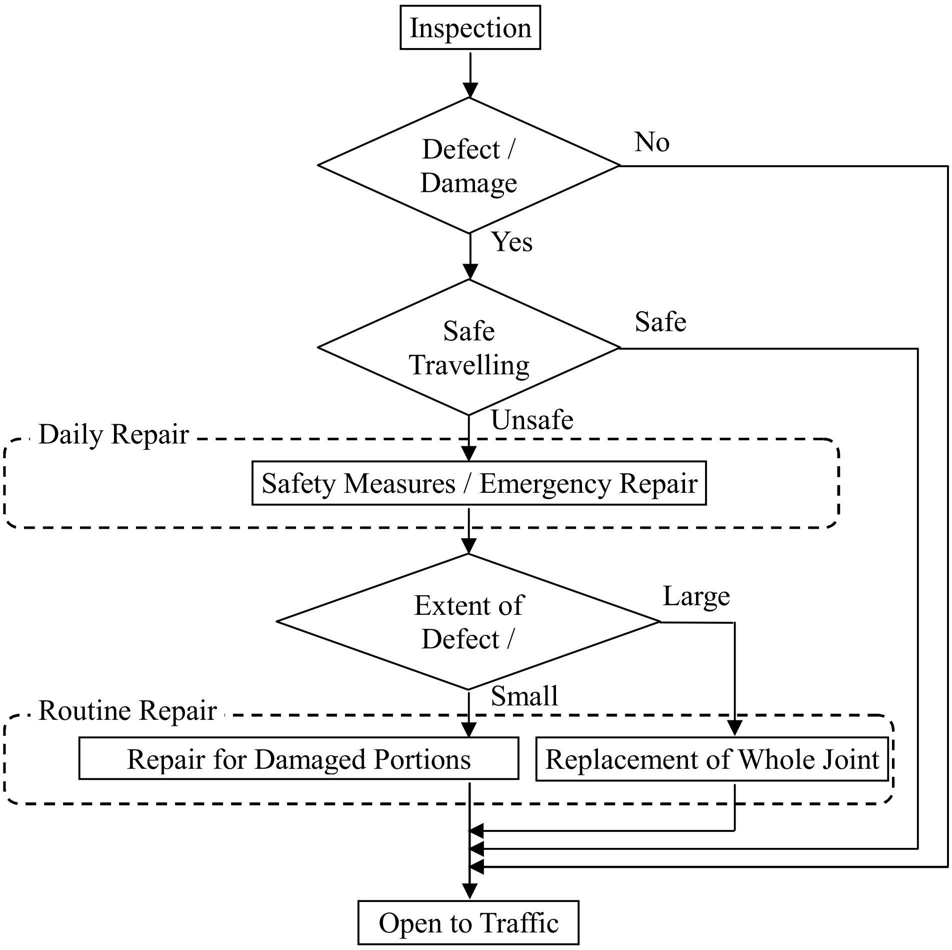


Figure 2.4-13 Repair Procedure for Bridge Expansion Joint

2.4.3.2 Bridge Bearing

Whenever decrease in vertical load carrying capacity is suspected or difference in level occurs at expansion joint due to fracture on bearing seat mortar and/or bridge seat concrete, such mortar and concrete shall be replaced.

Horizontal displacement on substructure may result in excessive deformation of bridge bearing out of the design limits. Whenever no serious fracture or defect / damage is observed on deformed bridge bearing, jacking up the bridge deck with slight raise will enable the release of deformation along with the casting of bearing seat mortar at different location. Jacking up can be done with traffic opening for reason of slight raise to approximately several millimeter difference in level at expansion joint.

Collapse or rupture in elastomeric materials or deformation in steel materials will need replacement of bridge bearing with big raise of bridge deck jacking up. To prevent any accidents due to large difference in level at expansion joint, the bridge shall be closed to traffic.

It is required to accurately calculate jacking forces as well as to check the loading capacities on bridge structure at jacking positions. Insufficient loading capacities need reinforcement on structures at jacking positions.

2.4.3.3 Bridge Railing

Whenever cracks and/or scaling are extensively observed on concrete element due to degradation with time, such defect / damage shall be repaired. Steel bridge railing degraded in load carrying capacity due to serious corrosion shall also be replaced.

Special attention shall be paid on safety management with traffic control, since such works are implemented very close to vehicles travelling at high speed.

2.4.3.4 Bridge Drainage System

Horizontally installed drain pipes are subject to clogging, deformation and defect / damage, water leakage from the pipe joints, defect / damage on attachments. Such defect / damage will result in injuries to a third party under the bridge, erosion on embankment fill or local degradation in concrete.

Maintenance activities on bridge drainage system will include restoration of drain box covers, replacement of drain pipes and attachments. During the work, soils and/or rubbish in drain pipes shall be removed.

2.4.4 Record-Keeping System

2.4.4.1 Documents in Construction Period

A variety of documents prepared during the construction period are effective for maintenance works. Such documents shall include design calculations, drawings, times and methods for inspection and repair, maintenance scenarios developed, and shall be kept in a proper manner for easy access for its service life.

Design standards, general and special conditions of contract and special conditions may be revised for its long service life. These documents used for design and construction of a structure shall also be kept for use for evaluation of soundness, development of maintenance program and repair works.

2.4.4.1.1 Design Documents

Design documents prepared during design periods shall include the following:

- Design calculations.
- General drawings.
- Detail drawings (bridge deck substructures, ancillary works).
- Quantity calculations.
- Topographical and geological data

2.4.4.1.2 Construction Records

Field management on concrete works is quite important to ensure required strength and durability and to prevent significant errors in reinforcement steel arrangement and unfavorable impurities in concrete, which cannot be detected after concrete casting. Records on quality control, construction progress and dimensions of finished works, in addition to design documents, shall therefore be kept for future maintenance work.

- Material tests and quality control data on cements, aggregates, admixtures and water.
- Records on concrete mix, pouring and curing, progress and quality control.
- Environments at times of concrete pouring.
- Photographs during construction.

2.4.4.2 Documents in Maintenance Period

2.4.4.2.1 Maintenance Program

Maintenance program will be revised many times during the service life. Design documents for repair work shall therefore include design service life of such repair as well as estimated heavy traffic volume and weather conditions, specified in the maintenance program.

2.4.4.2.2 Inspection Records

Various types of defect / damage occur on structures. Through collection and analysis on such defect / damage, it is expected that improvement of precision in prediction of degradation as well as analysis on mechanism of unprecedented defect / damage is achieved. Inspection results shall therefore be recorded.

2.4.4.2.3 Design Documents

Design documents for repair works as well as for original design shall be kept.

Repair works are designed based on defect / damage maps prepared at times of inspection. However such maps do not describe defect / damage inside the concrete. Actual quantities done will usually be increased compared to design ones. At the completion of repair works, revision and/or addition to design shall clearly be recorded in the design documents.

2.4.4.2.4 Records on Maintenance Work

Records on maintenance work shall include photographs during the work, material tests and quality control data on repair materials, as recorded in the original construction records.

2.4.5 Feedbacks

Structural details preferred for ease of maintenance works are specified in design standards. However, wherever such details are regarded not suitable through inspection and maintenance work activities, they shall be revised to better ones and specified in the standards. Such revisions shall be disseminated through seminars or workshops to the relevant organizations, governmental officials and engineers.

It will contribute to decrease in defect / damage on structures, time and cost savings.

2.5 Safety on Inspection and Maintenance Works

2.5.1 Safety Measures

In implementing inspection, investigation and repair works on expressway, due to passage of vehicles at high speed, traffic safety measures shall be taken. Traffic safety measures to be taken on expressway are discussed below:

2.5.1.1 General

2.5.1.1.1 Safe Driving

- The driver shall keep safe driving in mind as a member of road operator.
- The driver shall wear seat belt during driving.
- Vehicle used for maintenance work shall have visible indication in order to recognize itself as “Inspection Vehicle” from ordinary vehicles.

2.5.1.1.2 Clothes, Equipment and Health Care

- The work crew shall wear comfortable clothes for easy to move.
- The work crew shall wear such prescribed personal protective equipment (PPE) as hard hat, reflective safety vest, safety shoes and whistle.
- With prior medical checkup, the work crew physically in bad condition shall not work.

2.5.1.1.3 At Times of Parking / Stopping

- Hazard warning light shall be turned on at times of parking and stopping.
- Special attention shall be paid to ordinary vehicles at times of deceleration and acceleration.
- Vehicles shall park at a wider shoulder with an unobstructed view from ordinary vehicles.
- Front wheels shall direct to the outermost lane or shoulder at times of parking and stopping in order to prevent moving out to the traffic lane due to rear-end collision.

2.5.1.1.4 Traffic Control

- Traffic control is to ensure safety of work space and work crews.
- Traffic control devices and work space shall be arranged at locations easy to see from ordinary vehicles.
- Installation of traffic control devices shall be laid piece by piece in the direction of driving.
- Removal of traffic control devices shall be implemented against the direction of driving.

2.5.1.1.5 Work inside Protected Area by Traffic Control

- Watchmen deployed shall monitor the movement of ordinary vehicles.
- Work crews shall not work on expressway with their backs on ordinary vehicles.
- Work crews shall not go out of the protected area during the work.

2.5.1.2 Traffic Safety Measures at Times of Inspection / Investigation

2.5.1.2.1 General Precautions

- At least two (2) work crews shall inspect and investigate together.
- One work crew shall be a flagman to give the waning to ordinary vehicles and to ensure the safety.
- Vehicles on duty shall turn on yellow color revolving warning lamps in order to give the waning to ordinary vehicles.

At least two (2) work crews shall work together, of which one shall be a flagman for warning.

Figure 2.5-1 Safety management on the road surface

2.5.1.2.2 Precautions on Daily Inspection

- Daily patrol shall be implemented on slow lanes, not on overtaking lane, so that work crews can inspect the structures at slow speed.
- Whenever it is necessary to inspect the structures outside the patrol vehicle after detecting the defect / damage, the work crews shall ensure the safety in advance and patrol vehicle shall stop at a shoulder.
- Whenever high emergency is needed, work crews shall ensure the safety at work site with traffic control and promptly report to the head office for assistance.

2.5.1.2.3 Precautions on Routine Inspection and In-Depth Inspection

- The work crews shall wear safety belts when working at height.
- Special attention shall be paid not to drop off the inspection tools when working at height.
- So as to prevent incidents due to falling and stumbling, photographing with motion shall be prohibited.

- When working in the river / watercourse, safe evacuation route shall be secured for flooding.
- Such access equipment to bridge soffit as bridge inspection vehicles and suspended scaffolds will be described in 2.6.1.

2.5.1.2.4 Precautions on Emergency Inspection

- Work crews shall initially check the stability against the collapse of a structure and carry out the inspections to the extent work safety is ensured.
- Whenever any defect / damage, resulting in drastic reduction of load carrying capacity, are detected, work crews shall promptly report to the head office for assistance, and implement such necessary emergency measures as temporarily closure to traffic.

2.5.1.2.5 Traffic Safety measures during repair works

- Repair work shall be carried out within the work area protected by rubber pylons.
- No access to the work area is allowed except for members concerned.
- When the grinders / breakers are used, work crews shall wear safety goggles and work gloves to prevent injuries, and shall install sheets and plywood panels to prevent dispersion of fragments and sparks.
- When chemicals and hot materials are used, such appropriate equipment as safety goggles and work gloves shall be equipped.

2.5.2 Equipment for Safety Measures

Equipment for safety measures for inspection, investigation and repair works on expressway is described as follows:

2.5.2.1.1 Arrow Board

Arrow boards shall be installed at the beginning of traffic control area to provide the segment for reduction of traffic lanes. Eleven (11) numbers of arrow boards shall be arranged at 20m intervals for 200m long segment. Arrow board shall have suitable weight, not be so light to prevent blowing away by wind and not be so heavy for ease of transportation.

Arrow Board

Rubber Pylon

2.5.2.1.2 Rubber Pylon

Rubber pylon shall be arranged along the traffic lane marking so as to separate work area from vehicle driving lanes and at 10m to 20m intervals. Rubber pylon shall have suitable weight, not be so light to prevent blowing away by wind and not be so heavy for ease of transportation.

2.5.2.1.3 Mobile VMS (Variable Message Signs)

Mobile VMS shall be arranged at the beginning of traffic control area in order to clearly indicate the work area and to protect the work space. Mobile VMS shall equip arrow sign and hazard warning light for ease of recognition of work area.

2.5.2.1.4 Traffic Control Sign

Traffic control signs shall be installed in order to give the notice to the ordinary vehicles regarding the presence of traffic control. Contents displayed and installation locations shall be determined after discussion with road operator.

2.5.2.1.5 Flag

Using the flag, watchmen shall give the waning to ordinary vehicle on adjacent traffic lane.

2.6 Equipment for Inspection and Maintenance Work on Concrete Bridges

2.6.1 Equipment for Inspection

Provision of safe work space to the work crews and sufficient field of vision is of importance for inspection. Hereby described is the necessary equipment for inspection works.

2.6.1.1 Equipment for Daily Inspection

Equipment for daily inspection is given in Table 2.6-1.

Table 2.6-1 Necessary Equipment for Daily Inspection

Tools / Equipment		Remarks
Inspection Tools	inspection hammer, crack gauge or loupe, steel tape, measuring tape, measuring pole, binoculars, flashlight or headlight	
Writing Materials	recording papers, digital camera, black board, chalk, white board and pen	
Safety Equipment	work wear, hard hat, reflective safety vest, safety boots, work gloves, whistle, yellow flag for warning, mobile phones for communication, arrow board, rubber pylon	

2.6.1.2 Equipment for Routine and In-Depth Inspections

Equipment for routine inspection is given in Table2.6-2. Additional equipment will be needed for in-depth inspection, depending on types of defect / damage to be inspected.

Table2.6-2 Necessary Equipment for Routine Inspection

Tools / Equipment		Remarks
Inspection Tools	inspection hammer, crack gauge, steel tape, measuring tape, measuring pole, binoculars, flashlight or headlight, rebound hammer, vernier calipers, leveling string, wire brush, inspection mirror, phenolphthalein solution, drilling	
Writing Materials	recording papers, digital camera, black board, chalk, white board and pen	
Safety Equipment	work wear, hard hat, reflective safety vest, safety boots, work gloves, safety belt, safety goggles, dust mask, whistle, yellow flag for warning, mobile phones for communication, arrow board, rubber pylon, traffic control sign boards, life vest	Safety belts at high work place. Life vest on water.
Equipment for Access	rope, stepladder, ladder, mobile elevating work platform, under-bridge inspection vehicle, boat, wader, suspended scaffold	To be selected for site conditions.
Others	as-built drawings, thermometer, shovel, garbage bag, corrosion paint	Lighting equipment is needed for night work.

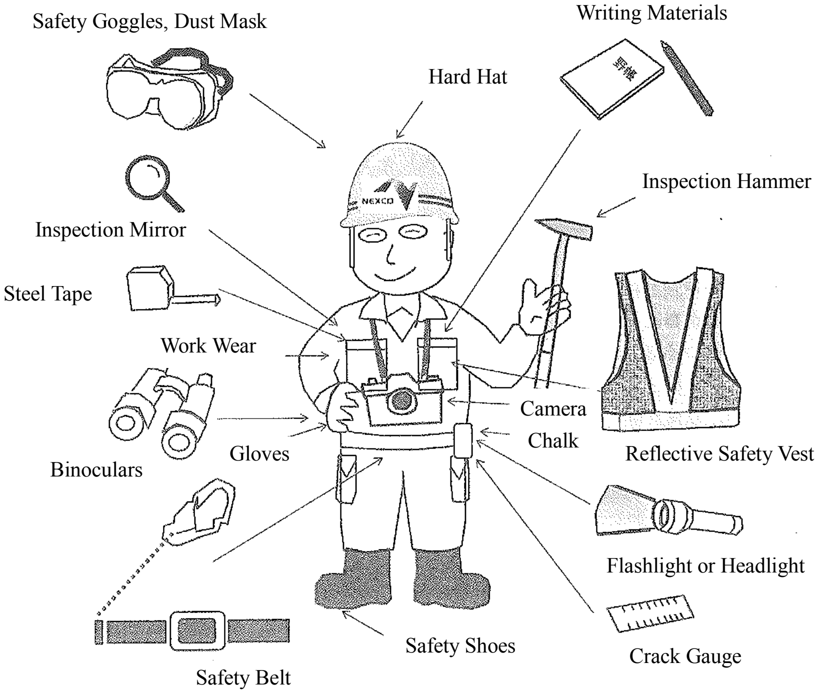


Figure 2.6-1 Standard Equipment and Clothes Necessary for Inspection

2.6.2 Equipment for Repair Works

Equipment for repair works shall be selected and prepared so that they are appropriate for use with types of defect / damage and repair methods. Particularly, for working on expressway, safety equipment shall fully be prepared to protect work place and work crews from vehicles at high speed.

Suspended scaffolds shall have sufficient strength to support work crews, materials and equipment used and impacts during the work. Safety net shall be provided to prevent fall of work crews, equipment and materials used and to prevent injuries / accidents to a third party due to disperse of sparks and broken pieces of materials.

Appendix Inspection Recording Form

Bridge Name.. BRIDGE INSPECTION SHEET **Form 2-1**

Routine, Daily Inspection for Bridge

General Information

Company: ………………………………	*Name Of The Bridge: ……………………..…………………………………………*
Inspection Department: ………………………………………	*Name of Expressway: ……………………………………… Inter Change: …………*
Inspector: ……………………………………………..........	*Type of Bridge:...*
District:……………………………........	*Position(Longitude):…….………………….. (Latitude):………………..……………*
Province/City………………………………………………………	*Allowable Load and Speed:…………………………………………………………..*
Start Time....................................	*Date of Inspection: day …… month …… year ……..…*
End Time...................................	*Total pages (Including the Sketch and Photos.............*

Results of inspection, evaluation, and diagnose for action to be taken are recorded in this form.

Sketch/photo of structures and damage positions are attached in additional pages at the end of the report, if applicable.

General comments:

……………………………………………………………….………..……………
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Proposal form the managing Unit: ……………….………..………….……….......
………………………………………………………….………..…………….

Engineer in charge
(Signature with full name)

....

Report checked and approved by:

....

(Notation):

(1) Instructions on how to make data entries*: It is imperative to fill in all the space boxes, on the degree of damage. In case of missing structural parts, enter the dash to confirm that there is no such part. In case it is impossible to check, clearly state* ***"Failure in checking"*** *and indicating the reasons.*

A=Good, B=Intermatiate, C= Bad , D= Very Bad

(2) Estimating the volume of damage: *recording the volume or the number of estimated damages for each damage level in the scale A, B, C, D as in the classified handbook. Total estimated volume or number of 4 levels of damage should be equal to the total volume / number as in the previous column.*

Description of damage: *to ensure those who read the test results can visualize the* ***extent, scope and location*** *of the damage. For all the damage evaluated* ***at level C or D there must be graphics and photos,*** *to indicate the degree of damage (measures in the taken photos). For structural components such as beams, piers of the bridge span, the description must specify the location of the damage to such detail as which span, which pier. It needs sketches of the damage location, photos and a detailed description of the damage location, attached with relevant document and bridge inspection sheet.*

(3) Proposed measures: *including maintenance work normally with pre-calculated volumes (including cleaning, rust brushing, re-painting, surface filling, crack filling, repairing the warping, greasing, coating the concrete, clearance and dismantling...) or proposing for overall repair when badly damaged. If the inspector is not sure to propose a repair, enter a note which says "for further discussions with engineers" and make sure to provide adequate information to help the engineer make decisions in office.*

(4) Priority: priority is proposed by writing: K – Khẩn *cấp =* ***Emergency****;* ***C – C****ao =* ***High****;* ***T – T****hấp =* ***Low****.*

Bridge Name.. BRIDGE INSPECTION SHEET

No	Structure / Damaged Part	Unit	Volume/Quantity	Level of Damage				Description of Damage (with Sketch in Case of C and D Level)	Proposed Measures	Priority
				A	B	C	D			
1	Superstructure									
1.1	Concrete Bridge									
	Abnormal Deflection	mm								
	Abnormal Sound	piece								
	Abnormal Vibration	piece								
	Abnormal Big/Small Girder End Gap	piece								
	Water Leakage	piece								
	Crack	m								
	Scaling/Delamination	m^2								
	Rebar Exposed/Corroded	piece								
	Void	piece								
	Honeycomb	piece								
	Free Lime (at Crack)	m								
	Rust Stain (at Crack)	m								
	Degradation/Discoloration	piece								
	Rupture of Prestressing Tendon	piece								
	Other									

No	Structure / Damaged Part	Unit	Volume/Quantity	Level of Damage				Description of Damage (with Sketch in Case of C and D Level)	Proposed Measures	Priority
				A	B	C	D			
1.2	Concrete Deck Slab									
	Crack	m								
	Scaling/Delamination	m^2								
	Rebar Exposed/Corroded	piece								
	Void	piece								
	Honeycomb	piece								
	Free Lime (at Crack)	m								
	Rust Stain (at Crack)	m								
	Degradation/Discoloration	piece								
	Water Leakage	piece								
	Other									
2	Substructure									
2.1	Abutment									
	Crack	m								
	Scaling/Delamination	m^2								
	Rebar Exposed/Corroded	piece								
	Void	piece								
	Honeycomb	piece								

No	Structure / Damaged Part	Unit	Volume/Quantity	Level of Damage				Description of Damage (with Sketch in Case of C and D Level)	Proposed Measures	Priority
				A	B	C	D			
	Free Lime (at Crack)	m								
	Rust Stain (at Crack)	m								
	Degradation/Discoloration	abutment								
	Other									
2.2	Pier									
	Crack	m								
	Scaling/Delamination	m^2								
	Rebar Exposed/Corroded	piece								
	Void	piece								
	Honeycomb	piece								
	Free Lime (at Crack)	m								
	Rust Stain (at Crack)	m								
	Degradation/Discoloration	pier								
	Other									
2.3	Foundation	cái								
	Settlement/Displacement	mm								
	Scour/Undermining	piece								
	Other									

No	Structure / Damaged Part	Unit	Volume/Quantity	Level of Damage				Description of Damage (with Sketch in Case of C and D Level)	Proposed Measures	Priority
				A	B	C	D			
2.4	Ancillary Work									
	Settlement/Displacement	piece								
	Crack	m								
	Scaling/Delamination	m^2								
	Other									
4	Bridge Bearing									
4.1	Steel Bridge Bearing									
	Deficiency on Steel Bearing	piece								
	Corrosion on Steel Bearing	piece								
	Deficiency on Attachments	piece								
	Corrosion on Attachments	piece								
	Deficiency on Bearing Seat Concrete/Mortar	piece								
	Abnormal Big/Small Gap	bearing line								
	Sediment of Dirt or Soil	bearing line								
	Abnormal Sound	piece								
	Other									
4.1	Elastomeric Bridge Bearing									
	Deficiency/Degration on Elastomer	piece								

No	Structure / Damaged Part	Unit	Volume/Quantity	Level of Damage				Description of Damage (with Sketch in Case of C and D Level)	Proposed Measures	Priority
				A	B	C	D			
	Deficiency on Attachments	piece								
	Corrosion on Attachments	piece								
	Deficiency on Bearing Seat Concrete/Mortar	piece								
	Abnormal Big/Small Gap	bearing line								
	Sediment of Dirt or Soil	bearing line								
	Other									
5	Bridge Expansion Joint									
5.1	Cushion Seal Type									
	Deficiency on Expansion Joint	piece								
	Deficiency on Joint Vicinity	piece								
	Deficiency on Blockout Materials	piece								
	Water Leakage	piece								
	Deficiency on Water Treatment Facility	piece								
	Girder End Gap	piece								
	Difference in Lever	piece								
	Abnormal Sound	piece								
	Other									
5.2	Steel Finger Joint									

No	Structure / Damaged Part	Unit	Volume/Quantity	Level of Damage				Description of Damage (with Sketch in Case of C and D Level)	Proposed Measures	Priority
				A	B	C	D			
	Deficiency on Expansion Joint	piece								
	Deficiency on Joint Vicinity	piece								
	Deficiency on Blockout Materials	piece								
	Water Leakage	piece								
	Deficiency on Water Treatment Facility	piece								
	Girder End Gap	piece								
	Difference in Lever	piece								
	Abnormal Sound	piece								
	Other									
6	Bridge Parapet/Railing									
6.1	Reinforced Concrete Parapet									
	Crack	m								
	Scaling/Delamination	m^2								
	Rebars Exposed/Corroded	piece								
	Free Lime	piece								
	Rust Stain	piece								
	Degration/Discoloration	piece								
	Water Leakage	piece								

No	Structure / Damaged Part	Unit	Volume/Quantity	Level of Damage				Description of Damage (with Sketch in Case of C and D Level)	Proposed Measures	Priority
				A	B	C	D			
	Other									
6.2	Curb									
	Crack	m								
	Scaling/Delamination	m^2								
	Rebars Exposed/Corroded	piece								
	Free Lime	piece								
	Rust Stain	piece								
	Degration/Discoloration	piece								
	Water Leakage	piece								
	Other									
6.3	Steel Railing									
	Deformation/Deficiency	m								
	Corrosion	m^2								
	Other									
7	Drainage System									
7.1	Drain Inlet									
	Deficiency on Inlet	piece								
	Deficiency/Corrosion on Fittings	piece								

No	Structure / Damaged Part	Unit	Volume/Quantity	Level of Damage				Description of Damage (with Sketch in Case of C and D Level)	Proposed Measures	Priority
				A	B	C	D			
	Deficiency on Drain Grates	piece								
	Clogging	piece								
	Deformation	piece								
	Other									
7.2	Drain Pipe									
	Deficiency	piece								
	Corrosion	piece								
	Clogging	piece								
	Disconnection/Unfit	piece								
	Deformation	piece								
	Water Leakage	piece								
	Other									
7.3	Attachment									
	Deficiency	piece								
	Corrosion	piece								
	Clogging	piece								
	Deformation	piece								
	Other									

Form 2-1

Summary Sheet for Inspection, Evaluation and Measures Taken

Bridge Name: (Kilometer-Post :) Type of Structure: Bridge, Culvert

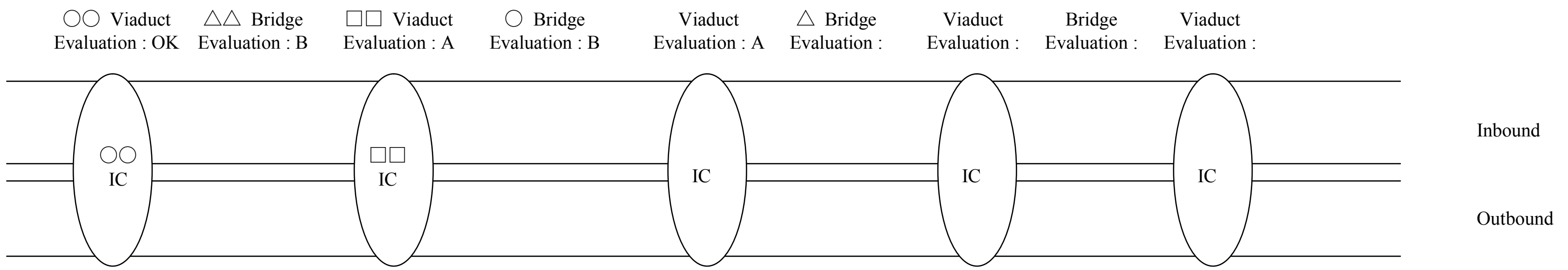
Sequence No	Date	Type of Inspection	Records on Inspection / Investigation Results		Repair History		Remarks
			Element Position in Element	Results of Inspection / Investigation	Date of Repair	Repair Method	Department in Charge

Note 1: Type of Inspection is recorded as Routine Inspection Type-A, Routine Inspection Type-B, In-Depth Inspection, Emergency Inspection or Special Inspection.
Note 2: Element or Position in Element is recorded as girder / beam, cross beam, deck slab, pier, abutment, bridge beating, bridge expansion joint, bridge drainage system, bridge railing / curb, or inspection platform.
Note 3: Results of Inspection / Investigation is recorded focusing on:
Good / fair, element / position in element not inspected, drastic progress of deterioration, unexpected defect / damage due to accidents / fire, progressive defect / damage, effect of repair
Note 4: Repair Method is recorded as resin injection, restoration of body of element, surface coating on steel element or so on.

