SAFETY REVIEW REPORT
OF ON-GOING ODA LOAN PROJECT
IN SRI LANKA

FINAL REPORT

March 2015

JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)

LANDTEC JAPAN INC.

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Chapter 1 Outline of Study

1.1 Background and Objective

(1) Background

This review was initiated based on the recommendation made by the committee deployed by Ministry of Foreign Affairs, Japan, in order to discuss the measures to prevent recurrence of the similar accident to that of Can Tho Bridge in Vietnam in September 2007. In July 2008, the committee recommended JICA to carry out an interim review of Special ODA Loan projects or Special Term for Economic Partnership (STEP) projects which include large scale and technically complex civil works. Ten projects were reviewed up to 2013, which are located in Indonesia, Vietnam, Turkey, Uzbekistan, Philippine, Malaysia and Sri Lanka.

The review in 2014 is to be done for the STEP project under construction which has repetitively undergone accidents on site. For that project, accident analysis is to be done from various angles including not only engineering/technical aspects but also soft aspects such as safety control and occupational health. Furthermore, the effects of the accident preventive measures implemented on site will be verified, issues/concerns to be tackled to ensure prevention of future accidents will be confirmed, and finally, effective/efficient safety measures and/or improvements will be recommended. Those achievements will be fed back to the stakeholders to promote further efforts to prevent/mitigate occupational accidents and third party accidents to contribute to prevention of construction accident in Japanese ODA projects.

(2) Objective

The following tasks will be implemented to the on-going STEP project:

- To collect the latest information on the laws, standards, etc. of the recipient countries safety control in Yen-loan projects and occupational safety and health.
- To conduct accident analysis on the accidents occurred in the projects from various angles, and to confirm the status of implementation of safety control and compliance including verification of effects of accident preventive measures taken.
- To work out proposals for improvements, and to feed back the study results to the stakeholders to promote further efforts to prevent/mitigate occupational accidents and third party accidents to contribute to prevention of construction accident.
- To derive recommendations and lessons toward resolution of problems/issues which are common in other similar projects to contribute to contribute to prevention of construction accident in Japanese ODA projects.

Project to be reviewed: The Outer Circular Highway Phase II in Sri Lanka

1.2 Study Team

Team Leader / Safety Management1 :	Haruo SAKASHITA (Landtec Japan Inc.)
Safety Management 2:	Toshio TAKEBAYASHI (Landtec Japan Inc.)
Accident Cause Analysis / Preventive Measures:	Toshiaki SHISHIDO (Landtec Japan Inc.)

1.3 Study Schedule

Table1.1 Field Study Schedule

Month	Day		Activities
October	25	Sat	11:10 Departure from Tokyo/Narita
	26	Sun	00:05 Arrival at Colombo, Sri Lanka Study Team Internal Meeting
	27	Mon	11:30 JICA Sri Lanka Office 14:30 Interview (Road Development Authority)
	28	Tue	09:30 Interview (Taisei Corporation) Site Visit
	29	Wed	10:30 Interview (Industrial Safety Division, Ministry of Labour) 14:00 Interview (Oriental Consultants Global)
	30	Thu	08:30 Safety Patrol 14:00 Safety Committee Meeting
			11:30 Interview (Police (Western Province) 14:00 Discussions on Seminar, etc. (JICA Sri Lanka Office)
	31	Fri	AM Information Analysis 15:00 Interview (National Institute of Occupational Safety and Health)
November	1	Sat	Information Analysis / Report Preparation
	2	Sun	Information Analysis / Report Preparation
	3	Mon	AM Study Team Internal Meeting 14:00 Interview (Industrial Safety Division, Ministry of Labour) 15:30 Interview (National Institute of Occupational Safety and Health)
	4	Tue	AM Information Analysis / Report Preparation 15:30 Interview (Road Development Authority) 16:15 Interview (Oriental Consultants Global)
	5	Wed	09:30 Interview (Police (Western Province) PM Information Analysis / Report Preparation
	6	Thu	Information Analysis / Report Preparation
	7	Fri	Information Analysis / Report Preparation
	8	Sat	AM Site Visit PM Information Analysis / Report Preparation
	9	Sun	Information Analysis / Report Preparation
	10	Mon	Information Analysis / Report Preparation, Seminar Preparation
	11	Tue	AM Seminar Preparation 13:30－17:00 Seminar
	12	Wed	AM Information Analysis / Report Preparation 16:00 Report on Field Study Result (JICA Sri Lanka Office)
	13	Thu	01:30 Departure from Colombo, Sri Lanka 17:05 Arrival at Tokyo/Narita

1.4 Interviewees

Table1.2 List of Interviewees

Organization	Name	Position
During preparation in Japan		
<Project-related>		
Oriental Consultants Global	Masataka Fujikuma	General Manager, Road Dept.
	Yujiro Imazawa	Quality Management Division
Taisei Corporation	Kimio Takeda	Counsellor, SA&E Dept.
<General>		
OCAJI	Keiji Habara	Manager, Int. Affairs & Planning Div.
During Field Survey		
<Project-related>		
JICA Sri Lanka Office	Kiyoshi Amada	Chief Representative
	Hiroyuki Abe	Senior Representative (11/12)
	Yosuke Sato	Representative
	Yasushi Taira	Representative
Road Development Authority (RDA)	T. S. H Abewickrama	PD, OCH Phase II
	K. Ravindralingam	DPD, OCH Phase II
	M. P. K. C. Gunarathna	SPD, OCH Phase II
	R. P. Chandralatha	PE, OCH Phase II
	P. H. Gunasinghe	CE
Oriental Consultants Global	Brian O'Shea	Team Leader
	R. S. A. Peiris	Deputy Team Leader
	Jun Nishimura	Senior Highway Engineer
	J. C. Tharuka	Safety Engineer
	Justin Shyu	Senior Bridge Engineer
	Yujiro Imazawa	Senior Technical Adviser Quality management Office
Taisei Corporation	Toshihiko Aoki	Project Director
	Ryo Takegawa	Deputy Project Director
	Yoshinori Okahara	Independent Safety Manager
	Akito Ando	Construction Manager
	Yuji Tadenuma	Senior Administration Manager
	Shun Moriyama	Administration Manager
<General>		
Industrial Safety Division, Ministry of Labour	W. L. S. Wijesundara	Commissioner of Labor
	Rohitha Fernando	Deputy Commissioner of Labor
	A. W. Alahakoon	Specialist Factory Inspecting Engineer
	D. L. Ashoka Peris	Specialist Factory Inspecting Engineer
National Institute of Safety and Health	Dr. Champika Amarasinghe	Director General, NIOSH
Police (Western Province)	A. Senarathne	DIG Traffic
	J. Weerakoon	ASP Traffic (WPN)
	P. Padmanathan	OIC Kadawatha
	E. M. S. Mahanama	OIC Athurugiriya
	R. Aruna Shantha	AOIC Sapugaskanda
	C. R. Abeygoonawardena	Security Consultant JICA

Chapter 2 Current Situation of Construction Safety in Sri Lanka

2.1 Sri Lanka Construction Industry - Outline

The economy of Sri Lanka has been showing rapid development after the end of the island ethnic war in 2009. One of the driving forces of economic growth is the construction industry. The upward trend of the construction industry is still continuing at the time of preparation of this report (the end of 2014) and the numbers of large-scaled projects and imported construction machineries, etc. are also increasing. On the contrary, however, there is no sign of labour force increase in the construction industry, which implies the tight relationship of supply-demand of labour in the sector.

Table 2.1 Changes of GDP and Labour Force from 2008 to 2013

Year			2008	2009	2010	2011	2012	2013
GDP (at current market prices) (Rs. billion)			4,411	4,835	5,604	6,543	7,579	8,674
GDP (at constant (2002) prices) (Rs. million)	Total		2,309,172	2,420,952	2,645,542	2,863,715	3,045,288	3,266,099
		Electricity, Gas & Water	56,847	58,974	63,682	69,547	72,452	79,913
		Construction	154,173	162,790	177,912	203,204	247,091	282,742
Population (x 1,000 persons)			20,217	20,450	20,653	20,869	20,328	20,483
Labour Force (x 1,000 persons)			8,082	8,074	8,108	8,555	8,454	8,802
Labour Force (Employed) (x 1,000 persons)	Total		7,648	7,602	7,707	8,197	8,118	8,418
		Electricity, Gas & Water	590	562	548	590	616	588
		Construction						

Source : Central Bank of Sri Lanka Annual Report

Table 2.2 Major Ongoing & Recently Completed Infrastructure Development Projects

Sector	Project Name		Year	
			Completed	To be Completed
Power	Norochcholai Coal Power Plant	Phase I	2011	
		Phase II: Unit 2		2014
		Phase II: Unit 3		2014
	Uma Oya Hydropower Plant			2014
	Sampur Coal Power Plant			2014
Road	Outhern Expressway	Phase I	2011	
		Phase II	2014	
	Colombo-Katunayake Expressway		2013	
	Outer Circular Highway	Phase I	2014	
		Phase II		2015
		Phase III		2017
Railway	Northern Railway Line Reconstruction Project	Medawachchiya - Madu	2013	
		Madu - Thaleimannar		2014
		Omanthai - Pallai	2014	
		Pallai - Kankasenthurai		2014
		Signalling & Telecommunication System		2015
	Matara - Kataragama Railway Line Project	Phase I: Matara - Beliatta		2016
Port	Colombo South Harbour Project	South Container Terminal	2013	
		East Container Terminal		2014
	Magam Ruhunupura Mahinda Rajapaksa Port	Phase I	2010	
		Phase II		2015
	Oluvil Port Development Project		2013	
Airport	Mattala Rajapaksa International Airport	Phase I	2013	
	Bandaranaike International Airport Expansion Project			2017

Source：Central Bank of Sri Lanka Annual Report

The following are some topics on the recent situation of the Sri Lankan construction industry.

<Year 2008>

In the 14th Asia Construct Conference (October 2008), Mr. Asitha Pathirage (Chairman, Institute for Construction Training and Development (ICTAD)) pointed out that the following factors are hindering the improvement of productivity:

① Incompetence of Project Manager
② Subcontractor's poor cash flow resulting from payment delays
③ Escalation of prices of inputs
④ Lapse on the part of consultants or manager
⑤ Contractual disputes
⑥ Social/environmental issues
⑦ Insufficient skilled labour
⑧ Poor maintenance of construction equipment

To cope with the above issues, ICTAD was taking the following actions:

(a) To make it mandatory for all registered contractors to have ISO Quality Management System established in their organizations.
(b) To venture into a new programme to uplift the knowledge of skills of tradesmen, and thereby to provide access to the newly set up University of Vocational Technology to attract more youngsters to the occupation as well as to gain recognition in the society.
(c) To conduct Construction Excellence Award Scheme that motivates all contractors for quality and productivity improvement.

Issues to be tackled in the future are:

(d) To minimize the disruption to work caused by payment delays,
(e) To provide means of direct state intervention in construction work, for ensuring quality, productivity and safety, and
(f) To have a higher level of basic education and literacy of the persons who intend to join the occupation and to conduct awareness buildup and earning of recognition for the occupation.

<Year 2010>

"Industry Report on Sri Lanka, Construction, September 2011" provides the following factors as key issues faced by players in the construction sector of Sri Lanka:

- High cost of construction material,
- Lack of funds,
- Low supply of high grade steel,
- Lack of skilled workers,
- Land acquisition delays, and
- Frequent changes in regulations

<Year 2012>

"Health and Safety Aspects in Building Construction Industry in Sri Lanka, Dr. R. U. Halwatura & T.L. Jayatunga, CSBE 2012" states that a large number of unskilled and unqualified workers are engaged in the industry and as a result workplace accidents still occur at an unacceptably elevated rate.
For reference, the numbers of casualties at construction sites in Sri Lanka reported during the period from Year 2000 to Year 2007 are summarized below:

Table 2.1 Fatal and Non-fatal Accidents on Construction sites in Sri Lanka from 2000 to 2007

Year	2000	2001	2002	2003	2004	2005	2006	2007
Fatal	16	19	13	13	12	14	15	19
Non-Fatal	138	123	121	86	45	50	89	113

(Source: Ministry of Labour)

<Year 2013>

A representative of a German manufacturing company set up in India exhibiting at Excon 2013 held in India stated the Sri Lankan construction sector as follows (source: Daily News November 26, 2013):

- The Sri Lanka construction heavy machinery sector has improved tremendously, and they are no longer relying on used heavy machinery. A few years ago used machinery were imported from Japan and Europe and today with Sri Lanka facing a construction boom new heavy machinery are being imported. With many of the international heavy manufacturing companies setting up factories in India Sri Lankan companies are today investing on brand new machinery mostly from India.
- There is an acute shortage of labour in both India and Sri Lanka as most of them go to Middle East for higher wages. Due to this machines are playing a bigger role.

<Year 2014>

In the interview conducted on October 28, 2014 with the Contractor of the project, the following comments were obtained on the Sri Lankan construction industry. In other words, the problems and issues pointed out in 2008 still remain unsolved despite the stakeholders' efforts to improve.

- The quality of workers is problematic.
- Due to the unique characteristics of each region, it is not necessarily possible to employ the same labor in a different region.
- Local contractors are not as capable as other countries.
- Since it is not practicable to recruit thousands of workers from Vietnam, Philippines or Indonesia, it is necessary to locally make up the safety culture as well as the technical expertise.
- In case a large number of workers to be employed, it is necessary to screen candidates from a large population gathered, which should be repeatedly done a number of times.
- Since it is not easy to do screening directly by foreign contractors, they often recruit workers through temporary personnel agencies.
- There are a few people with high skill and good quality available in the market. Most of those people have been employed by local contractors.

- It is not necessarily possible to buy good workers.
- Scramble for workers have been occurring after the civil war in 2009.

On the other hand, Road Development Authority (RDA), from a client's point of view, commented on the general situation of construction safety in Sri Lanka as follows:

- Poor management commitment of main contractor towards safety
- Lack of technical skills of safety management
- Poor responses to correct lapses highlighted and inability to learn from accidents already happened
- Poor control and focus on sub-contractors to educate repeated lapses observed
- Safety performance/References not considered in selecting subcontractors and equipment service providers
- Proper system needs to be introduced to certification of Plants & Equipment deployed at the Site

2.2 Legal system relating to occupational safety and health

(In the following, information in "Final Report on the Study on Safety Management for Construction Work in Japanese ODA Project February 2012" has been updated, incorporating additional/new information obtained by this study.)

(1) Occupational safety and health law

There is no labor safety and health act but an independent Factories Ordinance No. 45, 1942 is applied to construction sites as well. The most of the origin of this Factories Ordinance comes from the acts relating to labor safety and health of Britain which was the former colonial power but the ordinance has been used with gradual amendments over time. The Government of Sri Lanka is amending the ordinance with help from ILO (the International Labor Organization) to expand the scope of application from factory to other areas.

In 2014 Sri Lankan government is establishing a new Safety, Health and Welfare Act. The draft act has already been approved by the cabinet and will be submitted to the parliament in 2015. Prior to that, Department of Labour and Labour Relations established "The National Occupational Safety and Health Policy" in June 2014.

(2) Laws on construction machinery and facilities

As a result of hearing by the Department of Labor, there is no standard concerning quality of construction machinery. There is a qualification for cranes and electric chiefs concerning construction machinery and facilities, but there is no qualification for slinging. The provisions of transportation of construction machinery are included in the Road Traffic Ordinance issued by the Ministry of Transport.

2.3 Administration relating to labor safety and health

(1) Mechanism of administration relating to labor safety and health

The Department of Labor oversees occupational safety and health in general and prescribes labor standards, and standards relating to safety and health. The Government of Sri Lanka planned and administered training for clients pertaining to occupational safety and health as well as training for trade unions. It is expanding administrative functions concerning occupational safety and health by establishing NIOSH (National Institute of Occupational Safety & Health). NIOSH is currently training safety officers to be dispatched to the industries in the future. National Occupational Safety and Health Advisory Council will also be established to solve the problems by reaching a consensus with social partners to ensure health and social welfare of workers.

(2) Administrative organizations for oversight and approval

The Department of Labor gives documentary approval on starting construction of building, etc. based on Factories Ordinance, but it has no power to give license, which institutional design is not completed yet. Concerning renewal of laws and regulations pertaining to occupational safety and health, they are to be renewed when a new law or regulation is enacted, and the future plan in the field of occupational safety and health of the Department of Labor is called for as part of the 10-year National Development Plan.

(3) Accident report system and response to accident

a. Accident report system

The Item 16 of Factories Ordinance like an Occupational Safety and Health Act requires report of accident to the Ministry of Labor by the firm which caused the accident. In each sector, the client of a project knows that it has to report any occurrence of accident to the Ministry of Labor, and reports it thereby. Sometimes, the Ministry of Labor acquires information of accident from media reports or the report from its regional officers, hospitals, the police, or report from other ministries. In fact the reports vary among administrative organizations which can be clients, and the Ministry of Labor would like to improve collection and accumulation of accident information.

For accidents in construction sites, police intervenes in accordance with Penal Code Section 298 “Accidental death” only in case fatal accidents are reported.

b. Response to accident reporting

When an occupational accident happens, the Department of Labor has the authority to implement investigation. It will issue recommendation for improvement required after site investigations.

(4) Penalties

There are penalty provisions based on laws against firms which caused accidents, but the penalties are only fines depending on the seriousness of the accident. A firm which has caused a material accident may be fined 100,000Rp (about ¥70,000). There is no such system as suspending qualification for participation in tender. When you fail to report on a material accident, the current provision fines you 5,000Rp (about ¥3,500). The Department of Labor has an opinion to amend this provision amid the prospects of construction boom in the future.

2.4 Qualification system relating to labor safety and health

(1) Qualification system

As national qualifications relating to labor safety and health, there are boiler operators, crane/fork lift operators and explosive handlers as well as “highly risky” machine operators, which are mainly qualifications in plants. The country conducts training on labor safety and health to raise safety managers in charge of safety management at sites, and grants training completion qualifications (diploma or certificate depending on courses), but they are not recognized as national vocational qualifications. Concerning construction qualifications, there is an association established with contributions from the World Bank, which is called Institute of Construction, Training and Development (ICTAD), and the institute conducts training for manipulation of construction machinery.

(2) Education system concerning occupational safety and health

There is a public organization doing education and human resources development concerning occupational safety and health called Ministry of Youth Affairs & Skills Development, which is performing activities focusing on vocational training for the youth. The Ministry has 18 vocational training organizations which conduct all the public training.

The NIOSH mentioned above (see 4-3-1) has a purpose of activities to foster safety awareness of the persons concerned in the industry through training activities and research pertaining to occupational safety and health. Specifically, it raises safety officers (National Diploma of Occupational Safety & Health). The 1-year course has 4 components: Occupational Safety for Engineering Aspects, Occupational Health, Occupational Health Management Systems, and Research Project. The persons completed the course will be given certificates of completion to be qualified as safety officer.

A private company is collaborating with ICTAD for construction safety and health officer training program, which will be added in the final report.

(3) Implementation of education and training

The Ministry of Youth Affairs & Skills Development mentioned above have developed about 110 skill standards, and providing 4 major vocational training for the youth. The training program follows National Vocational Qualification Framework which is recognized internationally, and if the training program under development is completed, the National Vocational Qualification System will be built up, and 7 levels will be set, which include Certificate level and Diploma level. Training will be given according to the course curricula, in which there are safety-related subjects. In the training course in construction, there are courses for workers including mason, plumber and constructor, including Diploma course and Certificate course.

The technical universities perform skill training of human resources. Sri Lanka plans to develop human resources who can manage safety in various industries without limiting the area, and safety officers are raised over a year at NIOSH. National certificate of qualified safety officer is presentable at application to the relevant position in and outside Sri Lanka.

(4) Outsourcing of safety audit and guidance

RDA (Road Development Authority) employs consultants as Safety Officers in the Greater Colombo Urban Transport Development Project. The Safety Consultant is not only auditing the project but also attending safety committee meetings held monthly on site as a member of RDA to address comments actively.

2.5 Safety standards, guidelines and manuals

A mechanism ensuring safety in construction is established usually on a project basis, while details of technical guidelines and standards on safe construction prescribed by the national government and ordering organizations in Sri Lanka are unknown.

2.6 Workmen's compensation and construction insurance

(1) Workmen's compensation

A contractor is 100% responsible for accidents occurring at sites. An accident as a result of trespassing by a local resident at the construction site is also a responsibility of the contractor now. It is up to the judgment of the client to prevent trespassing from the outside by erecting fences at the construction site or otherwise. The Workmen's Compensation Ordinance prescribes occupational accident, and 550,000Rp (about ¥385,000) should be paid in the case of death.

(2) Workmen's accident compensation insurance and contractors' all risks insurance

The private insurance companies provide various insurance conditions. In RDA, there are RDA insurance (for employees) participated by the organization itself and contractor's insurance. Contractor's Workers Compensation Insurance covers works by workers of the contractors, and all persons related to construction are insured. The amount of compensation is assessed in consideration of various conditions like the degree of injury, the degree of disability by injury (loss of functions of the limbs), age and earning ability. There are three kinds of ordinary construction insurance, namely, contractor's all risks insurance, third party's insurance and workmen's compensation insurance, which should be purchased in all projects conducted on the basis of FIDIC terms and conditions.

<Supplemental Information>

During the study period, the parliament of the Democratic Socialist Republic of Sri Lanka a new act on construction.

1. Name of Act
   "Construction Industry Development Act, No. 33 of 2014'

2. Contents of Act

Part I	National Policy on Construction and its Implementation
Part II	National Advisory Council on Construction
Part III	Construction Industry Development Authority
Part IV	Construction Industry Development Fund and Fund of the Authority
Part V	Qualified Persons
Part VI	Registration of Contractors, Property Developers &C.
Part VII	Technical Auditing
Part VIII	Standard Documents and Human Resource Development
Part IX	Settlement of Disputes
Part X	Appeals Board
Part XI	Collection, Processing and Distribution of Information in the Construction Industry
Part XII	General

3. Note

Institute for Construction Training and Development (ICTAD) has been reorganized and renamed as "Construction Industry Development Authority" by the above Act. However, since "ICTAD" is still more popular in Sri Lanka and has a web site, the name of ICTAD is used in this report.

At the reorganization, the functions of the authority has been expanded to include that on health & safety. The relevant function is described as follows:

"to recommend to the relevant authority to regulate the health and safety standards and the use of hazardous material in construction industry"

Chapter 3 Site Visit － The Outer Circular Highway Phase II in Sri Lanka

3.1 Project Outline

3.1.1 Project

(1) Project Name: The Outer Circular Highway Phase II – NS 1

(2) L/A: SL-P91 (29th July 2008)
SL-P101 (22nd March 2011)

(3) Objectives: To construct an expressway connecting main national highways and Southern Expressway at Colombo Suburbs to mitigate traffic congestion at Colombo Metropolitan area and to improve accessibility between provinces, by which to contribute promotion of freight transport in Sri Lanka

(4) Location: Colombo North Suburbs, Sri Lanka（Kadawatha – Kaduwela）

(5) Employer: Road Development Authority, Ministry of Ports and Highways

(6) Designer: Oriental Consultants Co., Ltd. (general), Taisei Corporation (bridges)

(7) Construction Supervision: Oriental Consultants Co., Ltd. (The Engineer)

(8) Contractor: Taisei Corporation

(9) Contract Price: Rs.44,880,000,000.00

(10) Construction Period: 9th January 2012 – 15th July 2015 (41 months) (initially 36 months)

(11) Quantities:

Table 3.1.1 Quantities

Item	Quantity	Remarks
Main Line Length	8.86ｋｍ	
No. of Lanes	4 lanes	3.5m/lane
Excavation	620,000m3	
Embankment	530,000m3	
Soft Soil Treatment	3.19km	Incl. A1 Interchange
Gravel Mat	63,480m3	
Band Drain	221,200m	
Geotextile	104,250m2	
Rock Replacement	99,250m3	
Gravel Compaction Piles	120,900m	φ700
Bridge (Main Line)	1 no.	
Bridges (Ramps)	2 nos.	
Viaducts	15 nos.	5.5km
Small Bridges / Overpass	5 nos.	
Box Culverts	27 nos.	
Pipe Culverts	26 nos.	