Form 2-2

Form of Records for Daily Inspection, Routine Inspection Type-A 1 / 2

<table>
<tr><td rowspan="3">Name of Expressway</td><td rowspan="3"></td><td>Date</td><td></td><td>Vehicle Registration No.</td><td></td><td rowspan="2">Checked By:</td><td colspan="3" rowspan="2"></td></tr>
<tr><td>Section</td><td>～</td><td rowspan="2">Time of Inspection</td><td>Departure ：</td></tr>
<tr><td>Weather</td><td></td><td>Arrival ：</td><td>Department</td><td></td><td>Inspector</td><td></td></tr>
</table>



Form 2-2

Form of Records for Daily Inspection, Routine Inspection Type-A 2 / 2

Name of Expressway		Date		Vehicle Registration No.					
		Section	～	Time of Inspection	Departure ：				
		Weather			Arrival ：	Department		Inspector	

1. Bridge				
(1) Concrete Bridge □ Excessive Deflection □ Abnormal Sound □ Excessive Vibration □ excessive Big / Small Girder End Gap □ Water stagnation / Leakage □ Rebar Exposed / Corroded □ Rust Stain □ Rupture of Pre-stressing Tendon (2) Concrete Deck Slab □ Rebar Exposed / Corroded □ Water Leakage, Free Lime, Rust Stain	(3) Substructure 1) Abutment □ Rebar Exposed / Corroded □ Rust Stain 2) Pier □ Rebar Exposed / Corroded □ Rust Stain	(4) Bridge Bearing 1) Steel Bridge Bearing □ Defect / Damage on Bearing □ Defect / Damage on Attachments □ Corrosion □ Defect / Damage on Bearing Seat Concrete / Mortar □ Excessive Big / Small Girder End Gap □ Abnormal Sound □ Sediment of Rubbish / Soils 2) Elastomeric Bridge Bearing □ Degradation on Elastomeric Materials □ Defect / Damage on Attachments □ Corrosion □ Defect / Damage on Bearing Seat Concrete / Mortar □ Excessive Big / Small Girder End Gap □ Abnormal Sound □ Sediment of Rubbish / Soils	(5) Bridge Expansion Joint 1) Cushion Seal Type a) Expansion Joint □ Elastomeric Materials b) In the Vicinity of Joints □ Sealing Materials □ Opening of Joint c) Block out Material □ Block out Materials □ Seam between Expansion Joint and Block out Material □ Seam between Block out Materials and Pavement d) Difference in Level □ Seam between Expansion Joint and Block out Material □ Seam between Block out Materials and Pavement	e) Girder End Gap □ Opening of Gap f) Water Leakage □ Water Leakage from Girder End Gap □ Water stop Sealing Materials □ Water Leakage from Curb 2) Steel Finger Joint a) Expansion Joint □ Steel Materials □ Sealing Materials □ Face Plates □ Welding on Face Plates □ Loosening and Rupture of Anchor Bolts □ Capping of Anchor Bolt b) In the Vicinity of Joints □ Sealing Materials □ Opening of Joint

1. Bridge				2. Culvert
c) Block out Material □ Block out Materials □ Seam between Expansion Joint and Block out Material □ Seam between Block out Materials and Pavement d) Difference in Level □ Seam between Expansion Joint and Block out Material □ Deam between Block out Materials and Pavement e) Girder End Gap □ Opening of Gap f) Water Leakage □ Water Leakage from Girder End Gap □ Water stop Sealing Materials □ Water Leakage from Curb	(6) Bridge Railing 1) Reinforced Concrete Parapet □ Crack □ Water Leakage , Free Lime □ Scaling / Delamination of Cover Concrete □ Spalling □ Rebar Exposed / Corroded 2) Curb □ Crack □ Water Leakage , Free Lime □ Scaling / Delamination of Cover Concrete □ Spalling □ Rebar Exposed / Corroded 3) Steel Railing □ Deformation / Damage □ Corrosion	(7) Bridge Drainage System 1) Bridge Drain Box □ Deficiency □ Corrosion □ Clogging with Soils □ Deformation □ Deficiency / Corrosion on Attachments □ Defect / Damage on Cover 2) Drain Pipe □ Deficiency □ Clogging with Soils □ Dropping Off □ Deformation □ Water Leakage	3) Attachments □ Deficiency □ Clogging with Soils □ Deformation	(1) Reinforced Concrete Culvert □ Displacement □ Settlement / Scour □ Irregularity on Joint □ Crack □ Air Void / Honeycomb □ Free Lime □ Rust Stain □ Scaling / Delamination / Spalling □ Rebar Exposed / Corroded □ Discoloration □ Sediment of Rubbish / Soils

* After the check, ☐ shall be marked with “x”.
* Wherever defect / damage is judged D or A, such defect / damage shall be recorded in Form 2-2.

Form 2-3

Records of Defect / Damage Found in Daily Inspection & Necessary for Urgent Measures

<< Daily Inspection, Routine Inspection Type-A, Routine Inspection Type-B, Emergency Inspection, Special Inspection >>

Name of Expressway: Section: IC / JCT – IC / JCT
Inbound / Outbound: Name of Bridge / Culvert:

Day / Month / Year, Weather Condition ( )	Inspector				Checked By:	

Location Kilometer-Post Name of Ramp way		Position in Element			Detail of Defect / Damage			
		Span / Substructure	Name of Structure	Detail Position in Element	Defect / Damage	Evaluation	Quantity	
[Descriptions of Defect / Damage]								[Comments by Checker]
[Photograph, Figures, Comments, etc.] : Photographs shall be taken in both close-range and distant views. Sketch shall be drawn in order to identify the detail positions of defect / damage in element.								

Form 2-4

Monthly Summary Sheet of Inspection, Evaluation and Measures Taken

<< Defect / Damage necessary for Daily Inspection and Emergency Measures >>

Name of Expressway :

Target Section :

Sequence No.	Location		Type of Structure	Name of Structure	Element	Position in Element	Type of Defect / Damage	Descriptions of Defect / Damage	Evaluation	Date of Evaluation	Measures Taken			Department in Charge	Type of Repair	Date of Repair
	Inbound / outbound	Kilometer-Post									Measures Taken	Expected Date	Interval of Monitoring			

Form 2-5

Inspection Records - Photographing

Expressway Route	IC (From)	IC (To)	Type of Structure	Name of Structure

Sequence No.		Sequence No.		Sequence No.		Sequence No.	
Defect / Damage		Defect / Damage		Defect / Damage		Defect / Damage	
Date		Date		Date		Date	
Descriptions of Defect / Damage		Descriptions of Defect / Damage		Descriptions of Defect / Damage		Descriptions of Defect / Damage	
Element		Element		Element		Element	
Sequence No.		Sequence No.		Sequence No.		Sequence No.	
Defect / Damage		Defect / Damage		Defect / Damage		Defect / Damage	
Date		Date		Date		Date	
Descriptions of Defect / Damage		Descriptions of Defect / Damage		Descriptions of Defect / Damage		Descriptions of Defect / Damage	
Element		Element		Element		Element	

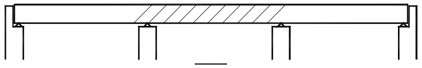
Form 2-6 (Sample)

Defect / Damage Map (Sample)

Defect / Damage Map for Girder / Beam per Span

(Bridge Deck)

Location Map



A1 P1 P2 A2

Crossing Route Name

Pier (Abutment) No

No. of Girder

P1 Ⓕ

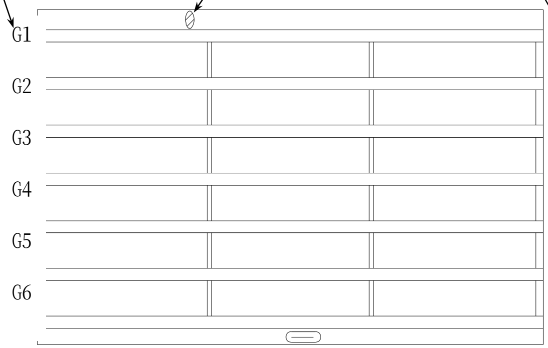
①-2002.6 U-(E→B)-0.6m

P2 Ⓜ

Type of Support

M: Move, F: Fix

Inbound / Outbound



②-2001.9 T-B-3.0m
Width 0.1m

Bridge Name	
Type of Bridge	
Type of Structure	
Target Span	P ～P
Span	Inbound / Outbound m
Curb-to-Curb Width	
Crossing Road	

History of Inspection

Date	Inspector	Name of Firm
2000.6.20	aaa	bbb
2001.9.15	ccc	bbb
2002.3.10	ddd	bbb

Remarks

Legend on Defect / Damage

Measures Taken at Times of Construction

Prepared By:	Date of Completion: Year, Month, Day	Name of Contractor :
(Example) This is a 3-span continuous steel plate girder bridge. Since honeycombs are detected around drip groove of deck overhang after completion of concreting deck slab, chipping work was conducted. Attention shall be paid on this work at the time of inspection, as defect / damage will be expedited with deterioration in concrete with time. (recorded on day / month / year)		

Type of Defect / Damage (refer to Legend)

Time of Detection

Evaluation of Defect / Damage

No of Element

Quantity of Defect / Damage

②-2000.6 U-AA-0.6m^2
Width 0.3m x Length 2.0m

Breakdown of Defect / Damage Quantity

Legend

Defect / Damage	Illustration	Symbol	Element
Crack		Hi	Girder, Slab, Railing, Curb
Broken Edge		K	Girder, Slab, Railing, Curb
Blister		U	Girder, Slab, Railing, Curb
Scaling		Ha	Girder, Slab, Railing, Curb
Spalling		N	Girder, Slab, Railing, Curb
Air Void, Honeycomb		Ma	Girder, Slab, Railing, Curb
Water Leakage		R	Girder, Slab, Railing, Curb
Free Lime		Y	Girder, Slab, Railing, Curb
Rebar Exposed / Corroded		T	Girder, Slab, Railing, Curb

* Hammering test results shall be enclosed √ .

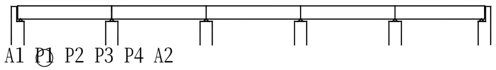
Form 2-6 (Sample)

Defect / Damage Map (Sample)

Defect / Damage Map per Substructure

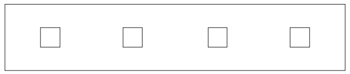
(Substructure)

Location Map



(Destination side)
③

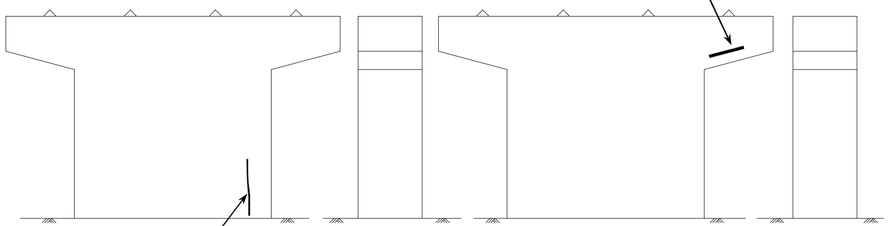
(Median side)



② (Shoulder side)

①
(Origin side)

Record of Repair at time of Construction
0.2mm wide and 1.00m long crack
- Crack Injection



①-2000.6 Hi-B-1.0m
Width 0.2m

Bridge Name	
Type of Bridge	
Type of Structure	
Target Span	P ～P
Span	Inbound / Outbound m
Curb-to-Curb Width	
Crossing Road	

History of Inspection

Date	Inspector	Name of Firm
2000.6.20	aaa	bbb

Legend

Defect / Damage	Illustration	Symbol	Element
Crack		Hi	Abutment, Pier
Broken Edge		K	Abutment, Pier
Blister		U	Abutment, Pier
Scaling		Ha	Abutment, Pier
Spalling		N	Abutment, Pier
Air Void, Honeycomb		Ma	Abutment, Pier
Water Leakage		R	Abutment, Pier
Free Lime		Y	Abutment, Pier
Rebar Exposed / Corroded		T	Abutment, Pier

Remarks

Measures Taken at Times of Construction

Prepared By:	Date of Completion: Year, Month, Day	Name of Contractor :
(Example) At the completion of construction, a 1.0 m long and 0.2mm wide crack was detected on the wall. Crack injection using polymer-cement resin was conducted. (recorded on day / month / year)		

Legend on Defect / Damage

Type of Defect / Damage (refer to Legend)
Time of Detection
Evaluation of Defect / Damage
No of Element
Quantity of Defect / Damage

②-2000.6 U-AA-0.6m^2
Width 0.3m x Length 2.0m
Breakdown of Defect / Damage Quantity

* Hammering test results shall be enclosed w .

Form 2-7

Annual Summary Sheet of Inspection, Evaluation and Measures Taken

<< Routine Inspection, In-Depth Inspection >>

Name of Expressway :

Target Section :

Sequence No.	Location		Type of Structure	Name of Structure	Element	Position in Element	Type of Defect / Damage	Descriptions of Defect / Damage	Evaluation	Date of Evaluation	Measures Taken			Department in Charge	Type of Repair	Date of Repair
	Inbound / outbound	Kilometer-Post									Measures Taken	Expected Date	Interval of Monitoring			

Directorate for Roads of Vietnam Japan International Cooperation Agency

The Project for Strengthening Operation and Maintenance System for Expressway in Vietnam

SECTION 3
TECHNICAL SPECIFICATION GUIDELINES FOR INSPECTION AND MAINTENANCE OF ELECTRICAL FACILITIES

Vietnam Expressway Management Office
JICA Experts Team

JUNE 2013

Table of Contents

3 Electrical Facilities

3.1 Outline

3.1.1 Scope of Application

General matters regarding checking and inspection work of the electrical facilities and power distribution equipment for the highways of Vietnam are covered in the following.

3.1.2 Overview of Work

Checking and inspection work are carried out to keep highway operations in a consistently normal state, and conducted as follows for electrical facilities and equipment. In addition, while conducting the maintenance checks and inspections as appropriate for enforcement of highway safety and reliability, it is crucial to strive for the optimal employment of equipment, such as checking and constant re-examination of the techniques used and frequency of inspections, as may be required.

3.1.2.1 Periodic inspections

Daily routine checks as part of periodic inspections involve visual observation of equipment and checking of operation and maintenance, and include basic checks and general attention to the existence of abnormalities mainly through the use of the physical senses, such as sight and touch. More thorough periodic checks are also done, generally requiring the functional stop of the system, and involving the coordinated checking of operations using measurement equipment and metering, at which time maintenance procedures are also undertaken.

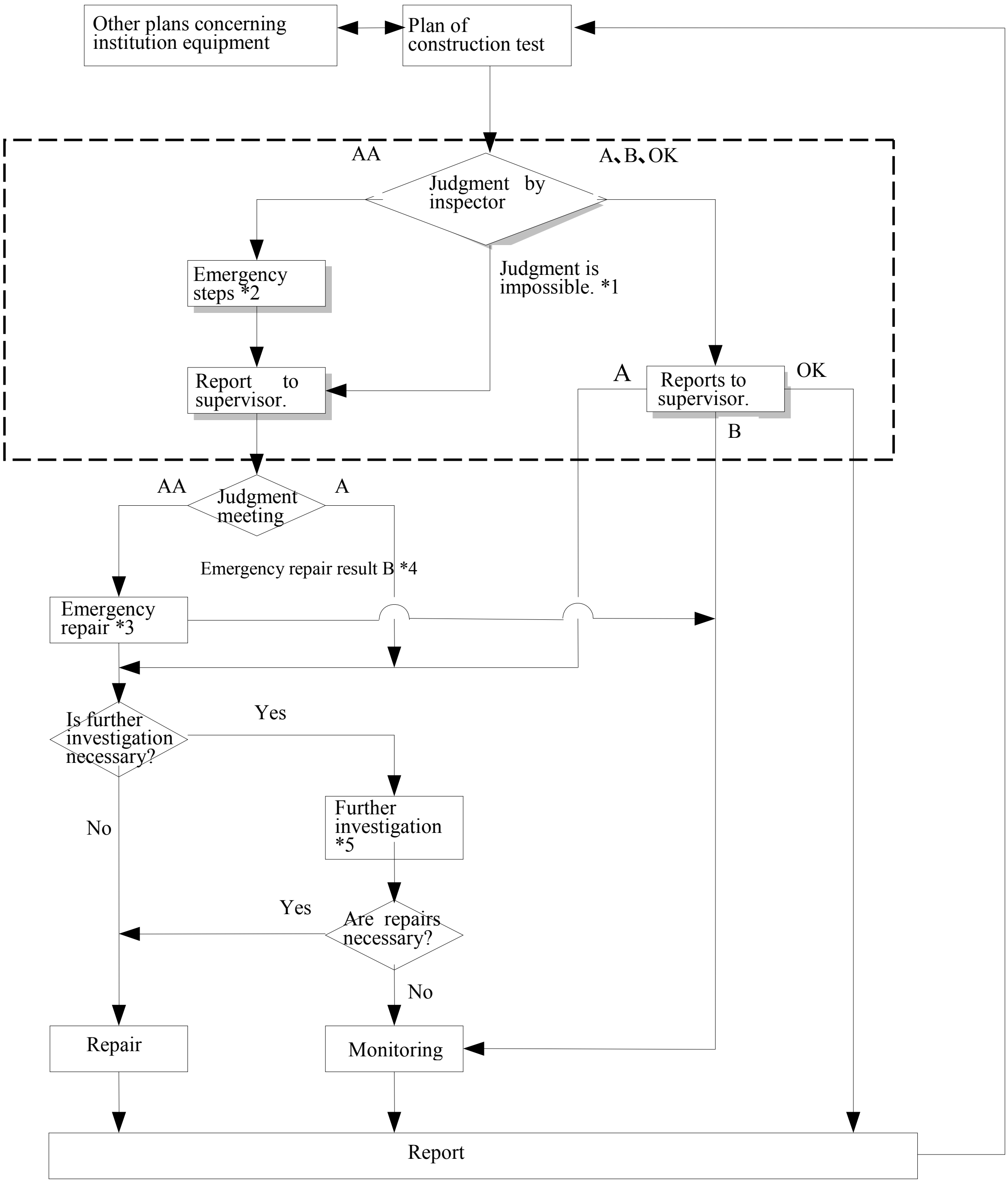
A structural test shall be used to assess a potentially abnormal condition of a component or system, and follows a progressive assessment sequence that is performed on-site, and which shall be carried out using a combination of close-up visual observation, electrical probe, simple meter, or measuring instrument. Securing safe and smooth road traffic aims at the prevention of third party*1 damage by suitable structural test described below.

*1 “Third party” refers to all passing vehicles using the road system other than those engaged in road management.

As shown in

Figure 3.1-1, structural inspection is not a separate function but it plays purposed functions: after the inspection, diagnose will be performed for either for urgent repair, or further detailed investigation, maintenance or repair, and moreover, data will be recorded for the next inspection.

Therefore, in order to conduct the structural test most effectively, it is necessary to make precise



*1: "A judgment is impossible" refers to cases which are difficult to judge because they are on the border between judgment categories AA and A.

*2: "Emergency steps" refers to measures to prevent falling or collapse, and similar measures, which can be performed by the inspector.

*3: "Emergency repair" refers to temporary emergency measures to restore diminished structural function or eliminate the risk of damage to third parties.

*4: "Emergency repair result B" refers to the state following emergency repairs when the judgment category has been restored to B.

*5: "Further investigation" refers to investigation conducted by experienced academic professionals in related fields, specialist engineers, and similar experts to decide the methods of repair.

recording and make use of the test result, and link them to other associated areas and sections.

Figure 3.1-1 Flowchart for structural test

The results of the structural test shall be determined by the following judgment classifications.

Judgment classification	Judgment criteria
AA	When damage etc. is significant and urgent repair is required as seen from the functional aspect.
A	While there is damage, etc., and functional decline is apparent and repair is required, urgent repair itself is not mandated.
B	Although there is some damage, functional decline is not immediately evident and it is necessary to monitor the gradual progress of deterioration that may ultimately occur.
OK	There is no damage.

3.1.2.1.1 Criteria of judgment classifications

Judgment classifications used to assess the damage or deterioration of a subject, etc., fall into the four classifications of “AA,” “A,” “B,” and “OK,” as determined by the urgency and extent of damage and the repair measures required as seen from the structural functional aspect.

In addition, the criteria of each judgment classification are considered as the transition of a) to d) in the following.

a) Judgment classification AA

Assessment of judgment classification AA results from the possibility that structural functional decline may be or is presently significant or may cause trouble to a third party, etc., and considered to be a condition for which urgent repair is mandated.

b) Judgment classification A

A condition of minor damage or gradual deterioration can be assessed as judgment classification A, and is considered to be a condition for which repair is not urgently required but is expected to result in eventual structural functional decline.

c) Judgment classification B

Although the extent of damage or deterioration can be assessed as judgment classification B, repair measures for structural functional decline are considered unnecessary for the time being, and it is assessed as a condition for which progressive stages of deterioration must be monitored.

d) Judgment classification OK

Judgment classification OK is assessed as a case in which damage or deterioration cannot be seen, or damage or deterioration is slight and does not need either repair or progress monitoring.

In addition, the judgment classification OK is formed in order to assist in inspection planning and the prevention of omission during an inspection, and to record the fact of inspection implementation.

3.1.2.1.2 Proximity viewing

Proximity viewing is the most basic inspection method using a high-type or elevated vehicle, platform, scaffold, etc., if needed, so that the object of inspection can be approached and viewed at a close range, and an abnormal situation can be assessed using observation, probe, or simple meter, and forms the basis of a structural test.

Key aspects in proximity viewing are to:

a) Carry out the procedure after the structure inspection, previous checking results, failure history, and repair history have been reviewed and understood.
b) Detect the abnormal changes not only by visual observation, touch, or utilizing a probe, simple meter but also by slightly tapping and shaking.
c) For equipment located in a place under vibration, it is advised to compare the results of inspection with that of the same object in no-vibration operation condition.
d) When the judgment of an item being inspected is assessed as “AA,” be sure to check as well whether the same damage may exist in neighboring structures or parts.

3.1.2.2 Emergency inspections

In emergencies, such as outright equipment failure, the identification of the nature of a road obstacle or hazard, etc., shall be performed immediately and shall be dealt with by restoration or initial communications to highway control staff, etc.

3.1.2.3 Records

Following checking and inspection works, the responsible person shall write the result in report form.

3.1.3 Target Equipment

Equipment that is the target of checking and inspection work is covered in 3.2 Inspection Work (ITS excluded), below.

3.2 Inspection Work（ITS excluded）

3.2.1 Power Distribution Equipment

3.2.1.1 Work description

Power distribution equipment inspection work refers to the daily check on each apparatus of the power distribution equipment installed in interchanges, mainly conducted by the senses, such as viewing and touch. This also involves the daily visual check performed on each apparatus of the electrical line equipment installed in interchanges.

Power distribution equipment inspection includes performing status observation, checking operation and care, and may include carrying out a functional stop, if needed, of the system or each apparatus of the power distribution equipment installed in interchanges, and requires coordinated checking of operations using measurement devices such as meters and testers. Moreover, junction boxes, electrical conduits, etc., particularly for electrical lines and equipment installed outdoors, and suspended conduits and support conduits are approached, and close-up inspection is performed by observation, using a probe, simple meter, measuring instrument, etc. The parts to be given particular attention are shown in Figure 3.2-1 and Figure3.2-2.

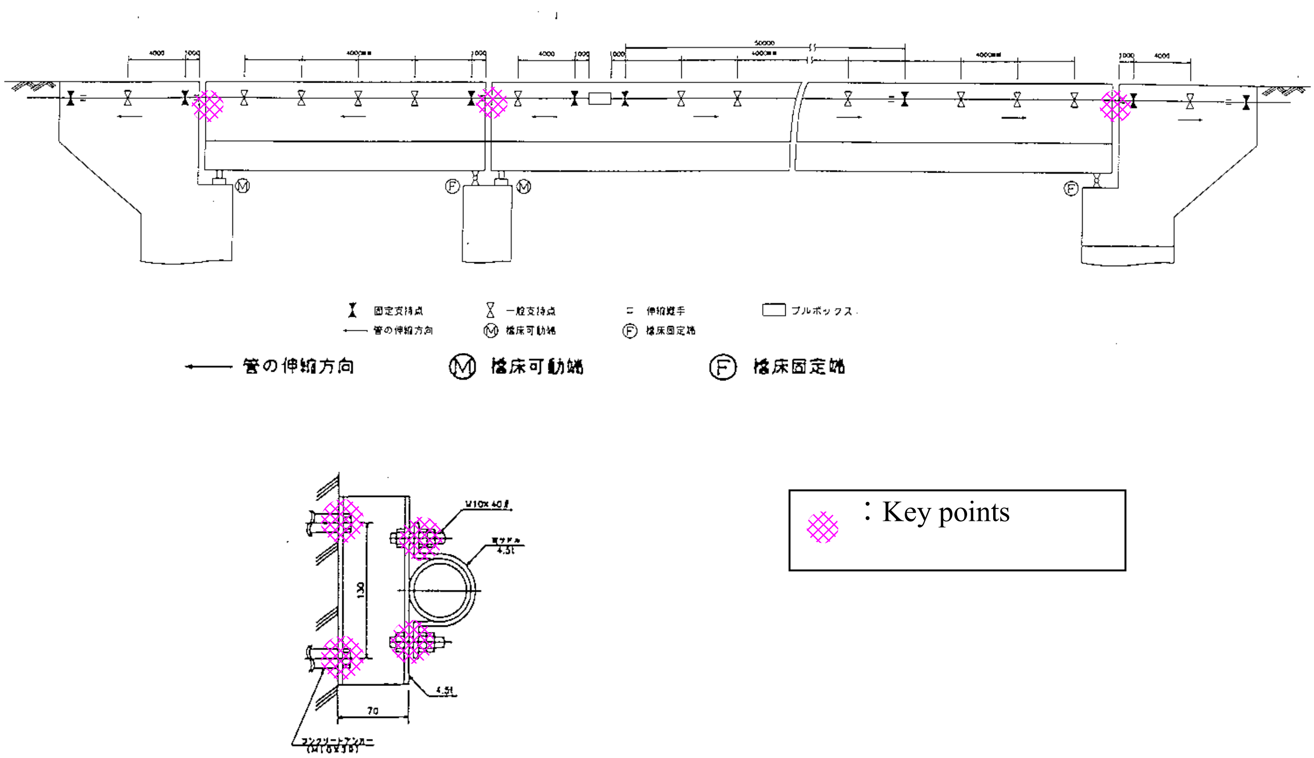


Figure 3.2-1 Key points for inspection of electrical line equipment

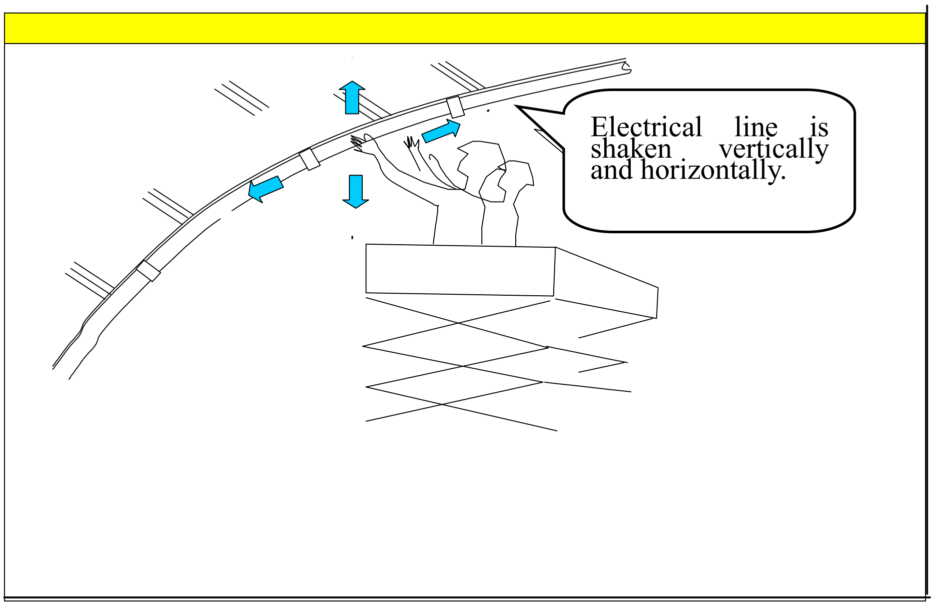


Figure3.2-2 Schematic of close-up visual inspection of electrical line equipment

3.2.1.2 Types of work

The types of work are as shown below.

3.2.1.2.1 Daily checking of high-voltage enclosed switchboards, low-voltage enclosed switchboards, and control center panels that are installed in power receiving equipment.

3.2.1.2.2 Regular checking of power distribution equipment that receives high-voltage and low-voltage power, conducted at intervals of 12 months

3.2.1.2.3 Replacement of the insulating oil in oil circuit breakers and oil-immersed transformers

3.2.1.2.4 Daily checking of high-voltage leading-in poles, high-voltage leading-in cables, and other cables that are installed as power supply lines

3.2.1.2.5 Structural inspections of support conduits and suspended conduits of electrical line equipment and similar equipment that is installed outdoors. The inspections are performed visually, by touch, and using simple instruments.

3.2.2 Checking and Inspection Work for Private Power Generation Equipment

3.2.2.1 Work

Inspection work for private power generation equipment refers to observing the conditions, checking operation, and performing simple maintenance of the various devices on private power generation equipment that is installed at interchanges. As necessary, system functions are stopped in order to perform measurement using instruments, checks of coordinated operation between sets of equipment, and other inspections.

3.2.2.2 Types of work

The types of work are as shown below:

3.2.2.2.1 Daily checking of private power generation equipment. The checking shall not involve operation with actual loads.

3.2.2.2.2 Regular checking of private power generation equipment, conducted at intervals of 12 months. The checking shall involve operation with actual loads.

3.2.2.2.3 Regular checking of radiator-type private power generation equipment, conducted at intervals of 12 months.

3.2.2.2.4 Replacement of engine oil, radiator coolant, and air compressor V-belts in compressed-air driven private power generation equipment.

3.2.3 Checking and inspection Work for Road Lighting Equipment

3.2.3.1 Work description

Checking work for road lighting equipment refers to daily checking primarily of various devices on road lighting equipment that is installed on main expressway roads and interchanges. The checking is performed by visual and other sensory inspection.

Inspection work for road lighting equipment refers to observing the conditions, checking operation, and performing simple maintenance of various devices on the road lighting equipment that is installed on main expressway roads and at interchanges. As necessary, system functions are stopped in order to perform measurement using instruments, checks of coordinated operation between sets of equipment, and other inspections.

Structural inspection work for road lighting equipment refers to observation and inspections of poles, steel towers, and lights on road lighting equipment that is installed on main expressway roads and interchanges. The observation and inspections are performed by moving up close to the structures and inspecting visually, by touch, by using simple instruments or measuring devices, and other means. The points that require particular attention are shown in Figure 3.2-3 and Figure 3.2-4.

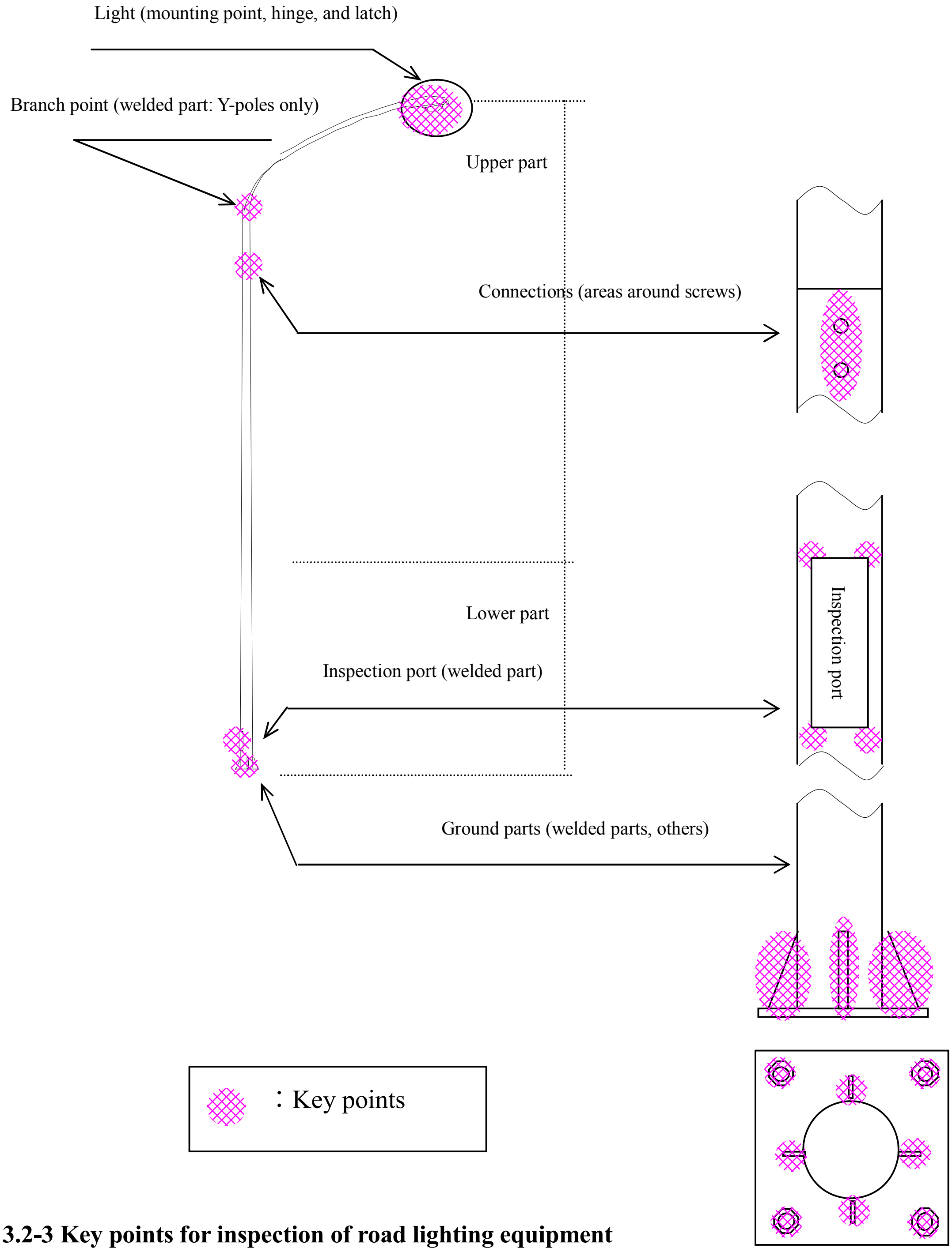


Figure 3.2-3 Key points for inspection of road lighting equipment

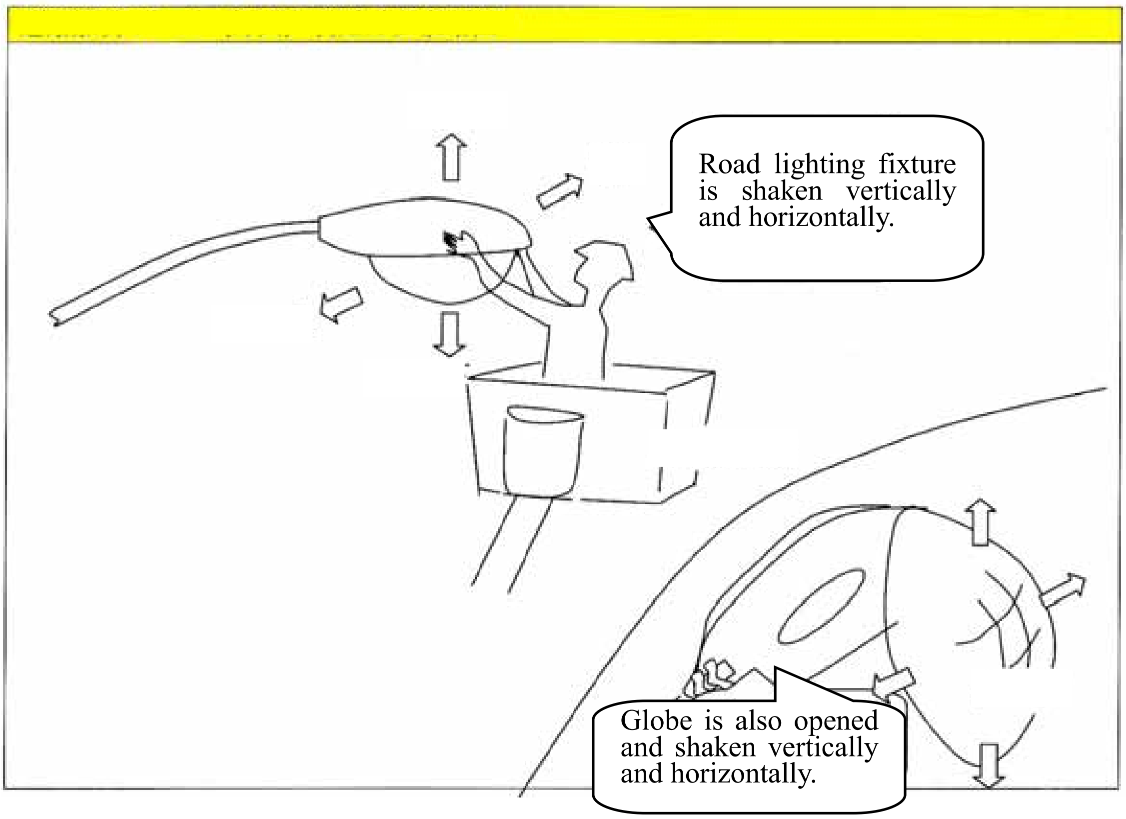


Figure 3.2-4 Schematic of close-up visual inspection of road lighting equipment

3.2.3.2 Types of work

The types of work are as shown below.

3.2.3.2.1 Regular checking of road lighting equipment that is installed on main expressway roads and at interchanges, conducted at interval of 12 months.

3.2.3.2.2 Structural inspections of road lighting equipment supports and lights, performed visually, by touch, and using simple instruments

3.2.4 Checking and Inspection Work for Warning Light Equipment

3.2.4.1 Work description

Inspection work for warning light equipment refers to observing the conditions, checking the operation, and performing simple maintenance of the flashing lights at branching points that are installed on main expressway roads and at interchanges. As necessary, system functions are stopped in order to perform measurement using instruments and other inspections.

3.2.4.2 Types of work

The types of work are as shown below.

3.2.4.2.1 Regular checking of warning light equipment, conducted at intervals of 12 months

3.2.5 Checking and Inspection Work for Variable Road Information Board Equipment

3.2.5.1 Work description

Checking work for variable road information board equipment refers to daily checking performed by visual and other sensory inspection, and by operation of the equipment.

Inspection work for variable road information board equipment refers to observing the conditions, checking operation, and performing simple maintenance of the variable road information board equipment that is installed on main expressway roads. As necessary, system functions are stopped in order to perform measurement using instruments, checks of coordinated operation between sets of equipment, and other inspections.

Structural inspection work for variable road information board equipment refers to observation and inspections of the supports and foundations of the variable road information board equipment that is installed on main expressway roads. The observation and inspections are performed by moving up close to the structures and inspecting visually, by touch, by using simple instruments or measuring devices, and other means. The points that require particular attention are shown in Figure 3.2-5.

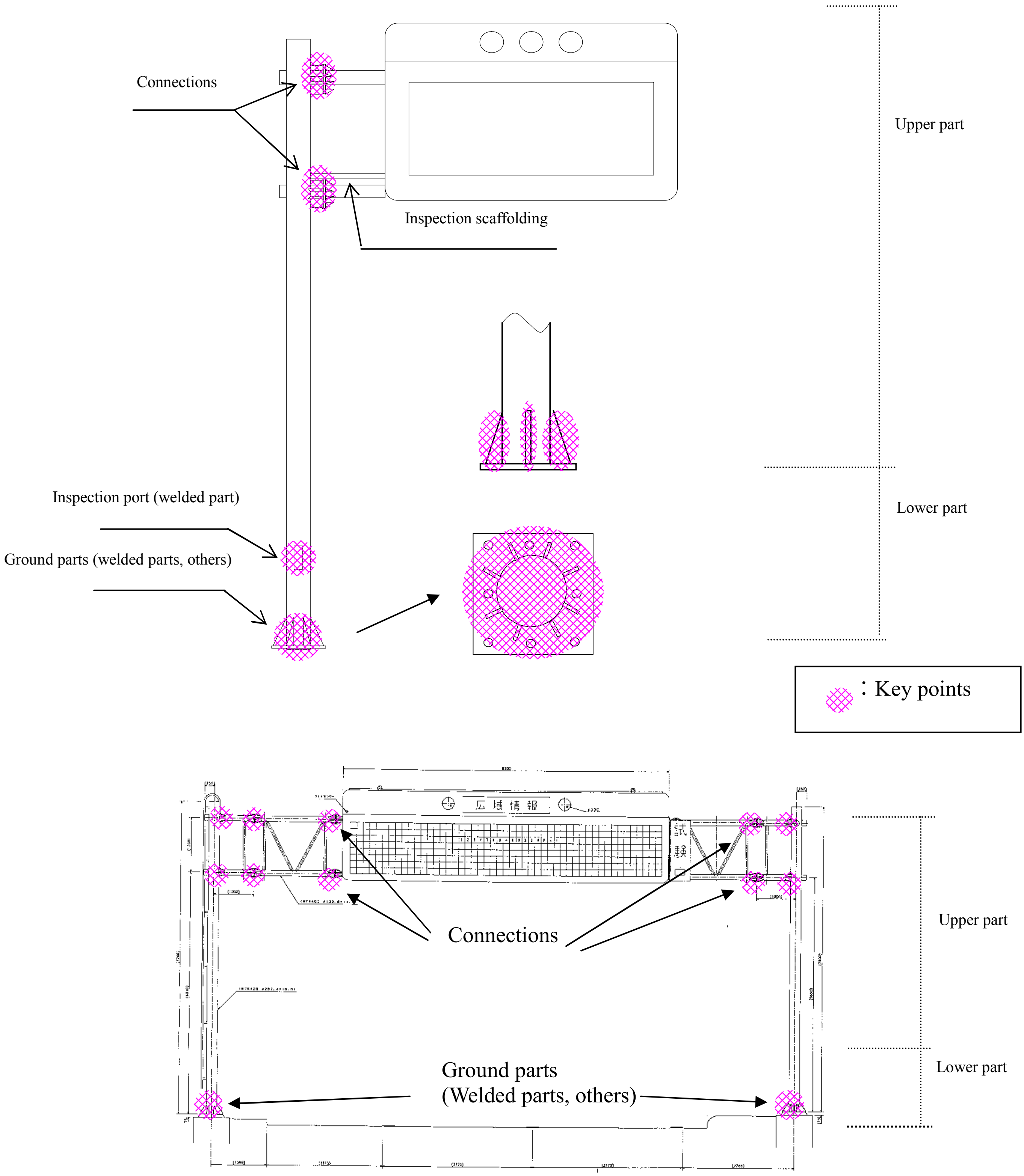


Figure 3.2-5 Key points for inspection of variable road information board equipment

3.2.5.2 Types of work

The types of work are as shown below.

3.2.5.2.1 Daily checking of LED-type variable road information board equipment that is installed on main expressways.

3.2.5.2.2 Regular checking of LED-type variable road information board equipment, conducted at intervals of 12 months

3.2.5.2.3 Structural inspections of the F-type supports and gate-type supports of variable road information board equipment, performed visually, by touch, and by using simple instruments

3.2.6 Checking and Inspection Work for Mobile Radio Equipment

3.2.6.1 Work description

Inspection work for mobile radio equipment refers to observing the condition, checking operation, and performing simple maintenance of the various devices of mobile radio equipment that is installed at interchanges, in vehicles, and at other locations. As necessary, system functions are stopped in order to perform measurement using instruments, checks of coordinated operation between sets of equipment, and other inspections. At 12-month inspection intervals, the information listed in the application documents for the radio station license shall be checked against the serial numbers, models, and specifications of the radio equipment.

Structural inspection work for mobile radio equipment refers to observation and inspections of the steel towers, foundations, and guide wires of mobile radio equipment that is installed at interchanges. The observation and inspections are performed by moving up close to the structures and inspecting visually, by touch, by using simple instruments or measuring devices, and other means.

3.2.6.2 Types of work

The types of work are as shown below.

3.2.6.2.1 Daily checking of the base stations, portable base stations, and control fixed stations of mobile radio equipment (analog radio)

3.2.6.2.2 Regular checking of the base stations, portable base stations, control fixed stations, steel towers, land-based mobile stations, portable stations, and antennas (excluding measurement of antenna receiver input voltage) of mobile radio equipment (analog radio), conducted at intervals of 12 months. If the equipment is subject to the regular inspections prescribed in radio laws and regulations, the Registration Inspection Results Notice (reference document) shall be created.

3.2.6.2.3 Measurement of the receiver input voltage (dBμV) of mobile radio equipment (analog radio) at locations along the road

3.2.6.2.4 Structural inspections of the steel towers of mobile radio equipment, performed visually, by touch, and using simple instruments

3.2.7 Checking and Inspection Work for Communication Line Equipment

3.2.7.1 Work description

Inspection work for communication line equipment refers to observing the conditions, checking operation, and performing simple maintenance of various cables, conduit lines, and related equipment. As necessary, system functions are stopped in order to perform measurement using instruments, checks of coordinated operation between sets of equipment, and other inspections.

Structural inspection work for communication line equipment refers to observation and inspections of support conduits and suspended conduits of communication line equipment that is installed on bridges and other locations. The observation and inspections are performed by moving up close to the structures and inspecting visually, by touch, by using simple instruments or measuring devices, and other means. The points that require particular attention are shown in Figure 3.2-6 and Figure 3.2-7.

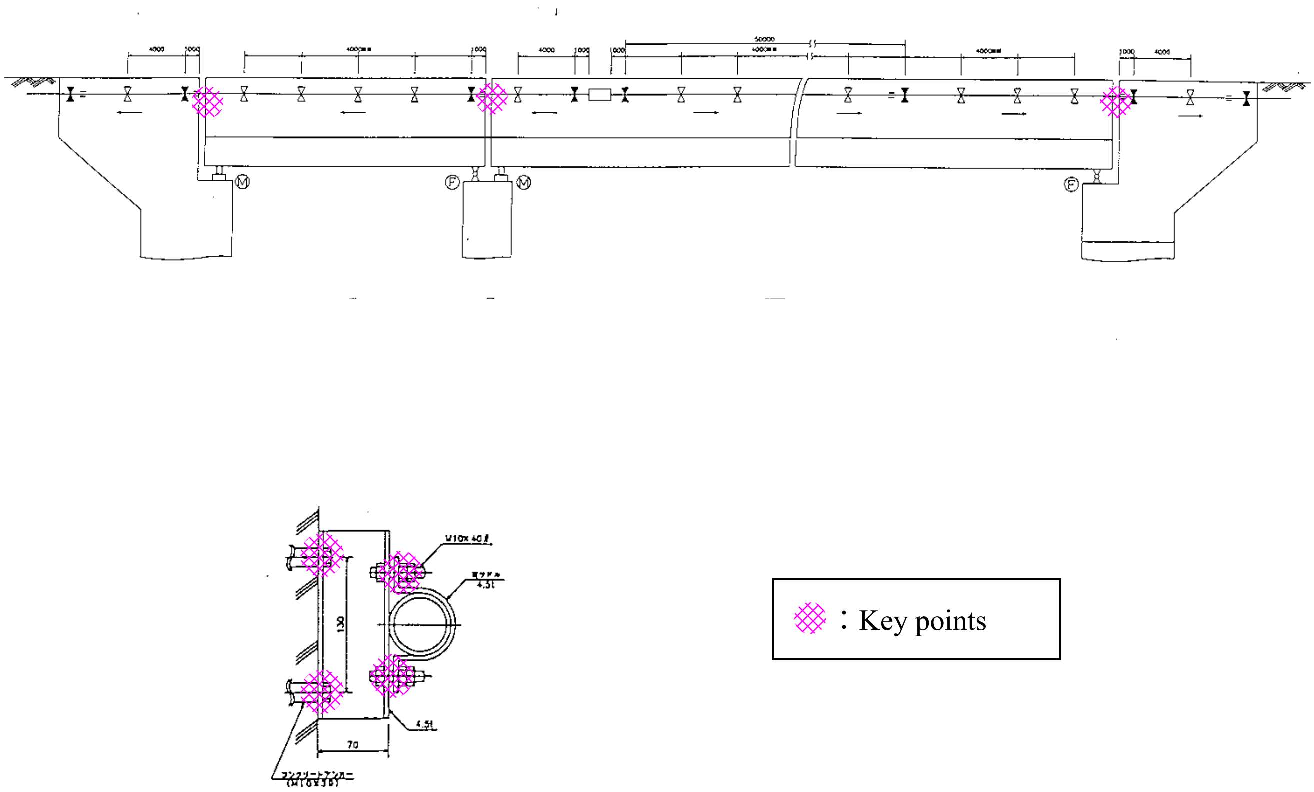


Figure 3.2-6 Key points for inspection of communication line equipment

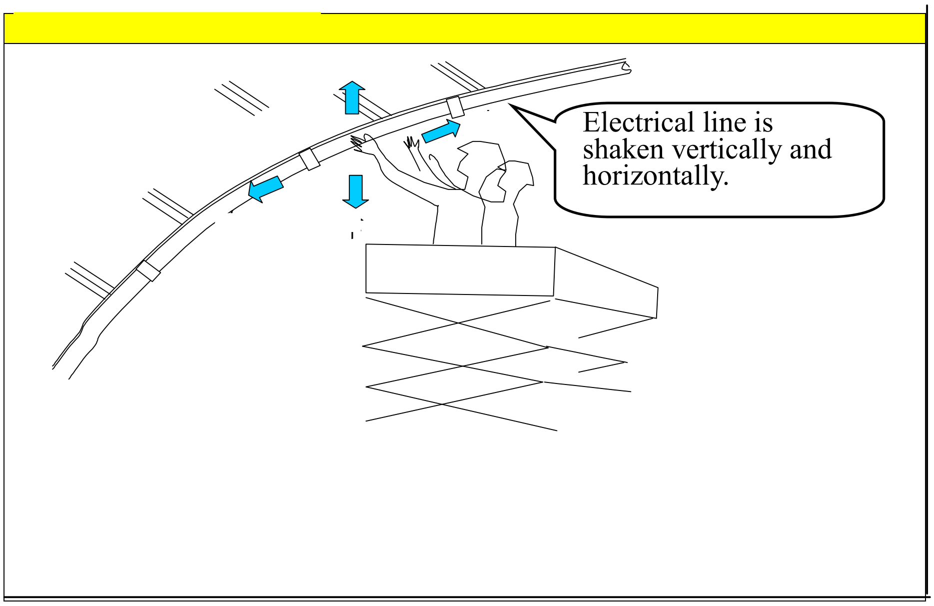


Figure 3.2-7 Schematic of close-up visual inspection of communication line equipment

3.2.7.2 Types of work

The types of work are as shown below.

3.2.7.2.1 Daily checking (alarm line insulation resistance test) of metallic cables.

3.2.7.2.2 Regular checking of metallic cables, conduits, hand holes, optical-fiber cables, and other equipment, conducted at intervals of 12 months.

3.2.7.2.3 Structural inspections of support conduits and suspended conduits of the communications line equipment that is installed outdoors and elsewhere. The inspections are performed visually, by touch, and using simple instruments.

3.3 Maintenance and Management Work

3.3.1 Daily Maintenance and Management

3.3.1.1 Cleaning of power distribution equipment

3.3.1.1.1 Work description

Cleaning of power distribution equipment refers to cleaning and dead lamp replacement for MDP panels and similar equipment. It also includes cleaning of manholes and hand holes.

3.3.1.1.2 Types of work

The types of work are as shown below.

a) Cleaning of MDP panels and other equipment using cloth, brushes, and similar means in order to remove dust, grime, and other substances
b) Replacement of dead lamps refers to replacing lamps both inside and outside the panels.
c) Cleaning of manholes and hand holes refers to using manual means or cleaning machines to clean accumulated substances and water from inside the manholes and hand holes that are installed on expressway main roads, interchanges, and other locations.

3.3.1.2 Cleaning of private power generation equipment

3.3.1.2.1 Work description

Cleaning of private power generation equipment refers to work for removing dust, grime, and other substances from generators and other equipment.

3.3.1.2.2 Types of work

The types of work are as shown below.

a) Cleaning of generators and other equipment using cloth, brushes, and similar means in order to remove dust, grime, and other substances

3.3.1.3 Cleaning of road lighting equipment

3.3.1.3.1 Work description

Cleaning of road lighting equipment refers to cleaning lighting equipment that is installed on main expressway roads, interchanges, and other locations, as well as lamp replacement that is performed at the same time as the cleaning. The range to be cleaned is the lamp, inside and outside the light cover, reflecting plates, and the exterior of the light. However, when a lamp is replaced at the same time with lamp cleaning, then the cleaning of old lamp is not necessary.

3.3.1.3.2 Types of work

The types of work are as shown below.

a) Cleaning and lamp replacement, using an elevating work vehicle, of lights installed at heights of 8 – 14 meters, and of elevating-type lights that are installed on high poles and on steel towers for lighting

3.3.1.3.3 Required performance

(1) There must not be 3 or more consecutive lights that do not illuminate.

(2) Work to ensure that (1) above is satisfied must be performed within 1 month after the check for lights that do not illuminate.

3.3.1.3.4 Performance check method

The performance check shall be performed at the time of the inspection for checking the light illumination conditions that is carried out each month.

3.3.1.3.5 Handling in case required performance is not satisfied

If the required performance is not satisfied following the work, the party that ordered the work and the party that contracted the work shall immediately investigate to determine the cause, and shall hold discussions concerning corrections with a supervisor.

3.3.1.4 Cleaning of warning light equipment

3.3.1.4.1 Work description

Cleaning of warning light equipment refers to cleaning of the blinker lights that are installed at interchanges.

3.3.1.4.2 Types of work

The types of work are as shown below.

a) Cleaning of the blinker lights using cloth, brushes, and similar means in order to remove dust, grime, and other substances

3.3.1.5 Cleaning of variable information board equipment

3.3.1.5.1 Work description

Cleaning of variable information boards refers to work for cleaning of the variable road information boards that are installed on main expressway roads, interchanges, ordinary roads, and other locations. The area to be cleaned is the front of the main unit display.

3.3.1.5.2 Types of work

The types of work are as shown below.

a) Cleaning of LED-type variable road information boards that are installed on main expressway roads, interchanges, and ordinary roads

3.3.1.5.3 Required performance

(1) Cleaning must be performed a minimum of once each year.

(2) If there are regional characteristics resulting from traffic volume or other factors, the matter shall be discussed with a supervisor.

3.3.1.6 Cleaning of mobile radio equipment

3.3.1.6.1 Work description

Cleaning of mobile radio equipment refers to work for cleaning of various devices of the mobile radio equipment that is installed at interchanges, in vehicles, and in other locations.