Figure 3.1.1 Project Location

3.1.2 Natural and Social Environment

(1) Natural Conditions

a. Climate

Colombo features a tropical monsoon climate. Colombo's temperate is stable all throughout the year with the annual average temperature of around 28℃. The hottest season is from April to May, and it is cool in the morning and evening from December to February. Colombo sees heavy rains with occasional thunder during the period from April to May and from October to November.

Table 3.1.2 Climate at Colombo

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ave. Max. Temp. (℃)	30	30	31	31	30	30	30	29	29	29	29	30
Ave. Min. Temp. (℃)	23	24	25	26	26	26	26	26	26	25	25	24
Ave. Precipitation (mm)	83	63	114	254	335	190	129	96	157	353	307	152

（Source: Embassy of Japan in Sri Lanka HP）

b. Topography

The project area traverses across different types of land topography, which consists of flood plains, hilly terrain, wetlands and flat areas of raised beaches.

Along the proposed route undulating hilly terrain or isolated round hill, consisting of precambrian rocks and its residual soil, rise to about 10 to 50m above the mean sea level (MSL). Intermittently, the valleys are situated between the hills. The valleys are filled with alluvial materials originating from the flood plains of adjacent rivers. Therefore, the low lands between hills are generally flat. Paddy has been cultivated in some of the valleys, particularly those at a higher elevation (more than about 2 to 3 m above the MSL. Low-lying valleys (less than 2 to 3m above the MSL) in Welisara, Weliwita and around Bolgoda river consists of marshes.

(Source: The Study on the Outer Circular Highway to the City of Colombo, Final Report, Feb. 2000)

(2) Social Environment

Accompanying this project is the acquisition of approximately 80ha of land, and the resettlement of 323 households is expected. The Road Development Authority is carrying out discussions with the affected persons subject to land acquisition/resettlement, and the procedures for land acquisition are being carried out.

（Source: Greater Colombo Urban Transport Development Project Phase 2 (II), Ex-Ante Evaluation, March 22, 2011

3.2 Project Organization

3.2.1 Stakeholders

The General Conditions of Contract used in this project is "FIDIC Red Book 1987 4th Edition, wherein the project organization consists of 3 parties, i.e. the Employer, the Engineer and the Contractor.

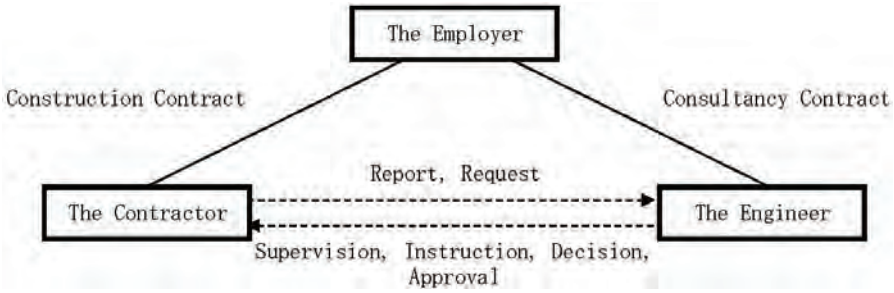


Figure 3.2.1 Three Parties Structure

3.2.2 The Engineer's Duties

The Consultant's duties as the Engineer with regard to construction supervision are as follows:

3. Construction Supervision
3.1 Control of Works
1) Conformance with Plans and Specifications
2) Supervision/Monitoring of the following during Construction
3) Acceptance of Contractor's work programmes/plans
4) Cooperation with utilities Agencies
5) Datum points and Benchmarks
6) Safety
7) Further Soil Investigation
8) Drainage
9) Load Restrictions
10) Contractor's Site Installation
11) Maintenance during Construction
12) Opening Project Sections to Traffic
13) Project Acceptance
14) Claims
15) As-built Drawings
3.2 Control of Materials
1) Supply Sources and Quality Management
2) Sampling and Testing

The consultancy contract was signed before finalization of the tender documents such as conditions of contract, Specifications, BOQ and so on. Consequently, it does not necessarily include detailed description on the scope of each work to be undertaken by the consultant. Detailed information on the Engineer's duties is described in the conditions of construction contract and specifications prepared by the consultant itself.

3.3 Operation and Management Procedure

In Japan, safety of works is managed under the construction contract, while occupational safety and health is managed in accordance with the laws and regulations which takes precedence over the construction contract.
In developing countries, on the other hand, where ODA projects are implemented, it is often that laws and regulations on the safety management for construction work are not well prepared. In such cases, issues on safety for construction work are to be addressed in the construction contract.
The following table summarizes the foregoing:

Table 3.3.1 Management of Safety for Construction Work

Management of Safety for Construction Work		Japan	ODA Recipient Countries (in case ODA projects)
Safety of Works	Dominant Framework	Contract	Contract
	Referee	Employer	Engineer (Consultant)
Occupational Safety and Health	Dominant Framework	Laws & Regulations	Laws & Regulations / Contract
	Referee	Competent Agency (Labor Standard Inspection Office)	Engineer (Consultant)

(Source: Consultant)

In this study, bearing the above in mind, it is defined that safety in construction projects consists of two components, “Safety of Works” and “Occupational Safety and Health”, with a view to analyzing the information on the project to describe the operation and management procedure.
The reasons of highlighting “Safety of Works” are; (1) The cause of the Can Tho bridge accident occurred in 2007 in Vietnam is attributable to technical problems related to design & construction of temporary structures; and (2) To highlight the differences between ODA projects and projects in Japan summarized in Table 3.3.1 above.
Management of each safety component in construction projects is summarized in the following table:

Table 3.3.2 Management of Safety in Construction Projects

Safety of Works	Occupational Safety and Health
1. Contract Provisions	1. Legal Responsibilities
2. Design Review System	2. Involvement of Competent Authorities
3. Method Statement Review System	3. Contract Provisions
4. Quality Assurance / Management System	4. Application of OSH Management System
5. Risk Management	5. Safety Management System
6. Contractor's All Risks Insurance	6. Workmen's Compensation Insurance
7. Others	7. Others

(Source: Safety Management in Infrastructure Projects in Developing Countries)

3.3.1 Framework of Management of Construction Work in ODA Project

The framework of operation and management of construction work in ODA projects usually constitutes a hierarchy shown below:

Figure 3.3.1 Framework of operation and management of construction work in ODA projects

The framework of management of safety for the project is summarized based on the information obtained through document research and interviews and shown in the following table

Table 3.3.3 Framework of Management of Safety for the Project

Level	Organization	Laws, Regulations, Guidelines, Manuals, Contract Provisions, etc.	Safety of Works	Occupational Safety and Health
National	Ministry of Labour	Factories Ordinance No. 45 of 1942		✔✔
Department	Ministry of Ports and Highways Road Development Authority (RDA)	Manual in Traffic devices Part I & Part II	✔✔	✔✔
Project (1)	Outer Circular Highway to the City of Colombo Kadawa to Kaduwela <Contract Provisions>	Contract Agreements		
		General Conditions of Contract (FIDIC 1987 4th Edition)	✔	✔✔
		Conditions of Particular Application (Part II)	✔	✔✔
		Specifications	✔✔	✔✔
		Terms of Reference for Consulting Services	✔✔	✔✔
Project (2)	Outer Circular Highway to the City of Colombo Kadawa to Kaduwela <Activities on site>	Quality Assurance Plan	✔✔	
		Design Review	✔✔	
		Shop Drawings	✔✔	
		Method Statements	✔✔	✔
		Safety Plan	✔	✔✔
		Safety Meetings	✔	✔✔
		Tool Box Meetings	✔✔	✔✔
		Safety Patrols		✔✔
		Inspections	✔✔	

(Legend: ✔✔- directly related, ✓: partially related)

(Source: Consultant)

The meetings and reports being periodically implemented for smooth operation of the project are summarized below:

Table 3.3.4 Meetings and Reports

Item		Reference
Meetings	Progress Meetings	Monthly; attended by Employer/Consultant/Contractor; 2 hrs.
	Safety Committee	Monthly; attended by Employer/Consultant/Contractor; 2.5 hrs.
	Environmental Monitoring	As necessary; attended by Employer/Consultant/Contractor; 1 hrs.
Reports	Monthly Reports (by the Contractor)	<Re. Construction> Resources, Progress, Delay Notices/Claims/V.O., Environmental Matters, Traffic & Safety, Quality Control, Construction Photographs, Weather Records, Monthly Working Programme
	Monthly Reports (by the Consultant)	<Re. Construction> Programme, Payment Certificate, V.O. Register, Claims Register, NCPN & NCR Register, Progress, Environmental Matters, Safety, Cash Flow <Re. Consultancy Services> Payment, Staff Schedule, V.O. Register, Organization Chart

(Source: Consultant, based on month reports, etc.)

The typical procedure and documentation executed at each part of construction work is as follows:

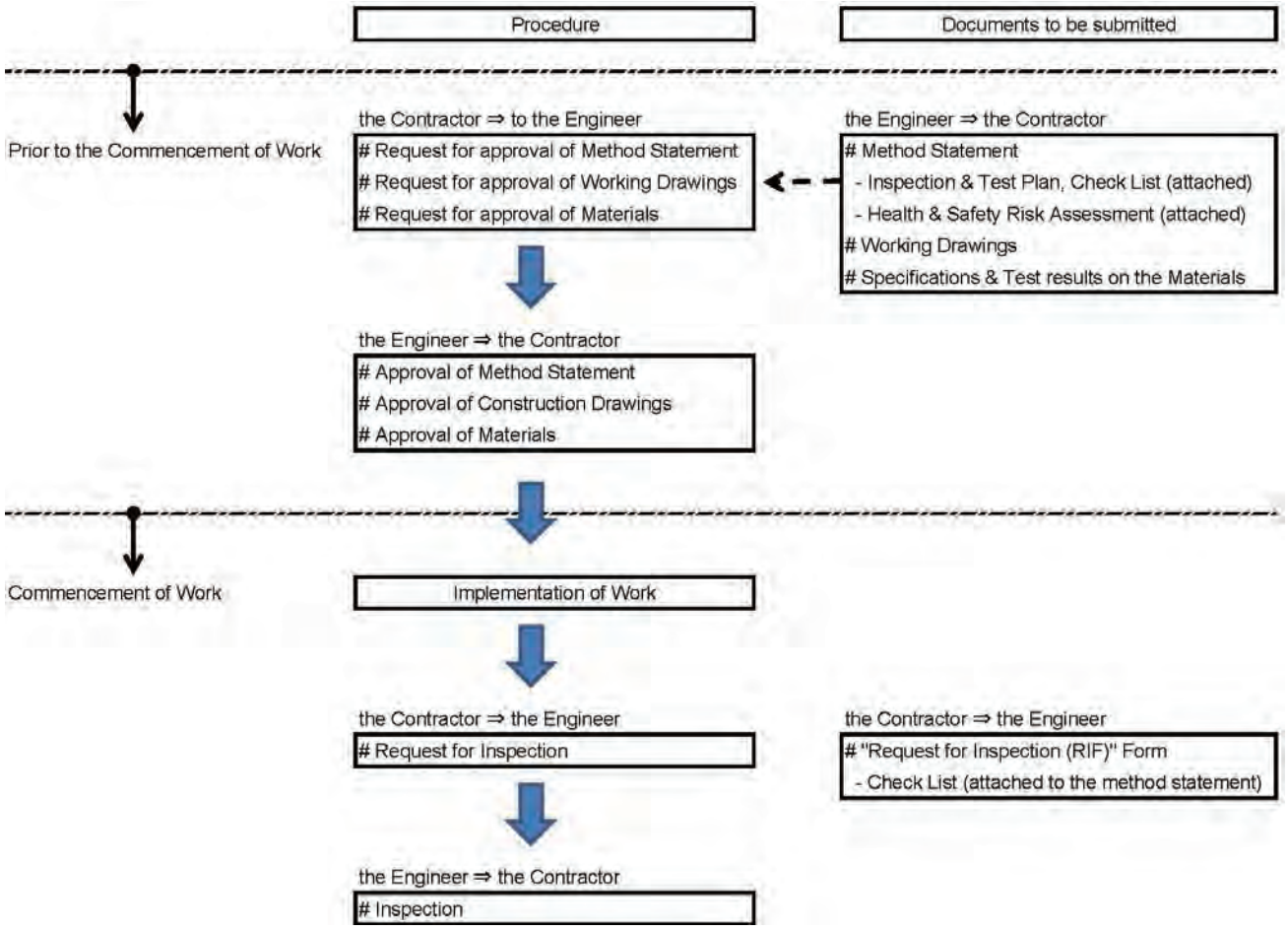


Figure 3.3.2 Procedure and documentation executed at each part of construction work

3.3.2 Construction Contract Documents

(1) Conditions of Contract

The conditions of contract of the project consist of General Conditions of Contract (FIDIC Red Book 1987 4th Edition) and Conditions of Particular Application. The safety-related sub-clauses in the Conditions of Particular Application are summarized in the following table:

Table 3.3.5 Safety-related sub-clauses in the Conditions of Particular Application

Sub-Clause	Title	Safety of Works	Occupational Safety & Health
19.1	Safety, Security and Protection of the Environment		✔
34.5	Safety Manager for Accidents Prevention		✔
34.6	Health and Safety		✔
35.2	Records of Safety and Health		✔
35.3	Reporting of Accidents		✔
36.6	Method of Working	✔	
36.7	Method of Construction Affecting Others	✔	
36.8	Method of Construction Affecting Permanent Works	✔	

(2) Specifications

Safety provisions in the Specifications are summarized in the following table:

Table 3.3.6 Safety provisions in the Specifications

Specifications \ Management of Safety		Safety of Works						Occupational Safety and Health					
		Contract Provisions	Design Review System	Method Statement Review System	Quality Assurance / Management System	Risk Management	Contractor's All Risks Insurance	Legal Responsibilities	Involvement of Competent Authorities	Contract Provisions	Application of OSH Management System	Safety Management System	Workmen's Compensation Insurance
SECTION 100	PRELIMINARIES												
Section 101	Equivalent Standards and Codes	✔		✔	✔								
Section 102	Facilities for the Engineer.												
Section 103	Contractor's Site Establishment												
Section 104	Operatives for the Engineer's Staff												
Section 105	Vehicles for The Engineer /The Employer												
Section 106	Traffic Safety and Control									✔			
Section 107	Temporary Access and Maintenance									✔			
Section 108	Project Sign Board												
Section 109	Monthly Progress Report												
Section 110	Insurances, Bonds and Securities				✔		✔						✔
Section 111	Check Survey												
Section 112	Programme of Work												
Section 113	Contractor's Drawings	✔	✔	✔	✔								
Section 114	Safety, Security and Protection of the Environment	✔		✔		✔		✔	✔	✔		✔	
Section 115	Control of Works												
Section 116	Control of Materials												
Section 117	Work Executed by The Employer or Other Contractors												
Section 118	Remedial work												
Section 119	Water Supply Arrangements												
Section 120	Designs by the Contractor	✔	✔		✔								
SECTION 200	EARTHWORKS												
SECTION 300	SUB-BASE AND BASE COURSES												
SECTION 500	STRUCTURES												
SECTION 600	DRAINAGE												
SECTION 700	INCIDENTALS												
SECTION 800	FACILITIES												
SECTION 900	DAY WORKS												
SECTION 1000	PROVISIONAL SUMS												
SECTION 1100	QUALITY MANAGEMENT	✔		✔	✔								
SECTION 1200	SITE INVESTIGATIONS FOR EMBANKMENT CONSTRUCTION, BRIDGES & OTHER STRUCTURES AND CUTTINGS	✔	✔										
SECTION 1300	TESTS FOR QUALITY CONTROL OF MATERIALS AND WORKS												

a. Quality Assurance/Management（Specifications Sections 101 & 1100）

Quality Assurance/Management System is a mechanism ensuring the “Safety of Works” in the project.
The relevant provisions in the Specifications cover not only materials quality control but also quality assurance/management of the work in a broader meaning.

Table 3.3.7 Sub-Clause 101.2 Safety Assurance Plan & Section 1100 Safety Management

Section 101 Equivalent Standards and Codes
Sub-Clause 101.2 Safety Assurance Plan
Hold Point The Contractor’s hold points The Consultant’s hold points Contractor’s organization, management and document control Contractor’s method statements and construction procedures
Section 1100 Quality Management
1.1 Introduction 1.2 Quality Plan 1.3 Construction Procedure 1.4 Identification and Traceability 1.4.1 Lots 1.4.2 Lot Registration 1.4.3 Lot Identification 1.4.4 Lot Notification and Status 1.4.5 Traceability 1.5 Inspection and Test Plans 1.5.1 List of Items to be included in Inspection and Test Plan 1.5.2 Hold Points and Witness Points 1.5.3 Compliance Inspection and Testing 1.5.4 Frequency of Testing 1.5.4.1 Materials Compliance Testing 1.5.4.2 Construction Compliance Testing 1.5.5 Sampling 1.5.6 Reinstatement 1.5.7 Auditing 1.6 Conformance and Non-conformance 1.6.1 Conformance 1.6.2 Non-conformance 1.7 Quality Records 1.8 Measurement and Payment

b. Safety (Specifications Section 114)

Detailed requirements for occupational safety and health are described in Section 114 as follows:

Table 3.3.8 Composition of "Section 114: Safety, Security and Protection of the Environment"

Item	Title	Safety of Works	Occupational Safety and Health
114.1	Description	-	-
1)	Laws, Rules and Regulations to be Observed		✔
2)	Cooperation and Duties of Tree Parties	✔	✔
3)	High Risk Activities	✔	✔
4)	Security		✔
5)	Environment	-	
114.2	Requirements	-	-
2.1	Safety and Security	-	✔
2.1.1	General		✔
2.1.2	Contractor's Safety Plan (The Safety Plan)		✔
	− Safety Organizational Structure		✔
	− Lines of Communication		✔
	− Safety table		✔
	− Interaction and Communication Procedures		✔
	− Safety Training		✔
	− Subcontractors' Safety Plan		✔
	− Safety Equipment and Clothing		✔
	− Safety Inspection		✔
	− Supervision and Auditing		✔
	− Records		✔
	− First Aid and Rescue		✔
	- Health Hazards		✔
	− Safety regarding Construction Methods	✔	✔
	− First Aid Base		✔
	− Others		✔
2.1.3	Safety Manager		✔
2.1.4	Special Requirements for Safety	-	✔
	(a) Safety of Public		✔
	(b) Availability of Safety-related Documents		✔
	(c) Safety Reports		✔
	(d) Safety Information		✔
	(e) Safety Meetings		✔
	(f) Fire Extinguishers		✔
	(g) First Aid Base		✔
	(h) Qualified Personnel		✔
	(i) Notification of Accidents		✔
	(j) Cooperation and assistance to the Engineer	✔	✔
114.3	Measurement and Payment	✔	✔
3.1	Measurement	✔	✔
3.2	Payment for Project Safety and Security and Protection of the Environment	✔	✔

In this project, payments to project safety are being made on a monthly basis. However, the method of measurement does not look quantitative and there remains ambiguity.

Table 3.3.9 Duties of Three Parties on Construction Safety

Contractor's duties	Designer's and Consultant's duties	Client's duties
General duties 1. Plan, manage and monitor the construction safety in liaison with sub-contractors. 2. Prepare, develop and implement a written plan and site rules. (Initial plan completed before the construction phase begins.) 3. Give sub-contractors relevant parts of the plan 4. Make sure suitable welfare facilities are provided from the start and maintained throughout the construction phase. 5. Take reasonable steps to prevent unauthorised access to the site. 6. Prepare and enforce any necessary site rules. 7. Liaise with the Consultant on design (incl. temporary works) carried out during the construction phase. 8. Report to the Consultant with any information relevant to the health and safety incidents 9. Provide all the workers with suitable health and safety instruction and information. 10. Consult with the workers on health and safety on site. 11. Train own employees regularly and secure the site. Special Duties 12. Use only licensed operators for heavy equipment (cranes, welding, plant operation etc.) 13.Provide safety equipment and warnings for workers, such as • Helmets, • Safety harness, • Safety shoes, 14. Working at height • Adequate scaffolds with fences and ladders, 15. Working over or near to water, e.g. bridge work, • Buoyancy aids, Life jackets etc. 16. Lifting operations by cranes • Use licensed operators and trained workers for lifting, • Provide movable fence around the working space, • Avoid unstable loadings and kinked wire ropes, • Use hook with spring-loaded safety catch, • Provide warning sign near electric cables, 17. Provide rigid fence at openings and pond area (prevent from drowning), 18. Provide sufficient lighting facilities during night works, 19. Working in and around excavations • Provide sufficient soil supports designed by a competent person 20. Provide guide men near heavy equipment working places. 21. Explosives: prevent injury by flying material. 22. Take care during maintenance of plant and equipment. 23. Take are for natural disaster, like landslides. 24. Provide various warning signs for safety. 25. Provide various safety notifications.	During the design: 1. Avoid foreseeable risks in the construction and eliminate hazards. (Designers are not expected to consider or address risks which cannot be foreseen, and do not require zero risk designs because this is simply impossible.) 2. Designers must not produce designs that cannot be constructed, maintained and used in reasonable safety. 3. Provide adequate information about any significant risks associated with the design. During supervision: 1. Ensure that the Contractor is given the sufficient time to prepare safety plan before start of the site works. 2. Monitor whether the construction phase is properly planned, managed and monitored, with adequately resourced competent site management appropriate to the risk and activity. 3. Instruct the Contractor to improve the work if any deficiency was found. 4. Ensure that all sub-contractors are provided with the safety information to carry out their works safely.	1. Check competence and resources of the Contractors and the Consultants. 2. Allow sufficient time for each stage of the project, such as F/S, D/D and construction. 3. Coordinate with residents who may be affected by the project. 4. Coordinate with utility agencies, such as electricity, telephone, water and sewage. 5. Ensure there are suitable management arrangements to ensure the construction work can be carried out safely and without risk to health. (This does not mean managing the work themselves.) 6. Check the contractors have made arrangements for suitable welfare facilities. 7. Check any fixed workplaces (e.g. offices, accommodation, plants, and workshops) will comply with local regulations. 8. Provide pre-construction information to the consultants and the contractors.

c. Design Responsibilities (Specifications Sections 120, 113 & 1200)

The demarcation of responsibilities on soil investigations, designs and drawings in the project is shown below:

Table 3.3.10 Demarcation of responsibilities on soil investigations, designs and drawings

Design & Drawings		Permanent Structures						Temporary Structures
		Highway (soft ground)	Highway (no soft ground)	Major Cutting	Box Culvert Retaining Wall	Bridges/Viaduct (16 bridges)	Overpass	
Before Tender	Soil Investigation	Consultant	Consultant	Consultant	Consultant	Consultant	Consultant	–
	Concept Design	Consultant	Consultant	Consultant	Consultant	Consultant	Consultant	–
	Detailed Design	Consultant	Consultant	Consultant	Consultant	–	Consultant	–
During Construction	Additional Soil Investigation	Contractor	Contractor	Contractor	Contractor	Contractor	Contractor	Contractor (its own cost)
	Detailed Design	Contractor (review, revise)	–	–	–	Contractor	–	Contractor
	Design Review	Consultant	–	–	–	Contractor (Independent Checker)	–	Contractor (Independent Checker)
	Design Approval （No Objection）	Consultant	–	–	–	Consultant	–	Consultant
	Construction drawing approval	Contractor	Contractor	Contractor	Contractor	Contractor	Contractor	Contractor
	Construction drawing preparation	Consultant	Consultant	Consultant	Consultant	Consultant	Consultant	Consultant
	Method statement preparation	Contractor	Contractor	Contractor	Contractor	Contractor	Contractor	Contractor
	Method statement review	–	–	–	–	Contractor (Independent Checker)	–	Contractor (Independent Checker)
	Method statement approval (No Objection)	Consultant	Consultant	Consultant	Consultant	Consultant	Consultant	Consultant
	As-buil drawing Preparation	Contractor	Contractor	Contractor	Contractor	Contractor	Contractor	Contractor
	As-buil drawing Approval	Consultant	Consultant	Consultant	Consultant	Consultant	Consultant	Consultant

（Source : Consultant, based on Specifications Sections 120, 113 & 1200）

a. The project required the designs and soil investigations for bridges & viaducts (16 nos.) be conducted by the contractor after commencement of the construction, which has resulted in a significantly shorter actual construction period.

b. In this project, main activities where “safety of works” is to be considered are supposed to be design and construction of bridges and viaducts (both permanent and temporary structures). Hence, the designer’s duties on construction safety described in Table 3.3.9 are interpreted to be with the contractor who designed those structures.

c. It is noted that the concept of “Independent Checker” is introduced to ensure safety of works. The design, erection plan and temporary works plan of bridges and viaducts should be reviewed by the independent checker (employed by the contractor) before submission to the Engineer.

d. As of September 2014, 250 sets of design drawings were prepared by the Contractor and approved by the Engineer.