3.3.1.6.2 Types of work

The types of work are as shown below.

a) Cleaning of various devices on the mobile radio equipment that is installed at interchanges, in vehicles, and in other locations, using cloth, brushes, and similar means in order to remove dust, grime, and other substances

3.3.1.7 Cleaning of communications line equipment

3.3.1.7.1 Work description

Cleaning of communications line equipment refers to work for cleaning of communications manholes and hand holes.

3.3.1.7.2 Types of work

The types of work are as shown below.

a) Manhole cleaning work and hand hole cleaning work refer to using manual means or cleaning machines to clean accumulated substances and water from inside the communications manholes and hand holes that are installed on expressway main roads, interchanges, and other locations.

3.3.1.8 Repair work

3.3.1.8.1 Work description

Repair work refers to repairs for extending the lifetimes at locations where minor deterioration was discovered at regular inspections, structural inspections, and other inspections.

3.3.1.8.2 Types of work

The types of work are as shown below.

a) Repairs of corrosion caused by minor rusting of embedded-type light poles (hot-dip galvanized finish) at the locations that contact the ground, or other repairs, of sizes 0.02 m^2 or more to less than 0.07 m^2. The repairs consist of removing the rust and applying a rust-replacement type synthetic resin anti-corrosion agent.

b) Repairs of corrosion caused by minor rusting of steel plate (painted finish) lighting equipment, or other repairs, of sizes 0.005 m^2 or more to less than 0.05 m^2. The repairs consist of removing the rust and applying a rust-replacement type synthetic resin anti-corrosion agent.

c) Repairs of corrosion caused by minor rusting of stainless steel (painted finish) lighting equipment, or other repairs, of sizes 0.005 m^2 or more to less than 0.05 m^2. The repairs consist of removing the rust and applying an anti-corrosion agent for use with stainless steel.

d) Repairs of corrosion caused by minor rusting of steel towers for mobile radio equipment (hot-dip galvanized finish) at the locations that contact the ground, or other repairs, of sizes 0.02 m^2 or more to less than 0.07 m^2. The repairs consist of removing the rust and applying a rust-replacement type synthetic resin anti-corrosion agent.

3.4 Emergency Responsive Work

3.4.1 Work Description

Emergency work refers to the emergency work and similar work necessary for maintenance and management of road facilities.

3.4.2 Types of Work

The types of work are as shown below.

3.4.2.1 Emergency work and similar work that is necessary for maintenance of road facilities and requires approximately 2 hours of time

3.5 <Appendix> Standards Related to Checking and Inspection Work

For electrical equipment and communications equipment that are installed on expressways in Vietnam, the work contents that serve as the standards for checking and inspection work shall be as prescribed in the "Standards Related to Checking and Inspection Work" defined herein.

3.5.1 Checking and Inspection Work (Facilities)

3.5.1.1 Checking and inspection work for power distribution equipment

Power distribution equipment refers to equipment that receives, converts, and distributes electrical power. The range covers up to the secondary-side terminals of power receiving panels, transformer panels, switchboards, and load switches (including wiring inside and between panels). It also covers the range from the leading-in poles to the primary sides of switchboards or equivalent devices, as well as the range from the switchboard secondary side to the power distribution panels or equivalent devices of terminal loads.

3.5.1.2 Checking and inspection work for stand-by power generation equipment

Stand-by power generation equipment refers to equipment that supplies electrical power to various load equipment during times of power blackouts. The range covers up to the secondary-sides of generator panel main switches.

3.5.1.3 Checking and inspection work for road lighting equipment

Road lighting equipment refers to lighting equipment that is installed on roads. The range covers from the electrical lines to the terminal devices.

3.5.1.4 Checking and inspection work for warning light equipment

Warning light equipment refers to the warning lights installed on roads.

3.5.1.5 Checking and inspection work for variable road information board equipment

Variable road information board equipment refers to the variable signboard equipment that is installed on roads in order to communicate various road information. The range covers the devices, supports, and foundations.

3.5.1.6 Checking and inspection work for mobile radio equipment

Mobile radio equipment refers to base stations, land-based mobile stations, portable stations, and ancillary equipment.

3.5.1.7 Checking and inspection work for communication line equipment

Communication line equipment refers to the following.

3.5.1.7.1 This refers to the range from the low-voltage leading-in poles for a road communication facility to the power distribution panels or equivalent devices of terminal loads (if direct loads are connected, up to the load terminal block or equivalent device). Ancillary power distribution panels are also included.

3.5.1.7.2 This refers to the metallic cables, optical-fiber cables, and ancillary equipment that are used as transmission lines between sets of road communications equipment.

3.5.2 Inspection Items and Frequency for Checking and Inspection Work

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Power distribution equipment(for special high voltage and high voltage)	Disconnect switch	General	1	Appearance check (dirt,damage)				○			○	Visual inspection	Check that there is no dirt, damage, corrosion, paint peeling, or deformation.
			2	Overheating (temp. indicator tape), discoloration				○			○	Visual inspection	Check that there is no deformation or discoloration caused by overheating. Check that there is no discoloration of temp. indicator tape.
			3	Contact of blade and blade receiver, looseness (retighten),contact roughness							○	Visual, touch,operation, and tool inspection	Check that blade contacts blade receiver without looseness during operation. Check marking of bolts, etc. and retighten if necessary. Check that there is no corrosion or roughness of contacts and contacting parts.
			4	Application of grease to contacting surfaces							○	Visual, touch, and operation inspection	Remove old grease from the contacting surfaces of the blade and blade receiver, and apply new grease.
			5	Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
			6	Interlock system check							○	Visual and operation inspection	Check that operation is not possible when breaker is ON, and that operation is possible when breaker is OFF.
		Installation parts	1	Function of steady brace system, looseness (retighten)							○	Visual, operation, and tool inspection	Check that blade does not deviate and contacts the blade receiver smoothly during operation. Check marking of bolts, etc. and retighten if necessary.
		Switchgear mechanism	1	Operation check, looseness(retighten)							○	Visual, operation, and tool inspection	Check that there is no looseness, abnormal noise, or other abnormal feel during operation. Check marking of bolts, etc. and retighten if necessary.
		Insulator	1	Cracking							○	Visual inspection	Check that there is no cracking or damage.
		Connecting terminal	1	Looseness (retighten)							○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.
	Transformer	General	1	Appearance check (dirt,damage)				○			○	Visual inspection	Check that there is no dirt, damage, corrosion,paint peeling, or deformation.

Facility name	System name	Inspection location		Inspection item	Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Power distribution equipment(for special high voltage and high voltage)	Transformer	General	2	Oil leakage, vibration, noise				○			○	Visual and sound inspection	Check that there is no oil leakage at welded parts and packing. Check that there is no abnormal noise or vibration.
			3	Installation condition				○			○	Visual inspection	Check that installation onto mounting supports is solid and secure.
			4	Oil level, temp. (using provided meter)				○			○	Measurement by provided meter	Check that oil level gauge and temp. gauge readings are within the prescribed range.
			5	Condition of attachments							○	Visual and touch inspection	Check that there is no dirt, damage, corrosion,paint peeling, or deformation. Check that installation is solid and secure.
			6	Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
			7	Grounding resistance							○	Measurement by instrument	Check that grounding resistance value is within the prescribed range.
			8	Insulating oil withstand voltage test							○	Measurement by instrument	Check that insulation breakdown voltage is within the prescribed range.
			9	Insulating oil oxidation measurement							○	Measurement by instrument	Check that degree of oxidation is within the prescribed range.
		Installation parts	1	Looseness (retighten)							○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.
		Bushing	1	Cracking							○	Visual inspection	Check that there is no cracking or damage.
		Heat dissipation system	1	Cracking							○	Visual inspection	Check that there is no cracking or damage.
		Dehumidifying system	1	Desiccant discoloration,condition of moisture adsorption							○	Visual inspection	Check that there is no discoloration or deformation of desiccant. Check that there is no discoloration caused by deterioration of desiccant, and replace if necessary.
		Connecting terminal	1	Looseness (retighten)							○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.
	Lightning arrester	General	1	Appearance check (looseness)							○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.
			2	Condition of parts (dirt,damage, looseness (retighten),cracking)							○	Visual and tool inspection	Check that there is no dirt, damage, or cracking of all parts. Check marking of bolts, etc. and retighten if necessary.

Facility name	System name	Inspection location		Inspection item	Frequency: Daily checking (Random failure period) 1,2days	3days	1w	1 mo.	Periodic checking 3mo.	6 mo.	12 mo.	Inspection method	Work procedure
Power distribution equipment(for special high voltage and high voltage)	Lightning arrester	General	3	Marks from discharge							○	Visual inspection	Check that there are no marks from electrical discharge
			4	Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
			5	Grounding resistance							○	Measurement by instrument	Check that grounding resistance value is within the prescribed range.
	Leading-in poles		1	Pole health				○				Visual inspection	Check that there is no dirt, cracking, or inclination. Check that the foundation is not covered by dirt and that earth has not been washed out from under it.
			2	Tension of support wires				○				Visual and touch inspection	Check that there is no looseness of support wires. Check that there is no damage to ball insulator. Check that support wire grips have not fallen off or are loose.
			3	Installation condition of protective materials and signs				○				Visual inspection	Check that there is no damage to mounting bolts or that they have fallen off. Check that there is no damage to protective covers or that they have fallen off. Check that there is no damage to signs or that they have fallen off.
			4	Corrosion, damage of pole brackets				○				Visual, touch, and tool inspection	Check that there is no damage, rusting, or corrosion of cross arms. Check that there is no looseness of mounting bolts. Check that there is no looseness of scaffolding bolts or that they have fallen off. Check that there is no looseness of binding wires.

Facility name	System name	Inspection location		Inspection item	Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Power distribution equipment(for special high voltage and high voltage)	Leading-in poles		5	Appearance check (dirt, damage) of pole devices				○				Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that the installation is not inclined.
	Wires and support brackets		1	Installation condition				○				Visual, touch, and tool inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that the installation is not inclined.
			2	Distance from other objects				○				Visual inspection	Check that there is no contact with surrounding trees or other objects. Check that there is no damage or rusting of protective conduits at rise-up points.
			3	Insulation resistance				○				Measurement by instrument	Check that insulation resistance is within the prescribed range.
	Cables (including leading-in cables)	For load	1	Condition of head connections (overheating, damage)				○				Visual and touch inspection	Check that there is no deformation or discoloration caused by overheating.
			2	Underground installation condition (presence of unauthorized digging, etc.)				○				Visual inspection	Check that there is no evidence of digging. Check that there is no subsidence.
			3	Distance from other objects				○				Visual inspection	Check that there is no contact with surrounding trees or other objects. Check that there is no damage or rusting of protective conduits at rise-up points.
			4	Dirt, damage on exterior				○				Visual inspection	Check that there is no dirt, corrosion, damage, cracking, or deformation.
			5	Dirt, damage on parts				○				Visual inspection	Check that there is no dirt, corrosion, damage, cracking, or deformation.
			6	Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.

Facility name	System name	Inspection location	Inspection item		Frequency: Daily checking / Random failure period: 1,2days	3days	1w	1 mo.	Periodic checking: 3mo.	6 mo.	12 mo.	Inspection method	Work procedure
Power distribution equipment(for special high voltage and high voltage)	Conduits	Conduits and support brackets	1	Installation condition (presence of unauthorized digging, etc.)				○			○	Visual inspection	Check that there is no evidence of digging. Check that there is no subsidence.
			2	Condition of underground installation sign poles				○			○	Visual inspection	Check that letters and symbols have not disappeared. Check that signs are not covered by weeds or dirt.
	Manholes, hand-holes		1	Condition of cover installation				○			○	Visual and touch inspection	Check that there is no dirt, damage, or chipping. Check that there is no looseness. Check that they are not covered by weeds or dirt.
			2	Installation condition (presence of unauthorized digging, etc.)				○			○	Visual inspection	Check that there is no evidence of digging. Check that there is no subsidence.
Power distribution equipment Low voltage switchboard	Distribution panel, relay panel, etc. (hereafter, "distribution panel, etc.")	General	1	Appearance check (dirt, damage)				○			○	Visual inspection	Check that there is no dirt, damage, corrosion, paint peeling, or deformation. Check that there are no marks from rainwater intrusion or condensation. Check that space for inspections has been secured. Check that locks and related items are good.
			2	Abnormalities of instruments, indicator lamps, failure indicators				○			○	Visual inspection	Check that there is no damage to instrument covers or frames. Check that there is no damage to indicator lamps and that lenses have not fallen off. Replace any lamps that do not light. Check that indication and display condition are good.
			3	Abnormalities of operation switches, selector switches, relays, electromagnetic switches, wiring breakers				○			○	Visual, sound, smell, and touch inspection	Check that there is no dirt, damage, abnormal noise, abnormal odor, overheating, or other problems with switches, etc.

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Power distribution equipment Low voltage switchboard	Distribution panel, relay panel, etc. (hereafter, "distribution panel, etc.")	General	4	Dirt, damage, overheating, open circuit of wiring inside panel				○			○	Visual and touch inspection	Check that there is no dirt, damage, overheating, or open circuit. Check that there are no unnecessary wires, displaced wires, or foreign objects.
			5	Voltage, current measurement (using provided meter)				○			○	Measurement by provided meter	Check that voltage and current values are within the prescribed ranges.
			6	Main conducting part insulation resistance				○			○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
			7	Control circuit insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
		Panel body	1	Looseness (retighten)							○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.
		Operation switches and selector switches	1	Operation check							○	Visual, touch, and operation inspection	Check that switching operation is smooth.
		Wiring, terminals inside panel	1	Wiring condition, looseness (retighten)				○			○	Visual and tool inspection	Check that wiring connections are neat and organized. Check that there are no unnecessary wires, displaced wires, or foreign objects. Check marking of bolts, etc. and retighten if necessary.
		Indicator	1	Condition of connections for provided resistor, shunt, and other devices							○	Visual and touch inspection, and manual cleaning	Check that there is no deterioration, cracking, overheating, or discoloration. Check that installation and connections are solid and secure. Use a shopcloth, brush or similar tool to remove dust or other material.
			2	Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
			3	Calibration test							○	Measurement by instrument	Check that instrument measurement value and indicator reading are within the prescribed range.
		Automatic circuit breaker	1	Operation check							○	Visual, touch, and operation inspection	Check that switching operation is smooth. Check that installation is solid and secure.

Facility name	System name	Inspection location	Inspection item		Frequency: Daily checking / Random failure period: 1,2days	3days	1w	1 mo.	Frequency: Periodic checking: 3mo.	6 mo.	12 mo.	Inspection method	Work procedure
Power distribution equipment Low voltage switchboard		Insulating coating	1	Dirt, damage							○	Visual and smell inspection	Check that there is no dirt, damage, abnormal odor, or discoloration.
	Outdoor distribution panel	General	1	Same as the above "distribution panel, etc." item				○			○	Same as the above "distribution panel, etc." item	
			2	Water intrusion				○			○	Visual inspection	Check that there are no marks from rainwater intrusion or condensation. Check that there is no risk of rain or snow intrusion from ventilation holes, doors, or elsewhere.
		Lightning arrester	1	Appearance check (looseness)				○			○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.
			2	Condition of parts (dirt,damage, looseness (retighten),cracking)				○			○	Visual and tool inspection	Check that there is no dirt, damage, or cracking of all parts. Check marking of bolts, etc. and retighten if necessary.
			3	Marks from discharge				○			○	Visual inspection	Check that there are no marks from electrical discharge
			4	Grounding resistance				○			○	Measurement by instrument	Check that grounding resistance value is within the prescribed range.
	MDP panel	General	1	Appearance check (dirt, damage)				○			○	Visual inspection	Check that there is no dirt, damage, corrosion, paint peeling, or deformation. Check that there are no marks from rainwater intrusion or condensation. Check that space for inspections has been secured. Check that locks and related items are good.
			2	Abnormalities of instruments, indicator lamps, failure indicators				○			○	Visual inspection	Check that there is no damage to instrument covers or frames. Check that there is no damage to indicator lamps and that lenses have not fallen off. Replace any lamps that do not light. Check that indication and display condition are good.

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Power distribution equipment Low voltage switchboard	MDP panel	General	3	Abnormalities of operation switches, selector switches, relays, electromagnetic switches, wiring breakers				○			○	Visual, sound, smell, and touch inspection	Check that there is no dirt, damage, abnormal noise, abnormal odor, overheating, or other problems with switches, etc.
			4	Dirt, damage, overheating, open circuit of wiring inside panel				○			○	Visual and touch inspection	Check that there is no dirt, damage, overheating, or open circuit. Check that there are no unnecessary wires, displaced wires, or foreign objects.
			5	Voltage, current measurement (using provided meter)				○			○	Measurement by provided meter	Check that voltage and current values are within the prescribed ranges.
			6	Main conducting part insulation resistance				○			○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
			7	Control circuit insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
		Panel body	1	Looseness (retighten)							○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.
		Operation switches and selector switches	1	Operation check							○	Visual, touch, and operation inspection	Check that switching operation is smooth.
		Wiring, terminals	1	Wiring condition, looseness (retighten)				○			○	Visual and tool inspection	Check that wiring connections are neat and organized. Check that there are no unnecessary wires, displaced wires, or foreign objects. Check marking of bolts, etc. and retighten if necessary.
		Indicator	1	Condition of connections for provided resistor, shunt, and other devices							○	Visual and touch inspection, and manual cleaning	Check that there is no deterioration, cracking, overheating, or discoloration. Check that installation and connections are solid and secure. Use a shopcloth, brush or similar tool to remove dust or other material.
			2	Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Power distribution equipment Low voltage switchboard	MDP panel	Indicator	3	Calibration test							○	Measurement by instrument	Check that instrument measurement value and indicator reading are within the prescribed range.
		Wiring breaker	1	Operation check							○	Visual, touch, and operation inspection	Check that switching operation is smooth. Check that installation is solid and secure.
		Insulating coating	1	Dirt, damage							○	Visual and smell inspection	Check that there is no dirt, damage, abnormal odor, or discoloration.
		Grounding resistance	4	Grounding resistance				○			○	Measurement by instrument	Check that grounding resistance value is within the prescribed range.
	Cables (including leading-in cables)	For load	1	Condition of head connections (overheating, damage)				○				Visual and touch inspection	Check that there is no deformation or discoloration caused by overheating.
			2	Underground installation condition (presence of unauthorized digging, etc.)				○				Visual inspection	Check that there is no evidence of digging. Check that there is no subsidence.
			3	Distance from other objects				○				Visual inspection	Check that there is no contact with surrounding trees or other objects. Check that there is no damage or rusting of protective conduits at rise-up points.
			4	Dirt, damage on exterior	○					○		Visual inspection	Check that there is no dirt, corrosion, damage, cracking, or deformation.
			5	Dirt, damage on parts				○			○	Visual inspection	Check that there is no dirt, corrosion, damage, cracking, or deformation.
			6	Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
	Conduits	Conduits and support	1	Installation condition (presence of unauthorized digging, etc.)	○					○		Visual inspection	Check that there is no evidence of digging. Check that there is no subsidence.
	Manholes, hand-holes		1	Condition of cover installation	○					○		Visual and touch inspection	Check that there is no dirt, damage, or chipping. Check that there is no looseness. Check that they are not covered by weeds or dirt.

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
	Manholes, hand-holes	Conduits and support brackets	2	Installation condition (presence of unauthorized digging, etc.)	○					○		Visual inspection	Check that there is no evidence of digging. Check that there is no subsidence.
Private power generation equipment	Operation	General	1	Start/stop test				○			○	Visual and operation inspection	Operate and check that start and stop operations are good.
			2	Establish rated speed and voltage (by provided meter)				○			○	Measurement by provided meter	Check that values of each indicator reading are within the prescribed range.
			3	Operation check of each equipment				○			○	Visual and operation inspection	Check that operating conditions of equipments are good.
			4	Hydraulic pressure, abnormal noise, vibration, overheating				○			○	Visual inspection, by hearing and tentacles	Check that hydraulic pressure is within the prescribed range. Check that there is no abnormal noise, abnormal odor, obnormal vibration and overheating.
			5	Temperature condition of each part				○			○	Visual inspection	Check that there is no abnormal temperature rise.
	Diesel engine	General	1	Appearance check (dirt, damage)				○				Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Abnormality, oil leakage, water leakage of instruments				○				By visual inspection and tentacles	Check that indication and display condition are good. Check that the installation of tachometers and thermometers are solid and secure. Check that there is no oil and liquid leakage from joint parts.
			3	Apply oils and fats to each part						○		Visual inspection	After checking oils and fats, apply them an appropriate amount if necessary.
			4	Looseness of each part (retighten)							○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking Random failure period				Periodic checking				
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Private power generation equipment	Diesel engine	General	5	Various noise and vibration measurement							○	Measurement by instrument	Check that values of noice and vibration are within the prescribed range.
			6	Check the rise values of oil temperature, water temperature and exhaust temperature on rotating machines							○	Visual inspection Measurement by provided meter	Check that the temperature rise values of oil, water and exhaust air are within the prescribed range.
	Generator	General	1	Appearance check (dirt, damage)				○				Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Grounding resistance							○	Measurement by instrument	Check that grounding resistance value is within the prescribed range.
		lead wire	1	Contact condition							○	Visual inspection Measurement by provided meter	Check that contact conditions are good. Check that there is no adhesion and burn mark caused by overheating. Use a shopcloth, brush or similar tool to remove dust or other material. Check that there is no rusting and rough part on contact areas.
	Electricsystem		1	Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
	starter	electric starting accumulator(alkali）	1	Appearance check (dirt,damage)				○				Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, deformation and cracking on battery cases, covers and terminals
			2	Liquid surface, precipitation, hue, curved polar plate, separator				○				Visual inspection	Check that there is no short circuit, parts fallen off, cracking and curvature between polar plates. Check that separator conditions are good. Check that hues of each cell are good. Check that fluid volume is appropriate. Apply fluid replacement if necessary. Check that there is no precipitation in electrolytes. Check that there is no turbidity in electrolytes

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Private power generation equipment	starter	electric starting accumulator (alkali)	3	Loosening of the terminal, leakage Loosening of terminals, liquid leakage							○	Visual and tool inspection	Check that there is no looseness of cable connection and connection bar. Retighten those parts if necessary. Check that there is no liquid leakage caused by cracks and deformation of cases.
			4	Voltage of each cell, liquid temperature							○	Measurement by instrument	Check that voltage levels for each battery are within the prescribed range. Check that liquid temperature levels are within the prescribed range.(Measurement of the degree of one cell per line)
		Other	1	Corrosion of the floor surface, damage Damage and corrosion on floor surfaces							○	Visual inspection	Check that there is no damage and corrosion on floor surfaces caused by liquid leakage.
	fuel system	General	1	Appearance check (dirt,damage)				○				Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Oil leakage, an amount of oil to be stored (performed during operation)				○				Visual inspection	Check that there is no oil leakage from piping. Check that an appropriate amount of oil has been stored.
	lubricating oil system	General	1	Appearance check (dirt,damage)				○				Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Viscosity test of lubricating oil (Inspection of oil quantity and viscosity)							○	Visual and touch inspection	Check that the amount of lubricating oil is within the prescribed range. Check that there is no extreme deterioration of viscocity compared with new oil.
	cooling system	Radiator system	1	Appearance check (dirt,damage)				○				Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that there is no looseness in exhaust air ducts.

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Private power generation equipment	cooling system	Radiator system	3	State of the fan belt Fan belt conditoin				○				Visual, sound, and touch inspection	Check that there is no crack caused by deterioration. Check that fan belts keep good tention. Check that there is no abnormal noise during operation. Check that pressure sensors keep good condition.
	Equipment supply and	Damper, ventilation fan	1	Appearance check (dirt,damage)				○				Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	The color of exhaust gas				○			○	Visual inspection	Check that there is no unusual color. Check that it is close to colorless state during warming.
			3	Cracking or corrosion of exhaust pipes and mounting brackets							○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
	Vibration-proofing device	General	1	Deformation or damage of anchor bolts and vibration-proof rubbers etc							○	Visual and tool inspection	Check that there is no deformation and damage on vibration-proof rubbers, no deformation on anchor bolts. Check marking of bolts, etc. and retighten if necessary.
	Grounding line	General	1	Open circuit, condition and looseness (retighten) of connections							○	Visual and tool inspection	Check that there is no open circuit in the grounding line. Check marking of bolts, etc. and retighten if necessary.
	Other	General	1	Cleaning of fine parts							○	Manual cleaning	Use a shopcloth, brush or similar tool to remove dust or other material.
Road lighting equipment	Poles and steel towers	Main bodies	1	Appearance check (dirt, damage)				○			○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Installation condition				○			○	Visual and touch inspection	Check that the structure is maintained level and vertical. Check that there is no abnormal vibration.
		Foundation	1	Installation condition				○			○	Visual inspection	Check that there is no cracking, damage, or inclination. Check that the foundation is not covered by dirt and that earth has not been washed out from under it.

Facility name	System name	Inspection location	Inspection item		Frequency							Inspection method	Work procedure
					Daily checking / Random failure period				Periodic checking				
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Road lighting equipment	Poles and steel towers	Anchor bolts	1	Appearance check (dirt, damage)				○			○	Visual and tool inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check marking of bolts, etc. and retighten if necessary.
	Road lights	General	1	Appearance check (dirt, damage)				○			○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that there is no cracking or damage of glass surfaces.
	Other		1	Grounding resistance							○	Measurement by instrument	Check that grounding resistance value is within the prescribed range.
blinker lights equipment	blinker light	General	1	Appearance check (dirt, damage)				○			○	Visual, touch, and operation inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that there are no marks from rainwater intrusion or condensation. Check that there is no damage and deterioration of lenses and seals etc. Check that there is no inclination. Check marking of bolts, etc. and retighten if necessary.
Mobile radio equipment	Base station、Control Fixed station、Portable base station(analog Radio)		1	Appearance check (dirt, damage)					○		○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Call testing					○		○	Visual and operation inspection	Check that we can get a clear line with traffic control room by pressing press-to-talk switch
			3	VSWR measurement and transmitting output							○	Measurement by instrument	Check that values of transmitting output and VSWR are within the prescribed range.
			4	Transmit frequency measurement							○	Measurement by instrument	Check that transmit frequency values are within the prescribed range.
			5	Spurious transmission intensity measurement							○	Measurement by instrument	Check that spurious intensity values are within the prescribed range.

Facility name	System name	Inspection location		Inspection item	Frequency: Daily checking / Random failure period: 1,2days	3days	1w	1 mo.	Periodic checking: 3mo.	6 mo.	12 mo.	Inspection method	Work procedure
Mobile radio equipment	Base station、Control Fixed station、Portable base station(analog Radio)		6	Measured maximum frequency deviation and modulation characteristics							○	Measurement by instrument	Check that values of modulation characteristics and values of maximum frequency deviation are within the prescribed range.
			7	Receiver sensitivity measurement							○	Measurement by instrument	Check that values of receiving sensitivity are within the prescribed range.
			8	S / N Measurement (send and receive)							○	Measurement by instrument	Check that values of S/N is within the prescribed range.
			9	Distortion measurement							○	Measurement by instrument	Check that values of distortion are within the prescribed range.
	Land mobile station、Mobile station(Analog Radio)		1	Appearance check (dirt, damage)							○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Call testing							○	Visual and operation inspection	Check that we can get a clear line with traffic control room by pressing press-to-talk switch
			3	VSWR measurement and the transmitting output							○	Measurement by instrument	Check that values of VSWR are within the prescribed range.
			4	Transmit frequency measurement							○	Measurement by instrument	Check that values of transmit frequency are within the prescribed range.
			5	Spurious transmission intensity measurement							○	Measurement by instrument	Check that values of transmission spurious intensity are within the prescribed range.
			6	Measured maximum frequency deviation and modulation characteristics							○	Measurement by instrument	Check that values of modulation characteristics and values of maximum frequency deviation are within the prescribed range.
			7	Receiving sensitivity measurement							○	Measurement by instrument	Check that values of receiving sensitivity are within the prescribed range.
			8	S / N Measurement (send and receive)							○	Measurement by instrument	Check that values of S/N are within the prescribed range.
			9	Distortion measurement							○	Measurement by instrument	Check that values of distortion are within the prescribed range.
			10	Modulation input level measurement							○	Measurement by instrument	Check that values of modulation input level are within the prescribed range.
	Steel tower	Steel tower	1	Appearance check (dirt, damage)							○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Installation condition							○	Visual inspection	Check that the structure is maintained level and vertical.

Facility name	System name	Inspection location	Inspection item	Frequency							Inspection method	Work procedure
				Daily checking				Periodic checking				
				Random failure period								
				1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Mobile radio equipment	Steel tower	Steel tower	3 State of lightning rods (disconnection, the state of each connection and damage)							○	Visual and touch inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that there is no open circuit in the grounding line. Check that installation for each connection are solid and secure.
		Basis	1 Installation condition							○	Visual inspection	Check that there is no cracking, damage, or inclination. Check that the foundation is not covered by dirt and that earth has not been washed out from under it.
		Anchor bolt	1 Appearance check (dirt, damage)							○	Visual and tool inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check marking of bolts, etc. and retighten if necessary.
Variable type road information board equipment	LED type label board	board	1 Appearance check (dirt,damage)				○			○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that there are no marks from rainwater intrusion or condensation. Check that locks and related items are good.
			2 Operation check of heat exchanger fan				○			○	Visual, sound, smell, and touch inspection	Check of shutdown operation by manual operation good Check that there is no dirty, abnormal noise, abnormal odor, obnormal vibration and overheating.
			3 Operation check of Automatic ON/OFF device							○	Visual and operation inspection	Check of Automatic ON/OFF device operation
			4 Abnormalities of wiring breakers,magnetic contactor,transformer,surge absorption element							○	Visual, sound, smell, and touch inspection	Check that there is no dirt, damage, abnormal noise, abnormal odor, overheating, or other problems with breakers, etc.
			5 Condition of printed circuit board ,relay							○	Visual and touch inspection	Check that there is no looseness. Check that locks and related items are good.
			6 Cleaning of heat exchanger							○	Manual cleaning	fan and air duct Use a shopcloth, brush or similar tool to remove dust or other material.
			7 Transmit level measurement							○	Measurement by instrument	Check that Transmit level measurement are within the prescribed ranges.
			8 Loosening of the terminal(retighten)							○	Visual and tool inspection	Check marking of bolts, etc. and retighten if necessary.
		Label board	1 condition of LED type laber board unit							○	Visual, touch, and operation inspection	Check that there is no looseness. Check that locks and related items are good.

Facility name	System name	Inspection location		Inspection item	Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Variable type road information board equipment	Pole	Body,basis,Anchor bolt	1	Same as the above "Poles and steel towers." item							○	Same as the above "Poles and steel towers." item	
	Hand board (Manual control board ?)	General	1	Operation check from Hand board							○	Visual and operation inspection	Check of all item control operation
	Control board	General	1	Appearance check (dirt,damage)							○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that there are no marks from rainwater intrusion or condensation. Check that space for inspections has been secured. Check that locks and related items are good.
			2	Abnormalities of instruments, indicator lamps, failure indicators							○	Visual inspection	Check that there is no damage to instrument covers or frames. Check that there is no damage to indicator lamps and that lenses have not fallen off. Replace any lamps that do not light. Check that indication and display condition are good.
			3	Abnormalities of operation switches, selector switches, relays, electromagnetic switches, wiring breakers							○	Visual, sound, smell, and touch inspection	Check that there is no dirt, damage, abnormal noise, abnormal odor, overheating, or other problems with switches, etc.
			4	Dirt, damage, overheating, open circuit of wiring inside panel							○	Visual and touch inspection	Check that there is no dirt, damage, overheating, or open circuit. Check that there are no unnecessary wires, displaced wires, or foreign objects. Check marking of bolts, etc. and retighten if necessary.
			5	Voltage, current measurement (using provided meter)							○	Measurement by provided meter	Check that voltage and current values are within the prescribed ranges.
			6	Condition of parts (dirt,damage,overheating,looseness,displaced wires,open circuit.)							○	Visual, touch, and operation inspection	Check that there is no dirt, loss, or open circuit. Check marking of bolts, etc. and retighten if necessary. Check that there is no open circuit or contact.
			7	Condition of terminal wiring mark							○	Visual inspection	Check that there is no dirt, damage, overheating, or open circuit.
			8	Cleaning of fine parts							○	Manual cleaning	Use a shopcloth, brush or similar tool to remove dust or other material.
		Transmission part	1	Transmit level measurement							○	Measurement by instrument	Check that Transmit level measurement are within the prescribed ranges.
		Control board	1	Operation check from Control Board							○	Visual and operation inspection	Check of select item control operation
		Other	1	Insulation resistance							○	Measurement by instrument	Check that insulation resistance is within the prescribed range.
			2	Grounding resistance							○	Measurement by instrument	Check that grounding resistance value is within the prescribed range.

Facility name	System name	Inspection location		Inspection item	Frequency							Inspection method	Work procedure
					Daily checking				Periodic checking				
					Random failure period								
					1,2days	3days	1w	1 mo.	3mo.	6 mo.	12 mo.		
Communication wireway equipment	Communication cable	Metallic cable	1	Path loss (About 15% of all the logarithm is extracted and measured)							○	Measurement by instrument	Check that Path loss is within the prescribed range.
			2	Insulation resistance (About 15% of all the logarithm is extracted and measured)							○	Measurement by instrument	Check that Insulation resistance is within the prescribed range.
		Optical cable	1	Optical loss test							○	Measurement by instrument	Check that optical loss is within the prescribed range.
		Optical cable in office	1	Maintenance and accommodation state of cable (Bend,Support and Protection etc)							○	Visual and touch inspection	Check of Maintenance and accommodation state of cable load. Check of damage in covering
	Conduits	Conduits and support brackets	1	Installation condition (presence of unauthorized digging, etc.)							○	Visual inspection	Check that there is no evidence of digging. Check that there is no subsidence. Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation.
			2	Condition of Burial ranging poles							○	Visual inspection	Check of Character and Sign disappeared Check that they are not covered by weeds or dirt.
	Manholes, hand-holes		1	Condition of cover installation							○	Visual inspection	Check that there is no dirt, corrosion, damage, rusting, paint peeling, or deformation. Check that there is no looseness. Check that they are not covered by weeds or dirt.
			2	Installation condition (presence of unauthorized digging, etc.)							○	Visual inspection	Check that there is no cracking, damage, or inclination. Check that the foundation is not covered by dirt and that earth has not been washed out from under it.

3.5.3 Report Form

Power Distribution Equipment

NO 1／3

Inspection Area			Inspection Day	
			Weather	
			Temprature	
			Humidity	
System Name	Inspection Location	Work procedure	Inspection Result	Remarks
Disconnect switch	General	1 Appearance check (dirt,damage)	Nothing	
		2 Overheating (temp. indicator tape), discoloration	Nothing	
		3 Contact of blade and blade receiver, looseness (retighten),contact roughness	Good	
		4 Application of grease to contacting surfaces	Do	
		5 Insulation resistance	Good	
		6 Interlock system check	Good	
	Installation parts	1 Function of steady brace system, looseness (retighten)	Good	
	Switchgear mechanism	1 Operation check, looseness(retighten)	Good	
	Insulator	1 Cracking	Nothing	
	Connecting terminal	1 Looseness (retighten)	Nothing	
Transformer	General	1 Appearance check (dirt,damage)	Nothing	
		2 Oil leakage, vibration, noise	Nothing	
		3 Installation condition	Good	
		4 Oil level, temp. (using provided meter)	Good	
		5 Condition of attachments	Good	
		6 Insulation resistance	Good	
		7 Grounding resistance	Good	
		8 Insulating oil withstand voltage test (Perform every 3 years.)	—	
		9 Insulating oil oxidation measurement(Perform every 3 years.)	—	
	Installation parts	1 Looseness (retighten)	Nothing	
	Bushing	1 Cracking	Nothing	
	Heat dissipation system	1 Cracking Visual	Nothing	
	Dehumidifying system	1 Desiccant discoloration,condition of moisture adsorption	—	
	Connecting terminal	1 Looseness (retighten)	Nothing	
Lightning arrester	General	1 Appearance check (looseness)	Nothing	
		2 Condition of parts (dirt,damage, looseness (retighten),cracking)	Nothing	
		3 Marks from discharge	Nothing	
		4 Insulation resistance	Good	
		5 Grounding resistance	Good	
Leading-in poles	General	1 Pole health	Good	
		2 Tension of support wires	Good	
		3 Installation condition of protective materials and signs	Good	
		4 Corrosion, damage of pole brackets	Nothing	
		5 Appearance check (dirt,damage) of pole devices	Nothing	
Wires and support brackets		1 Installation condition	Good	
		2 Distance from other objects	Good	
		3 Insulation resistance	Good	
Remarks				

Power Distribution Equipment

NO 2／3

Inspection Area		Inspection Day	
		Weather	
		Temprature	
		Humidity	

System Name	Inspection Location	Work procedure	Inspection Result	Remarks
Cables (including leading-in cables)	For load	1 Condition of head connections (overheating, damage)	Good	
		2 Underground installation condition (presence of unauthorized digging, etc.)	Good	
		3 Distance from other objects	Good	
		4 Dirt, damage on exterior	Nothing	
		5 Dirt, damage on parts	Nothing	
		6 Insulation resistance	Good	
Conduits	Conduits and support brackets	1 Installation condition (presence of unauthorized digging, etc.)	Good	
		2 Condition of underground installation sign poles	Good	
Manholes, hand-holes		1 Condition of cover installation	Good	
		2 Installation condition (presence of unauthorized digging, etc.)	Good	
Distribution panel, relay panel, etc. (hereafter, "distribution panel, etc.")	General	1 Appearance check (dirt,damage)	Nothing	
		2 Abnormalities of instruments, indicator lamps, failure indicators	Nothing	
		3 Abnormalities of operation switches, selector switches, relays, electromagnetic switches, wiring breakers	Nothing	
		4 Dirt, damage, overheating, open circuit of wiring inside panel	Nothing	
		5 Voltage, current measurement (using provided meter)	Good	
		6 Main conducting part insulation resistance	Good	
		7 Control circuit insulation resistance	Good	
	Panel body	1 Looseness (retighten)	Nothing	
	Operation switches and selector switches	1 Operation check	Good	
	Wiring, terminals inside panel	1 Wiring condition, looseness (retighten)	Nothing	
	Indicator	1 Condition of connections for provided resistor, shunt, and other devices	Good	
		2 Insulation resistance	Good	
		3 Calibration test	Good	
	Wiring breaker	1 Operation check	Good	
	Insulating coating	1 Dirt, damage	Nothing	
Outdoor distribution panel	General	1 Appearance check (dirt,damage)	Nothing	
		2 Abnormalities of instruments, indicator lamps, failure indicators	Nothing	
		3 Abnormalities of operation switches, selector switches, relays, electromagnetic switches, wiring breakers	Nothing	
		4 Dirt, damage, overheating, open circuit of wiring inside panel	Nothing	
Remarks				

Power Distribution Equipment				
				NO 3／3
Inspection Area			Inspection Day	
			Weather	
			Temprature	
			Humidity	
System Name	Inspection Location	Work procedure	Inspection Result	Remarks
Outdoor distribution panel	General	5 Voltage, current measurement (using provided meter)	Good	
		6 Main conducting part insulation resistance	Good	
		7 Control circuit insulation resistance	Good	
		8 Water intrusion	Nothing	
Lightning arrester	General	1 Appearance check (looseness)	Nothing	
		2 Condition of parts (dirt,damage, looseness (retighten),cracking)	Nothing	
		3 Marks from discharge	Nothing	
		4 Grounding resistance	Good	
MDP panel	General	1 Appearance check (dirt,damage)	Nothing	
		2 Abnormalities of instruments, indicator lamps, failure indicators	Nothing	
		3 Abnormalities of operation switches, selector switches, relays, electromagnetic switches, wiring breakers	Nothing	
		4 Dirt, damage, overheating, open circuit of wiring inside panel	Nothing	
		5 Voltage, current measurement (using provided meter)	Good	
		6 Main conducting part insulation resistance	Good	
		7 Control circuit insulation resistance	Good	
	Panel body	1 Looseness (retighten)	Nothing	
	Operation switches and selector switches	1 Operation check	Good	
	Wiring, terminals inside panel	1 Wiring condition, looseness (retighten)	Nothing	
MDP panel	Indicator	1 Condition of connections for provided resistor, shunt, and other devices	Good	
		2 Insulation resistance	Good	
		3 Calibration test	Good	
	Wiring breaker	1 Operation check	Good	
	Insulating coating	1 Dirt, damage	Nothing	
	Grounding resistance	1 Grounding resistance	Good	
Cables (including leading-in cables)	For load	1 Condition of head connections (overheating, damage)	Good	
		2 Underground installation condition (presence of unauthorized digging, etc.)	Good	
		3 Distance from other objects	Good	
		4 Dirt, damage on exterior	Nothing	
		5 Dirt, damage on parts	Nothing	
		6 Insulation resistance	Good	
Conduits	Conduits and support brackets	1 Installation condition (presence of unauthorized digging, etc.)	Good	
Manholes, hand-holes		1 Condition of cover installation	Good	
		2 Installation condition (presence of unauthorized digging, etc.)	Good	
Remarks				
			Inspection Person	

Generation Electric Equipment

NO 1／1

Inspection Area		Inspection Day	
		Weather	
		Temprature	
		Humidity	

System Name	Inspection Location	Work procedure	Inspection Result	Remarks
Operation	General	1 Start/stop test	Good	
		2 Establish rated speed and voltage (by provided meter)	Good	
		3 Operation check of each equipment	Good	
		4 Hydraulic pressure, abnormal noise, vibration, overheating	Nothing	
		5 Temperature condition of each part	Good	
Diesel engine	General	1 Appearance check (dirt,damage)	Good	
		2 Abnormality, oil leakage, water leakage of instruments	Nothing	
		3 Apply oils and fats to each part	Good	
		4 Looseness of each part (retighten)	Good	
		5 Various noise and vibration measurement	Good	
		6 Check the rise values of oil temperature, water temperature and exhaust temperature on rotating machines	Good	
Generator	General	1 Appearance check (dirt,damage)	Good	
		2 Grounding resistance	Good	
	lead wire	1 Contact condition	Good	
Electricsystem		1 Insulation resistance	Good	
starter	electric starting accumulator(alkali)	1 Appearance check (dirt,damage)	Good	
		2 Liquid surface, precipitation, hue, curved polar plate, separator	Good	
		3 Loosening of the terminal, leakage Loosening of terminals, liquid leakage	Good	
		4 Voltage of each cell, liquid temperature	Good	
	Other	1 Corrosion of the floor surface, damage Damage and corrosion on floor surfaces	Good	
fuel system	General	1 Appearance check (dirt,damage)	Good	
		2 Oil leakage, an amount of oil to be stored (performed during operation)	Good	
lubricating oil system	General	1 Appearance check (dirt,damage)	Good	
		2 Viscosity test of lubricating oil (Inspection of oil quantity and viscosity)	Good	
cooling system	Radiator system	1 Appearance check (dirt,damage)	Good	
		2 State of the fan belt Fan belt conditoin	Good	
Equipment supply and exhaust	Damper, ventilation fan	1 Appearance check (dirt,damage)	Good	
		2 The color of exhaust gas	Good	
		3 Cracking or corrosion of exhaust pipes and mounting brackets	Good	
Vibration-proofing device	General	1 Deformation or damage of anchor bolts and vibration-proof rubbers etc	Good	
Grounding line	General	1 Open circuit, condition and looseness (retighten) of connections	Good	
Other	General	1 Cleaning of fine parts	Good	
Remarks				
			Inspection Person	

Road Lighting Equipment

NO 1／1

Inspection Area		Inspection Day	
		Weather	
		Temprature	
		Humidity	

System Name	Inspection Location	Work procedure	Inspection Result	Remarks
Poles and steel towers	Main bodies	1 Appearance check (dirt, damage)	Good	
		2 Installation condition	Good	
	Foundation	1 Installation condition	Good	
	Anchor bolts	1 Appearance check (dirt, damage)	Good	
Road lights	General	1 Appearance check (dirt, damage)	Good	
Other		1 Grounding resistance	Good	
Remarks				
			Inspection Person	

Warning Light Equipment

				NO 1／1
Inspection Area			Inspection Day	
			Weather	
			Temprature	
			Humidity	
System Name	Inspection Location	Work procedure	Inspection Result	Remarks
blinker light	General	1 Appearance check (dirt, damage)	Good	
Remarks				
			Inspection Person	

Road Electric Sign Equipment

NO 1／1

Inspection Area			Inspection Day	
			Weather	
			Temprature	
			Humidity	
System Name	Inspection Location	Work procedure	Inspection Result	Remarks
LED type label board	board	1 Appearance check (dirt,damage)	Nothing	
		2 Operation check of heat exchanger fan	Good	
		3 Operation check of Automatic ON/OFF device	Good	
		4 Abnormalities of wiring breakers,magnetic contactor,transformer,surge absorption element	Nothing	
		5 Condition of printed circuit board ,relay	Good	
		6 Cleaning of heat exchanger	Do	
		7 Transmit level measurement	Good	
		8 Loosening of the terminal(retighten)	Good	
	Label board	1 condition of LED type laber board unit	Good	
Poles	Main bodies	1 Appearance check (dirt, damage)	Good	
		2 Installation condition	Good	
	Foundation	1 Installation condition	Good	
	Anchor bolts	1 Appearance check (dirt, damage)	Good	
Hand board	General	1 Operation check from Hand board	Good	
Control board	General	1 Appearance check (dirt,damage)	Nothing	
		2 Abnormalities of instruments, indicator lamps, failure indicators	Good	
		3 Abnormalities of operation switches, selector switches, relays, electromagnetic switches, wiring breakers	Nothing	
		4 Dirt, damage, overheating, open circuit of wiring inside panel	Nothing	
		5 Voltage, current measurement (using provided meter)	Good	
		6 Condition of parts (dirt,damage,overheating,looseness,displaced wires,open circuit.)	Nothing	
		7 Condition of terminal wiring mark	Good	
		8 Cleaning of fine parts	Do	
	Transmission part	1 Transmit level measurement	Good	
	Control board	1 Operation check from Control Board	Good	
	Other	1 Insulation resistance	Good	
		2 Grounding resistance	Good	
Remarks				
			Inspection Person	

Movement Radio Equipment

NO 1／1

Inspection Area			Inspection Day	
			Weather	
			Temprature	
			Humidity	

System Name	Inspection Location	Work procedure	Inspection Result	Remarks
Base station、Control Fixed station、Portable base station(analog Radio)		1 Appearance check (dirt, damage)	Good	
		2 Call testing	Good	
		3 VSWR measurement and transmitting output	Good	
		4 Transmit frequency measurement	Good	
		5 Spurious transmission intensity measurement	Good	
		6 Measured maximum frequency deviation and modulation characteristics	Good	
		7 Receiver sensitivity measurement	Good	
		8 S / N Measurement (send and receive)	Good	
		9 Distortion measurement	Good	
Land mobile station、Mobile station(Analog Radio)		1 Appearance check (dirt, damage)	Good	
		2 Call testing	Good	
		3 VSWR measurement and the transmitting output	Good	
		4 Transmit frequency measurement	Good	
		5 Spurious transmission intensity measurement	Good	
		6 Measured maximum frequency deviation and modulation characteristics	Good	
		7 Receiving sensitivity measurement	Good	
		8 S / N Measurement (send and receive)	Good	
		9 Distortion measurement	Good	
		10 Modulation input level measurement	Good	
Steel tower	Steel tower	1 Appearance check (dirt, damage)	Good	
		2 Installation condition	Good	
		3 State of lightning rods (disconnection, the state of each connection and damage)	Good	
	Basis	1 Installation condition	Good	
	Anchor bolt	1 Appearance check (dirt, damage)	Good	
Remarks				
			Inspection Person	

Communication Wire Way Equipment

NO 1／1

Inspection Area		Inspection Day	
		Weather	
		Temprature	
		Humidity	

System Name	Inspection Location	Work procedure	Inspection Result	Remarks
Communication cable	Metallic cable	1 Path loss(About 15% of all the logarithm is extracted and measured)	Good	
		2 Insulation resistance(About 15% of all the logarithm is extracted and measured)	Good	
	Optical cable	1 Optical loss test	Good	
	Optical cable in office	1 Maintenance and accommodation state of cable (Bend,Support and Protection etc)	Good	
Conduits	Conduits and support brackets	1 Installation condition (presence of unauthorized digging, etc.)	Good	
		2 Condition of Burial ranging poles	Good	
Manholes, hand-holes		1 Condition of cover installation	Good	
		2 Installation condition (presence of unauthorized digging, etc.)	Good	
Remarks				
			Inspection Person	

Construction Test Result Form(Proximity Viewing)

Inspection Equipment:
Inspection Person:

Place(Sta)		Place(Fin)		

	Complete View	View1	View2	View3	View4	Last Quantity	This Quantity	Remarks
A A								
A								
B								
OK								
					Total		0	

Directorate for Roads of Vietnam   Japan International Cooperation Agency

The Project for Strengthening Operation and Maintenance System for Expressway in Vietnam

SECTION 4
TECHNICAL SPECIFICATION GUIDELINES FOR TRAFFIC MANAGEMENT

Vietnam Expressway Management Office

JICA Experts Team

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4 Traffic Management

4.1 Traffic Management System

4.1.1 Outline

Traffic Management Crews of the expressway, shall ensure safe and smooth traffic, and shall endeavor to communicate and cooperate closely with the police, fire brigade, ambulance, toll gate, rescue company, maintenance and repair workers and other related agencies.

Traffic Management System comprises a “Traffic Patrol Team” and a “Traffic Control Center”.

The “Traffic Patrol Team” carries out patrol intended to prevent occurrence of unusual incidents, collect relevant information, and to maintain preparedness to recover rapidly from unexpected incidents.

The “Traffic Control Center”, as the core function of Traffic Management System, carries out control of the Traffic Patrol Team, collection and dissemination of the information and cooperation with other responsible agencies to resolve incidents on the expressway.

The traffic patrol teams and the Traffic Control Center frequently communicate with each other in dealing with traffic control on the expressway.

4.1.2 Patrol stations

Traffic Patrol Team patrols are on duty and based at stations.

The Patrol stations shall be established at the place where the Traffic Patrol Team can arrive at the farthest points within about 30 minutes, by driving at the maximum speed allowed by the Law.

4.1.3 Deployed Staff

Traffic Patrol Team shall always (for 24 hours 365 days) mobilize more than 1 team on duty to ensure continuous operation (for 24 hours/ day of 365 days/ year)

Traffic Control Center shall mobilize more than 2 operators on duty (for 24 hours/ day of 365 days/ year).

4.1.4 Frequency of patrol

The number of regular traffic patrols per day shall be determined upon the traffic volume of the expressway (see the below Table) and the frequency of traffic patrol may be adjusted, taking into consideration of the road structures and other elements.

Traffic volume (daily average traffic volume)	Frequency of Regular patrols/day
Less than 5,000 vehicles	3
5,000 – Less than 10,000 vehicles	4
10,000 - Less than 15,000 vehicles	5
15,000 - Less than 20,000 vehicles	6
20,000 - Less than 25,000 vehicles	7
25,000 - Less than 30,000 vehicles	8
30,000 - Less than 40,000 vehicles	9
40,000 - Less than 50,000 vehicles	10
50,000 - Less than 70,000 vehicles	11
70,000 - Less than 90,000 vehicles	12
90,000 - Less than 110,000 vehicles	13
110,000 or more vehicles	14

4.2 Traffic Patrol

4.2.1 General

4.2.1.1 Principal Code of Conduct

Crews engaged in Traffic Patrol shall, at all times, work to ensure the safe and smooth flow of traffic on the expressway, and shall observe the principal code of conduct enumerated below.

(1) Traffic Patrol Team operates under the order of the Traffic Control Center. However, in case road traffic safety is in risk, necessary measures, within the scope of ensuring the safe and smooth traffic flow, may be taken without instructions from the Road Traffic Control Center, only if safe and smooth traffic is hindered or is likely to be hindered and there is not enough time to obtain instructions from the Traffic Control Center. In such a case, the taken measures shall be reported immediately to the Traffic Control Center.

(2) When delivering on-road duties such as handling of unusual incidents, enforcing traffic regulations, the patrol crews shall maintain close communications with related agencies, and cooperate with them.

(3) During working hours, the patrol crews must not leave the Patrol station or the expressway.
And shift changes shall be carried out quickly, to ensure no hindrance to duty work.

(4) The patrol crew shall maintain or improve their physical agility by doing stretching exercises before commencement of the duty work, in order to effectively deliver on-road duty works and keep themselves safe.

(5) Patrol crews of the Patrol station shall be given technical training related to vehicle operation and on-road work, as well as knowledge of relevant laws and regulations, several times a month.

4.2.1.2 Standard accessories of the Patrol Crews

In delivering duties of the expressway patrol, the Patrol crews shall be equipped with the following particles as enumerated below.

(1) Helmet

(2) Safety vest

(3) Whistle

4.2.1.3 Standard Set of On-Vehicle Equipment

At the time of the expressway patrol, as a general rule, the patrol crews ensure the following apparatuses ready with them inside the patrol vehicle:

No	Purpose of Use	Equipment	Quantity
1	Traffic Regulations	Reflective Color cone	7
2		Arrow sign	4
3		High intensity light	2
4		Directing/guidance baton	2
5		Hand flag (Red flag)	2
6	O&M Works	Handkerchief	2
7		Rubber gloves	2 pairs
8		Working gloves	2 pairs
9		Shovel	2
10		Bamboo broom	2
11		Bucket	1
12		Tow rope	1
13		Rope	1 roll
14		Plastic bag	discretionary
15		Jude bag	discretionary
16		Chemicals for treating	discretionary
17		Water tank	1

No	Purpose of Use	Equipment	Quantity
18		other tool gadget	1
19		Hammer	1
20		Fire extinguisher	1
21		First aid box	1
22		Blanket	2
23		Wheel chock	1
24	Communication	Handy micro	1
25		Portable transceiver	1
26		Mobile telephone	1
27	Other subordinate tools	Camera	1
28		Binoculars	1
29		Rolled ruler	1
30		Log book and document	1

4.2.1.4 Standard specifications of the vehicle

Standard specifications of the vehicle for traffic patrol is enumerated below:

(1) Name of Comp: Station Wagon

(2) Engine: 2,800cc or more

(3) Drive system: 4WD

(4) Equipment: Radio Equipment, Rotation lamp, Siren, Loudspeaker

(5) Body Color : Yellow and White Line (Body), Red and White (Bumper)

4.2.2 Crews Organizational Setup

A basic patrol unit comprises two traffic patrol crews, including a chief patrol crew, in one traffic patrol vehicle, except the cases enumerated below:

(1) The vehicle is accompanied by another traffic patrol vehicle.

(2) The patrol crew is going to support the implementation of secondary traffic control at the site where traffic control has already been put in place.

(3) The vehicle is going to transport equipment or materials that are required by other traffic patrol crews to the work site.

(4) The patrol crew has received special instruction from the Traffic control center, which can be safely implemented by a single person.

4.2.3 Traffic Patrol

4.2.3.1 Inspection and Maintenance of the Patrol Vehicle

The patrol crews shall endeavor to keep traffic patrol vehicles and a standardized set of on-vehicle equipment clean and organized. And they shall inspect the items enumerated below. If the inspection results identify insufficient quantity or articles with guarantee dates expired, it shall be replenished or replaced immediately.