3.3.3 Contractor's Plans

(1) Quality Assurance

a. Contractor's In-house System (Company, International Branch)

A copy of the following documents was submitted by the Contractor to the Employer as evidence of its in-house quality assurance system.

#ISO 9001:2000 Certificate (3rd April 2009)

Quality Manual (Ver. 6) (20th April 2006)

b. Quality Assurance Plan (Project) (refer to Specifications Sub-Clause 101.2)

The composition of Quality Assurance Plan submitted in the project is summarized below.

The Quality Assurance Plan for the project is based on the Quality Manual which is a common manual in the Contractor's International Branch.

Table 3.3.11 Composition of Contractor's Quality Assurance Plan

Quality Assurance Plan	Quality Manual
1. Contractor's Quality Assurance Plan 1.1 Taisei Corporation's Quality Assurance Advantage 1.2 Project Site Quality Implementation 1.3 Quality Assurance Procedure 2. Contractor's Organization Chart for OCH 2.1 Organization Structure 2.2 Staff Structure 3. Authority & Limitation of Project Manager & Site Superintendent 3.1 Project Manager Decision Making Authority 3.2 Project Manager Limitations in Financial Implementation Matters 3.3 Quality Assurance Manager (Site Superintendent) Authority 4. Head Office Support & Monitoring 4.1 Head Office Support Structure 4.2 Head Office Auditing and Monitoring 5. ISO Certificates 6. Contractor Firm's **Quality Manual**	1. Applicable Scope 2. Applicable Standard 3. Definitions 4. Quality Management System 4.1 General 4.2 Documentation Requirements 5. Management Responsibility 5.1 Management Commitments 5.2 Customer Focus 5.3 Quality Policy 5.4 Planning 5.5 Responsibility, Authority and Communication 5.6 Management Review 6. Resource Management 6.1 Provision of Resources 6.2 Human Resources 6.3 Infrastructure 6.4 Work Environment 7. Project Realization 7.1 Planning of Project Realization 7.2 Customer-Related Process 7.3 Design 7.4 Procurement 7.5 Construction 7.6 Control of Monitoring and Measuring Devices 8. Measurement, Analysis and Improvement 8.1 General 8.2 Monitoring and Measurement 8.3 Noncompliant Product Control 8.4 Data Analysis 8.5 Improvement

(2) Safety

a. Occupational Safety and Health Management System (Company, International Branch)

Occupational safety and health for the project is being managed within the frame work of the contractor's in-house OSH management system (TAISEI OHSMS). This project is designated by the Company's International Branch as "Special Construction Site" wherein the following actions are taken in accordance with the company's rules and regulations:

Review of method statements for hazardous works by Safety Admin, Div. & Civil Eng. Div.
Confirmation of monthly progress by Safety Admin. Div. & Civil Eng. Div.
Inspection during implementation of hazardous work by Safety Admin. Div. & Civil Eng. Div.
Site patrol by qualified in-house staff
International Branch's Safety Committee

b. Safety Plan (Project)

Shown below is the composition of OSH Management Policy and Safety Plan submitted by the Contractor, which are in compliance with the Contractor's in-house system (TAISEI OHSMS) as well as the contract provisions of the project (Conditions of Particular Application Sub-Clause 34.6 & Specifications Sub-Clause 114.2).

It is found that the safety & health related requirements in the project are generally covered by the Contractor's plans and the contract provisions (in particular, Specifications.

Table 3.3.12 Composition of Contractor's OSH Management Policy and Safety Plan

OSH Management Policy	Safety Plan
◆ Health and Safety Policy ◆ Message from the President ◆ Safety Target ◆ Priority Implementation Items ◆ Priority Management Items for Project Managers (Building & Civil) ◆ Definition of Priority Dangerous Works & Dangerous Works (Building & Civil) ◆ Flowchart for Control of Priority Dangerous Works & Dangerous Works ◆ Control of "**Special Construction Sites**"	Section 1: Safety Policy Statement Section 2: Safety Responsibilities Section 3: Planning Section 4: Authorities Regulations Section 5: Safe Work Practices Section 6: Safety Training Section 7: Group Meeting Section 8: Accidents Section 9: In-House Safety Rules and Regulations Section 10: Safety Promotion and Publication Section 11: Control and Monitoring of Subcontractors Section 12: Safety Inspections Section 13: Safety Management System Section 14: Documentation Requirements Section 15: Conclusion Appendix A: Hazard Analysis Appendix B: Safety Management System on site Appendix C: Explosive-Powered Tools Regulations Appendix D: Administrative Forms

(3) Method Statements

In accordance with the contract provisions (Conditions of Particular Application Sub-Clause 36.6, Specifications Sub-Clause 101.2), for each part of work the Contractor submits a method statement to the Engineer in advance, and starts the work after getting the Engineer's approval to it. The procedure and necessary documentation are shown in Figure 3.3.1.

As of September 2014, the Contractor had submitted 169 sets of method statements to the Engineer.

Typical composition of method statements is shown below, while the actual contents of method statement vary depending on the type of works, environment or detailed operation.

Description of "safety" (or occasionally "risk") is included in all method statements, as required by the contract provisions (Conditions of Particular Application, Specifications).

Table 3.3.13 Typical Composition of Method Statements

A	B	C
1. General 2. Work Procedure 3. Materials 4. Resources Provision 5. Construction Method 6. Detailed Drawings 7. **Safety Management – Risk Analysis** 8. Quality Control 9. Environmental Control Attachments	1. Scope of Method Statement 2. General Approach 3. Pre-requisite Approvals 4. Temporary Works 5. Site Traffic Control Plan 6. Work Narrative and Sketches 7. Diversion of Utilities 8. Shop Drawings 9. Quality Control 10. Access Road 11. **Risk Analysis** 12. Environmental Control/Monitoring Attachments	1. Scope of the work 2. Organization 3. Coordination 4. Training and quality 5. **Safety** 6. Equipment 7. Work procedure Attachments

Shown below are examples of "Prevention of defects (incl. accidents) from a standpoint of quality assurance" which the Contractor is undertaking through the process of method statement preparation, submission, and approval (no objection).

Table 3.3.14 Prevention of defects (incl. accidents) from a standpoint of quality assurance

Item	Implementation of Quality Control	Confirmation of Quality
Permanent Works	※Implement the work after obtaining approval on the method statement	
Quality assurance of piling works	For bored piles, secure the pile diameter, confirm the position of rebar cage, removal of bottom slime, and confirm concrete replacement. Confirm the pile integrity by sonic logging after concreting. In case any defects found, remove the poor quality portion to fill the cabity by mortar.	Select typical piles to conduct loading tests (static, dynamic) and PIT tests to confirm the pile design as well as the pile integrity.
Quality assurance of ground improvement works	Carry out gotechnical survey at the soft ground areas to grasp the characteristics of the soil in advane. Based on that, propose the optimum ground improvement method. propose the safest and most reasonable construction method considering both the slope stability and settlement caused by soft soil consolidation.	Monitor the settlement providing surcharge to the embankment and predict the residual settlement to confirm no problem. Since rapid embankment construction may induce the base ground failure, minotoring stakes were installed to daily monitor longitudinal & transverse displacement of the embankment during construction period. "Tominaga-Hashimoto Method" was applied to monitor the risk of slope failure.
Quality assurance of embankment works	Select soil materials suitable for embankment to ensure the quality. Construct the embankment after confirming the optimum materials and machinery through trial construction.	Confirm the layer thickness and carry out site dencity tests to ensure the quality. Carry out material tests (grading, abrasive tests) on a daily basis to confirm the conformity.
Quality assurance of PC girder fabrication works (prestress tensioning force control)	Prepare a reasonable prestress tensioning force control plan at the design stage. Consider the loss of tensioning force and minimize the creep deformation from the initial stressing, girder erection to slab concrete casting.	Confirm the safety by confirming the concrete strength at the initial stressing. Determine the timing of the final stressing back-calculating from the erection schedule.
Quality assurance of concrete temparature control	As a countermeasure to hot weather concreting, proposed to control the initial temparature by precooling aggregates and mixing water. Used flyash as admixture to mitigate the cement hydration heat after mixing.	Managed to control the fresh concrete temparature below 32℃ and cast concrete temperature below 70℃. Avoided quality problems such as temperature cracking.
Temporary Works	※Implement the work after obtaining approval/no objection on the method statement	
Excavation of soft ground	Confirm the stable angle of slope for open excavation. Prepare ashoring plan in conpliance with the excavation depth and the ground conditions.	For excavation of soft ground, trial excavation is carried out to observe the behaviour of the ground to provide a suitable shoring system as necessary. In particular, for the excavation in the cofferdam in the river, considering the risk of heaving, carry out pre-boring to ensure the sheet pile embedment and water-stopping grout injection.
Self-launching erection truss	Where erection of PC girder with truck crane is not possible, use a self-launching erection truss.	The contractor's HQ staff carried out the safety review of the erection truss design and operation prior to the site use, and the same are confirmed on site during operation.
Traffic management on adjacent public roads	Prepare a plan to prevent accidents, in particular public accidents, at intersections of adjacent public roads in careful consideration of crane position and works area. In case works on public roads are unavoidable, detouring is planned to separate the road from the work area. For trasport of PC girders, etc. on public roads, works are done with temporary traffic management, measures preventing fall of objects.	For works on/near public roads, acquire a road occupation permit, install warning sings, assign flagmen in cooperation with local police, detour the road, or regulate the traffic.
Temporary bridges spanning over public rivers	For temporary bridge construction, design review and maintenance of the bridge is done in cooperation with the Employer and River Management authority.	Carry out the gate check for the temporary bridges to bar third party, limit the use of the bridge during bad weather or flooding to ensure the safety. Observe/investigate the bridge conditions at strong current, remove driftwood.
Waste water treatment	Provide a sedimentation tank to treat wast water from the batching plant. Circulate excess water, and discharge outside after confirmin pH.	Assign inspectors to confirm the water circulation and pH to discharge water conforming the regulation.

3.3.4 Conformance of Project Documents with the Safety Guidance

Conformance of the project documents as described above with ”Guidance for Safety Management of Construction Project in ODA Project” (the Safety Guidance) is shown in the table below.

It can be concluded that the contract documents describing the Employer’s requirements, the corresponding Contractor’s plans and the Contractor’s in-house quality/safety & health management system contain sufficient information on safety (safety of works, occupational safety and health) collectively as well as individually.

Table 3.3.15 Conformance of Project Documents with the Safety Guidance

Outer Circular Highway to the City of Colombo Kadawatha to Kaduwelall / <The Guidance for the Management of Safety for Construction Works in Japanese ODA Projects>			Contract Documents			Contractor's Plans				
			General Conditions of Contract	Conditions of particular Application	Specifications	Quality Assurance Plan	Quality Manual	Health & Safety Management Policy	Safety Plan	Method Statements
Chapter 1 General Rules	1.1	Purpose								
	1.2	Scope of Application								
	1.3	Plans for Safety Management			✔					
	1.4	Roles and Responsibilities of Project Shareholders			✔					
Chapter 2 Basic Policies for Safety Management	2.1	Basic Principles of Safety Management		✔	✔	✔	✔		✔	
	2.2	Compliance with Relevant Laws and Regulations	✔		✔	✔	✔		✔	
	2.3	PCDA for Safety Management			✔	✔	✔		✔	
Chapter 3 Contents of the "Safety Plan"	3.1	Composition of the Safety Plan		✔	✔				✔	
	3.2	Basic Policies for Safety Management			✔	✔	✔		✔	
	3.3	Internal Organizational Structure for Safety Management			✔	✔	✔		✔	
	3.4	Promotion of the PDCA Cycle			✔	✔	✔		✔	
	3.5	Monitoring			✔	✔	✔		✔	
	3.6	Safety Education anfd Training			✔	✔	✔		✔	
	3.7	Voluntary Safety Management Activities			✔				✔	
	3.8	Sharing Information			✔				✔	
	3.9	Response to Emergencies and Unforeseen Circumstances			✔				✔	
Chapter 4 Contents of the "Method Satements on Safety"	4.1	Composition of the "Methd Statements on Safety"		✔	✔					
	4.2	Applicable Standards for the "Technical Guidance for Safe Execution of Works"								
Chapter 5 Technical Guidance for Safety Execution (by the Type of Work)	5.1	Excavation Works							✔	✔
	5.2	Pile Foundation Works						✔	✔	✔
	5.3	Formwork and Form Shoring System Work								✔
	5.4	Reinforcing Bar Work								✔
	5.5	Concrete Work								✔
	5.6	Work over Water								✔
	5.7	Demolition Work								✔
	5.8	Work where there is danger of oxygen deficiency								
	5.9	Slinging Work							✔	✔
Chapter 6 Technical Guidance for Safety Execution (by the Type of Accident)	6.1	Measures for Prevention of Fall Accidents			✔			✔	✔	✔
	6.2	Measures for Prevention of Accidents Involving Flying or Falling Objects			✔			✔	✔	✔
	6.3	Measures for Prevention of Accidents Involving Collapse of Structures			✔			✔	✔	✔
	6.4	Measures for Prevention of Accidents Involving Construction Machinery			✔			✔	✔	✔
	6.5	Measures for Prevention of Explosion Accidents			✔				✔	✔
	6.6	Measures for Fire Prevention			✔				✔	✔
	6.7	Measures for Prevention of Public Accidents			✔			✔	✔	✔
	6.8	Measures for Prevention of Traffic Accidents		✔	✔				✔	✔
	6.9	Protective Gear			✔				✔	✔

3.4 Site Visit

3.4.1 Construction Schedule

(1) Contract Period

Due to the design changes determined during the detailed design period, it became difficult to complete the design of the 16 bridges over the main line of the road within the design contract period. Consequently, in order to keep the overall project schedule, the project scheme was changed so that those bridges are to be designed by the contractor (i.e. Design & Construct Scheme). In the contract negotiation the contractor accepted to construct those bridges on a design & construct basis, confirming allocation of 1 year time for design and 2 years for construction would be manageable, while the construction period at the project formation had been 3 years. The same was also confirmed by the consultant.

In reality, however, delays attributable to many factors made the actual construction period further shorter, and the project became like a crash work at the peak period. Some of those factors are explained below:

(2) Influence of Natural Environment

The project is located in a flood-prone area, and it is reported that the work stopped more than 10 times due to flooding since the commencement of work. There is a dam located upstream of Kelani River and its discharge of water sometimes results in increase of river water level to flood the project area. The Contractor evacuates construction equipment upon receipt of flood warnings.

The records of rainfall and Kelani river water level in August 2013 and June 2014 are shown below:

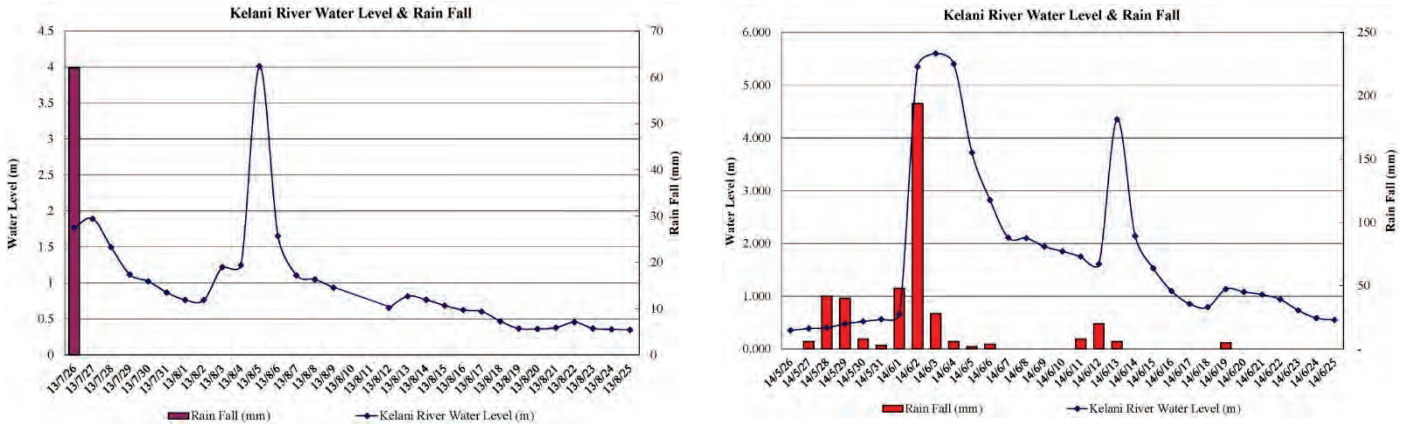


Figure 3.4.1 Rainfall and Kelani river water level in August 2013 and June 2014

(3) Influence of Geotechnical Conditions

The geology of the project significantly varies from place to place and it is difficult to know the actual soil conditions exactly based on the initial soil investigation. Reportedly, consequently, it turned out that the actual soil conditions sometimes differ from those inferred based on the advance soil investigation, which led to

delays of the work.

Those cases are summarized below based on the information collected by interviews.

Table 3.4.1 Delays caused by Soil Conditions different from estimation (as of September 2014)

Year	Delays
2012	● Rock unexpectedly found during piling works ● The actual rock line was higher than expected, which required additional pre-borings at sheet pile driving and additional water stop grout injection behind sheet piles.
2013	● The actual soil conditions required additional GCPs ● The actual soil conditions required additional GCPs at ramps ● The actual soil conditions required additional consolidation period
2014	● The actual soil conditions required design change from piled foundation to mat foundation.

(Source: Consultant, based on information collected during field study)

(4) Land Hand-over, etc.

The land hand-over for the permanent works construction was implemented in accordance with the contract provisions.

On the other hand, concerning temporary facilities, e.g. provision of PC-girder stock yard, requisition f permissions on the temporary bridge over Kelani River, the actual arrangement was not exactly the same as required in the contractor's plan, according to the contractor.

3.4.2 Project Organization

The number of personnel in each organization extracted from organization charts, etc. varies from time to time, but are generally as shown in the following table. The necessity to cope with the large scale of the project and the short construction period actually available has resulted in a large number of work fronts & management teams and a large size of the Contractor's organization. The number of Contractor's Japanese staff is around 25 persons.

The initial/latest organization charts of the Engineer and the Contractor are shown in the appendices.

Table 3.4.2 No. of Personnel in Each Organization

Stakeholder	November 2012 (10 months after commencement)		September 2014 (32 months after commencement)	
	Total	Safety	Total	Safety
Employer	7	4 (Safety & Quality Control Dept.)	7	4 (Safety & Quality Control Dept.)
Engineer	40	1 (another staff dispatched to the Employer as Safety Consultant)	50	1 (another staff dispatched to the Employer as Safety Consultant)
Contractor	Ave. 633	15	Ave. 2,444	24

(Source: Consultant, based on information collected during field study)

The number of workers exceeds 2,000, most of whom are employed through worker dispatching companies.

The background, etc. of such arrangement are summarized in the following table.

Table 3.4.3 Usage of Worker Dispatching Companies

Background	● No reliable local subcontractors are available in this region. ● Partially because of insufficient local laws & regulations, the technical skill and the awareness of safety of local workers are poor. Hence, in case of projects with tight schedule and/or technical difficulties cannot help relying on the direct employment system wherein the contractor can supervise workers directly.
Advantages	● It is difficult for Japanese contractors to procure thousands of workers. ● The management of workers is troublesome requiring the arrangement of camp and daily transport and familiarity with local customs. ● If worker dispatching companies are engaged, though costly, the above problems can be handled by them and the number of workers can be adjusted to the contractor's plan.
Issues	● People in this region do not necessarily have sufficient sense of safety management/ labor management and consequently worker dispatching companies tend to stick to the position of worker dispatching (keeping a distance from the management). ● Even worker dispatching companies can hardly procure skillful workers in case a large demand.

Demarcation of Responsibilities in Worker Dispatching Contract is summarized in the following table.

Table 3.4.4 Demarcation of Responsibilities in Worker Dispatching Contract

Item	Worker Dispatching Companies' Responsibilities	Contractor's Undertakings
Laws & Regulations	Comply with laws & regulations	-
	Take out wokmen's conpensation insurance	-
	Pay social insurance premium	Remuneration paid to the worker dispatching companies include social insurance premium
	Pay salary	In case of delay of or no payment, the Contractor may pay temporarily
	Manage workers' working hours	-
Laborwork	Dispatch workers with skill & experience demanded by the Contractor	Confirm workers competence, work situation, etc.
	Replace non-conforming workers (incompetent, negligent, violating rules)	Order to replace non-conforming workers (incompetent, negligent, violating rules)
	Provide workers with personal protective equipment (hard hat, safety vest, safety harness, safety shoes, raincoat, any other equipment directed by the Contractor)	Confirm workers wearing personal protective equipment
	Provide drinking water; Provide and maintain welfare facilities (toilet, garbage disposal)	Confirm the maintenance conditions of drinking water and welfare facilities
	Provide accomodation (as necessary)	-
	Provide transport fee or means to/from the site	-
Safety	Conduct the Contractor's safety rule training before dispatchning to the site	Provide safety rule book (English & local language)
	Safety harness to be wore at high-place work	Inspect usage of safety harness and penalize violators
	Foreman's responsibility for safety management	Inspect usage of safety harness and penalize violators
	Assign safety officers to manage workers' compliance with safety rule	Grasp the safety offiers' work situation
	Assign a liaison (representative on site) with the Contractor	-
Medical Care	-	Provide first aid stations on site

3.4.3 Project Status

(1) Progress as of September 2014

The progress of the project as of September 2014 is summarize below based on the monthly report for September 2014 which was the latest report available at the time of field study in October 2014.

The extension of time of about 6 months had been granted in August 2014, and compared with the revised schedule incorporating the EOT the actual project progress was almost on schedule.