(1) Before departing for patrol, the patrol crews shall inspect the items enumerated below:

- Operating conditions of braking and steering systems
- Visibility of rearview mirrors
- Degree of wear and air pressure of tires
- Fuel level
- Radio equipment setting
- Illuminating condition of warning lights and other lights

(2) Each time the patrol crews are dislodged from field duties, they shall inspect the items enumerated below:

- Fuel level
- Check for leakage of fuel, lubricating oil, or coolant
- Degree of wear and air pressure of tires
- Other abnormal items identified during the patrol

(3) Each time the patrol team switches the shift to the succeeding team, both shall inspect the items enumerated below:

- The standardized set of on-vehicle equipment shall be checked to confirm that it is present in designated quantities.
- Operating condition of the standardized set of on-vehicle equipment shall be checked.

4.2.3.2 Regular Patrols

4.2.3.2.1 Objectives

The primary objectives of regular expressway patrol are to collect information related to road traffic, and to remove damaged and/or disabled vehicles and debris from the road. These are ultimately intended to prevent accidents and other incidents from occurring (preventive management) to ensure safe and smooth flow of expressway traffic.

4.2.3.2.2 Traffic Patrol Plan

Crews, responsible for the operation of patrol station, should make a patrol plan in accordance with the attachment "Creating the Traffic Patrol Plan", which is then approved by the Traffic Control Center.

Patrol team should carry out regular patrol trips in accordance with this plan.

4.2.3.2.3 Reporting during the Regular Patrol

During the regular patrol, the patrol team shall report the items enumerated below to the Traffic Control Center

(1) Embarking on and dislodging from the patrol duties

(2) The clock time of the incidence of the patrol vehicle's passage through the interchange and the junction

(3) Traffic conditions; weather conditions and road conditions

(4) Other particular items instructed by the Traffic Control Center

4.2.3.3 Special Patrols

4.2.3.3.1 Purpose

When the patrol team waiting on standby for instructions at the patrol station, receives an instruction for emergency mobilization from the Traffic Control Center, they shall hurry to the scene instructed by the Traffic Control Center and carry out the instructed duties.

4.2.3.3.2 Report during the Special Patrol

During the Special Patrol, the patrol team shall report the following items to the Traffic Control Center:

(1) Commencement and dislodge from duty engagement

(2) The clock time of the incidence of the patrol vehicle's passage through the interchange and/or junction

(3) Arrival at and dislodge from the site where unusual incident is handled

(4) Matters of the unusual incidents specified in the Chapter 4.4

(5) Other items for which reporting is instructed by the Traffic Control Center

4.2.4 Reporting and record

At the end of the duty work shift, the traffic patrol crews shall fill in details of dutiable works performed and other necessary items on a daily work report. At this duty changeover time, handover information described in the daily work report shall be confirmed by both parties - the crew handing them over and the crew receiving them.

Attachment

Creating the Traffic Patrol Plan

(4.2.3.2.2)

1. Objectives of Regular Patrols

Traffic patrol team patrols the expressway regularly in a 24-hour day, 365-day year basis, in order to ensure the safety, high-speed service, and punctuality for travelling vehicles. In the event that a traffic accident or other unusual incident occurs, traffic patrol crews immediately hurry to the site and handle the situation to ensure public safety.

The primary objectives of regular road patrols are: (1) to collect information related to road traffic, and (2) to remove damaged/disabled vehicle and/or debris from the roads. These are ultimately intended to prevent accidents and other incidents from occurring (preventive management) to ensure safe and smooth flow of expressway traffic.

Primary objectives of regular patrols

① **Collect accurate information related to road traffic and report it to the Traffic Control Center.**

Major types of information collected

I. Road condition
- Existence of Road obstacles (disabled vehicles, debris, fallen objects, etc.)
- Road surface condition

II. Traffic conditions
- Occurrence and prediction of traffic congestion

III. Weather conditions
- Fog, wind, rain, or other weather that interferes with driving

② **Removal of road obstacles (Disabled vehicles, debris, fallen objects, etc.)**
(Whenever the Traffic patrol crews discover road obstacles, remove those articles that may interfere with expressway driving, so that accidents or congestion caused by these articles are prevented.)

2. Preparation of the Patrol Plan

The patrol plan prescribes the frequency and routes for the regular patrols to be conducted based on traffic volume, expressway characteristics and the structure. The patrol plan shall be produced so that the objectives of regular patrols described above can be achieved.

The following items shall be satisfied in producing the patrol plan.

(1) Prerequisites

The average driving speed for regular patrols shall be designated as 50 km/h. For sections where the actual average patrol speed is 50 km/h or above, the speed may be set as 60 km/h.

(2) Key consideration

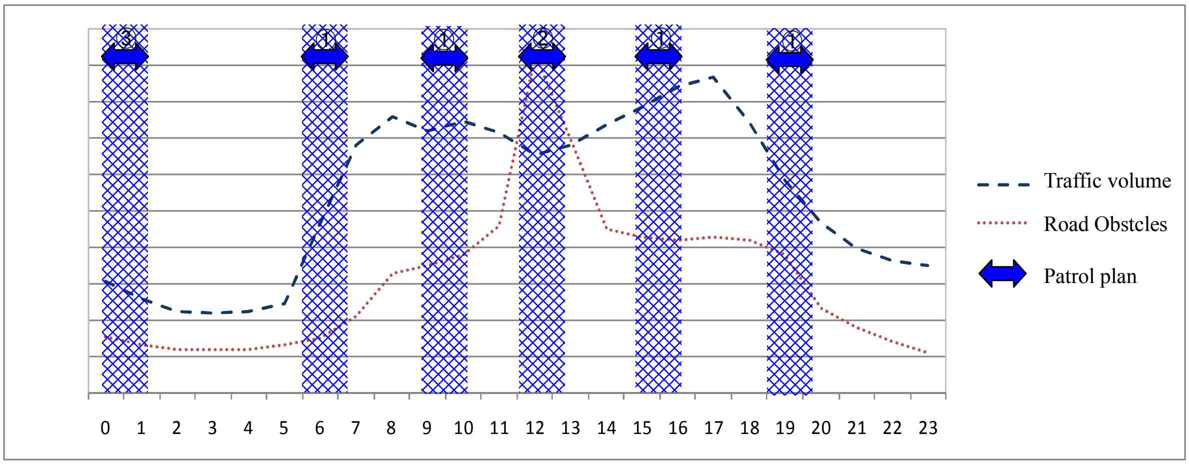
① Patrol time zones shall be so designated for intensive patrol, just before and after the peak hours, through examination of hourly distribution pattern of traffic volume over a day (24 hours）.

② Patrol time zone shall also be designated for intensive patrol at hours when road obstacles are frequently detected.

③ Patrol plan shall carefully be produced to minimize the time length unattended by patrol.

④ Considering the expressway characteristics within the responsible sections, the patrol may also be scheduled so as to attend the high time of occurrence of unusual incidents or changing weather conditions.

Traffic volume / Road obstacles over 1 day



4.2.5 On-road works

4.2.5.1 Glossary of Terms

The terms used in this chapter is defined as enumerated in the table below:

Term	Meaning
Red flags, etc.	Red flags, yellow flags, powerful lights and directing/ guidance batons
Signals	Signals using red flags, voice, or warning whistles For important signals, see separately listed *Attachment table*.
Pointing and calling	Finger-pointing and visually confirming safety before and after each individual task, and using signals. It includes other means of communicating with other traffic patrol crew when necessary, in order to ensure work safety
Monitoring and related activities	Activities that include traffic monitoring, cautioning or guiding traffic, detecting and warning vehicles driving recklessly or entering restricted areas, and providing instructions for evacuation
the Monitor and the Worker	At the site of the On-road work, “Monitor” is the person who is responsible for monitoring and related activities, and “Worker” is the person who is responsible for investigation and works.
Crew 1 and Crew 2	"Crew 1" is the person who is seated in the driver's seat and is responsible for driving and patrol inspections. "Crew 2" is the person who is seated in the assistant driver’s seat or back seat and is responsible for patrol inspections, reporting, and recording.
Obstacle	Accident vehicle, disabled vehicle, objects on the road, road damage, injured persons on the road difficult to be moved, or other items which obstruct traffic
Controlled area	Lanes, etc. where vehicle traffic is restricted by means of traffic control installments
Advance warning point	The point where arrow signs are placed for advance warning, located approximately 60 m in advance of the restriction start point
Start point of Control	The point in the taper section where the traffic control equipment is installed farthest from the patrol vehicle
Taper section	The section beginning from the starting point of control where traffic control equipment is installed at an angle relative to the lanes
Parallel section	The section from the changeover point to the end of the control where the traffic control equipment is installed parallel to the lanes
Changeover point	Location where the taper section changes to the parallel section

4.2.5.2 Code of Conduct During Duty Driving

Traffic patrol crews shall observe the items enumerated below during duty driving.

(1) In order to be able to respond immediately in the event of spotting unusual incident, in general, patrol crews shall drive somewhat toward the right side of the traffic lane (the first lane in the case of a 6-lane section),.

(2) Patrol crews shall drive at a speed which can ensure safety, whenever driving at the speed limit is perceived dangerous, in such instances as; at night, in bad weather, poor visibility, slippery road, and heavy traffic.

(3) During emergency driving, headlights shall be turned on with blazing sirens. As necessary, loudspeakers shall be used to warn other vehicles on the expressway.

(4) Headlights and side lights shall be turned on when driving inside the tunnels.

(5) Whenever merging with or out of the main expressway, or changing lanes, the Crew 2 shall point and call, followed by the Crew 1's calling out, in order to ensure complete checking for safety.

4.2.5.3 Code of Conduct for Parking and Stopping Vehicles

The traffic patrol crews shall observe the items enumerated below when parking or stopping. In order to prevent incidents of rear-end collisions, the traffic patrol crew shall turn on the flashing lights when parking or stopping, and also use the loudspeaker to warn surrounding passing vehicles and encourage customers to evacuate their vehicles.

(1) In general, the traffic patrol crew shall park and stop the vehicles in the positions prescribed by the restriction diagrams contained in the attached "Collection of Traffic Restriction Diagrams". However, when it is dangerous to park vehicles at the position prescribed by the restriction diagram, it is advised to first temporarily stop at the shoulder or other location confirmed as safe and not interfering with work, and then verifying safety and performing traffic restrictions as necessary before moving the vehicle to the position prescribed by the diagram. When stopping on the shoulder, if the shoulder at that location is narrow, stop as close as possible to the left side so that the vehicle does not protrude into the cruising lane.

(2) When parking or stopping, the traffic patrol crew shall engage the parking brake and turn the front wheels of the traffic patrol vehicle toward the shoulder side when stopping at the shoulder side, and toward the median strip when stopping at the median strip side.
When parking or stopping a traffic patrol vehicle on a steep slope, wheel chocks must be used.

(3) When stepping away from a traffic patrol vehicle, as necessary, the traffic patrol crew shall lock the vehicle and place traffic restriction equipment to the rear of it.

4.2.5.4 Code of Conduct for Exiting the Vehicle

The traffic patrol crew shall observe the items enumerated below when exiting the Vehicle.

(1) Exiting the Vehicle Parked or Stopped on the Shoulder Side

When exiting a traffic patrol vehicle that is parked or stopped on the shoulder side, first Crew 2 points and calls to verify safety to the rear, then exits from the right side of the vehicle. Next Crew 1 waits for Crew 2 to point and call to verify safety to the rear, then points and calls himself/herself to verify safety to the rear, and then exits to the left side of the vehicle. However when traffic is heavy or other circumstances make exiting from the left side of the vehicle dangerous, Crew 1 shall also exit from the right side of the vehicle.

(2) Exiting the Vehicle Parked or Stopped on the Median Strip Side

When exiting a traffic patrol vehicle parked or stopped on the median strip side, the first Crew 1 points and calls to verify safety to the rear, then exits from the left side of the vehicle. Then, the Crew 2 waits for the Crew 1 to point and call to verify safety of the rear side, then points and calls himself/herself to verify safety to the rear, and then exits to the right side of the vehicle. However, when the traffic is heavy or other circumstances make exiting from the right side of the vehicle dangerous, Crew 2 shall also exit from the left side of the vehicle.

(3) Exiting the Vehicle Parked or Stopped in a Cruising lane

When exiting a traffic patrol vehicle parked or stopped at the cruising lane of a 4-lane section, or at the first lane or the second lane of a 6-lane section, first point and call to verify safety to the right and left sides of the vehicle, then either Crew 1 or Crew 2 (whomever is on the safe side) points and calls to verify safety to the rear and then exits the vehicle first. After the crew who exited the vehicle first points and calls to verify safety of the rear side, the other crew points and calls to verify safety to the rear side and then exits the vehicle on the safe side.

4.2.5.5 Patrol Crews' Duty Assignment for On-road Operations

When two patrol crews ride the vehicle, on-road work shall be as prescribed by the items enumerated below. However this may not be applicable more than three patrol crews ride.

(1) When the patrol vehicle is parked or stopped on the road shoulder, the "work on the road" shall be done by "Crew 1" assigned to undertake the worker's role while "Crew 2"is assigned to monitor traffic and enforcement

(2) When parked or stopped at the median side (passing) lane , the "work on the road" shall be carried out by "Crew 1" assigned to monitor traffic and enforcement, while "Crew 2" is assigned to undertake worker's role.

(3) When parked or stopped at the cruising lane of a 4-lane section, or at the first lane or the

second lane of a 6-lane section, work shall be carried out with the crew who exited the traffic patrol vehicle first as the monitor and the crew who exited second as the worker.

(4) Exchanging of Roles

"Crew 1" and "Crew 2" shall exchange roles when necessary. However when traffic control is required, roles shall not be switched until installation of the traffic control equipment (used in the taper section when performing traffic control) has been completed.

4.2.5.6 Code of Conduct When Patrol Crews Are Engaged in On-Road Work

The traffic patrol crews shall observe the items enumerated below while engaged in on-road work.

(1) General Items to be Observed

① The patrol crews shall give first priority in securing the safety of the customers and themselves, and shall take action promptly, being aware of places of evacuation, and shall maintain close communications with the other patrol crews on duty.

② When moving parallel to the lanes, in general, movement shall be on the shoulders, median strip of, or off the road.

③ When crossing travel lanes, patrol crews shall point and call in order to check safety of left/right sides, use red flags, etc. while crossing, and run across perpendicular to the lane whenever possible.

④ One patrol crew assigned as a Worker and the Other as a Monitor shall point and call with each other in order to ensure safety before the commencement of and after the executing the "on the road work".

⑤ Traffic patrol crews shall confirm with each other the signals deployed by them versus intended messages for ensuring mutual understanding, and securing the smooth conduct of the work on the road.

(2) Code of Conduct of the Monitor

The monitor shall stand facing toward oncoming traffic in a location on the road shoulder, median strip, or inside a restricted area where he/she can communicate with the workers, while avoiding danger, using red flags, engaged in monitoring and related activities, thereby protecting the safety of the workers until all on-road work is completed. When the monitor detects a danger, he/she shall use the designated signals so that the worker can immediately avoid the danger, and also shall take steps to avoid the danger him/herself.

(3) Code of Conduct for the Worker

The worker shall always keep aware of the place of evacuation, and in general shall face toward the oncoming traffic and perform work during breaks in the traffic flow when safety has been confirmed. When the worker detects a danger, or receives instructions to evade danger from a monitor, the worker shall immediately move to the road shoulder, median strip, off the road, or another safe location.

4.2.5.7 Traffic Control by Traffic Patrol Team

Upon arriving at the scene of unusual incident, the Traffic patrol team shall impose traffic control, as stipulated by the articles enumerated below. However, this may not be the case when the incident was due to an obstacle on the expressway, which can be handled quickly.

4.2.5.7.1 Measures of Traffic Controls

When traffic control is necessary, the Traffic patrol team shall determine the most suitable type of control with a minimum impact on traffic, considering the extent of the expected traffic disturbance and possible scope of adverse impacts during traffic control, as well as the safety of the lanes for travelling vehicles. The Traffic Patrol team shall pay attention to the matter enumerated below during traffic control.

(1) Installing Traffic Control Devices/Equipment

Traffic control devices/equipment shall in general be installed in the positions shown in the control diagrams contained in the collection of “Traffic Control Diagrams”. While transporting the traffic control devices/equipment from the traffic patrol vehicle to the restriction starting point, the devices/equipment may temporarily be placed on the shoulder or median strip close to the planned installation positions.

(2) Procedure for Installing Traffic Control Devices/Equipment

The worker (Crew-1/Crew 2) shall secure own safety by means of signals from the monitor (Crew-1/Crew 2) while moving the traffic control devices/equipment from their temporary position and installing them at the designated position. When imposing traffic control on a section with a taper section, firstly traffic control devices/equipment in the taper section shall be installed, followed by installing them in the parallel section.

(3) Spacing Between Traffic Control Devices/equipment

① Traffic control devices/equipment in the taper section shall be installed with an interval of approximately 10 m each, at as small an angle as possible to the cruising lane.

② Traffic control devices/equipment in the parallel section shall be installed with an interval of approximately 30 m each, so that all the obstacles (debris and damaged vehicles) are within the control area.

③ Traffic control devices/equipment placed perpendicular to the cruising lanes shall be installed at intervals of approximately1.5m each.

4.2.5.7.2 Disengaging Traffic Control

In general when disengaging the traffic control, the Traffic Patrol team shall remove the traffic control devices/equipment in the reverse order when they were initially installed at the imposition of the restriction.

4.2.5.8 Dislodging from the Site

Traffic patrol crews shall observe the items enumerated below and report to the Traffic Control Center before dislodging from the site of on-road work.

4.2.5.8.1 Items that need to be completed before dislodgement

When dislodging from the site of on-road work, duly observe the items enumerated below and report to the Traffic Control Center before leaving.

(1) All the on-road duty tasks performed by patrol crews are completed.

(2) Ascertain that no more monitoring and related activities by the monitor (Crew 1/Crew 2) are necessary in order to ensure the safety of the worker (Crew 1/Crew 2) engaged and travelling vehicles.

4.2.5.8.2 Procedure of Launching Vehicles from the Site

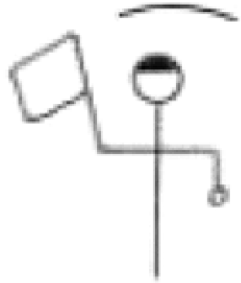
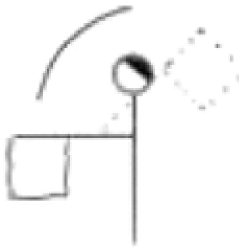
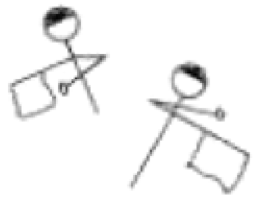
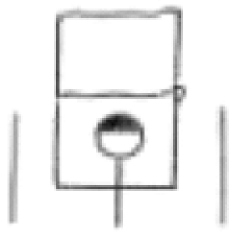
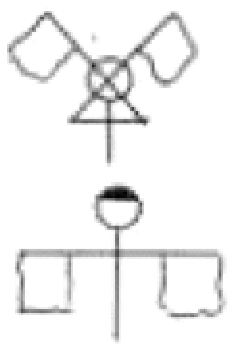
In disengaging all vehicles engaged in traffic control on-road work and withdrawing from the site, the following items are to be observed.

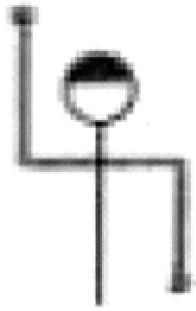
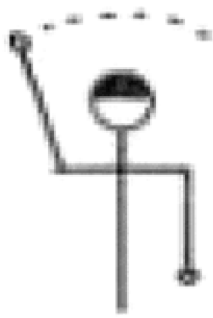
(1) Pay attention to other passing vehicles, and conduct pointing and call to verify safety.

(2) Keep the red warning lights, yellow warning lights, and flashing lights on until the vehicles reach approximately the same speed as other vehicles

(3) Keep the flashing lights on until the vehicles reach approximately the same speed as other vehicles

Attachment

(I) For approaching traffic				
No.	Meaning	Flag Waving		Warning whistle
1	Caution	Slowly wave flag overhead in big motions. (Repeat.)		
2	Proceed with caution.	Bend the elbow to raise flag from in front of the body to behind the head. (Repeat.)		
3	Move to the right (left).	Wave flag in big motions from right (left) to left (right). (Repeat, moving body together with flag.) When returning flag, hold it level.		
4	Slow down.	Hold flag above the head with both hands and then lower it. (Repeat.)		
5	Stop.	Cross flags above the head several times, then hold flags level and still. (If using only one flag, use your hand in place of the other flag.)		Multiple short whistles (Repeat extremely forcefully.) Pi! Pi! Pi!

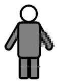
(II) For on-site workers				
No.	Meaning	Hands/flags		Warning whistle
1	Attention OK	Raise hand (flag) straight over the head and hold it there.		1 long whistle (Continue until other party notices.) Piiiiii!
2	Start the work.	Lower hand (flag) from overhead.		1 short whistle Pi!
3	Stop the work. End of work.	Cross hands (flags) in front of the body.		1 long whistle (Continue until other party notices.) Piiiiii!
4	Caution	Same as (I)-1	Same as at left	Multiple long whistles (Repeat forcefully.) Piiiiii!
5	Danger Run to a safe place.	Wave hand (flag) forcefully side to side over the head. (Repeat.)		Multiple short whistles (Repeat extremely forcefully.) Pi! Pi! Pi!

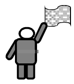
A Collection of Traffic Control Diagrams

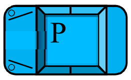
(Meanings of symbols)

 ···· Color cone

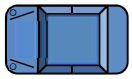
 ···· Arrow sign

 ···· Worker

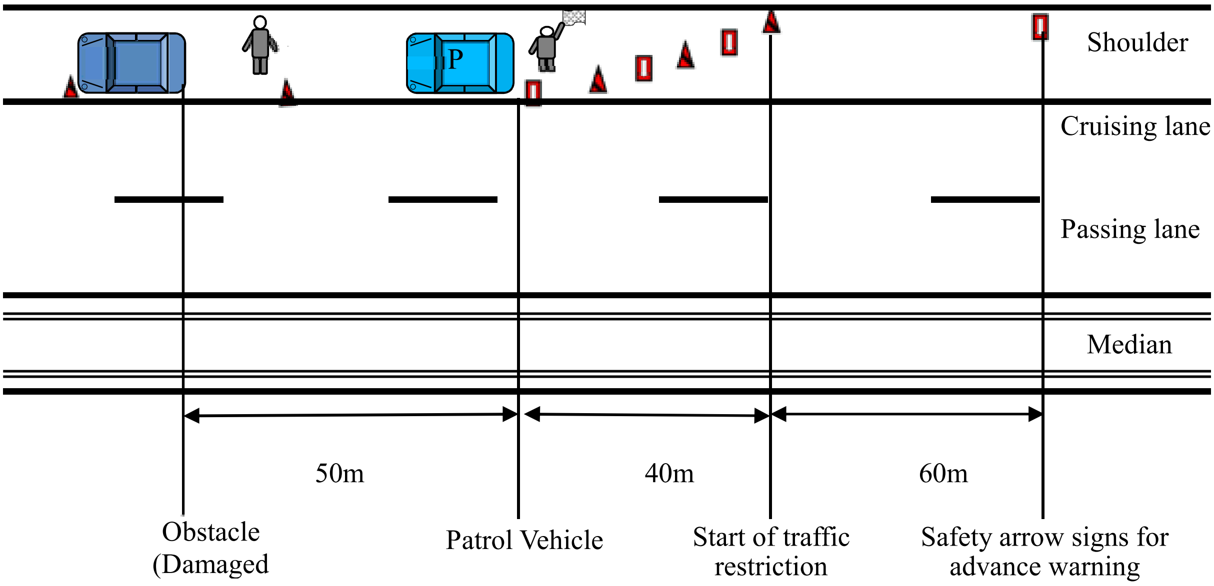
 ···· Monitor



···· Patrol Vehicle

 ···· Obstacle

■Shoulder control



① Patrol vehicle shall park on the shoulder approximately 50 m behind the obstacle.

② Patrol crews assigned as a worker and a monitor shall move to the point on the shoulder approximately 40 m behind the patrol vehicle.

③ The patrol crew assigned as a monitor shall further proceed to reach the point approximately 60m behind the start point of control, and shall install arrow sign devices/equipment on the shoulder in order to warn approaching vehicles. During that time, the worker shall perform monitoring and related activities.

④ After the work described in ③ is completed, the monitor shall start monitoring and related activities inside the advance warning point.

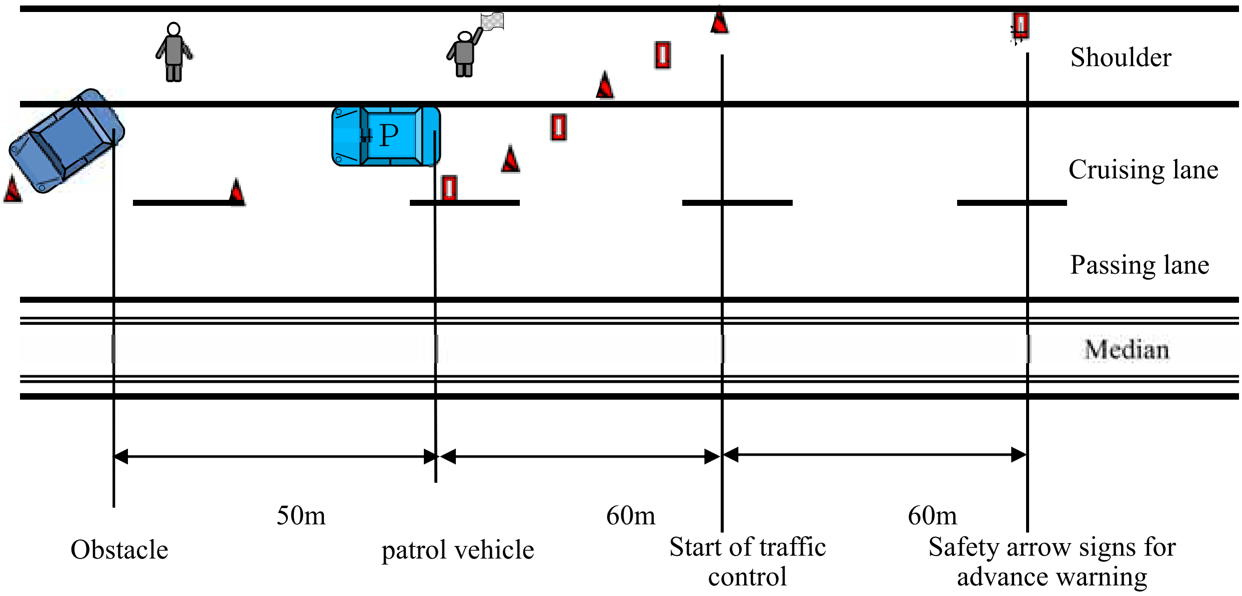
⑤ The worker shall install traffic control devices/equipment (color cones) behind the patrol vehicle, at a distance of approximately 40 m, in a way that the color-cones cross the shoulder diagonally

⑥ After the worker completes the work described above ⑤ the monitor shall move and stay inside the restricted area, and resume monitoring and related activities.

⑦ The worker shall install the traffic control devices/equipment in a line, parallel to the lane until they reach in front of the obstacle.

⑧ The worker shall report the conditions of the obstacle to the Traffic Control Center.

■Traffic lane control



① Patrol vehicle shall park approximately 50m behind of the obstacle.

② The worker and the monitor shall move to the point on the shoulder approximately 60 m behind the patrol vehicle.

③ The monitor shall further proceed to reach the point approximately 60 m behind the beginning point of the control, and shall install arrow signs on the shoulder in order to warn approaching vehicles. During delivering the task, the worker shall perform monitoring and related activities

④ After the task ③ is completed, the monitor shall proceed to the zone inside the advance warning point and resume monitoring.