Table 3.4.5 Progress as of September 2014

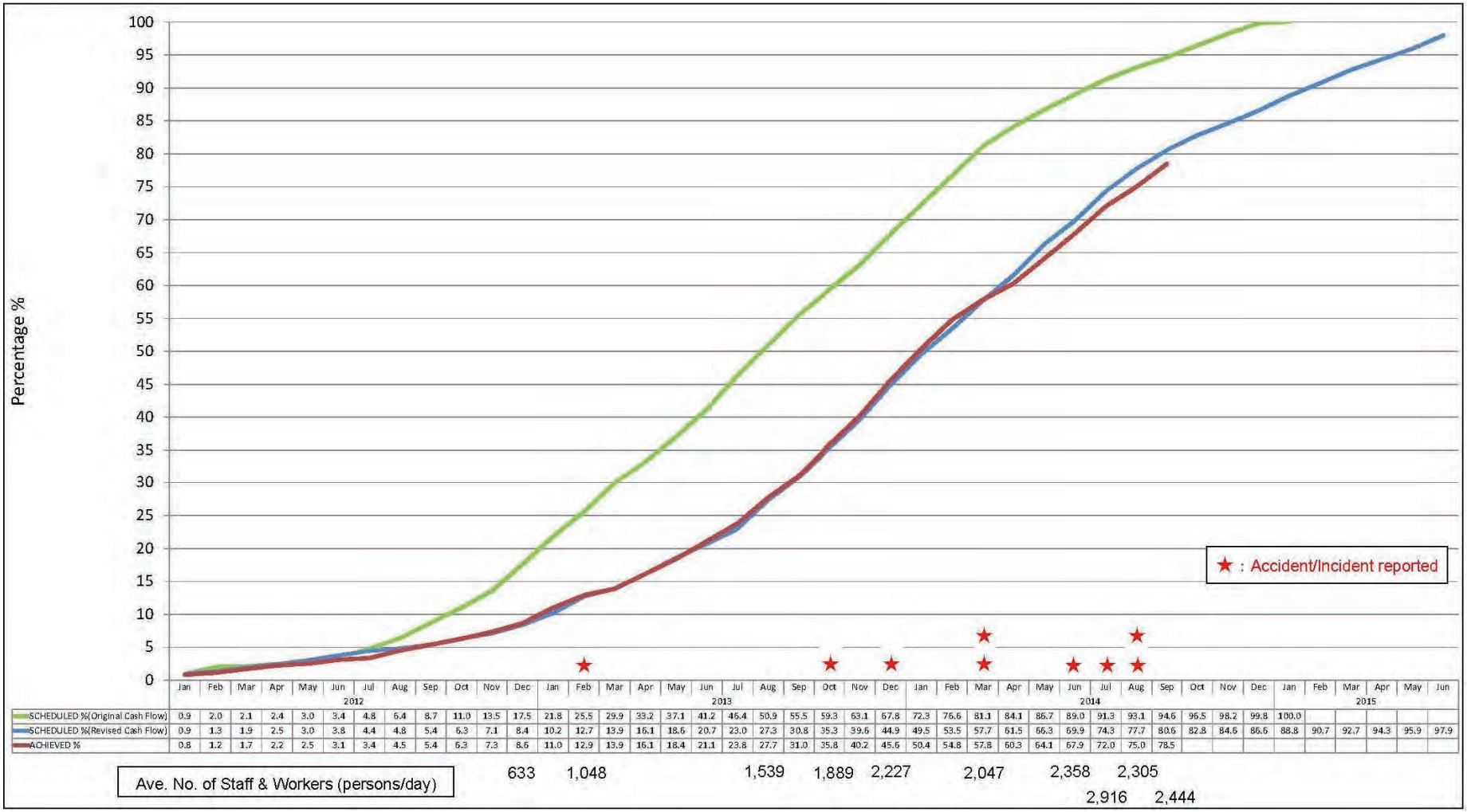
Item		Progress
Earthwork/ Pavement	Excavation	99%
	Embankment	83%
	Sub-Base Course	51%
	Base Course	30%
	Asphalt Binder Course	16%
Box Culverts		85%
Bridges/ Viaducts	Overpass (5 nos.)	OB8: 44%,OB 9: 51%, OB10: 98%, OB11: 98, OB12: 61%
	Bridge No.9 (*)	52%
	Viaducts (15 nos.)(*)	V1: 77%, V2: 88%, V3: 92%, V4: 82%, V5: 73%, V6: 51%, V7: 55%, V8: 61%, V9: 49%, V10: 71%, V11: 92%, V12: 56%, V13: 67%, V14: 98%, V15: 74%
Total		78.5%

(*) : Design & Construction by the Contractor

(2) General Situation of Site

The Study Team's observations on the site visits conducted on 28th & 30th October 2014 are as follows:

- ✓ The site is kept tidy and in order given a good impression to the study team. According to the independent safety manager of the Contractor, it would not be easy to make the arrangement better.
- ✓ The place where the fatal accident occurred on 14th March 2014 has been totally cleared and it was not possible to find any trace of the accident.
- ✓ Foundation construction works were ongoing at the Kelani Bridge, where it was observed that a foreman was supervising the operation with due care to safety.
- ✓ The project was divided into 6 sections, to each of which one or two Japanese engineers were assigned as deputy PM.
- ✓ In response to a query by the study team on the language used in instructions to foremen and from foremen to workers, a deputy PM explained that the language is not an issue, but effective is giving every possible help to foremen/workers in learning the work procedure and foremen are being managing it.
- ✓ Foremen and workers can be identified easily by the color of hard hats.

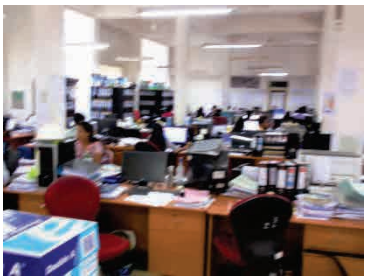


	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
	2012												2013												2014												2015					
SCHEDULED %(Original Cash Flow)	0.9	2.0	2.1	2.4	3.0	3.4	4.8	6.4	8.7	11.0	13.5	17.5	21.8	25.5	29.9	33.2	37.1	41.2	46.4	50.9	55.5	59.3	63.1	67.8	72.3	76.6	81.1	84.1	86.7	89.0	91.3	93.1	94.6	96.5	98.2	99.8	100.0					
SCHEDULED %(Revised Cash Flow)	0.9	1.3	1.9	2.5	3.0	3.8	4.4	4.8	5.4	6.3	7.1	8.4	10.2	12.7	13.9	16.1	18.6	20.7	23.0	27.3	30.8	35.3	39.6	44.9	49.5	53.5	57.7	61.5	66.3	69.9	74.3	77.7	80.6	82.8	84.6	86.6	88.8	90.7	92.7	94.3	95.9	97.9
ACHIEVED %	0.8	1.2	1.7	2.2	2.5	3.1	3.4	4.5	5.4	6.3	7.3	8.6	11.0	12.9	13.9	16.1	18.4	21.1	23.8	27.7	31.0	35.8	40.2	45.6	50.4	54.8	57.8	60.3	64.1	67.9	72.0	75.0	78.5									

Figure 3.4.2 S-Curve (Extracted from Monthly Report for Sep. 2014)

a. Site Photos taken on 28th October 2014 after the interview to the Contractor

Interview to the Contractor



Contractor's Office

Starting Point (STA17+500)

Site Visit Group (1)

Site Visit Group (2)

Parapet Formwork

Provision for Future Widening

Temporary Access

Parapet Construction

Scaffolding supported by brackets

Extracting Sheetpile at Kelani River

Pier Construction at Kelani River

Erection Truss at Kelani River

Formwork Storage at Kelani River

Extracting Sheetpile at Kelani River

PC Girders & Pier

Girder Fabrication Yard

Gantry Crane at Yard

Viaduct Soffit (1)

Viaduct Soffit (2)

Slab Reinforcement

PC Girders Temp. Storage Yard

Transport Formwork

RC Slab Soffit Form

Erection of PC Girder

Viaduct Abutment

Concrete Slab

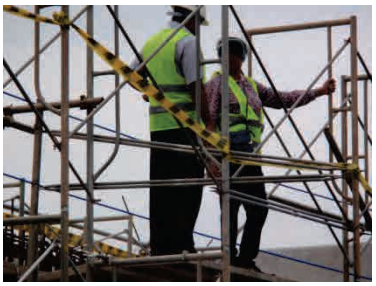
Garbage Collection Bag

Safety Fence and Net

Photo 3.4.1 Site Scenery

b. Site Photos taken on 30th October 2014 during safety patrol

Safety Patrol



PD of the Employer (RDA)

Temp. Bridge on Kelani River

Scaffolding for Ramp Pier

Parapet Formwork

Parapet Concreting (1)

Parapet Concreting (1)

Girder Fabrication Yard (S)

Girder Fabrication Yard (N)

No Back Mirror

Batching Plant

Crossover Bridge

No Entry Sign

Chipping Construction Joint

No Goggles

Photo 3.4.2 Site Scenery

(3) Project Safety Committee Meeting

The study team attended the safety patrol and the project safety committee meeting for the month of October 2014. In the meeting where all senior staff attended, representatives from the Employer, the Consultant and the Contractor made presentation respectively, which was followed by systematic and detailed discussions. Summary records of the Project Safety Committee Meeting for October 2014 are shown below:

Table 3.4.6 Summary Records of Project Safety Committee Meeting

Date/Time	30th October 2014, 14:00～15:20
Venue	Project Office
Attendees	30 persons (Employer: 4, Consultant: 6, Contractor: 12, Subcontractors: 7, JICA Study Team: 1)
Outline	1.0 Preliminaries 2.0 Approval of minutes of previous meeting 3.0 Review of Safety Lapses 3.1 Presentation by the Safety Consultant # Photographs taken on 16th October 2014 # Photographs taken on 30th October 2014 # Photographs taken by OC on 29th October 2014 3.2 Presentation by Safety Engineer, OC 3.3 Presentation by Deputy Safety Manager, Taisei # Photographs of meetings, work carried out 4.0 Any other matters 1. Shramadana Mawatha 2. Status on Working on heights 3. Kelani River Bank Protection 4. B214 Diversion 5. Effectiveness of the Safety Department 6. Representatives of the subcontractors 7. Flagmen for night work 8. Monitoring work of the subcontractors 9. Regarding meeting
Photo of Meeting	

Chapter 4 Analysis of Accidents

4.1 Outline of Accidents

The accidents to analyze in this study are shown in the table below (Table 4.1.1) which has been reported in nine months from February 2013 to August 2014.

Table 4.1.1 List of Accidents to Study

No.	Date and Time of Accident	Outline of Accident	Dead	Injured	Third Party
1	2013/02/01 18:30	The operator while lifting and swinging the H-beam (400×400×6.5 meter) using 65 ton crawler crane, the boom controlling lever malfunctioned and the movement of the boom went out of control. The lattice boom (length 30 m) fell down to the roof of a house. The main hook fell on the van which was parked by the house. The auxiliary hook fell on to the roof of the house. The boom of the crane, rested on its roof.	–	–	A house and a van damaged
2	2013/02/18 18:40	A 25 ton mobile crane which is owned by the subcontractor for in situ piles was stumbled down whilst lifting up a steel bentonite tank for mobilization to next location. The crane has not parked properly with outrigger pads; especially ground condition under the right side of front outrigger of the crane was pretty bad. As a result, the crane had toppled over.	–	–	–
3	2013/10/11 15:00	While the bus was passing on a steep and curved elevation area of diversion road, it stopped suddenly due to engine trouble and moved backward and the driver tried to stop the bus but he could not due to break failure. The bus moved further backward and run off the road and toppled into the south side excavated area.	–	–	1
4	2013/12/04 17:00	Whilst correcting the verticality of pier rebar (32mm) of inside the pier reinforcement cylindrical cageφ1.7m, two workers were injured who were inside of the cage due to tilting the whole cage with the workers because of inadequate support. The two workers trapped inside of the rebar cage. When they came out from the tilted rebar cage they got minor injuries.	–	2	–

No.	Date and Time of Accident	Outline of Accident	Dead	Injured	Third Party
5	2014/03/14 18:30	At the temporary girder stock yard, after shifting the PC girder (L=35m, H=2m, W=70t) from the trolley to the temporary supporting H-400 by using a hydraulic jack, the wood levelling filler gave away which caused the PC girder to topple. Three workers from the girder finishing work team died and two workers sustained minor injuries.	3	2	–
6	2014/06/02 16:30	A private car with three passengers was driving along the diversion road built for construction of a box culvert. When it was passing the temporary pipe culvert, the asphalt layer collapsed with the car and the car fell down due to washing out of all the soil underneath the asphalt layer around the steel pipe culvert.	–	–	2
7	2014/07/20 17:15	A crew of four workers including contractor's flaggers and a prime mover operator were transporting the PC girder. When the front cabin of the prime mover reached the top of the ramp road, its front wheels skidded and subsequently the prime mover was stopped and dragged down along the ramp road and toppled.	–	1	–
8	2014/08/03 02:30	On the pier head a worker was working at night sift carrying out preparation work for bearing plinth. Suddenly he felt sickness and headache, and sat in on the pier. Then he passed out and fell from the pier head through the lower gap of guardrail into the water filled pier base which depth was about one meter.	–	1	–
9	2014/08/06 08:35	A crew of five workers including a foreman was working on the deck slab of the Viaduct. A worker fell through the opening to the ground, because of a sudden movement made by him as he was afraid of being knocked by the crane hook. The worker fell down from 9.0 m high place on to the muddy ground.	–	1	–

The relationship between the occurrences of accident and the progress of the project can be seen that they have occurred when the work became so active with more than two thousand workers, as shown in Figure 3.4.2.

4.2 Procedure of Analysis of Accidents

(1) Course of Analysis

The nine accidents (including accidents with no casualty) to be analyzed have been occurred in nineteen (19) months period, and seven out of the nine accidents are concentrated in eleven (11) months including the grave accident which victimized three workers.

Needless to say, the management have made great effort to secure safety in the project and took various measures to prevent accidents, however, it cannot be said that the situation is satisfactorily improved because accidents/near miss incidents are still happening even now. This situation would be happening because pursuit of root causes may have been insufficient, or the causes may have been left without proper countermeasures being taken or the countermeasures may not be efficient.

In this study we applied the Root Cause Analysis which is often used in Nuclear Power Plants, IT companies and some medical organizations for solving problems. The purpose of application of the method is to pursue management and organizational factors and to study countermeasures not reacting to mere phenomenon and results but solving the real problems existing behind the superficial phenomenon.

(2) Root Cause Analysis

1) Necessity of the Root Cause Analysis

The concepts and methods of the root cause analysis are rather new, and there are some definitions regarding “Root Cause Analysis” as shown in the table below.

Table 4.2.1 Examples of definition of Root Cause Analysis

Source	Definition of Root Cause Analysis
A Guide to the Project Management Body of Knowledge（PMBOK）Fifth edition, Chapter 11 Risk Management	A technique which specifies the problems, investigates subsisting causes which lead to the problem and makes preventive measures.
Guideline for the regulatory body to appraise the result of the root cause analysis conducted by business operators Revised 2010/09/03 Revision 1, Nuclear and Industrial Safety Agency, Japan Nuclear Energy Safety Organization	Based on the direct cause analysis, analyze organizational factors and take measures to improve the management system. (Note) The definition was made as state considering many accidents and troubles are happening due to inadequate action by the organization although the reason has already been technically clear.

The root cause analysis was originally developed for the purpose of preventing recurrence of accidents in nuclear power plants. However, there have been very few examples of application of the root cause analysis to accident analysis in the construction industry. There are similarities between construction sites and nuclear power plants as a working place where a lot of people work together as follows;

・They are the fields where both the soft engineering and hard engineering assimilate together.

・They are the fields where human interfaces with machine.
・They are the fields where a Quality Management System (QMS) approved in advance is applied to manage the process.
・They are the fields where the possibilities that organizational factors would lead to the accidents is high.

In the construction industry in Japan, the number of accidents and also the number of victims have been greatly decreased last three decades owing to improvement of safety awareness and various safety facilities/equipment and so on. However, the decreasing tendency seems to reach the ceiling recently. The phenomenon seems to imply that the traditional methods of analysis and countermeasures would come to its limit for further improvement.

In this sense, it is necessary to direct spotlight on not only to the direct/indirect causes but also to the management and organizational factors behind the accidents.

2) Process of Analysis

The process of the Root Cause Analysis applied in the study is outlined as follows;

a) Determination of accidents for analysis
b) Gathering information (domestically)
c) Understanding of the facts and problematic phenomenon
d) Conducting pre-analysis prior to the site investigation
e) The site investigation and information gathering (locally)
f) Conducting analysis of accidents
g) Extraction and evaluation of management/organizational factors
h) Study for countermeasures and recommendation on safety

3) Selection of Technique for Root Cause Analysis

There are several techniques that can be used as the Root Cause Analysis, such as “Why-why Analysis (5-Why Analysis)”, “Cause Effect Diagram” and “4M5E Matrix Analysis”. Those except for Why-why Analysis have defect that factors tend to diffuse and it becomes difficult to specify the true cause logically.

Why-why Analysis is judged as the most suitable method for the study by the easiness to understand for the people who might be unfamiliar with such an analytic area and its superiority in logical thinking by the relation of the cause and the result.

4) What is Why-why Analysis?

This is a technique of analysis to find out the true causes based on the facts by logically repeating not by inspiration or by the fifth sense. It is necessary to list all factors systematically which lead to the phenomenon.

This technique was originally started form the improvement activities in Toyota Motor Corp. It is a way of thinking to pursue the true cause of the phenomenon or flaws by repeating “Why?” (Fig. 4.2.1, 4.2.2)

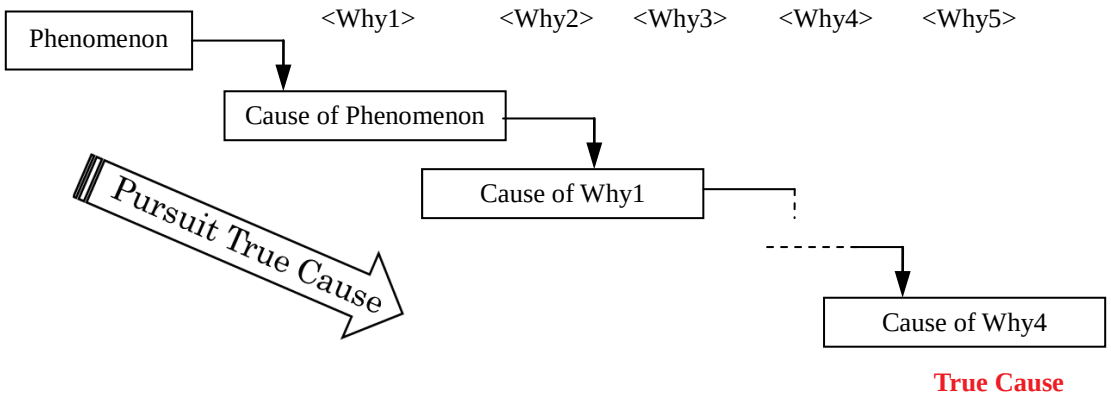
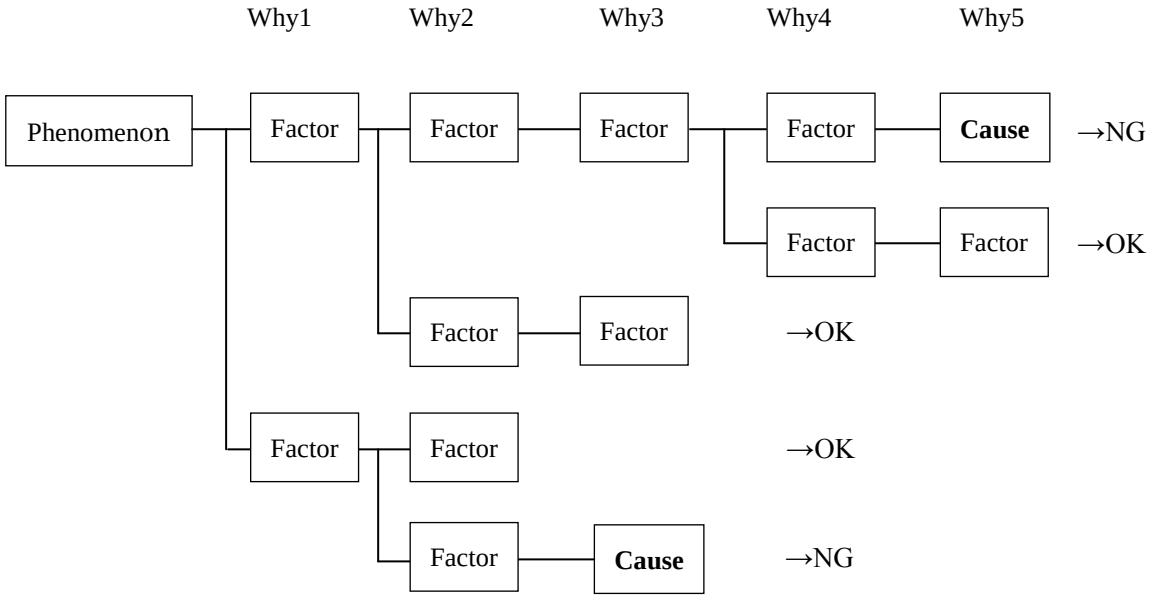


Fig. 4.2.1 Technique of Why-why Analysis



OK : Normal Situation (Countermeasure is not necessary)

NG : Abnormal Situation (Countermeasure is necessary)

Fig. 4.2.2 Image of Why-why Analysis

5) Combining Value Engineering (VE) with the Root Cause Analysis

If the management/organizational factors are specified, it is expected that the safety of the project will be improved by rectifying the factors. However, the countermeasures derived in general, tend to be too much direct to the phenomenon, in other words, the measures are taken by only just like flipping over the phenomenon, and would result in the situation that the real cause is left as it is.

Here, we decided to apply the theory and technique of Value Engineering in this study in order to clarify the process of occurrence of an accident by the management/organizational factors, and to devise effective countermeasures from the point of view of what is necessary to achieve functions (purposes) to prevent

recurrence of the accident.

VE is a theory and technique to improve the value of the object (goods and services). Everything that has some purpose and consumes any resource such as cost has “value”.
VE, first of all, understands the essence of the object an aggregate of necessary functions. And then, based on the understanding of the functions, any and all possible ideas to achieve the function are explored and searched to materializes new measures to achieve the purpose, and finally to improve the value of the object.

Generally speaking, improvement will be achieved in the safety management activities, by clarifying causes of the accident and by eliminating the causes. This is called the Analytical Approach.
In Value Engineering, the Designing Approach is applied, in which the ideal feature of the object (to-be). And using creativity ideas and measures are derived to achieve the ideal feature of the object.
The difference between two approaches is shown below.

a) Analytical Approach (IE: Industrial Engineering, QC: Quality Control and Safety Management, too)

	<Bad result>	→	<The cause?>	⇒	<To eliminate the cause?>
Ex)	Falling.		The handrail was defective.		Reinforce the handrail, etc.

b) Designing Approach (Mainstreams of Improvement Techniques; VE is its representative methods)

	<Bad Result>	→	<What is “to-be”?>	⇒	<To achieve the purpose?>
Ex1)	Falling.		A work without danger.		Work method with no work at height
Ex2)	Falling.		No possibility of falling.	⇒	Totally new facility to prevent falling

(3) Root Cause Analysis and Countermeasure Study Flow

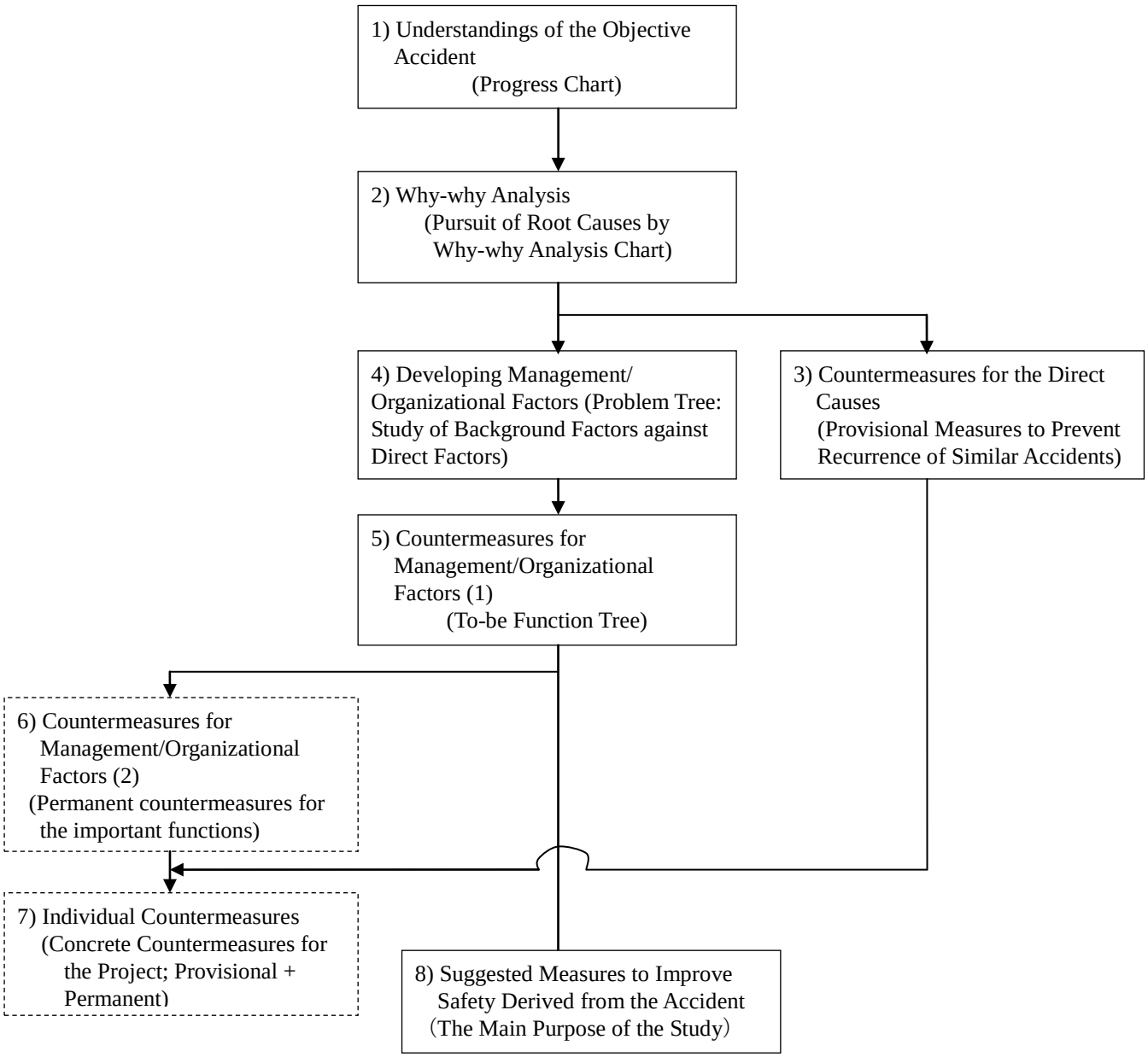


Fig. 4.2.3 Flow of Accident Analysis and Study of Countermeasures

4.3 Investigation and Sorting-Out of Facts

(1) Safety Management Organization in OCH2 Project

A grave and fatal accident occurred around 18:30 of March 14, 2014 victimizing three lives by toppled PC girder. The organization for safety management in the project was reviewed and changed drastically. The safety organization between the commencement of the project and the accident is shown in Fig. 4.3.1

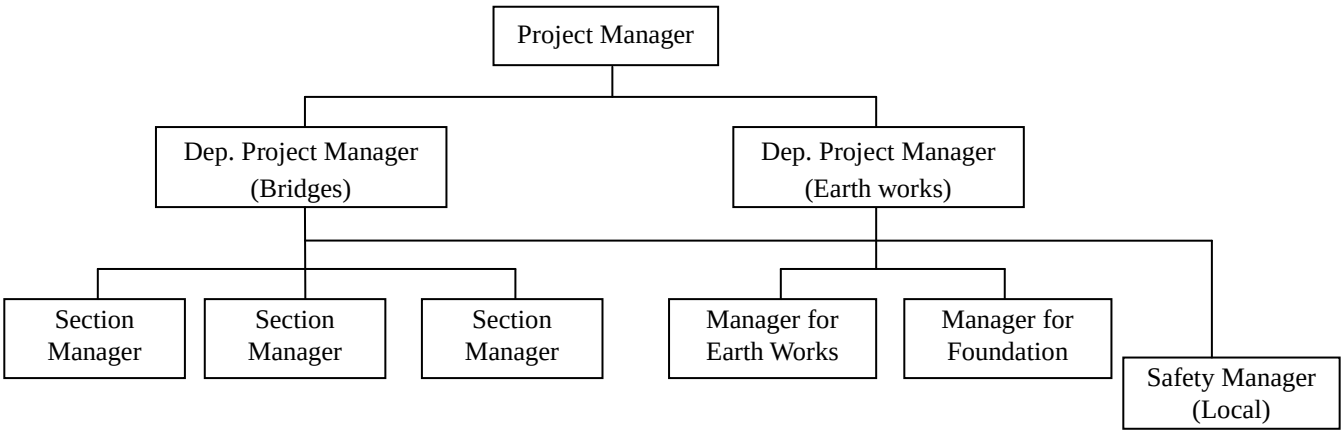


Fig. 4.3.1 Safety Organization (Commencement to the Grave Accident; March 2014)

After the accident, the safety organization and safety management procedures were reviewed and reinforced essentially. It was changed as shown in the Fig. 4.3.2 that a Japanese full-time safety manager is designate and he was positioned to report to the project manager directly. Thus, the roles and authorities were greatly reinforced.

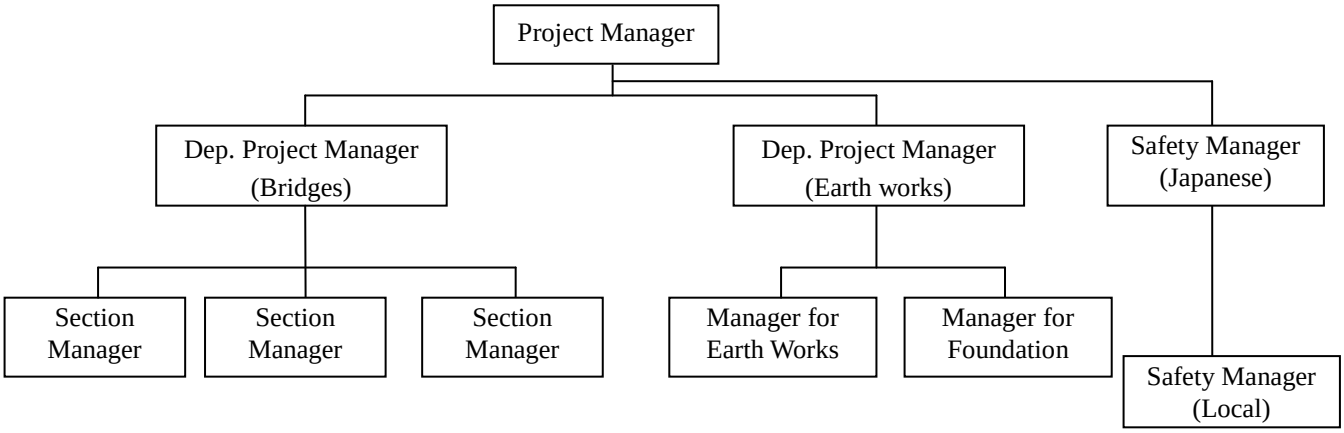


Fig. 4.3.2 The Latest Safety Organization (After the Grave Accident; March 2014)

In addition, the safety officers (local) who are actually control safety at the site have been also increased. Also, a Japanese safety expert was dispatched from Taisei head office after two falling accident occurred in August 2014. (The Safety Management Organization; Fig. 4.3.3, 4.3.4)

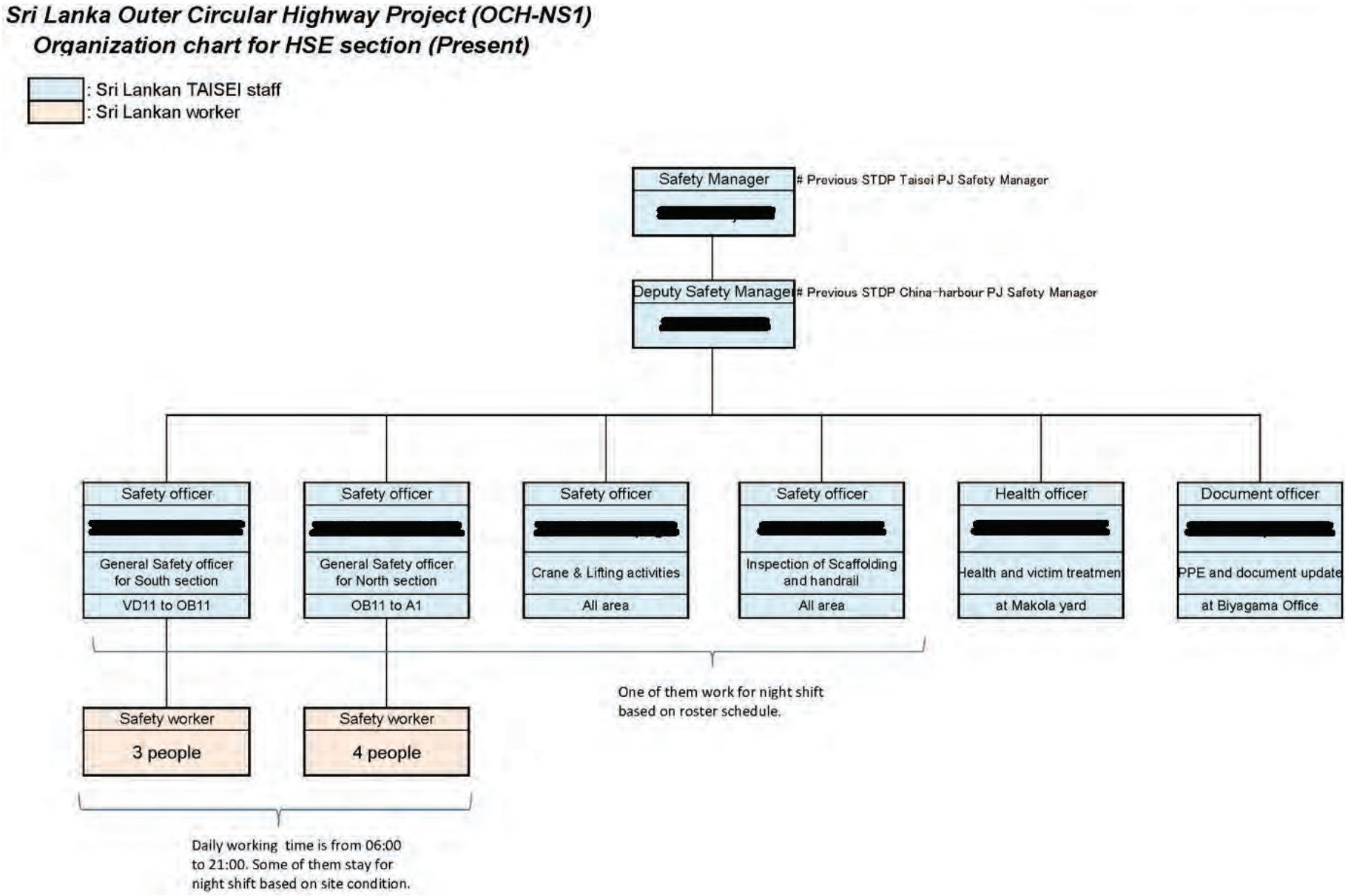


Fig. 4.3.3 Safety Management Organization (Commencement to the Grave Accident, March 2014)

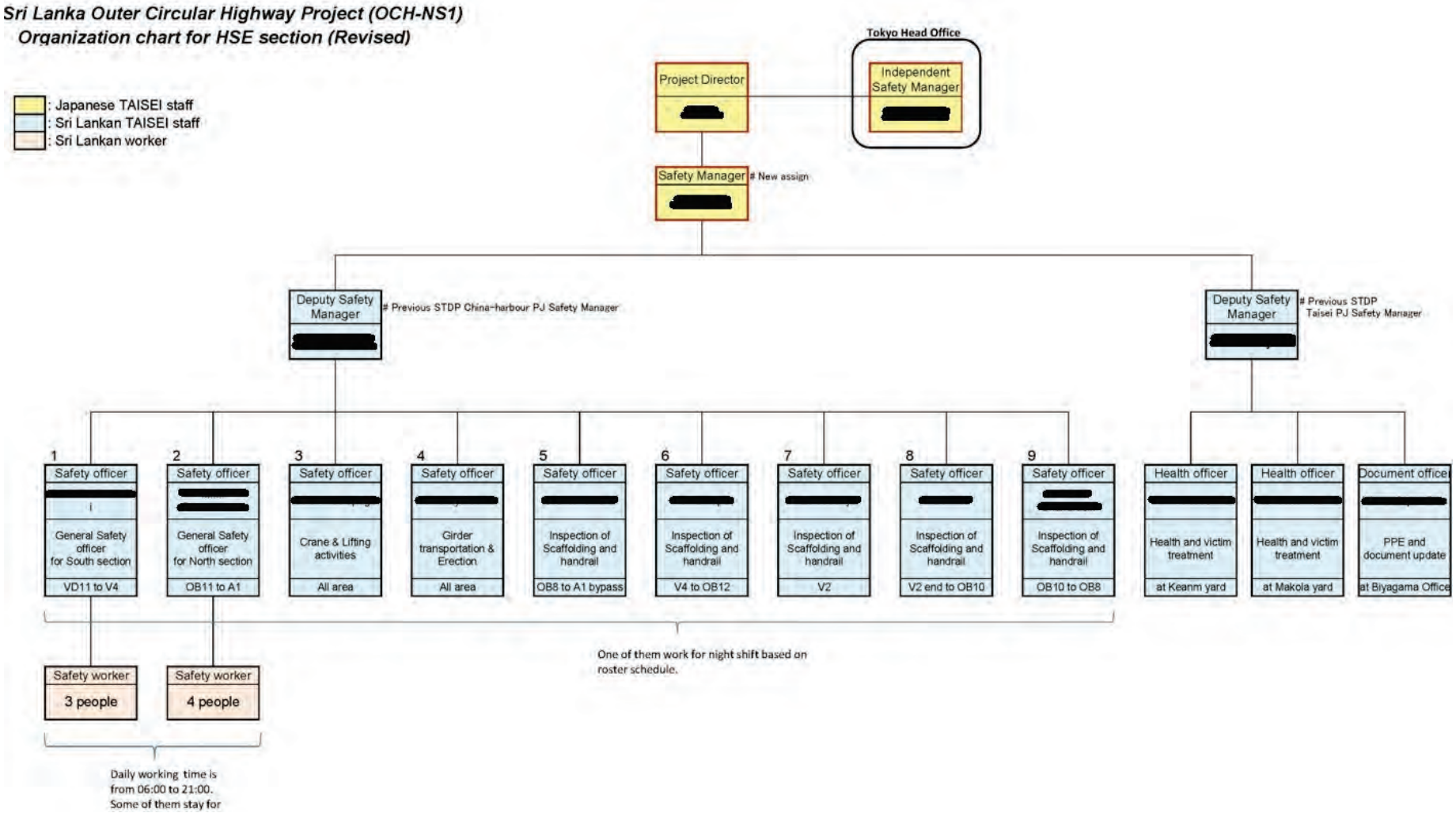


Fig. 4.3.4 Reinforced Safety Management Organization (After the Grave Accident, March 2014)

(2) Safety Management Activities in OCH2

a) General

As the result of the grave accident in March 2014 and two consecutive fall accidents in August 2014, it can be said that the status of safety has been improved considerably. The consultant gave following comments regarding the change of safety status before and after the accidents including some safety problems arising from the employment form of the workers.

Table 4.3.1 Evaluation of Safety Management Activities in OCH2

Team Leader：PM	The contractor seems to have difficulties in the labor management because they are using manpower supply companies. On the other hand the Chinese company in OCH1 is hiring workers directly, and they are facing many problems in labor management. The contractor has contracted out the foundation piles and some bridge superstructures, but the contractor was depending on the safety management to the subcontractors. After the accident occurred in their direct hiring section, the contractor changed the system to perform the safety management by them for the subcontracted section, too.
Bridge Chief Engineer	I feel that the safety management has been improved considerably after those accidents. However, I am doubtful if the contractor could start safety management from the beginning of the project. If other contractor, not the present this contractor, it must be far more difficult. There are difficult problems in subcontracting, too. The present situation of subcontractors in this country is that they are not yet capable to perform the high level safety management. In case of the direct hiring, it would be possible to improve safety management by establishing the organization and acting vigorously. But in addition, in case of subcontracting it would be difficult unless the safety management abilities of the subcontractors be improved.

b) Outline of Countermeasures Taken After the Grave Accident

After the grave accident occurred on March 14, 2014 the contractor submitted the final accident report on March 25. The report contained many measures for safety improvement including review and modification of the method statement. One of countermeasures to be noted was that the contractor designated a yard-foreman at each construction section. Because one of the major direct causes of the accident was the lack of communication between the girder transportation team and the girder finishing team, the yard-foreman is expected to manage both teams with a good coordination. (Fig. 4.3.5, 4.3.6)

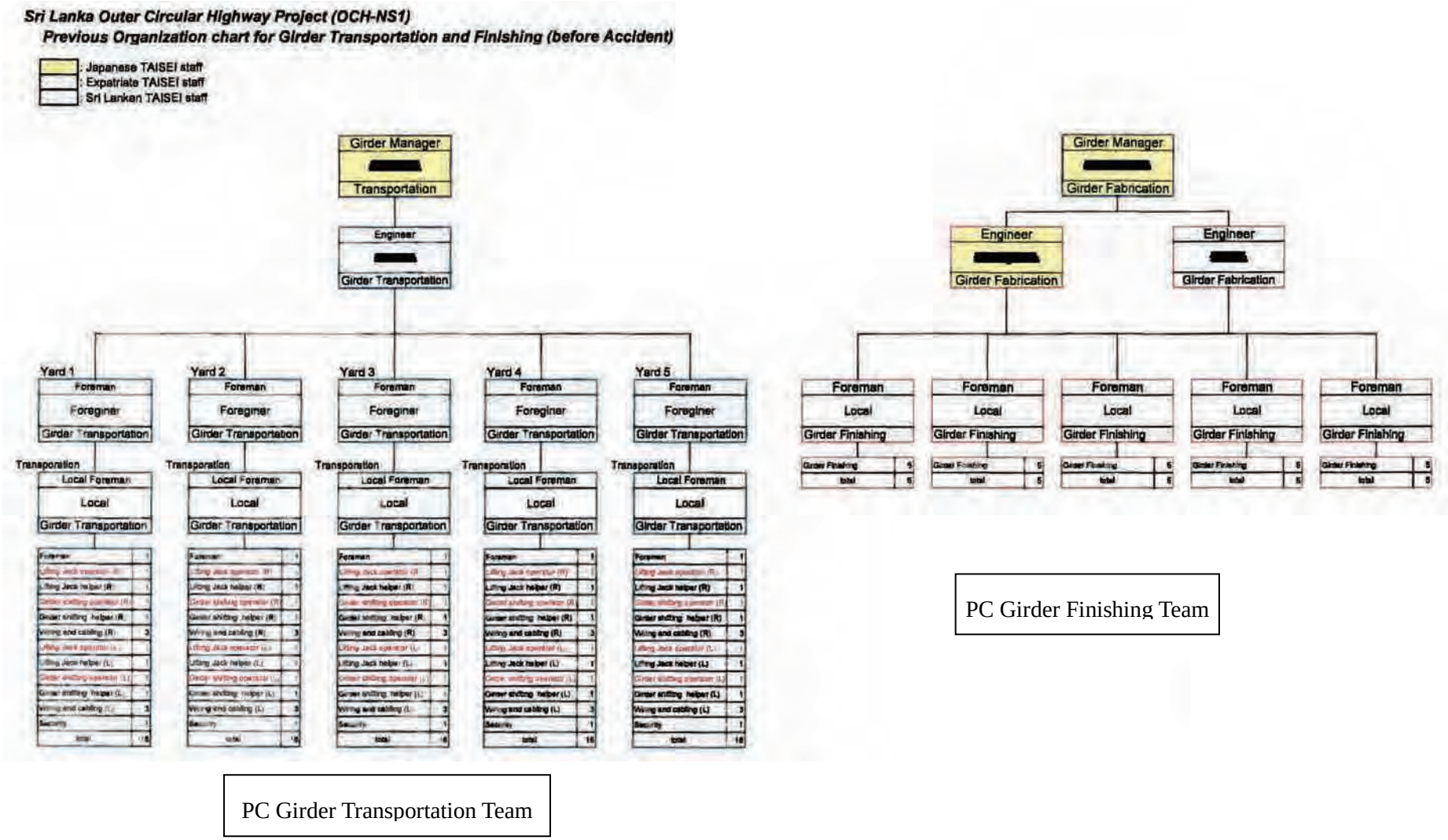


Fig. 4.3.5 Organizational Relationship between PC Girder Transportation Team and PC Girder Finishing Team before the Accident

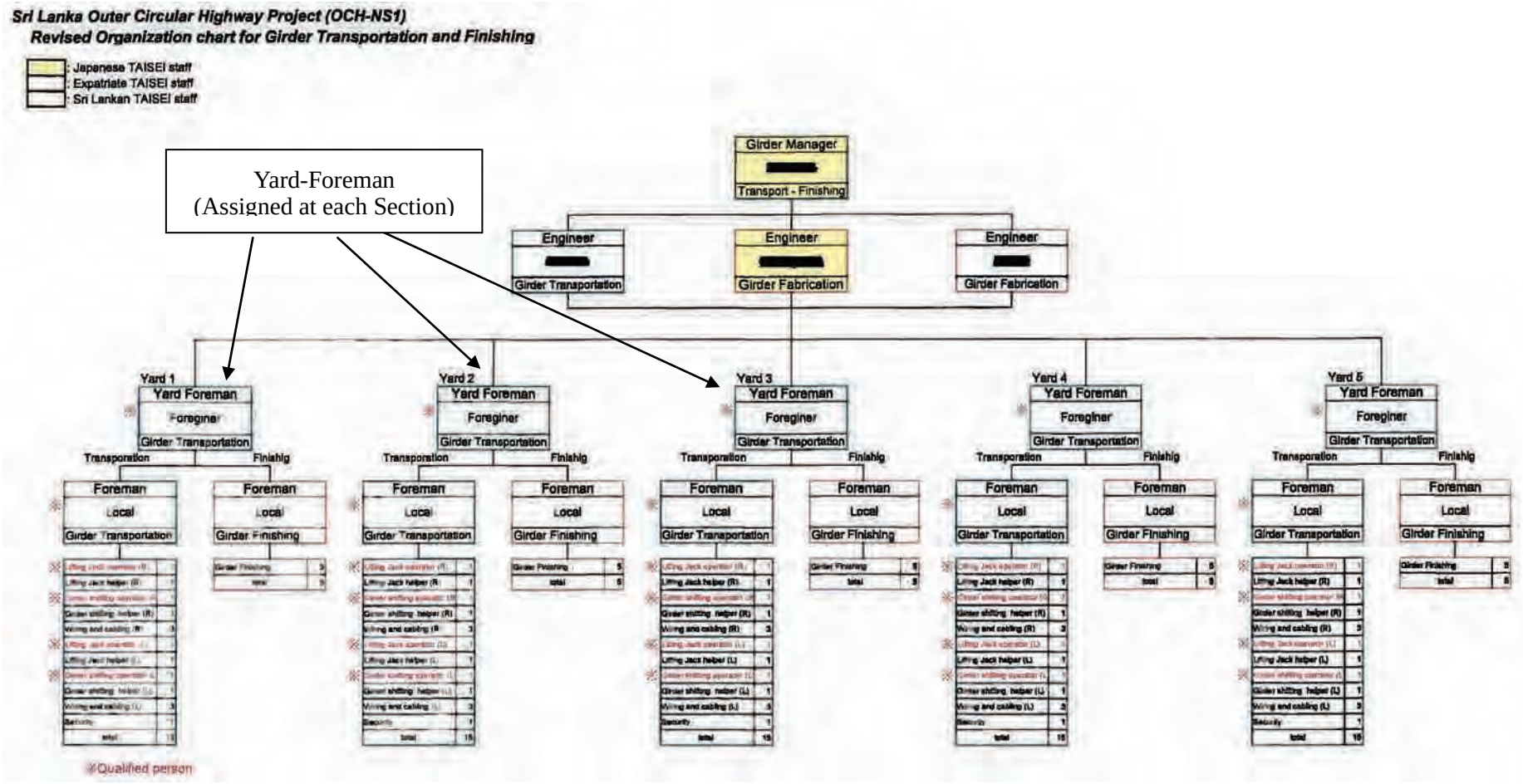


Fig. 4.3.6 Revised Organization of PC Girder Transportation Team and PC Girder Finishing Team after the Accident

c) Countermeasures Taken after the Consecutive Fall Accident in August 2104

Taisei had been working hard after the grave accident to prevent accident reinforcing safety management and activities, two consecutive fall accidents occurred on August 3rd and 6th. Fortunately, nobody died. However, JICA took the situation seriously and requested Taisei to review their safety management.