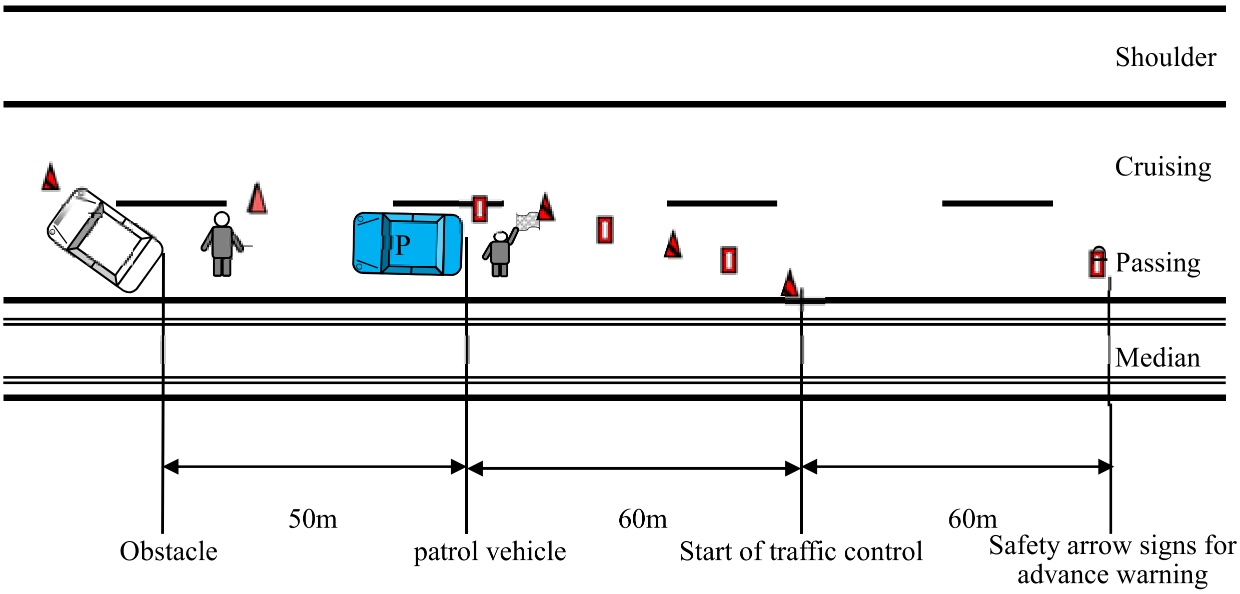
⑤ While the monitor resume monitoring and related activities as described in ④, the worker shall install color-cones approximately 60m behind the patrol vehicle in a way that the color-cones cross the shoulder diagonally..

⑥ After the above task ⑤ is completed, the monitor shall move and stay inside of the controlled area, and resume monitoring and related activities.

⑦ The worker shall place colored cones in a line up to the point of obstacle, in parallel with the lane.

⑧ The worker shall report the conditions of the obstacle (debris and the damaged vehicle) to the Traffic Control Center.

■Passing lane control



① A patrol vehicle shall park approximately 50m behind the obstacles (damaged vehicle and debris).

② The worker and the monitor shall move to the point on the shoulder approximately 60 m behind the patrol vehicle.

③ The monitor shall further proceed to reach the point approximately 60 m behind the beginning of the control point, and shall install arrow signs near the median strip in order to warn approaching vehicles. While the monitor is delivering the task, the worker shall undertake monitoring and related activities.

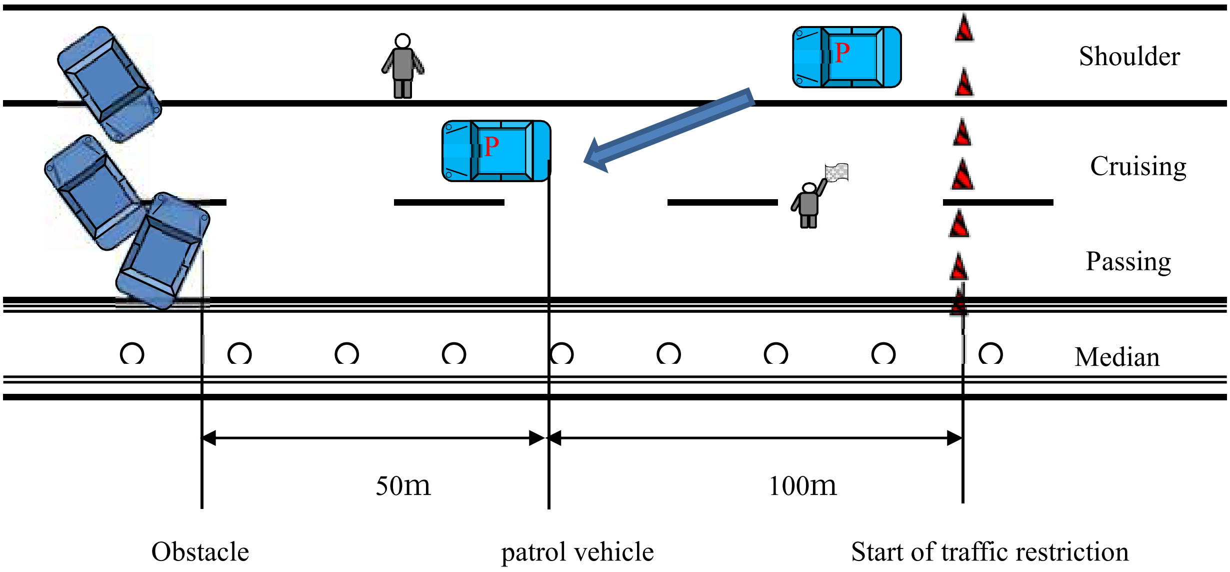
④ After the above task ③ is completed, the monitor shall resume monitoring and related activities staying inside of the advance warning point.

⑤ The worker shall install traffic control devices/equipment behind the patrol vehicle, over the length of approximately 60 m, in a way that the devices/equipment to cross the passing lane diagonally from the edge of the median strip..

⑥ After the worker completes the above task ⑤, the monitor shall move and stay inside of the restricted area, and resume monitoring and related activities.

⑦ The worker shall install the traffic restriction devices/equipment parallel to the lane until it passes over the obstacle. The worker shall report the conditions of the obstacle to the Traffic Control Center.

■Road closure on site



① Patrol vehicle shall stop approximately 100m behind the obstacle. If the flow of traffic on the main expressway road is being blocked, this shall be done in a way that fits the circumstances.

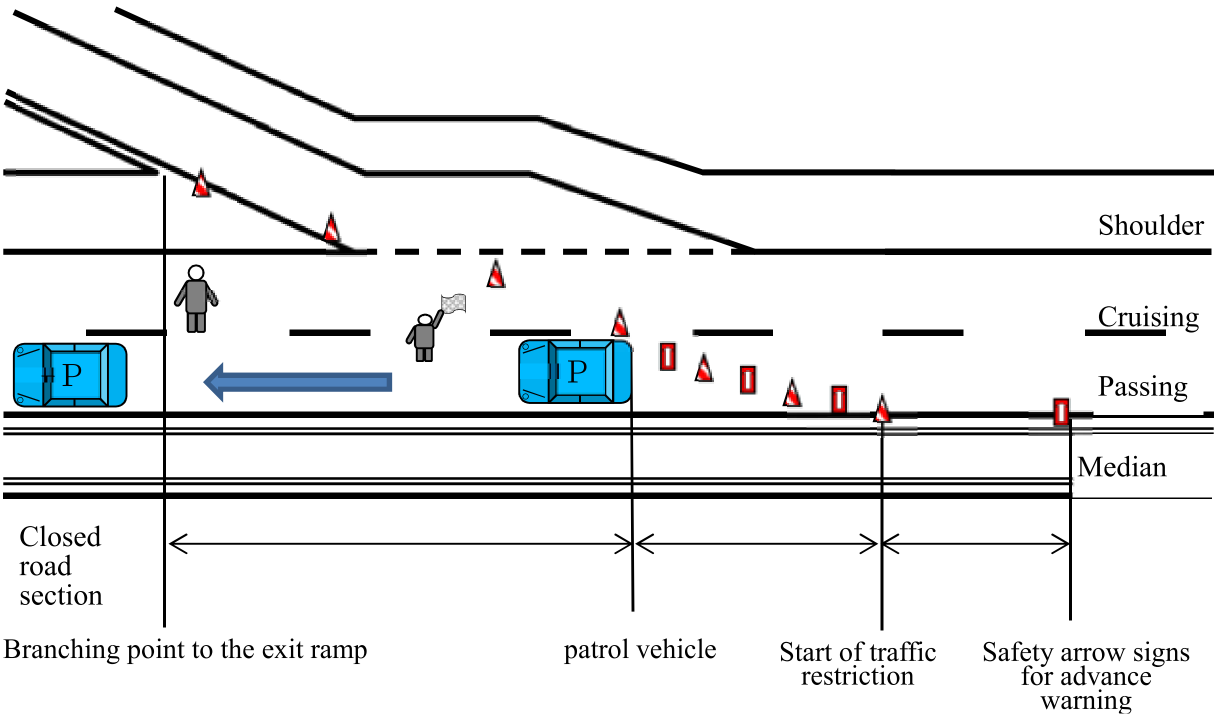
② The monitor and worker shall stand behind the patrol vehicle, with red flags in hand to direct approaching vehicles to slow down and stop.

③ The monitor and worker shall confirm that vehicles on the road are slowing down and safety is secured After the work described in completed, the worker shall install traffic control devices/equipment perpendicular to the lanes, beginning from the shoulder toward the median, behind the patrol vehicle (or starting from the median in case that the restriction is changed from passing lane restriction to road closure).

④ After installing the traffic control devices/equipment is completed, the monitor shall make the necessary announcements to the stopped vehicles and conduct monitoring and related activities while staying inside the control area.

The worker shall report the conditions of the obstacles (debris and the damaged vehicles) to the Traffic Control Center, and shall move the patrol vehicle to the position approximately 50 m behind the obstacles.

■Road closure between the ICs



① Patrol vehicle shall stop on the passing lane approximately 150m behind the branching point to the exit ramp.

② The worker and the monitor shall move to the point on the median strip, approximately 60 m behind the patrol vehicle.

③ The monitor shall further proceed to reach the median strip, approximately 60 m behind the beginning of the control point, and shall install the warning signal arrow signs.

④ When the above task ③ is completed, the monitor shall conduct monitoring and related activities inside the advance warning point, and shall direct approaching traffic to slow down and guide them to the exit ramp, with red flags in hand

⑤ After the monitor has started the monitoring and related activities described in ④, the worker shall confirm that vehicles on the road are slowing down and that safety is secured, followed by installing traffic control devices/equipment in sequence in a way that the equipment crosses lanes, diagonally, starting from the point on the median strip approximately 60m behind where the patrol vehicle to the point where patrol vehicle is parked

⑥ After the above task ⑤ is completed,

- The worker shall move the patrol vehicle forward and park it there.
- The monitor shall perform monitoring and related activities while staying inside the control area.

⑦ The worker guides and controls traffic flow at the place where the patrol vehicle is parked. The worker shall report to the Traffic Control that the disengaging control is complete..

4.3 Traffic Control (Excluding ITS)

4.3.1 General

4.3.1.1 Code of Conduct

The traffic control operators engaged in Traffic Control shall, at all times, deliver duties of ensuring the safe and smooth traffic flow on the expressway, and shall observe the code of conduct enumerated below.

(1) Traffic control operators shall maintain close communication with the police department, fire department, and other related agencies, and cooperate with them.

(2) Traffic control operators shall comprehend the current traffic conditions in the area of responsibility through the Traffic Patrol Team or related agencies.

(3) Traffic control operators shall respond to inquiries and reports received by the Traffic Control Center.

(4) The equipment used for works shall be operated correctly and quickly in accordance with the designated procedures.

(5) If the equipment used for works has failed, and it is not possible to carry out the work, or if an abnormality in the equipment is detected, it shall be replenished or replaced immediately.

(6) Except inevitable necessity, leaving the position is not allowed during duty hours. If it is necessary for inevitable reasons, the approval from one of the other traffic control operators shall be obtained.

And duty shift changeover shall be carried out promptly, and there shall be no interruption with duty work resulting from shift changeover

(7) At the end of the shift, the details of works performed and other necessary items shall be recorded in a daily work report. In shift changeover briefing, records of the daily work shall be confirmed by both parties.

4.3.1.2 Control of Traffic Control Crews

The traffic Control Center shall give necessary instructions to the Traffic Patrol crews, and receive necessary reports from them, by radio communications or by other means.

4.3.1.2.1 Locating the position of the Patrol Vehicle

The traffic Control Center shall receive the report on respective items cited below from the Traffic patrol crews by means of wireless phones or by other means, in order to confirm the positions of the Patrol Vehicle.

(1) Embarking on and disengagement from the patrol duties

(2) The time of the incidences of patrol vehicle's passing through the interchange and junction
(3) Arrival at and disengagement from the scene of unusual incident to be handled

4.3.1.2.2 Wireless Communications

The Traffic Control Center shall pay attention to the matter enumerated below when they uses wireless equipment,

(1) When using radio communications, traffic control operators shall only conveys key points, briefly and accurately.
(2) If the communicated message is understood, the traffic control operator receiving the call shall respond, saying "Roger" as a sign of understanding.
(3) If Traffic Control operator has difficulty understanding what the other party says, or if traffic control operator misses it, he/she shall endeavor to confirm the content of the communication to understand it accurately.
(4) When communications from multiple mobile stations are received at the same time, the traffic control operator shall communicate with one mobile station, instructing the other mobile station to "Hold", and maintain control over communications.
(5) When an "Urgent" communication request is received from a mobile station, traffic control operator shall stop the communication with the other mobile station and communicate with the mobile station requesting an urgent communication.

4.3.1.2.3 Record of the report

Duty operators at the Traffic Control Center shall record the contents of communication with the Traffic patrol crews.

4.3.2 Comprehending the Traffic Conditions

The Traffic Control Center shall be held responsible for collecting information from the Traffic Patrol crews, travelling vehicles, and other relevant agencies, and are responsible for comprehending the current traffic conditions in the area of responsibility.

4.3.2.1 Collecting Relevant Information from the Traffic Patrol Crews on Duty

The Traffic Control shall receive reports of the traffic condition, weather conditions and road conditions from the Traffic Patrol crews on duty. If an unusual incident occurs, the Traffic Control Center shall receive a detailed report specified in the chapter 4.4.

4.3.2.2 Traffic information gathering from travelling vehicles

Whenever the Traffic Control Center receives a report from the travelling vehicle, attention shall be paid to the matter enumerated below.

(1) The Traffic Control Center shall process the call in an efficient way.

(2) In confirming the reported facts over the communication link, the traffic control operators shall take initiatives in raising questions and confirm the fact as accurately and concisely as possible.

(3) If multiple calls arrive at the same time, the traffic control operators shall make sure not to be confused, and take necessary actions, such as giving priority to one call based on the importance of the contents while placing the other call on hold.

4.3.2.3 Traffic information collection from related Agencies

The Traffic Control Center shall exploit all available means to collect expressway traffic information from the police department, the fire department, and other related agencies. The Traffic Control Center shall not disclose to other parties the contents obtained from radio communication with police crews or with any police-related information learned during the course of the duty work.

4.3.3 Traffic information dissemination

The Traffic control Center shall undertake the following actions when such expressway information is received as shown below

(1) In principle, the traffic control operator shall immediately transfer messages to the Traffic patrol crews..

(2) If indications are that the situation could potentially hinder safe and smooth traffic, the traffic control operator shall notify the police department of such an incident immediately.

(3) When a report on an unusual incident is received, the Traffic Control Center shall take necessary actions stipulated by the rules of chapter 4.4.

4.4 Countermeasures to be taken against unusual incidents

4.4.1 Traffic accidents

4.4.1.1 Role of the Traffic Patrol Crews

Whenever the traffic patrol crews encounter a traffic accident, or when they receive instructions for emergency mobilization from the Traffic Control Center and arrive at the scene of the traffic accident, they shall respond by taking measures and report it as prescribed below.

4.4.1.1.1 Details on Measures To be Taken

At the traffic accident scene, traffic patrol crews shall deliver duties as enumerated below. At the accident scene, top priority shall be given to protection of life and safety of persons involved, and to taking urgent measures most suitable under the circumstances.

(1) When traffic patrol crews arrives close to the traffic accident scene, traffic patrol crews shall use loudspeakers to make the public aware of the incident and of enforcement measures being taken as follows.

① Targeting at vehicles travelling by the accident scene, alert them that the patrol vehicle (s) are stopping or parking at the site (excluding those making emergency stops)

② Targeting at persons involved in the accident, evacuate them off-the-road to a safer place.

(2) If the traffic control is deemed necessary, traffic patrol crews shall execute necessary measures as prescribed in the chapter 4.2.5.

(3) Traffic patrol crews shall rescue injured persons, and guide people to a safe place off-the -road. However depending on the severity of the injury, there are cases when the injured persons shall not be moved unless prior diagnosis indicates it will not worsen their injury. Be sure to carefully examine the conditions of the injured before assisting them to be evacuated or providing them with first aid.

(4) Traffic patrol crews shall investigate and check the items enumerated below

① Number of vehicles involved and positions where accident vehicles are stopped

② Types and model of accident vehicles and the severity of the damage

③ Vehicles loaded with hazardous substances and/or substances of potential leakage

④ Conditions of the injured persons

⑤ Damage to the road or road accessories, ⑥ Objects/debris scattered on the road

⑦ Traffic conditions

⑧ Supplementary information on unusual incidents

(5) Traffic patrol crews shall undertake the following tasks enumerated below.

① In case of a minor fire, extinguish the fire using portable fire extinguishers.

② If scattered obstacles/debris on the road is manageable, relocate the objects off-the-road where they will not interfere with the traffic. If removal of obstacles/debris is deemed beyond the capacity of the traffic patrol crews, they shall ask the Traffic Control Center to dispatch workers from maintenance and repair unit. And if obstacles are deemed to be associated with the accident or crime, the permission of the police department or an order from the Traffic Control Center shall be obtained.

③ In handling minor road surface contamination, the patrol crews shall undertake an urgent cleansing of the road surface. If cleansing operation is unsuccessful, traffic patrol crews shall report to the Traffic Control Center and request dispatch of workers of maintenance and repair unit.

④ Cooperate with the emergency medical department or other agencies in their rescue operation.

⑤ Cooperate with accident investigations conducted by the police department or other agencies.

⑥ If mobilization of a vehicle towing service is deemed necessary, urge the occupants of the accident vehicle to ask the towing company for a towing service. If they are unwilling to seek assistance of particular towing service provider, traffic patrol crews shall report the fact to the Traffic Control Center.

⑦ When removing the accident vehicle with a towing vehicle, the traffic patrol crews shall supervise the work.

⑧ Other tasks to be delivered on instructions from the Traffic Control Center

⑨ Other matters that can be handled by the traffic patrol crews by themselves. If the traffic patrol crews are unable to execute the task, traffic patrol crews shall report to the Traffic Control Center and demand assistance of workers who are used to be engaged in maintenance and repair.

4.4.1.1.2 Items to be Reported

At the traffic accident scene, traffic patrol crews shall report the items enumerated below to the Traffic Control Center.

(1) Location (kilometer post on inbound/outbound route) of the incident
(2) Number of deaths or injuries and the status of the injuries
(3) Need for and required number of ambulances
(4) General situation of the traffic accident
(5) Number and the model of accident vehicles, and the severity and extent of the damage
(6) Need for and required number of towing vehicles
(7) Flow of traffic at the accident site
(8) Need for and required type of traffic control
(9) Damage to the road or road accessories, or the situation where debris scattered on the road
(10) Need for and required number of maintenance/cleaning personnel, required type and required number of cleaning vehicles
(11) Name, property and quantity of the hazardous and/or difficult-to-handle substances carried by the accident vehicle, if any
(12) Name and quantity of cargo carried by the accident vehicle which needs to be disposed of immediately, if any
(13) Other necessary items

4.4.1.2 The Roles of Traffic Control Center

When a traffic accident occurs, the Traffic Control Center shall take necessary actions as prescribed below.

4.4.1.2.1 Initial Response

When an initial report on the traffic accident is received, the Traffic Control Center shall confirm the facts and take necessary actions as prescribed below.

(1) When an initial report on the traffic accident is received, the Traffic Control Center shall confirm the items listed below.

① Road name
② Inbound or outbound route
③ Kilometer post
④ Description of the accident

⑤ Need for ambulance

⑥ Whether or not the accident vehicle can run

⑦ Other items thought to be necessary in order to respond to the traffic accident

(2) When a report on a traffic accident is received, the Traffic Control Center shall immediately notify responsible police department of checked items and request mobilization.

(3) If the accident situation suggests that the traffic accident requires mobilization of a fire engine or ambulance, the Traffic Control Center shall immediately request mobilization of such vehicles from the responsible fire department.

(4) If the situation suggests that the traffic accident demands mobilization of the Traffic Patrol crews, the Traffic Control Center shall immediately instruct the Traffic Patrol Team to hurry.

(5) If the situation suggests that the traffic accident demands alerting passing vehicles of the incident, the Traffic Control Center shall notify it of adjacent toll gates.

(6) If the situation suggests that the traffic accident incident is needed to be notified to other related agencies, the Traffic Control Center shall do so.

4.4.1.2.2 Follow up Actions

When the Traffic Patrol crews arrives at the site of the traffic accident, the Traffic Control Center shall order them to check and take necessary actions as listed below.

(1) The Traffic Control Center shall check the items listed below.

① Location (kilometer post on inbound/outbound route) of the incident

② Number of deaths or injuries and condition of injuries

③ Need for and required number of ambulances

④ Details and particulars of the traffic accident

⑤ Number and types of accident vehicles, and condition of the damage

⑥ Need for and required number of towing vehicles

⑦ Traffic condition around the site

⑧ Need for and required type of traffic control

⑨ Damage to the road or road accessories, or condition of debris scattered on the road

⑩ Need for and required number of maintenance/cleaning personnel, required type and required number of cleaning vehicles

⑪ Name, property and quantity of the hazardous or difficult-to-handle substances carried by the accident vehicle, if any

⑫ Name and quantity of cargo carried by the accident vehicle which needs to be disposed of immediately, if any

⑬ Other necessary items

(2) The Traffic Control Center shall immediately notify the responsible police department of the facts confirmed by the Traffic Patrol Team.

(3) If the report from the Traffic Patrol crews suggests that mobilization of a fire engine or ambulance is needed, the Traffic Control Center shall immediately request mobilization of such vehicles from the responsible fire department.

(4) If the report from the Traffic Patrol crews suggests that alerting passing vehicles of the incident is necessary, the Traffic Control Center shall notify the incident to the adjacent toll gates.

(5) If the report from the Traffic Patrol crews suggests that mobilization of a towing vehicle is necessary, the Traffic Control Center shall notify the towing company of the incident.

(6) If the report from the Traffic Patrol Crews suggests that mobilization of maintenance and repair personnel is necessary, the Traffic Control Center shall notify the incident to the maintenance and repair unit.

(7) If the report from the Traffic Patrol Crews suggests that alerting other responsible agencies of the incident, the Traffic Control Center shall do so.

4.4.2 Disabled Vehicles

4.4.2.1 Role of Traffic Patrol Crews

When the traffic patrol crews encounters a disabled vehicle, or when they receive a command for emergency mobilization from the Traffic Control Center and arrive at the site of the disabled vehicle, they shall handle it and report as prescribed below.

4.4.2.1.1 Details of handling

At the site of the disabled vehicle, traffic patrol crews shall deliver the duties enumerated below.

(1) When traffic crews arrive close to the site of the disabled vehicle, traffic patrol crews shall use loudspeakers to make public announcements and emergency measures as below.

① Announcing the publics and the travelling vehicles in its vicinity on the situation that the patrol vehicles are stopping or parking (Such announcement shall not be done when patrol vehicles are making emergency stops)

② Evacuating persons involved in the disabled vehicle off of the road or transporting them to another safe location

(2) If the situation leads to traffic control, traffic patrol crews shall control traffic as prescribed in chapter 4.2.5

(3) Traffic patrol crews shall investigate and check the items as listed below

① Position where the disabled vehicle is stopped

② The type of the disabled vehicle and description of trouble

③ Whether or not the cargo contains hazardous substances

④ Whether or not asking for the service of a tow operator or a repair shop

⑤ Traffic conditions

⑥ Other unusual incidences involved with the accident

(4) Traffic patrol crews shall undertake the following tasks as below.

① In mobilizing a towing service, urge the persons charged with the accident vehicle to request the service of the tow and removal. If they do not wish to have a towing service, the traffic patrol crews shall report the fact to the Traffic Control Center.

② Traffic patrol crews shall be engaged in watch and alert at the rear of a disabled vehicle, upon an instruction from the Traffic Control Center, in the event that the lives of the on-board occupants are exposed to such risks as passengers aboard the bus, the vehicle loaded with hazardous substances, or in anticipation of longer repair time.

③ When removing the disabled vehicle with a towing vehicle, the traffic patrol crews shall supervise the operation. If supervision is deemed not necessary in ensuring the safety of occupants of the disabled vehicle, or safe travel of passing traffic, the patrol crews can offload such a duty.

④ Other duties as demanded by instructions from the Traffic Control Center

4.4.2.1.2 Items to be reported

At the scene of the disabled vehicle, traffic patrol crews shall report the items enumerated below to the Traffic Control Center.

(1) Location (kilometer post on inbound/outbound route) of the disabled vehicle

(2) Model of disabled vehicle

(3) Causes of the vehicle disabled

(4) Location where the vehicle stopped and the status of the stopped vehicle

(5) Traffic situation around the site

(6) Need for and required type of traffic control

(7) Need for staff from a repair shop

(8) Need for and required number of towing vehicles

(9) Name, property and quantity of the hazardous or difficult-to-handle substances carried by the accident vehicle, if any

(10) Other items

4.4.2.2 Role of the Traffic Control Center

Upon receipt of a report on an incident of disabled vehicle, the Traffic Control Center shall take necessary actions in the following.

4.4.2.2.1 Initial Response

When a report on an incident of a disabled vehicle is received, the Traffic Control Center shall check and take necessary actions as below.

(1) When a report on an incident of a disabled vehicle is received, the Traffic Control Center shall check the items listed below.

① Road name

② Inbound or outbound route

③ Kilometer post

④ Positions where a disabled vehicle is stopped

⑤ Description on causes of vehicle disabled

⑥ Need for towing vehicles

⑦ Other items thought to be necessary in order to respond to the disabled vehicle

(2) If the situation suggests that the disabled vehicle indicates the risk of a secondary accident or matters under the jurisdiction of police department, the Traffic Control Center shall immediately notify the responsible police crews of said incident.

(3) If the situation suggests that the disabled vehicle demands mobilization of fire department, the Traffic Control Center shall immediately request mobilization of such vehicles from the responsible fire department.

(4) If the situation suggests that the disabled vehicle requires mobilization of the Traffic Patrol Team, the Traffic Control Center shall immediately instruct the dispatch of the Traffic Patrol Team.

(5) If the situation of the disabled vehicle suggests that travelling vehicle need to be alerted,,

the Traffic Control Center shall notify the incident to adjacent toll gates.

(6) If the situation suggests that the disabled vehicle needs mobilization of a towing vehicle, the Traffic Control Center shall urge the driver or occupants of the disabled vehicle to seek the service of the towing company. If they do not specify a particular towing company of their choice, the Traffic Control Center shall appoint a towing company for service delivery.

(7) If the situation of the disabled vehicle suggests that other jurisdictional authority shall intervene, the Traffic Control Center shall notify the incident to relevant authorities.

4.4.2.2.2 Follow up actions

When the Traffic patrol crews arrives at the site of the disabled vehicle, the Traffic Control Center shall order the crews to check and take necessary actions based as prescribed below.

(1) The Traffic Control Center shall check the items listed below.

① Location (kilometer post on inbound/outbound route) of occurrence

② Type of disabled vehicle

③ Causes of vehicle disabled

④ Location where the vehicle stopped and the condition of the stopped vehicle

⑤ Traffic condition around the site

⑥ Need for and required type of traffic control

⑦ Need for a service of a repair shop

⑧ Need for and required number of towing vehicles

⑨ Name, property and quantity of the hazardous or difficult-to-handle substance carried by the disabled vehicle, if any

⑩ Other necessary items

(2) If the situation report from the Traffic Patrol crews suggests the necessity for mobilization of the police department, the Traffic Control Center shall immediately notify the responsible police department of the incident.

(3) If the situation report from the Traffic Patrol crews suggests the necessity for mobilization of a fire engine, the Traffic Control Center shall immediately request mobilization of such vehicles from the responsible fire department.

(4) If the situation report from the Traffic Patrol crews suggests the necessity of alerting passing vehicles, the Traffic Control Center shall notify adjacent toll gates of the incident.

(5) If the situation report from the Traffic Patrol crews suggests the necessity for mobilizing a

towing vehicle, the Traffic Control Center shall notify the towing company of the incident..

(6) If the situation report from the Traffic Patrol crews suggests the necessity for mobilization of maintenance and repair unit, the Traffic Control Center shall notify the unit of the incident.

(7) If the situation report from the Traffic Patrol crews suggests the necessity to alert other responsible agencies of the incident, the Traffic Control Center shall notify them of the incident.

4.4.3 Road Obstacles

4.4.3.1 Role of the Traffic Patrol Crews

When the traffic patrol crews encounters road obstacles, or when they mobilized themselves on command from the Traffic Control Center, and arrived at the road obstacle site, they shall deliver duties to handle the situation and report it to the Traffic Control Center as prescribed below.

4.4.3.1.1 Details of handling

At the site of the road obstacle, traffic patrol crews shall perform the works enumerated below.

(1) When traffic patrol crews arrives close to the location where the road obstacle will be handled, traffic patrol crews shall use loudspeakers to make the public aware of the obstacle and exercise enforcement as enumerated below.

・Notify surrounding passing vehicles of presence of the patrol vehicle stopped or parked (except for the events of patrol vehicle's emergency stop or park)

(2) Traffic patrol crews shall relocate objects on the road to the shoulder, off of the road, or to another location where they do not interfere with traffic. If removal is beyond the crews' capacity, traffic patrol crews shall report to the Traffic Control Center and demand assistance of workers from maintenance and repair unit. And if obstacles suggest an association with the accident or crime, the permission of the police department or order from the Traffic Control Center is required for the removal.

(3) If traffic control is deemed necessary to remove on-road obstacles, traffic crews shall perform it as prescribed in chapter4.2.5.

(4) When traffic control is deemed not necessary in removing obstacles, traffic patrol crews

shall remove them as prescribed below

① When it is possible to safely stop the vehicle in front of the obstacle after the object on the road was discovered, in general, traffic patrol crews shall stop the patrol vehicle on the shoulder or in another safe location approximately 50 m in front of the object on the road. If it is not possible to stop the patrol vehicle safely in front of the obstacle because the obstacle was discovered too late, traffic patrol crews shall stop the vehicle on the shoulder or in another safe location at a distance beyond the object on the road. Care shall be taken not to make a sudden stop or take any other action that would interfere with the flow of traffic.

② The monitor shall in general be engaged in monitoring and related activities staying at the shoulder or median strip, at a position approximately 50 m behind the workers, and shall guarantee safety before giving the workers the signal to commence work. Even on receipt of the signal to start work from the monitor, the workers shall confirm own safety before commencing the work.

(5) If the road obstacle is a valuable one, the traffic patrol crews shall recover and store it in the traffic patrol vehicle, and shall obtain instructions from the Traffic Control Center. Traffic patrol crews must abandon their claims to valuables that are acquired during the course of duty work.

4.4.3.1.2 Items to be reported

At the site of the obstacles on the expressway, traffic patrol crews shall report the items enumerated below to the Traffic Control Center.

(1) Location (kilometer post on inbound/outbound route) of the obstacles detected
(2) Type and shape of road obstacles
(3) Traffic condition around the site
(4) Need for and required type of traffic control
(5) Need for and required number of trucks to load and haul obstacles
(6) Other necessary items

4.4.3.2 The Role of the Traffic Control Center

When detection of a road obstacle is reported, the Traffic Control Center shall take necessary actions based as prescribed below.

4.4.3.2.1 Initial Response

When detection of the road obstacle is reported, the Traffic Control Center shall order the traffic patrol crews to check and take necessary actions based as prescribed below.

(1) When detection of a road obstacle is reported, the Traffic Control Center shall order the traffic patrol crews to check the items listed below.

① Road name

② Inbound or outbound route

③ Kilometer post

④ Type and shape of road obstacles

⑤ Other items thought to be necessary in order to respond to the road obstacle

(2) If the situation suggests that the road obstacle represents a risk of secondary accident or matters of police jurisdiction, the Traffic Control Center shall immediately notify the responsible police department of the obstacles.

(3) If the situation suggests that the road obstacle demands mobilization of a fire engine, the Traffic Control Center shall immediately request mobilization of such vehicles from the responsible fire department.

(4) If the situation suggests that the road obstacle demands mobilization of the Traffic patrol crews, the Traffic Control Center shall immediately instruct the Traffic Patrol Team to hurry to the scene.

(5) If the situation suggests that the travelling vehicles need to be aware of the road obstacle, the Traffic Control Center shall notify it to toll gates.

(6) If the situation suggests that the road obstacle demands mobilization of workers of maintenance and repair unit, the Traffic Control Center shall notify the unit of the incident..

(7) If the situation suggests that other related agencies shall be aware of said road obstacle, the Traffic control Center shall notify them of the incident.

4.4.3.2.2 Follow up actions

When the Traffic Patrol crews arrives at the road obstacle scene, the Traffic Control Center shall order them to check and take necessary actions based as prescribed below

(1) The Traffic Control Center shall instruct the Traffic Patrol crews to check the items listed below.

① Location (kilometer post on inbound/outbound route) of obstacles occurrence

② Type and shape of road obstacles

③ Traffic condition around the site

④ Need for and required type of traffic restriction

⑤ Need for and required number of trucks for loading and hauling obstacles

⑥ Other necessary items

(2) If the report from the Traffic Patrol crews suggests that mobilization of police is necessary, the Traffic Control Center shall immediately notify it to the responsible police department.

(3) If the report from the Traffic Patrol crews suggests that mobilization of a fire engine is necessary, the Traffic Control Center shall immediately demand mobilization of such vehicles from the responsible fire department.

(4) If the report from the Traffic Patrol crews suggests that the travelling vehicles shall be aware of the incident, the Traffic Control Center shall notify toll gates of the incident.

(5) If the report from the Traffic Patrol crews suggests mobilization of workers engaged in maintenance and repair is necessary, the Traffic Control Center shall notify the workers of the incident.

(6) If the report from the Traffic Patrol crews suggests that other related agencies need to be aware of the incident of road obstacle, the Traffic Control Center shall notify them of the incident.

4.4.4 Vehicle on fire

4.4.4.1 The Role of the Traffic Patrol Crews

When traffic patrol crews encounter a vehicle on fire, or when they receive instructions for emergency mobilization from the Traffic Control Center and arrive at the site of the vehicle fire, they shall handle and report as prescribed below.

4.4.4.1.1 Details of handling

At the site of the vehicle on fire, traffic patrol crews shall perform the works enumerated below. At the work site, top priority shall be given to protection of life and safety, and the prioritize measures that are most appropriate for the circumstances.

(1) When traffic patrol crewss arrive close to the location where the vehicle fire will be handled, traffic patrol crewss shall use the loudspeakers to make the public aware of the incident and enforcement measures as below.

① Making aware passing vehicles of the presence of the patrol vehicle stopped or parked (except for parking vehicles making emergency stops)

② Evacuating personnel involved in the vehicle on fire off-the-road or to another safe location

(2) If traffic control is deemed necessary, the traffic control crews shall impose control as prescribed in chapter4.2.5.

(3) Traffic patrol crews shall rescue injured persons, and guide people to a safe place off-road. However depending on the conditions of the injured, there are cases when the injured person must not be moved unnecessarily. Be sure to carefully examine the conditions of the injured before assisting evacuation or providing first aid.

(4) Traffic patrol crews shall investigate and check the items enumerated below

① Number of vehicles on fire and positions where vehicles on are stopped

② Types of vehicles on fire, and condition of the damage

③ Presence of vehicles carrying hazardous substances and potential leakage

④ Presence and conditions of the injured

⑤ Damage to the road or road accessories

⑥ Conditions of objects on the road

⑦ Traffic conditions

⑧ Other unusual conditions

(5) Traffic patrol crews shall perform the works enumerated below.

① In case of a minor fire, extinguish the fire using portable fire extinguishers.

② If the vehicle suffers minor fire, relocate the object to the shoulder or other location where they will not interfere with the traffic. If it is impossible, traffic patrol crews shall report to the Traffic Control Center and demand dispatching workers from the maintenance and repair unit to assist removal and clearance. And if the causes of fire suggest an association with an incident or crime, the permission of the police or order from the Traffic Control Center shall be obtained for the removal.

③ In case of minor fouling, perform temporary cleaning of the road surface. If it is impossible, traffic patrol crews shall report to the Traffic Control Center and demand an assistance of workers from the maintenance and repair unit.

④ Cooperate with the fire-fighting activities by the fire department or other agencies

⑤ Cooperate with rescue activities conducted by the medical department or other agencies

⑥ In case of mobilization of a towing vehicle, urge the driver or other person involved in the vehicle fire to seek assistance of the towing company. If they do not specify a particular towing company, traffic patrol crews shall report to the Traffic Control Center.

⑦ When removing the vehicles on fire with a towing vehicle, supervise the work.

② Other works based on instructions from the Traffic Control Center

③ Other items that can be handled by the traffic patrol crews by themselves. If it is impossible, traffic patrol crews shall report to the Traffic Control Center and require the assistance of workers of maintenance and repair unit.

4.4.4.1.2 Items to be reported

At the site of the vehicle fire, traffic patrol crews shall report the items enumerated below to the Traffic Control Center.

(1) Location (kilometer post on inbound/outbound route) of occurrence
(2) Number of deaths or injuries and condition of injuries
(3) Name, property and quantity of the hazardous or difficult-to-handle substance carried by the vehicle on fire, if any
(4) Need for and required number of fire engines
(5) Need for and required number of ambulances
(6) Condition of fire
(7) Number and types of vehicles on fire, and condition of the damage
(8) Need for and required number of towing vehicles
(9) Traffic condition around the site
(10) Need for and required type of traffic restriction
(11) Damage to the road or road accessories, or condition of debris scattered on the road
(12) Need for and required number of maintenance/cleaning staff, required type and required number of cleaning vehicles
(13) Other necessary items

4.4.4.2 The Role of the Traffic Control Center

When a vehicle fire occurs, the Traffic Control Center shall take necessary actions based as prescribed below.

4.4.4.2.1 Initial Response

When information concerning the vehicle fire is received, the Traffic Control Center shall order the traffic patrol crews to check the following items and take necessary actions as below.

(1) When a report on the vehicle fire is received, the Traffic Control Center shall order the traffic patrol crews to check the items listed below.

① Road name

② Inbound or outbound route

② Kilometer post

③ Description of the fire

④ Need for fire engines

⑤ Need for ambulance

⑥ Whether or not the vehicles on fire can be driven

⑦ Other items thought to be necessary in order to respond to the vehicle fire

(2) When information that the vehicle fire occurred is received, the Traffic Control Center shall immediately notify report the checked items to the responsible fire department, and request mobilization.

(3) When a report on the vehicle on fire is received, the Traffic Control Center shall immediately notify responsible police department of the incident and request mobilization.

(4) If the situation suggests that the incident of “vehicle on fire” demands mobilization of ambulance, the Traffic Control Center shall immediately request mobilization of such vehicles from the responsible medical department.

(5) If the situation suggests that the incident of “vehicle on fire” demands mobilization of the Traffic Patrol crews, the Traffic Control Center shall immediately instruct the Traffic Patrol crews to hurry to the scene.

(6) If the situation suggests that the passing vehicles shall be made aware of “vehicle on fire” incident, the Traffic Control Center shall notify toll gates of the incident.

(7) If the situation suggests that the other related agencies need to be made aware of the incident of “vehicle on fire” , the Traffic Control Center shall notify them of the incident.

4.4.4.2.2 Follow up actions

When the Traffic Patrol Team arrives at the scene of the “vehicle on fire”, the Traffic Control Center shall order the traffic patrol crews to check and take necessary actions based as prescribed below.

(1) The Traffic Control Center shall order the traffic patrol crews to check the items listed below.

① Location (kilometer post on inbound/outbound route) of occurrence

② Number of deaths or injuries and condition of injuries

② Name, property and quantity of the hazardous or difficult-to-handle substance carried by the vehicle on fire, if any

③ Need for and required number of fire engines

④ Need for and required number of ambulance

⑤ Condition of vehicle fire

⑥ Number and type of accident vehicles on fire, and condition of the damage

⑦ Need for and required number of towing vehicles

⑧ Traffic condition around the site

⑨ Need for and required type of traffic control

⑩ Damage to the road or road accessories, or condition of debris scattered on the road

⑪ Need for and required number of maintenance/cleaning personnel, required type and required number of cleaning vehicles

⑫ Other necessary items

(2) The Traffic Control Center shall immediately notify the responsible fire department of the incident report from the Traffic Patrol crews.

(3) The Traffic Control Center shall immediately notify the responsible police department of the incident report from the Traffic Patrol crews.

(4) If the report from the Traffic Patrol crews suggests that an ambulance shall be mobilized, the Traffic Control Center shall immediately request mobilization of such vehicles from the responsible fire department.

(5) If the report from the Traffic Patrol crews suggests that the passing vehicles nearby the vehicle fire scene shall be made aware of the incident, the Traffic Control Center shall notify toll gates of the incident

(6) If the report from the Traffic Patrol crews suggests that a towing vehicle need to be mobilized, the Traffic Control Center shall notify the towing company of service delivery.

(7) If the report from the Traffic Patrol crews suggests that the workers from the maintenance and repair unit need to be mobilized, the Traffic Control Center shall notify the unit of assistance delivery.

(8) If the report from the Traffic Patrol crews suggests that other related agencies need to be aware of the incident, the Traffic Control Center shall notify them of the incident.

4.4.5 Traffic Jam

4.4.5.1 The Role of Traffic Patrol Crews

When traffic patrol crews encounter traffic jam, or when they receive instructions for emergency mobilization from the Traffic Control Center and arrive at the traffic jam scene, they shall handle it and report the situation as prescribed below

4.4.5.1.1 Details of handling

At the traffic jam scene, traffic patrol crews shall perform the works enumerated below.

(1) When traffic patrol crews arrive close to the traffic jam scene, the patrol vehicle should follow the tail end of the traffic queue, as necessary, in order to give warnings to vehicles approaching from the rear. The position of a patrol vehicle giving warnings to approaching vehicles shall in general be in a safe location, such as the shoulder, at least 400 m away from the tail end of the traffic jam.

(2) When there is a change in the traffic queue length, or when it is deemed that the road condition is dangerous, traffic patrol crews shall immediately report to the Traffic Control Center and follow its instructions.

(3) When a patrol vehicle, giving warnings to vehicles approaching from the rear, needs to move in the reverse direction, one of the patrol crews should stand behind the vehicle as a guide in order to confirm safety. However when it is recognized that moving the vehicle in reverse is dangerous, reversing is prohibited. In such a case, the vehicle should turn around at the next interchange to resume providing such warnings.

(4) The vehicle engaged in warning the approaching vehicles shall suspend the task if emergency mobilization is invoked elsewhere..

4.4.5.1.2 Items to be reported

At the site of traffic jam, traffic patrol crews shall report the items enumerated below to the Traffic Control Center.

(1) Location (kilometer post on inbound/outbound route) of incident occurrence

(2) Condition of traffic jam and prospects for its clearing

(3) Cause of traffic jam

(4) Need for and required type of traffic restriction

(5) Other necessary items

4.4.5.2 The Role of the Traffic Control Center

When traffic jam occurs, the Traffic Control Center shall take necessary actions based as prescribed below.

4.4.5.2.1 Initial Response

When a report on the traffic jam is received, the Traffic Control Center shall order the traffic patrol crews to check and take necessary actions based as prescribed below.

(1) When a report on the traffic jam is received, the Traffic Control Center shall order the traffic patrol crews to check the items listed below.
   ① Road name
   ② Inbound or outbound route
   ③ Kilometer post
   ④ Causes of the traffic jam
   ⑤ Other items thought to be necessary in order to respond to the traffic jam

(2) When a report on the incident of traffic jam is received, the Traffic Control Center shall notify the responsible police crews of the incident.

(3) If the traffic jam situation suggests that emergency mobilization of the Traffic Patrol crews is necessary, the Traffic Control Center shall instruct the Traffic Patrol crews to hurry to the traffic congestion scene.

(4) If the situation suggests that the passing vehicles need to be alerted about the incident of traffic jam, the Traffic Control Center shall notify toll gates of the incident.

(5) If the situation suggests that other related agencies shall be made aware of the traffic jam, the Traffic Control Center shall notify them of the incident.

4.4.5.2.2 Follow up Actions

When the Traffic Patrol Team arrives at the site of the traffic jam, the Traffic Control Center shall order the traffic patrol crews to check and take necessary actions listed below.

(1) The Traffic Control Center shall order the traffic patrol crews to check the items listed below.
   ① Location (kilometer post on inbound/outbound route) of traffic jam incident
   ② Condition of traffic jam and prospects for its clearing
   ④ Cause of traffic jam
   ⑤ Need for and required type of traffic control
   ⑥ Other necessary items

(2) The Traffic Control Center shall immediately notify the responsible police department of the report from the Traffic Patrol crews

(3) If the report from the Traffic Patrol crews suggests that the passing vehicles shall be

alerted about the incident, the Traffic Control Center shall notify toll gates of the incident.

(4) If the report from the Traffic Patrol crews suggests that other related agencies shall be alerted about the incident, the Traffic Control Center shall notify them of the incident.

4.4.6 Sudden changes in the weather

4.4.6.1 The Role of Traffic Patrol Crews

When traffic patrol encounter a sudden change in weather, or when they receive instructions for emergency mobilization from the Traffic Control Center and arrive at the site of the unusual weather, they shall handle the scene and report as prescribed below.

4.4.6.1.1 Details of handling

At the site of the unusual weather, traffic patrol crews shall perform the works enumerated below.

(1) In order to prevent danger to traffic, traffic patrol crews shall perform road closures and take other necessary steps as needed.

(2) As necessary, Traffic patrol crews shall use loudspeakers and other means to alert traffic about the abnormal weather, and provide instructions for appropriate driving.

4.4.6.1.2 Items to be reported

At the site of the unusual weather, traffic patrol crews shall report the items enumerated below to the Traffic Control Center.

(1) Time and location (kilometer post on inbound/outbound route) of the incident of usual weather occurrence

(2) Weather type and conditions

(3) Need for and required type of traffic control

(4) Other necessary items

4.4.6.2 The Role of the Traffic Control Center

When unusual weather occurs, the Traffic Control Center shall take necessary actions as prescribed below.

4.4.6.2.1 Initial Response

When a report on an unusual weather is received, the Traffic Control Center shall check and take necessary actions based as prescribed below

(1) When information concerning the abnormal weather is received, the Traffic Control Center shall check the items listed below.

① Road name

② Inbound or outbound route

③ Kilometer post

④ Weather conditions

⑤ Other items thought to be necessary in order to respond to sudden change in weather

(2) When a report on an unusual weather incident is received, the Traffic Control Center shall notify responsible police department of the confirmed facts..

(3) If an unusual weather condition suggests that emergency dispatch of the Traffic Patrol Team is needed, the Traffic Control Center shall instruct the Traffic Patrol Team to mobilize immediately..

(4) If an unusual weather condition suggests that travelling vehicles need to be alerted, the Traffic Control Center shall notify toll gates of the incident.

(5) If an unusual weather condition suggests that other responsible agencies need to be alerted about the incident, the Traffic Control Center shall notify them of the incident.

4.4.6.2.2 Follow up actions

When the Traffic patrol team arrives at the site of the abnormal weather, the Traffic Control Center shall order the Traffic patrol to check and take necessary actions based as prescribed below.

(1) The Traffic Control Center shall check the items listed below

① Time and location (kilometer post on inbound/outbound route) of occurrence

② Weather type and conditions

③ Need for and required type of traffic control

④ Other necessary items

(2) The Traffic Control Center shall notify the responsible police departments of the report from the Traffic Patrol Team.

(3) If a report from the Traffic Patrol Team suggests that the passing vehicles need to be alerted about the incident, the Traffic Control Center shall notify toll gates of the incident.

(4) If it is considered that the report from the Traffic Patrol Team requires the information to other related agencies, the Traffic Control Center shall notify to them.

4.4.7 Other unusual incidents

4.4.7.1 The Role of Traffic Patrol Team

When traffic patrol crews encounter an unusual incident, or when they receive instructions for emergency mobilization from the Traffic Control Center and arrive at the site of the unusual incident scene, they shall handle and report as prescribed below.

4.4.7.1.1 Details of handling

At the unusual incident scene, traffic patrol crews shall perform the works enumerated below. At the work site, top priority shall be given to protection of life and safety of persons involved, and to measures most suited to the circumstances.

4.4.7.1.2 Items to be reported

At the unusual incident scene, traffic patrol crews shall report the items enumerated below to the Traffic Control Center.

(1) Time and location (kilometer post on inbound/outbound route) of the incident's occurrence

(2) Details of the unusual incident

(3) Other necessary items

4.4.7.2 The Role of Traffic Control Center

When an abnormal condition occurs, the Traffic Control Center shall take necessary actions based as prescribed below.

4.4.7.2.1 Initial Response

When a report on the unusual incident scene is received, the Traffic Control Center shall check and take necessary actions based as prescribed below.

(1) When information concerning the abnormal condition is received, the Traffic Control Center shall confirm the facts listed below and take necessary actions.

① Road name

② Inbound or outbound route

③ Kilometer post

④ Description of the unusual incident

⑤ Other items thought to be necessary in order to respond to the unusual incident

(2) If the unusual incident suggests that the mobilization the Traffic Patrol Team is necessary, the Traffic Control Center shall instruct the Traffic Patrol Team to hurry to the scene.

(3) If the unusual incident suggests that the passing vehicles need to be alerted about the incident, the Traffic Control Center shall notify toll gates of the incident.

(4) If the unusual incident suggests that the handling the incident falls under police jurisdiction, the Traffic Control Center shall notify the responsible police department of the incident.

(5) If the unusual incident suggests that other related agencies need to be alerted about it, the Traffic Control Center shall notify them of the incident.

4.4.7.2.2 Follow up actions

The Traffic Control Center shall confirm the items below and instruct actions when the Traffic Patrol arrives at the unusual incident scene.

(1) The Traffic Control Center shall confirm the items below

① Time and location (kilometer post on inbound/outbound route) of the incident's occurrence

② Details of the unusual incident

③ Other necessary items

(2) If the report from the Traffic Patrol crews suggests that travelling vehicles need to be alerted ,about the incident, the Traffic Control Center shall notify toll gates of the incident.

(3) If the report from the Traffic Patrol crews suggests that the police department shall be alerted about the incident, the Traffic Control Center shall notify responsible police department of the incident.

(4) If the report from the Traffic Patrol crews suggests that other related agencies need to be alerted about the incident, the Traffic Control Center shall notify them of the incident.

Forms for Reporting

Form 1

Reporting Notes on Traffic Control Patrol

№ 1

Ghi chép tuần tra quản lý giao thông

Ngày: ____________________

Nhân viên tuần tra						Số xe		
Tên đường								
Khoảng cách	~							
Thời gian tuần tra								
Giờ xuất phát (A)			Giờ quay về (B)			Thời gian yêu cầu (B-A)		
Cự ly tuần tra								
Số công tơ mét lúc xuất phát (α)			Số công tơ mét lúc trở về (β)			Cự ly tuần tra (β－α)		
Số vụ xử lý								
Tai nạn giao thông	Hỏng xe	Chướng ngại vật	Cháy xe	Tắc đường	Biến đổi thời tiết	Sự cố khác		
Giờ	Phút	Hướng	KP	Nội dung phát hiện - Thông tin - Xử lý				

№ 2

Giờ	Phút	Hướng	KP	Nội dung phát hiện - Thông tin - Xử lý

Reporting Notes on Taken Measures to Tackle Incidents

Ghi chép đối phó sự cố

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Form 2

Shift Handover Sheet (Traffic Patrol)

Phiếu giao ca (Tuần tra quản lý giao thông)

1 . Thời gian làm việc

Ngày/Tháng/năm		Thời gian	~

2 . Người phụ trách

3 . Tình trạng tuần tra

Tên đường	Khoảng cách	Thời gian tuần tra	Cự ly tuần tra
		~	
		~	
		~	
		~	
		~	
		~	

4 . Tình trạng phát sinh sự cố

Tên đường	Số vụ phát sinh sự cố						
	Tai nạn giao thông	Hỏng xe	Chướng ngại vật	Cháy xe	Tắc đường	Biến đổi thời tiết	Các sự cố khác

5 . Ghi chú đặc biệt

6 . Nội dung bàn giao

Form 3

Shift Handover Sheet (Traffic Control Center)

Phiếu giao ca (Trung tâm điều hành giao thông)

1 . Thời gian làm việc

Ngày/Tháng/năm		Thời gian	~

2 . Người phụ trách

3 . Tình trạng xử lý thông tin

Tên đường	Số vụ xử lý thông tin			
	Vô tuyến di động	Điện thoại	Thông tin trực tiếp	Phương tiện khác

4 . Tình trạng phát sinh sự cố

Tên đường	Số vụ phát sinh sự cố						
	Tai nạn giao thông	Hỏng xe	Chướng ngại vật	Cháy xe	Tắc đường	Biến đổi thời tiết	Các sự cố khác

5 . Ghi chú đặc biệt

6 . Nội dung bàn giao

Form 4

Recordings of Correspondence and Information at the Traffic Control Center

№ 1

Ghi chép thông tin Trung tâm điều hành giao thông

Ngày: ____________________

Người phụ trách	
Tên đường	

Giờ	Phút	Nhận thông tin	Gửi thông tin	Phương tiện trao đổi thông tin	Đối phương	Nội dung trao đổi

Phương tiện trao đổi thông tin: A : Vô tuyến di động B: Điện thoại C: Thông tin trực tiếp D: Phương tiện khác

№ 2

Giờ	Phút	Nhận thông tin	Gửi thông tin	Phương tiện trao đổi thông tin	Đối phương	Nội dung trao đổi

Phương tiện trao đổi thông tin: A : Vô tuyến di động B: Điện thoại C: Thông tin trực tiếp D: Phương tiện khác

Reference: Supplement Materials to Dispose of Difficult-to-Treat Substances

(Tham khảo) Các vật chất hỗ trợ xử lý chất khó xử lý

Tên gọi	Tiêu chuẩn - Thông số kỹ thuật	Công dụng/VD cách sử dụng
Bột thấm dầu trên mặt đường 	· Gốm xốp · Dạng hạt nhỏ	Thấm hút dầu loang trên mặt đường   
Tấm thảm thấm dầu 	· Hóa chất than hoạt tính · Khoảng 25cm×25cm	Thấm hút và chống loang rộng những chất như dầu trên mặt đường.   
Túi chắn dầu 	· Hoá chất than hoạt tính · Khoảng φ15cm×2m	Chống dầu loang trên đường tràn xuống cống rãnh