Taisei responded quickly and made the following “Four Center Pillar of Preventing Accidents”.

Table 4.3.2 Four Center Pillar of Preventing Accidents

Item	Contents of Measures
1. Reinforcing Safety Awareness of Foremen	In order that each and every work team can work safely, not to mention education of the workers, the safety awareness of foremen who should take important role for safety will be especially reinforced. ・Designated six hazardous works (below) shall be reviewed and study in detail together with foremen and by doing so reeducate them. (1) Erection of Girders (2) Installation of RC Panels between Girders (3) Hanging Scaffold for Cross Beam Construction (4) Bracket Scaffold for Overhang Slab (5) Bracket Scaffold for Wall Balustrade (6) Scaffolding for Pier Construction ・Conduct re-education of the safety rules of the project focusing to important ones. ・Workers who violate the rule and the foreman in charge will be instructed to rectify in accordance with the penalty code. (Foreman’s management responsibility)
2. Reinforcing Inspection for Safety Facilities (Assignment of Special Team for Safety Inspection)	Assign a safety inspection team for each construction section. The team will perform modifying facilities and correcting safety lapses which change every day in accordance with the pores of works, thus maintain facilities and environment for workers to work safely.
3.Reinforcing Site Patrol	All Japanese staff, supervisors and the third country engineers will cooperate each other to find and eliminate danger in the site. Conduct site patrol in every work areas by Japanese, Supervisors and Engineers. (Reinforcing pre-work inspections) ・Reinforcing site patrols by Japanese executive staff.
4. Reinforcing Safety Management Organization	Taisei dispatches a full-time safety expert who is independent from the site organization to reinforce the safety management. (Its purpose is to confirm the situation of execution and effect of safety improvement.

Detail of the Countermeasures is shown in Table 4.3.3.

Table 4.3.3 Contents of Countermeasures for preventing recurrence of the accident taken after the fall accidents in August 2014

Accident Factor Classification	Safety Management Items		Safety Point to Be Observed	Present Countermeasures	Additional Countermeasures	Number in the Four Principles	Contents of Additional Countermeasures
Management Factors	Safety Cycle	Morning and Toolbox Meeting	Perform every day in each construction section starting at 7:00 am. ・Confirmation of works of the day, safety points to be observed and status of physical condition of workers.	○	○	1	・Confirm the physical condition of workers using Physical Checklist and keep the record ・Confirm total working hours of each worker at the construction areas. (As a rule, working overtime shall be limited to 22:00.)
		Daily Meeting	Perform every day in each construction section during daytime. ・Confirmation of works of the day, safety points to be observed and works to be performed the next day.	●			
		Safety Meeting	Perform at the beginning of every month in each construction section. ・Explanation of schedule of the month, instruction of safety points for the works and notification of the safety targets.	○	○	1	・Award system has been applied for the foremen and workers who are the safety model performing safety works with no accident.
		Daily Safety Facility Inspection	Perform safety facility inspection in each construction section.	○	○	2	・Designate a special team for inspection of safety facilities at each construction section.
		Daily Safety Patrol (1)	Perform daily safety patrol by Japanese are managers, supervisor and engineer in each construction section. ・Vi	○	○	3	・Reinforce pre-work inspections.
		Daily Safety Patrol (2)	Perform daily safety patrol by Japanese Executive Officers ・Violation of safety rules, confirmation of safety facilities and patrol for workers doing unsafe activities.	○	○	3	・Reinforce site patrols..
		Weekly Safety Patrol	Perform safety patrol once a week by all the Japanese staff. ・Being inspected by other area managers, expect improvement of safety management.	●			
		Monthly Safety Meeting	Hold a safety meeting once a month by all the area managers and the safety managers.. ・Review the safety points due to progress of the project and discuss safety rules to be added or changed.	●			
		Accident Prevention Council	Hold once a month ・Gathering safety staff in charge in the subcontractors, explain safety status and inform safety management items.	○			
		Japanese Safety Manager	Assign a Japanese Safety Manager (Reinforcement of the Safety Section)	●	○	4	・Tokyo headquarter dispatched a safety management specialist (Japanese) who does not belong to the site organization.
		Site patrol by Manpower Supply Companies	—	—	○	3	・Manpower supply companies perform site patrol daily to check the working situation of the supplied workers. (5 companies ×4=20 personnel)
	Work Procedures, Safety Rules	Work Procedures	Understand thoroughly about the safety items to be observed in accordance with the work procedures.	●	○	1	・Understand the work procedures thoroughly by specifying works which may have danger of falling and by review the work procedures with the relevant foremen.
		Safety Rules	Establish particular safety rules in accordance with the peculiarities of the project.	●	○	1	・Make an education material for foremen by combining additional safety rules.
Material Factors	Safety Facilities	Correction of Safety Lapses	Correct safety lapses, if found.	●	○	2	・Designate a special team for inspection of safety facilities at each construction section to correct safety lapses.
Human Factors	Safety Education of Foremen and Workers	Safety Education of Workers	Inform thoroughly the safety work procedures and the safety rules.	●	○	1	・Instruction for use of safety belts and protective gears by the safety section staff's demonstration.
		Safety Education of Foremen	Inform thoroughly the safety work procedures and the safety rules.	●	○	1	・Educate foremen aiming improvement of safety awareness.
		Penalties for Violation of Safety Rules	Warning to the violator (Warning letter, fine, dismissal)	○	○	1	・Add a management responsibility to foremen.

●Countermeasures for preventing recurrence of the accident taken after the fatal accident in March 2014.

d) Toolbox Meeting

In OCH2, toolbox box meetings (TBM) have been held from the start of the project.

Photo 4.3.1 TBM at Viaduct2

Photo 4.3.2 TBM of the Earthwork Team

Photo 4.3.3 TBM at Viaduct1

4.4 Root Cause Analysis – Individual Accident Analysis

The purpose of Root Cause Analysis can be described in three points as follows;

(1) To clarify management/organizational factors existing behind the accidents together with the direct causes by analyzing accidents from various point of view.

(2) To propose recommendations on safety and to prompt all parties concerned in the project to make effort to prevent occupational accidents by feeding back the result of the study.

(3) To contribute for preventing accident in Japanese ODA construction projects by recommending measures to solve common safety problems in other similar projects.

The objects of the root cause analysis are nine accidents as shown in the table below. Four accidents which are considered to have important common factors in other projects are analyzed in detail, and through integral analysis recommendations are formed with management/organizational factors.

Other five accidents are considered as simple cases or accidents which the contractor is not responsible. For this reason, they are analyzed by "Why-why Analysis" and if there are meaningful management/organizational factor, they will be used in the integral analysis.

Table 4.4.1 Lit of Accidents to analyze

No.	Date of Accident	Accident	Victim	Importance	Analysis	Order to Report
1	2013/02/01	Accident Caused by Broken Boom of Crane	Nil	Medium	○	**2**
2	2013/02/18	Accident of the Crane toppled on the Soft Ground	Nil	Low	△	5
3	2013/10/11	Accident of Public Vehicle (Bus) Falling Due to Engine Trouble	2-minor injury	Low	△	6
4	2013/12/04	Accident by Tilted Pier Rebar Cage with Inadequate Support	2-minor injury	Low	△	7
5	2014/03/14	Accident Caused by Toppling of PC Girder During Transportation	3-fataly 2-minor injury	High	◎	**1**
6	2014/06/02	Accident of Public Vehicle (Family Car) Fell in the Risen River	1-minor injury	Low	△	8
7	2014/07/20	Accident of Trailer Toppled During PC Girder Transportation	1-minor injury	Low	△	9
8	2014/08/03	Accident Caused by Falling from Pier by Passing Out	1-minor injury	Medium	○	**3**
9	2014/08/06	Accident Caused by Falling from the Girder During Adjusting Work	1-serious injury	Medium	○	**4**

Note: Numbers in red show accidents for major object of the analysis.

4.4.1 Root Cause Analysis of the Accident Caused by Toppling of PC Girder

(2014/03/14)

1. The Accident

A root cause analysis of the grave accident in which three workers were fatally injured, on 14th March 2014 at the site of the Outer Circular Highway to the City of Colombo Project is presented in detail hereinafter.

[Outline of the Accident] (Following information is based on the final accident report submitted by the contractor, Taisei Corporation.)

At the temporary girder stock yard, after shifting the PC girder (L=35m, H=2m, W=70t) from the trolley to the temporary supporting H-400 by using a hydraulic jack, the wood levelling filler gave away which caused the PC girder to topple. Three workers from the girder finishing work team died and two workers sustained minor injuries.

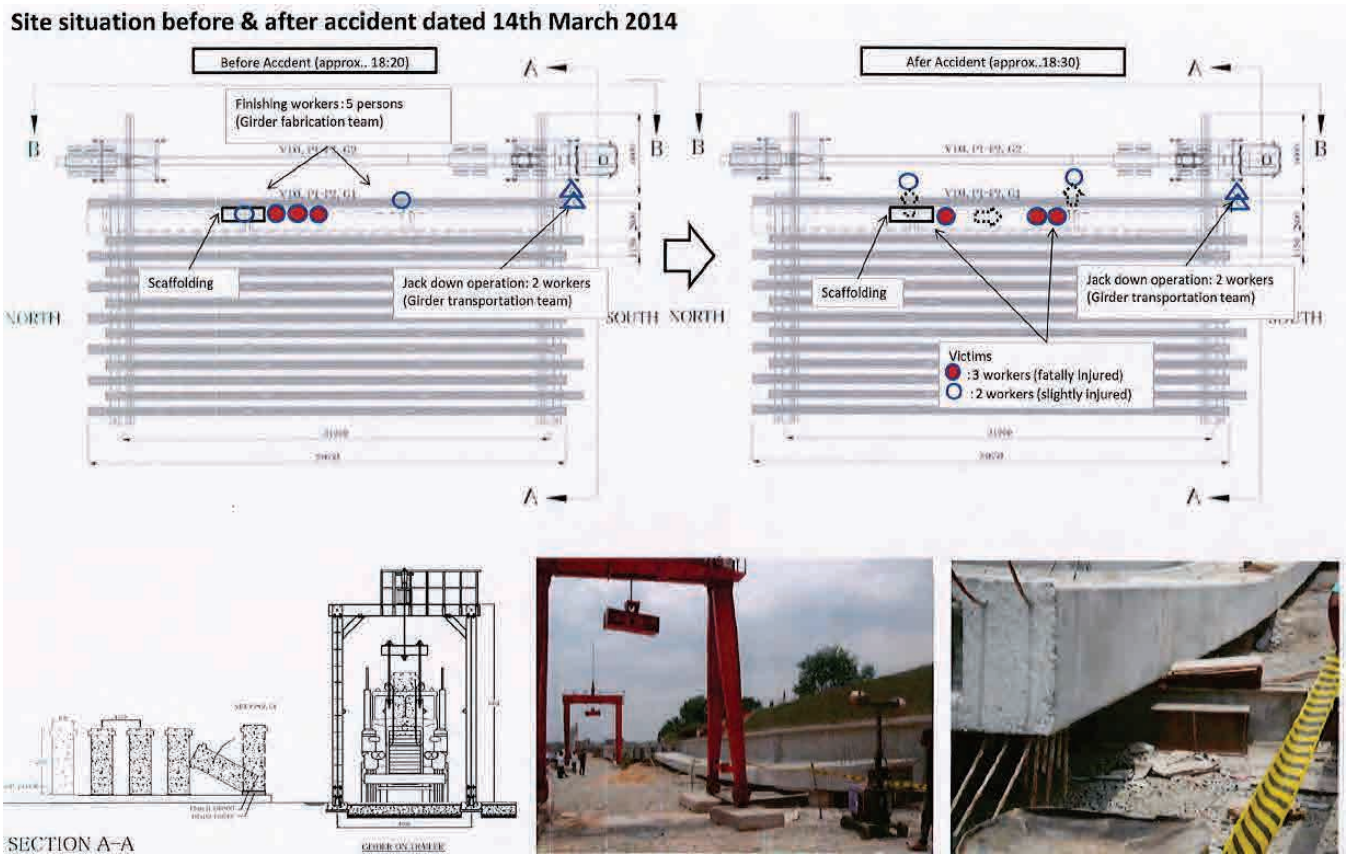


Fig. 4.4.1 Site Situation of Accident Caused by Toppling of PC Girder

2. Sequence of Events and Causes of the Accident Stated in the Accident Report by the Consultant

2.1 Sequence of Events

Table 4.4.2 Sequence of Events

1) Girder Shifting (~17:30)	The girder was slid by trolley to its designated position in order to create space for finishing work.
2) Transfer of the Girder	After sliding the girder, the girder was transferred from the trolley to the temporary supporting H-400 with steel H-100 as filler by 50t hydraulic jack at the north side. The trolley at the south side was fixed by a lever block.
3) Finishing Work (around 18:00~)	Chipping of the construction joint, re-bar work, cleaning work were started by the girder finishing team.
4) Transfer of Trolley at South Side (around. 18:20~)	The girder was transferred from the trolley to the temporary supporting H-400 with wood as filler at the south side. The girder transfer team was instructed to move the trolley to the stockyard of Viaduct 2.
5) Girder Toppled (around. 18:30)	The wood fillers were crushed and the girder toppled inward. Three workers were fatally injured and two workers slightly injured.

2.2 Statements of Relevant Persons

Table 4.4.3 Statements of Relevant Persons

1) Foreman for Girder Finishing (M, Philippines)	a) After the girder was shifted into the position, transportation foreman (J) informed us that finishing work could start. We then started work. b) First group of 2 persons belong to GEBS start chipping for the intermediate crossbeam. Within about 10 to 15 minutes the work was done, and they left the location. c) Foreman (M) entered the working area with other three workers belonging to Civitech to rectify the problem with the rebar at intermediate crossbeam. d) Foreman (M) worked on the Bity frame with other local worker whose name is I. e) After about 10 minutes, the girder toppled. f) Foreman (M) did not know the girder jack-up was on going at that time. g) Foreman (M) saw the girder come down to his side. He then jumped onto the girder and went over it.
2) Foreman for Girder Transportation (J, Philippines)	a) Around 17:30, he finished shifting the girder by 2m for the finishing work. b) He removed the trolley from the north side using a jack and the girder was supported on 2 pieces of H-100 with layers of plywood adjusting the height. c) He fixed the south end of the girder with a lever block because the south end was still supported by the trolley. d) After he shifted the girder, he informed the finishing team to start work. e) He went to a different location in the OB12 area to check the girder unloading from the fabrication yard. f) He planned to remove the south side trolley after he came back. g) When he came back to this area, the accident had already happened. h) He had enough nos. of H-100 to support both end of the girder.
3) Foreman for Girder Transportation (D, Sri Lanka)	a) He went to the V2 stock yard with Engineer Mr. (K) for preparation of the night shift work. b) (K) said to him that two trolleys were needed for night shift work, and one needed to be brought from the OB12 girder stock yard. c) He walked to OB12 girder stock yard. d) When he reached the OB12 yard, he saw the north side trolley was removed and two numbers of H-100 were installed under the girder. e) He started to remove the south side trolley. f) He jacked up and installed two pieces of wood instead of H beams, because he could not find H beams around there. g) After he removed the trolley, he started to lower the jack.

	h) After the girder touched the wood, the girder started to tilt and turned over. I) He said that before starting the removal work, he warned to the finishing team to move away from behind girder. But they continued their work.
4) Engineer for Girder Transportation (K, Pakistan)	a) He and foreman (D) went to the V2 girder stock yard to explain the night shift work for that day. b) At that time, he said to foreman (D) that two trolleys were needed for V2 yard shifting work tonight and to remove the trolley from OB12. c) Foreman D walked to OB12. d) After the explanation, he went to OB10 to meet another Philippine foreman (B) to explain night shift work. e) On his way back to OB12 after OB10, he was informed about the accident. At that time, he was near Viaduct A1 abutment with his car.
5) Worker for Girder Transportation (G, Sri Lanka)	a) He worked for south side trolley removal work with foreman (D). b) He said the north side trolley was removed first (time is uncertain) c) He installed 5 pcs. Of plywood under the girder. d) After removal south side trolley, the girder started to topple.
6) Worker for Girder Transportation (B, Sri Lanka)	a) He worked for south side trolley removal work with two other workers. b) The other workers were (G) and (P). c) He installed 50t jack under the girder. d) After removal of the trolley, he removed the jack. e) He was bringing the trolley to the boom truck with other workers. f) When he saw the girder, the girder had turned over. g) He said that it was approximately 10 minutes after removal of the trolley. h) He said that he warned to the finishing team to “get out”. But they did not do.
7) Worker for Girder Finishing (J, Sri Lanka)	a) Finishing work team foreman said to him to start the finishing work. b) He started work around 17:30 with other 4 members. c) When he did the work, suddenly he felt some movement of the girder. d) He jumped to outside ground and when he turned back, he found the girder had turned over. e) At 11 p.m. on15th March, his friend who works with foreman (D) called him, and then he knew what had happened at that time.

2.3 Causes of the Accident

Table 4.4.4 Causes of the Accident

1) Direct Cause	Overturn of the Girder
2) Root Cause	a) Usage of Inappropriate Materials: Instead of Steel H-beam, wooden materials were placed underneath the girder in order to remove the trolley. The placed wooden materials were two numbers of different size and also not strong enough to bear the girder load. b) Lack of Coordination: The removal of the trolley was not originally scheduled at the location where the accident happened, and simultaneous works (girder finishing and removal of trolley) took place due to lack of coordination.

2.4 Recommended Corrective/Preventive Safety Measures

Table 4.4.5 Recommended Corrective/Preventive Safety Measures

1) Usage of Appropriate Material	a) The usage of wooden materials for adjusting the height of the girder shall be strictly forbidden, Steel H-beams as stipulated in revised work procedures will be used to adjust height. b) Construction materials/equipment at the site for each phase of work will be managed by each yard foreman in order to prevent usage of inappropriate materials and equipment. c) The caution sign boards will be displayed in each yard to create awareness of the personnel deployed for girder works.
2) Review of the	a) The series of work procedures for girder transportation were reviewed detailing unloading,

Method of Statement	shifting and loading of girders at the temporary stockyard. b) Specified proper materials/equipment and their method of use shall be stipulated in the method of statement. c) The revised method of statement shall be well explained to the person who will be engaged for these specific works.
3) Qualification of Foremen/Workers	a) Through training, the Safety Manager and Engineer shall qualify foremen and workers for specified works such as jack operation and girder shifting. b) Qualified yard foremen will control the work complying with the revised method of statement and coordinate transportation work and finishing work. c) Workers not qualified are forbidden to perform specific works.
4) Restructure of Organization	In order to avoid miscommunication due to lack of coordination between the girder transportation teams and girder finishing teams, yard foreman will be appointed to coordinate works at the same location.
5) Strengthening of Safety Management	The contractor HQ will appoint and assign a Japanese safety manager who is competent in safety management.
6) Light Illumination for the Works	For work after 18:00, proper illumination shall be arranged before commencement of works. No work shall continue in the absence of proper illumination at the site.

3. Root Cause Analysis and Study for Countermeasures

1) Understandings of the Objective Accident

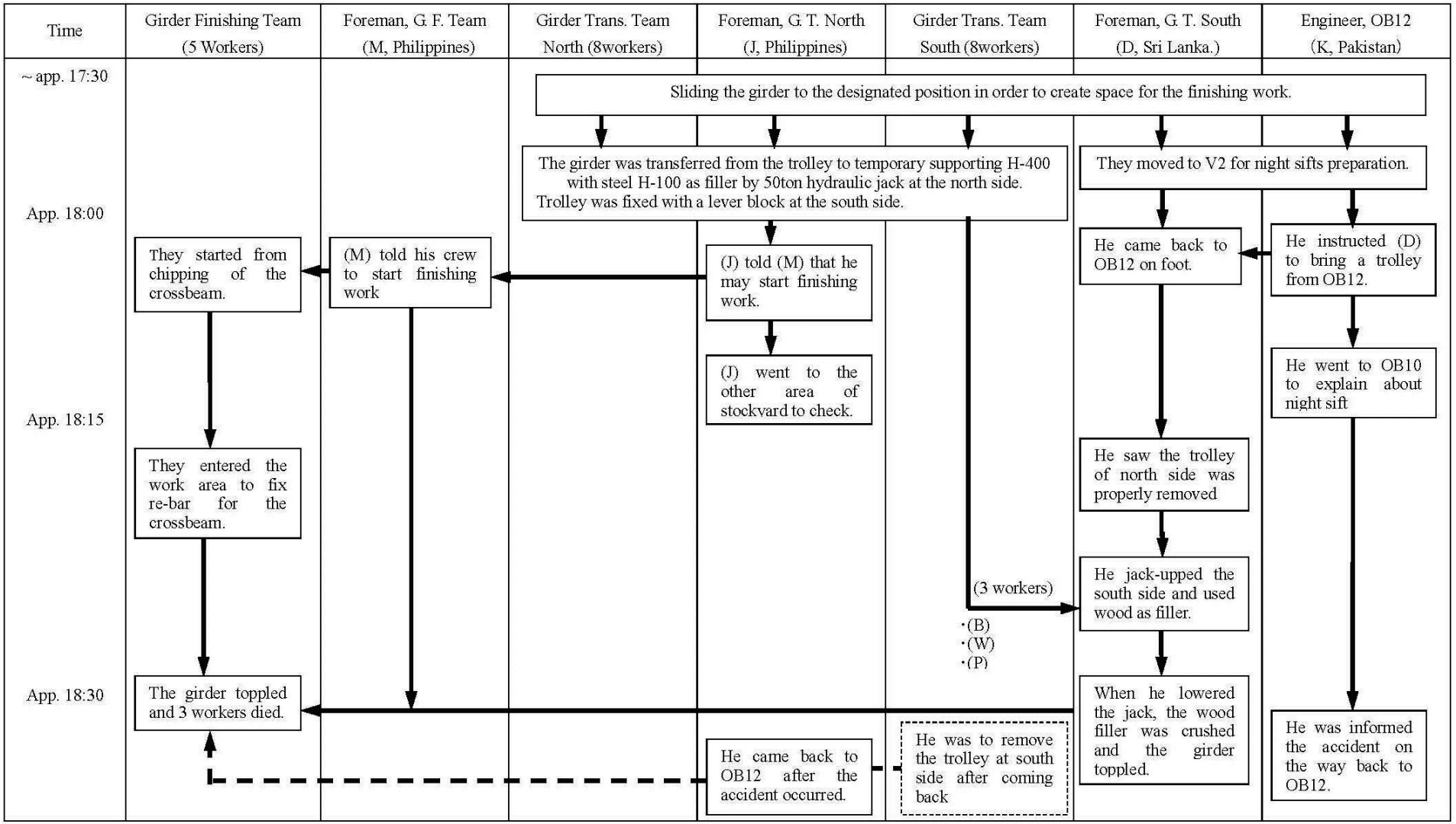


Fig. 4.4.2 [Progress Chart of the Objective Accident]

2) Why-why Analysis

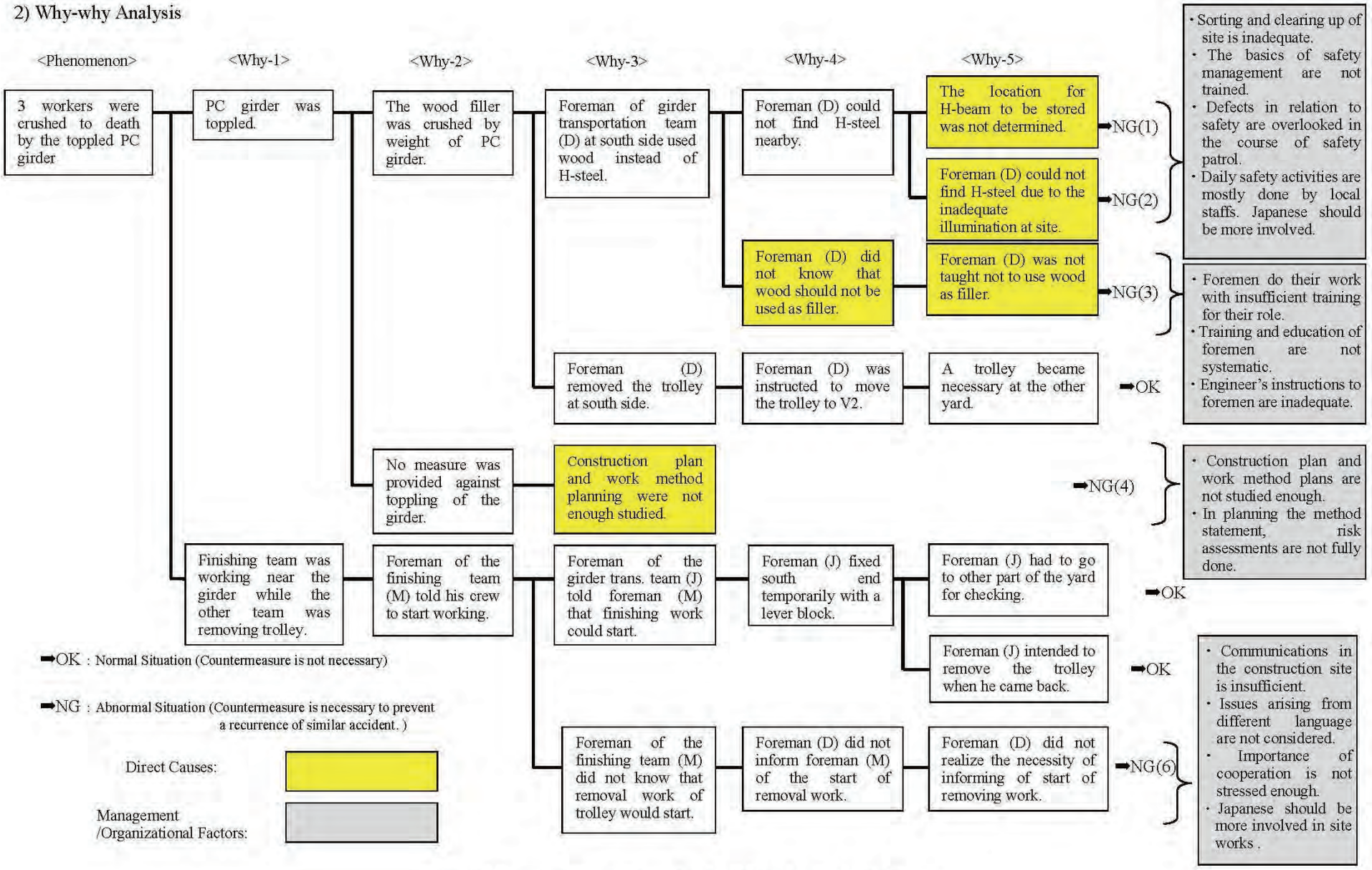


Fig. 4.4.3 Pursuit of Root Causes by the Why-why Analysis Diagram

3) Countermeasures against Direct Cause

Table 4.4.6 Provisional countermeasures to prevent recurrences of similar accidents

Direct Causes derived from Why-why Analysis (shown in yellow in the chart)	Countermeasure 1	Countermeasure 2	Countermeasure 3
1. Foreman (D: who is directly responsible for the accident) did not know that wood should not be used as filler.	Prepare a series of practical method statement showing every predictable risk and prohibited action.	Explain to and make the foremen fully understand the work, how to perform it and what they never are allowed to do.	-
2. The location for H-beams to be stored was not determined.	Keep everything in order in the site and clarify the locations where materials, equipment and tools are to be stored.	At the start and the end of the day, foremen shall check the numbers and location of objectives with his crew and record them daily.	-
3. Foreman (D) could not find H-steel due to the inadequate illumination at site.	Investigate and act quickly to create safe work environment by providing proper illuminations.	To achieve a safe work environment, recheck the site wholly from various points of view and confirm appropriateness of illumination.	-
4. Construction plan and work method planning were insufficiently studied.	Each aspect of work that contains dangerous factors shall be studied with special care and the result shall be reflected in both the construction plan and method statement.	At the planning stage of the work, risk assessment shall be practiced, and countermeasures if necessary, shall be included in the plan.	Reliable measures preventing toppling of girder shall be planned as quickly as possible and be applied at site.
5. Foreman (D) did not realize the necessity of informing the finishing team of start of removing work.	Make it a strict rule that the finishing work and other works which involve dangerous factors such as transporting girder shall not be done simultaneously.	Foremen must confirm that the site is clear of personnel except workers involved in the work directly.	-

4) Developing Management/ Organizational Factors

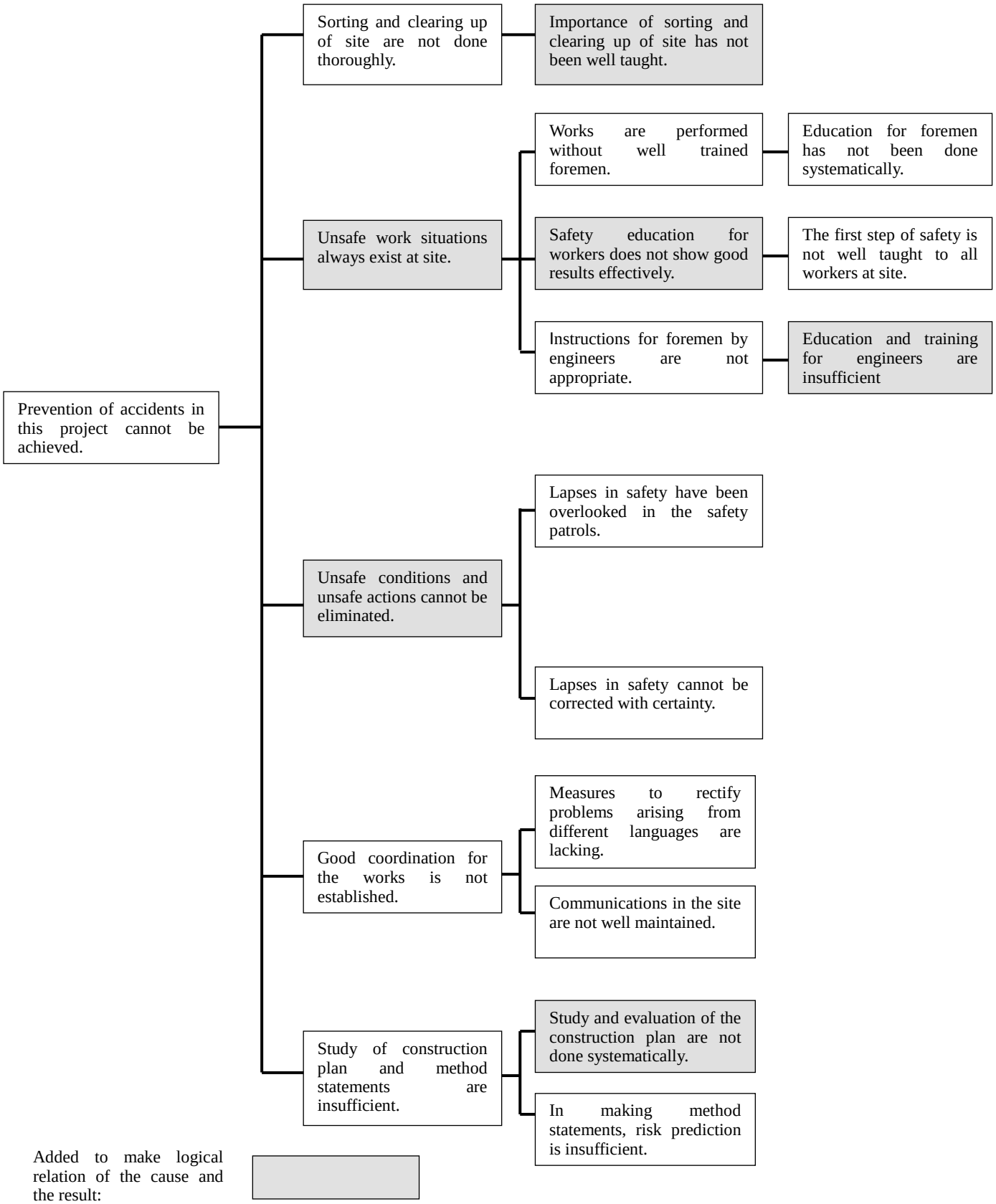


Fig. 4.4.4 [A Problem Tree Leading to the Accident] (Management/Organizational Factors)

5) Countermeasures for Management/Organizational Factors (1)

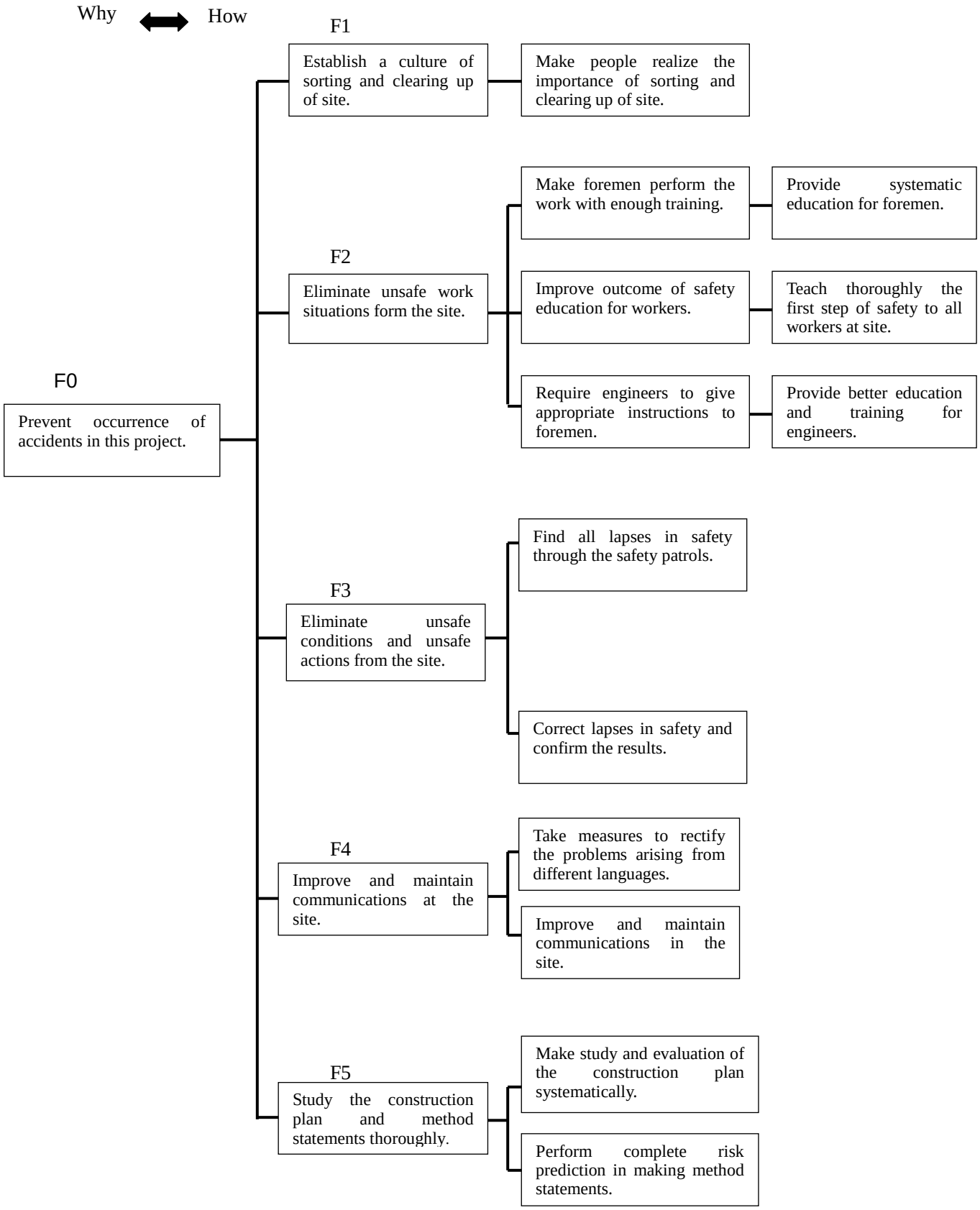


Fig. 4.4.5 [Function Tree to Prevent Grave Accident (Management/Organizational Factor)]

Convert the problems (in Problem Tree) by reversing to functions which are to be performed.

<Reference>

From the Function Tree obtained in 5) Countermeasures for Management/Organizational Factors (1), recommendations from the managerial and organizational point view will be derived by studying the actual situations and the to-be form.

As to the individual safety measures to be taken in OCH2 Project or other similar construction projects in the future, they should be studied carefully using the function tree and Value Engineering process. However, those measures must be constructed by those who concerned the project so that the measures will suit the characteristics and the actual conditions of the project. An example of the procedure to create the individual measures is presented as follows;

(1) Evaluation of Importance of Function Groups

Evaluate the order of importance among the function groups (F1~F5) by Forced Decision Method.

Table 4.4.7 Evaluation of Importance of Function Groups

	F1	F2	F3	F4	F5	Total	Rank
F1：Practice sorting and clearing up of site completely.		0	0	1	0	1	4
F2：Eliminate unsafe work situations from the site.	3		1	3	1	8	1
F3：Eliminate unsafe conditions and unsafe actions from the site.	3	0		3	1	7	2
F4：Improve and maintain communications at the site.	0	0	0		0	0	5
F5：Study the construction plan and method statements thoroughly.	1	0	0	3		4	3

[Forced Decision Method]

Compare importance of the functions from the customer's point of view by pairing each function.
Weight is given to the importance of the difference between functions.
(When the difference is large: 3 points, when the difference is small: 1 points)

Taking the above importance of the functions, many ideas are created freely for each function group. (Functions include the lower level functions which are positioned right side of the group.)

(2) Creating Ideas (Example of Brainstorming)

Table 4.4.8 Creating Ideas (Example of Brainstorming)

F1: Practice Sorting and Clearing Up of Site Completely.	(1) Initiate 5S movement. (Seiri (sorting), Seiton (clearing up), Seisou (sweep), Seiketsu (sanitary), Shitsuke (discipline)) (2) Reserve time for sorting, clearing up and sweep the site every morning and evening. (3) Determine location for storing of each piece of equipment, materials and tools. (4) Designate person (persons) responsible to confirm the level of neatness of the site. (5) Designate the above person alternately in the group. (6) Give award to the group/section which is evaluated as good by the safety patrol. (7) Educate all people that safety is always based on an orderly, organized site. (8) Place many placards to recommend sorting and clearing up the site. (9) Make a weekly (monthly) target regarding orderliness of the work site. (10) Recommend workers to offer ideas to their foreman regarding orderliness of the work site. (11) The foreman reports ideas and who offered them to his senior, the senior record it as nominee for an award. (12) Excellent work activities shall be presented in the monthly safety meeting. (13) Make a special facility to store materials/tools in the vicinity of the work place.

	(14) Emphasize the importance of sorting and clearing up of the site at the education for the new entrant.
F2: Eliminate Unsafe Work Situations Form the Site.	(1) All staff and local engineers shall fully understand that education of foremen is critical. (2) Review and reconstruct the training and education of foremen. (3) Make a systematic plan for training and education of foremen. (4) Staff and engineers shall cooperate to ensure proper and coordinated training content. (5) The education plan includes content that urges foremen to have strong sense of responsibility. (6) Review the education and training for new entrant to the project. (7) Practice safety education regularly. (8) When any part or procedure of the work is changed, the changed work method must be shown as specifically as possible. (9) Give opportunities to improve knowledge and capabilities of the engineers who direct works at the site. (10) Provide training to engineers to improve risk prediction capability. (11) Engineers taking charge must join the safety patrol at any time. (12) Engineers shall study the method statement thoroughly to identify any chance of hazard in the work. (13) Make a system to revise and improve a method statement in case any improper matter exists. (14) Provide safety education tools and materials for workers. (15) Investigate education tools used in Japan, and translate appropriate ones to local language. (16) Recommend foremen find out hazards hidden in the work and report them to relevant engineers. (17) Staff (Japanese) should not necessarily accept the local manner of doing work, but rather share the problems with the engineers and improve them. (18) Staff (Japanese) practice “pointing and calling” movement and spread it among engineers and foremen.
F3: Eliminate unsafe conditions and unsafe actions from the site	(1) Indicate defects in workmen’s clothes and PPE on a regular and sustained basis. (2) Arrange working environment so that safety belts can be used readily. (main rope for safety belts, device for decreasing frequency of changing the position for safety belts etc.) (3) Conduct a surprise safety patrol periodically. (4) Direct rectification of any lapse immediately in front of the safety patrol team. (5) Japanese staff practices more actively in the safety meeting to increase their participation in the safety matters. (6) All Japanese staff from the project manager to junior staff shall conduct a daily site patrol, including a safety point of view. (7) During the daily safety patrol, a safety armband must be worn. (8) The safety engineer will report the results of the safety patrol conducted by staff in charge of safety to the project manager and advise him of the important findings. (9) With regard to any unsafe situation, the staff in charge of safety makes correction plan in cooperation with the safety engineer within the same day. (10) Establish not only execute measures to correct lapses but also confirm and report the corrections. (11) Conduct safety patrols making important points for the day clear. (12) In the elimination of unsafe conditions, consider essential review of the method of the work, too. (13) Regarding lapses pointed out by the safety patrol, conduct not only execution of the correction but also evaluation of the result of improvement. (14) Record the names of workers and foremen who were cautioned for their unsafe actions and consider penalties to them when the cautions are accumulated. (15) In the morning meeting, Japanese staff speak out actively not rely on the local staff. (16) Contrive to improve safety knowledge and ability for predicting hazards in the morning meeting and other occasions. (17) Spare short period for meditating to pray safety at the end of the morning meeting in order to awake safety works again. (18) Check workers clothing and safety gears in the morning meeting and ban improper workers from the work for the day. (19) In the safety meeting or safety education, make a foreman present his safety theme given beforehand.

	(20) Make engineers express in the meeting that he will execute his task with what kind of safety target.
F4: Improve and maintain communications at the site.	(1) Japanese staff shall take initiative to greet to everybody in the site including workers. (2) Japanese staff makes effort to be able to call at least all foremen by their names. (3) Japanese staff shall actively talk to foremen who do speak English. (4) Japanese staff shall actively talk to foremen who do not understand English with other foreign foreman as an interpreter. (5) Japanese staff shall make effort to learn local language even a prattle talk. (6) Encourage foremen and engineer to have a party in the work teams or in the work section, Japanese staff should mingle with local workers. (7) Have a party occasionally with the budget of the project. (8) All Japanese staff makes effort to understand the local customs and respect them. (9) Praise workers at the very site when he works very well. (10) Try to find good points of the work or the worker and express a satisfaction for it.
F5 : Study the construction plan and method statements thoroughly.	(1) Determine the degree of the planning by clarifying what the crucial works are in the project. (2) Planning shall be made considering safety/hazard will change by the construction/work method. (3) In planning method statements, utilize risk assessment. (4) For the hazardous works, study countermeasures and measures for improvement thoroughly. (5) In making the construction plan, make the most of all organizational capabilities as a company not relying on individual or small group's ability. (6) The construction plan must be evaluated by more than two experienced engineers with similar construction project. (7) Establish the system of evaluation and approval for the construction plan. (8) Collect and utilize data of construction plans of similar projects. (9) Never rely on a single example of construction plan of similar work. (10) Make use of other accidents in similar works to reflect in the construction planning.

(3) Rough Evaluation of Ideas to Development of Measures

a) Rough Evaluation of Ideas

Evaluate ideas in each function groups by proper evaluation factors such as the possibility of function realization and the easiness of execution. In this step, the possibilities of the ideas should be respected as much as possible to nurture each idea. Only ideas with no possibility to contribute the function (purpose) are discarded in this process. Any ideas which have even very slim possibilities shall be brought to the next step.

b) Development of Measures

- Develop ideas in each function group by arranging, modifying and combining. (Basic idea concepts)
- Synthesize idea concepts by combining in various function groups and make alternative measures.
- Alternative measures can also be made in a single function group depending on the direction or needs of study for improvement.

c) Evaluation to Planning and Execution

- If there are some alternatives for same function/purpose, select the best measure by relative evaluation using evaluation factors determined in the rough evaluation step.
- Make a development and execution plan for each measure adopted. The plan must be shown in a manner of 5W1H (What, Who, When, Why, Where, How) and describe the point that special attention to be paid, and method to confirm the status of execution and effect, and also how to follow up the movement.

4.4.2 Root Cause Analysis of the Accident Caused by Broken Boom of Crane

(2013/02/01)

1. The Accident

[Outline, situations and causes of the accident are derived from the Crane Accident Investigation submitted to the Employer by the Consultant.]

[Outline of the Accident]

The operator while lifting and swinging the H-beam (400×400×6.5 meter) using 65 ton crawler crane installed at an angle instead of being leveled, the auxiliary hook and the boom controlling lever (upward and downward), malfunctioned and the movement of the boom went out of control. The lattice boom (length 30 m) with main hook and hook with load freely moved upward giving way to the welded joints of the boom end. With the welded joints giving way, the boom and hooks with load suddenly fell down to the roof of a house, located adjoining the Right of Way. The main hook fell on the van which was parked by the house. The auxiliary hook fell on to the roof of the house. The boom of the crane, rested on its roof.

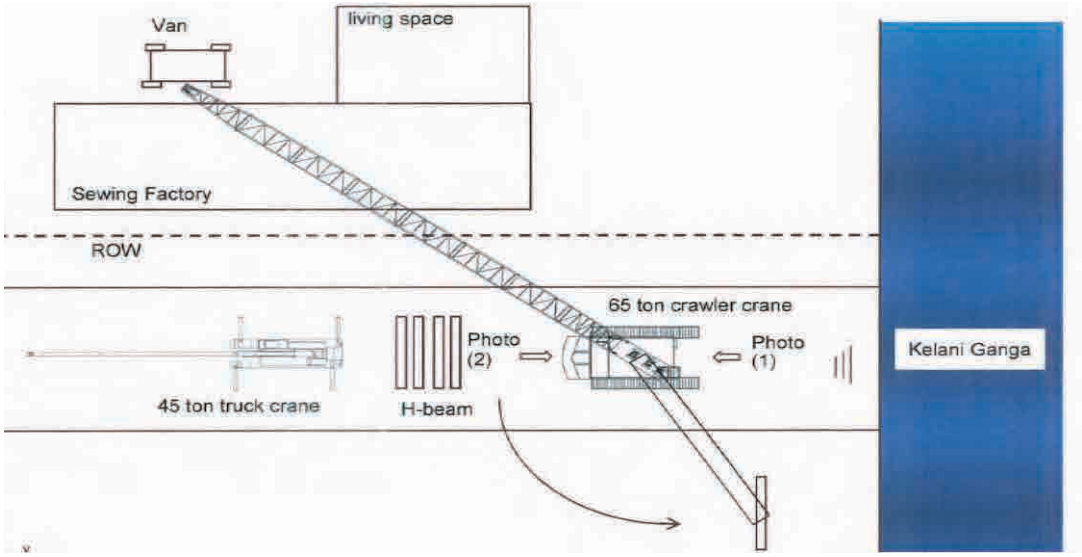


Fig. 4.4.6 Site Situation of Accident

2. Sequence of Events and Causes of the Accident Stated in the Accident Report by the Consultant

2.1 Sequence of Events

1) Findings by Investigation

(1) Through investigation, it was brought to light that one boom stopper was missing (see photograph) when the very same crane was working at the south bank of Kerani River. (The contractor protests that the fact has not been confirmed.)

(2) Pictures taken after the accident do not show clearly whether both boom stoppers were in place.

(3) But every possibility is that it worked with only one boo stopper as it had been working in South Bank.

(4) The photographs taken of the wreckage after the accident does not show that both stoppers were in place.

(5) According to the contractor, they had fixed the damaged boom stopper during work in the North Bank

Photo 4.4.1 Crane without stopper

2) Causes of Accident

Table 4.4.9 Causes of Accidents

Immediate Causes	(1) Disabling safety devices (The Boom Limit Switch Contacts did not function while lifting the boom) (2) Failure to follow procedure (Prior to operating the crane, the operator had not leveled the equipment and checked the safety devices). (3) Combination of unsafe moving and placing of equipment (At the time of incident, the crane was on an inclined position.)
Indirect Causes	(1) Inadequate maintenance (If proper maintenance was done, it would not have been possible to detect the safety devices failure.) (2) Inadequate training (The operator was not aware of the safety devices installed on the crane.) (3) Improper attention (The operator may have been distracted and not been in proper attention during boom moving up.) (4) Inadequate job planning (The residence/factory existed very near to the working area.) (5) Wear and tear (Due to lack of attention on maintenance)
Root Causes	(1) The operator could have been distracted. If so, why did it happen? No reason could be given. (2) Was a safe work procedure being followed? : No. If not, why not? Basic requirement of leveling the equipment was not followed. (3) Were safety devices in order? : No. If not, why not? Was it lack of maintenance and/or lack of attention by the supervisors? (4) Was the operator trained? : If not? Why not? Experienced operator, recruited new to the equipment, there is no system introduced to advice to implement pre-inspection of the crane safety devices prior to starting of any work. (5) The root case for the accident was lack of supervision by the contractor staff.

3. Root Cause Analysis and Study for Countermeasures

1) Understandings of the Objective Accident

[Progress Chart of the Objective Accident]: Omitted because of the simplicity of the incident.

2) Why-why Analysis

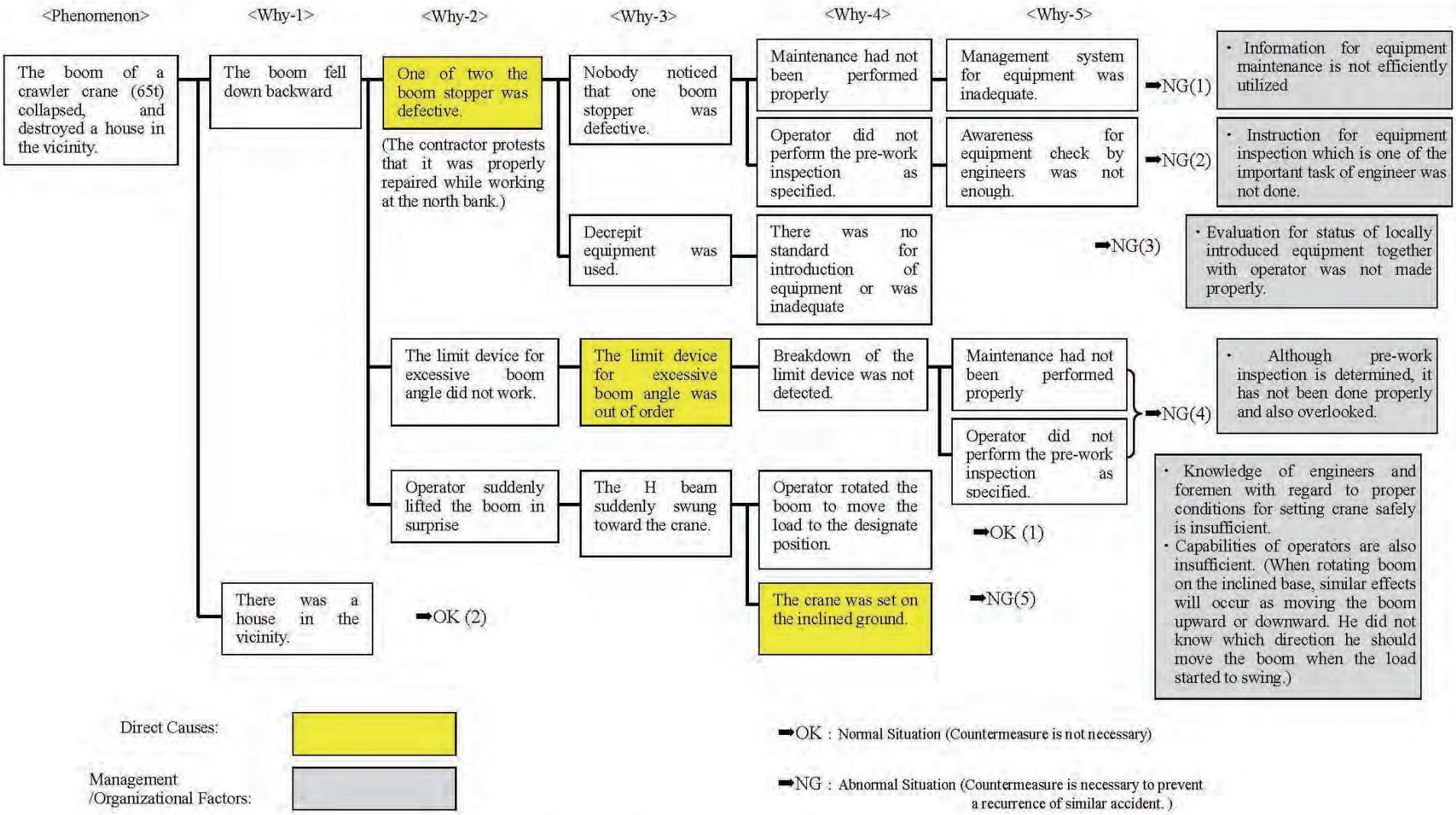


Fig. 4.4.7 Pursuit of Root Causes by the Why-why Analysis Diagram

3) Countermeasures against Direct Cause

Table 4.4.10 Provisional countermeasures to prevent recurrences of similar accidents

Direct Causes derived from Why-why Analysis (shown in yellow in the chart)	Countermeasure 1	Countermeasure 2	Countermeasure 3
1. One of two the boom stopper was missing. (Based on an assumption that the above cause is true. It is said that the contractor repaired the defect during the work at the north bank. However, the second stopper was never found at the accident site.)	Establish a system to perform maintenance as determined and to confirm the result. And execute maintenance work as planned. Check the degree of decrepit of equipment and if judged as substandard, never use them.	Direct that engineers and foremen shall always inspect the outside of equipment which they are going to use before commencing work of the day.	-
2. The limit device for excessive boom angle was out of order. (It is inconceivable that the operator nullified the safety limit device deliberately. Also, when he noticed excessive lifting of the boom, he tried to lower it but the boom continued to lift. Did the equipment was malfunctioning or did he operate adversely. This is another question)	Establish a system to perform maintenance as determined and to confirm the result. And execute maintenance work as planned. Make operator perform pre-work inspection as determined according the items in the check list and the engineer confirms the result.	-	-
3. The crane was set on the inclined ground.	Observe the fundamental rule to install a crane on flat and solid ground as possible. If it is inevitable to set the crane on a inclined ground, select position which will not effect to vicinity in case of accident.	Educate and train operators the relationship between the direction of boom rotation and the swing of the load when the crane is on an inclined ground. (In such a case of the accident in question, operators tend to act instinctively that is, one of the human errors, thus, hard to prevent. However, it can be reduced by education and training.)	-

4) Developing Management/ Organizational Factors

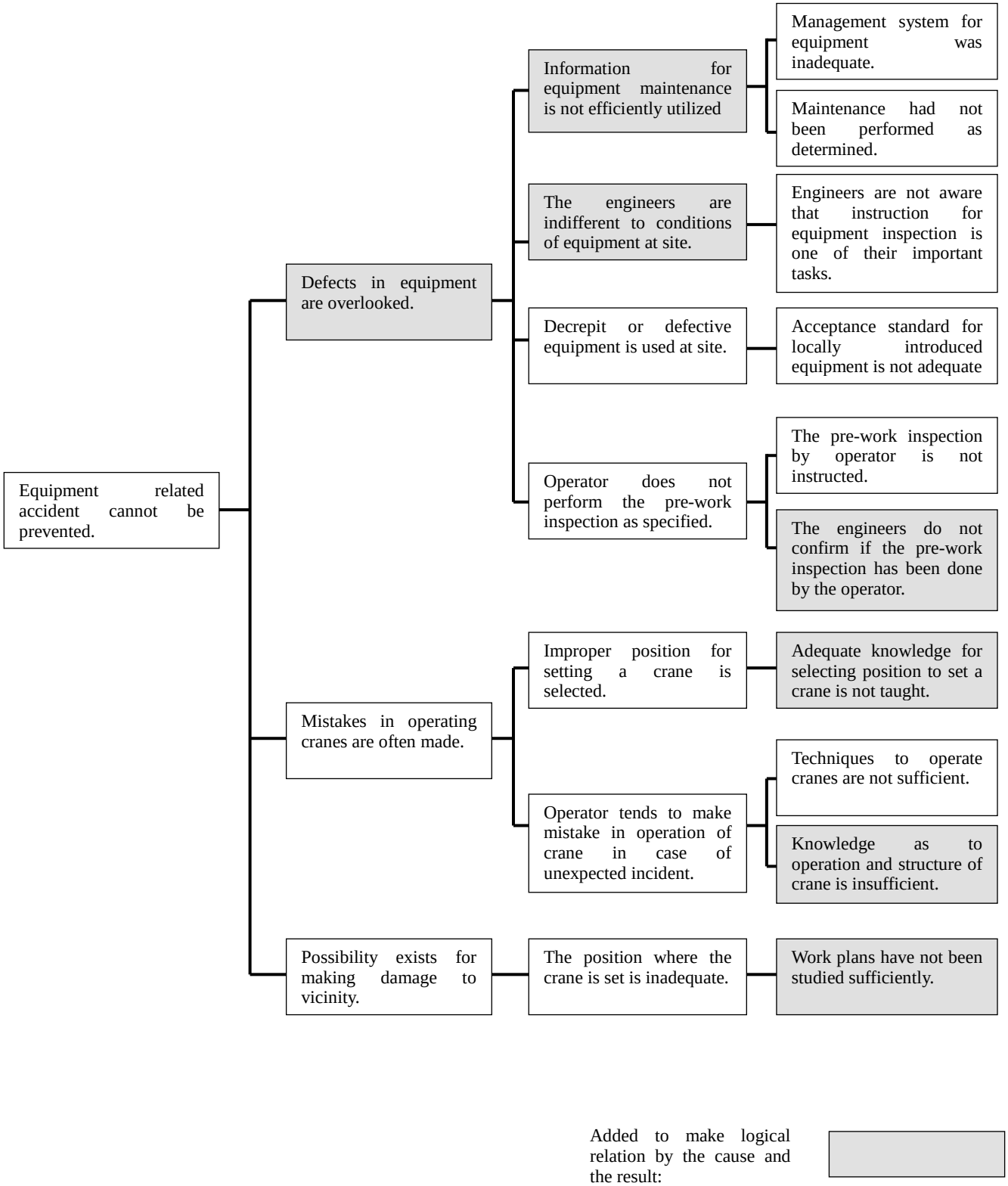


Fig. 4.4.8 [A Problem Tree Leading to the Accident] (Management/Organizational Factors)

5) Countermeasures for Management/Organizational Factors (1)

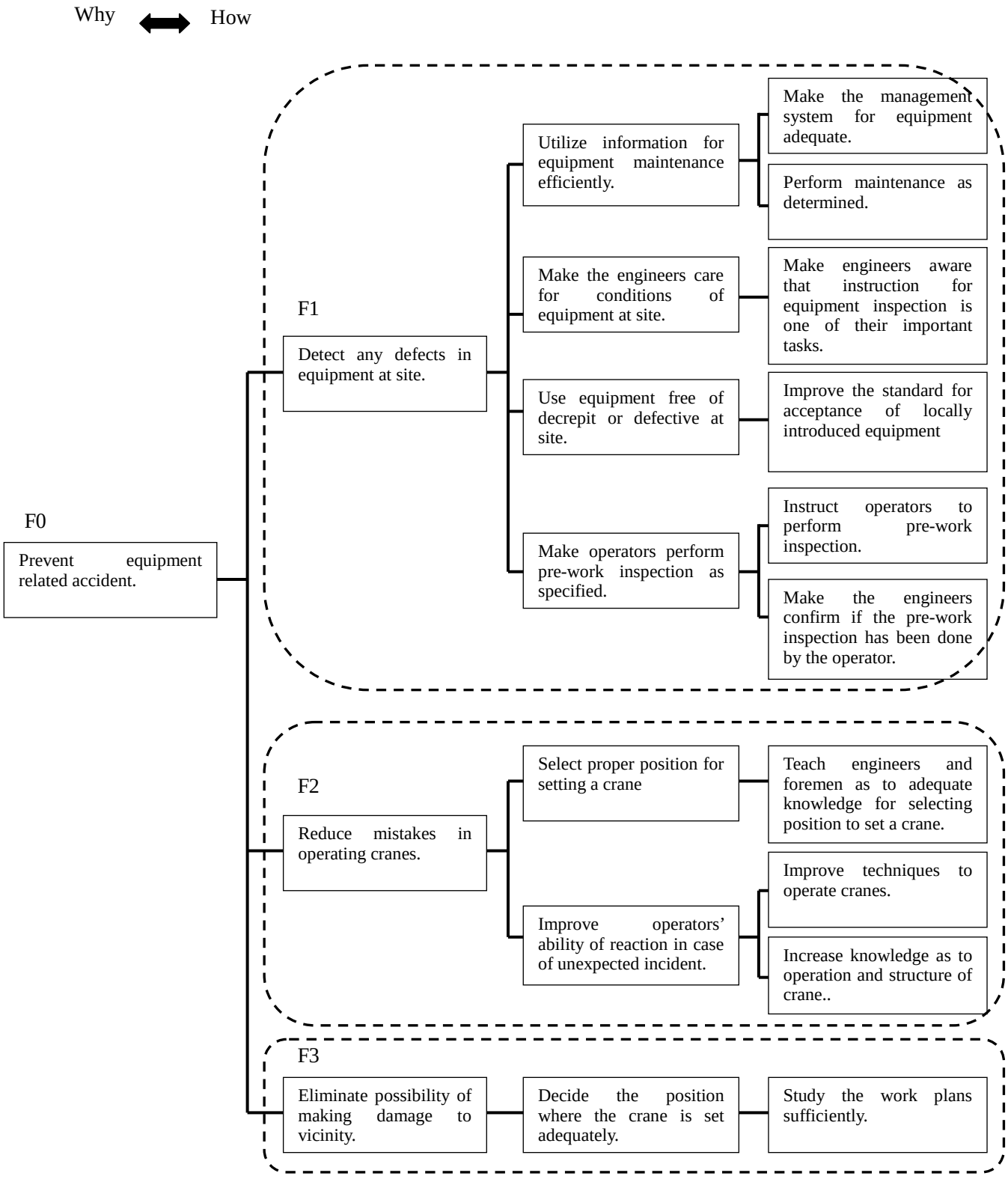


Fig. 4.4.9 [Function Tree to Prevent Grave Accident (Management/Organizational Factor)]

Convert the problems (in Problem Tree) by reversing to functions which are to be performed.

4.4.3 Root Cause Analysis of the Accident Caused by Falling from Pier by Passing Out

(2014/08/03)

1. The Accident

[Outline, situations and causes of the accident are derived from the Crane Accident Investigation submitted to the Employer by the Consultant.]

[Outline of the Accident]

On the pier head at Pier No.2 of Viaduct 1 at A1 Bypass, a worker named (A) was working at night sift with other six workers carrying out preparation work for bearing plinth. Suddenly he felt sickness and headache, and sat in on the pier. Then he passed out and fell from the pier head through the lower gap of guardrail into the water filled pier base which depth was about one meter. A fellow worker who was working with him has seen the fallen worker was waving his hand sitting on the bank of the pier base excavation. Immediately ha came down, helped him to come out from the water and took him the hospital for treatment.

Viaduct 1 Pier No.2 at A1 Bypass

Top of the Pier

Shed by Tarpaulin

Photo 4.4.2 Site Situation of Accident

2. Sequence of Events and Causes of the Accident Stated in the Accident Report by the Consultant

2.1 Sequence of Events and Causes of the Accident

Table 4.4.11 Sequence of Events and Causes of the Accident

1) Sequence of Events	(1) On 2nd August 2014 as usual the contractor started working at site at 07:00. (2) The Worker (A) who fell down form pier head and one of his co-workers (M) also started working at 07:00. (According to Taisei's information, the work was suspended from 18:00 to 22:00 for a break.) (3) (A) was scheduled to work continuously at both day and night shift, granting him a day off on 3rd August subsequently. At around 22:00 most workers including two foremen left, and at around 23:50, (M) the co-worker also departed. Hence only (A) with few night shift workers were working on the pier head at the time of the accident. (4) The working crew consisted of eight workers and one technical officer (D) and one site engineer (T). They were engaged in the preparation work for bearing plinths on Pier No.2 of Viaduct No.1 at A1 Bypass. (5) (A) was busy with re-bar dowelling works. He mixed adhesive chemicals and poured into holes into the concrete. He was instructed to do this task by his immediate supervisor (L). (6) At the corner of the left side pier there were few bags of cement grout kept under a tarpaulin shelter. (A) used this place to mix chemicals. At around 01:55 on 3rd August he opened a container of high performance building adhesive Sikadur A and Sikadur B. When he opened the Sikadur B adhesive he felt an irritant sensation of his nose, throat and eyes since (according to him) he opened the container close to his face. (7) (A) mixed the chemicals and poured into the holes starting from the left side corner of the pier head and continued his work for another 30-35 minutes. By this time he had blurred eye sight and some difficulty with breathing. At around 02:35 the rest of work crew started cleaning the bearing plinths by compressed air starting from the middle of the pier head. Due to the cloud of dust all other workers except (A) moved toward the right hand side of the pier. (8) By this time (A) realized that he felt dazed and wanted to drink some water. Hence he went under the tarpaulin shelter where it was and tried to drink but was unable to do so. It was then that he felt that he was going to faint. Subsequently, he apparently sat down near the side guardrail at the shelter area and fainted. He has no memory of what happened next. (9) Nobody saw (A) fall from the pier head. According to (A) he found himself in the water and realized he had fallen from the pier head. He then managed to get out of the pond and cried for help. But nobody heard him due to the loud noise of the compressor. Later one of co-workers noticed that (A) was in trouble sitting on the pier base excavated dirt and came down to assist. With assistance (A) walked to a vehicle parked nearby and requested help. He was taken to the Rgama Hospital and subsequently shifted to the Nawaloka Private Hospital. (10) After taking X-rai report and CT scan report, the doctor observed there was no immediate danger to his life. However, he had mud in his lung and was still undergoing medical treatment and recovering from the shock.
2) Findings after the Accident	(1) The pier is approximately 12.0m in height. Its head width is 2.0m. The top of the head is stepped. (2) As protection for falling, the pier head was provided with a fence using GI pipes except at the girder placing location. The girder placing location was covered by nylon ropes. The GI guardrail consisted with top-rail and mid-rail. Its height varied from 960mm to 1060mm. Toe board was not installed at the base of the fence. (3) Workers were provided with safety belts at the time of incident time. But nobody used them as the work group was moving here and there to undertake various work tasks. (4) Netting around the pier head was not provided. (5) Access to the pier head was constructed by scaffoldings and GI pipes. A few safety lapses were noted at the access to the top of the pier such as non-availability of handrails, missing plates and toe boards, slippery ladder access and unprotected gaps, etc. (6) No protection gear was provided against chemical hazard arising from using the adhesives. (7) Before the incident happened, neither any safety officer nor the work-in charge officer inspected the work location. (8) At the time of incident time, the site engineer stayed on the ground beyond the working area.

3) Presumed Direct Causes	<The direct causes were presumed due to the situation as mentioned below.> 1. There was no eye witness to this incident. 2. As stated by the victim, he fainted and lost memory as to what happened at the time on the incident.
<Direct Causes>	(1) Drowsiness is caused due to inhalation of these hazardous chemicals. (2) The victim had worked continuously for 19 hours. Hence he certainly must have been extremely tired.
<Indirect Causes>	(1) Deficient safety facilities such as lack of toe board at the guardrail, etc. (2) Poor supervision is evident as the victim had managed to come out from the water and inform a driver who was resting close by. This entire incident sequence progressed without knowledge of supervision.
<Root Causes>	(1) Inadequate awareness and adoption on fall protection procedure a) Inadequate fall protection procedure to prevent the risk. b) The contractor's initial safe work procedure preparation in the Safety Plan mentioned the procedures and the safety devices which shall be adopted to provide safe work at heights. But implementation of these procedures on site is inadequate. c) Inspection procedures instigated by the Contract Document are not executed. d) In Monthly Safety Committee Meetings, the risk of falling from the height was addressed several times. But the contractor did not act immediately to prevent accident form happening. (2) Inadequate risk analysis on chemical use. a) Proper risk analysis was not done for activities which apply to dangerous chemicals. b) Availability of material safety data sheet at site, personal protective equipment for hazardous chemical handling and first aid facilities, were either not known and therefore, not observed or completely unknown. (3) Inadequate supervision on labor arrangement a) Labor arrangement for site works as not supervised properly. As the contractor is hiring workers from labor supply companies, the monitoring of the workers and supervision of labor arrangements are problematic.

3. Root Cause Analysis and Study for Countermeasures

1) Understandings of the Objective Accident

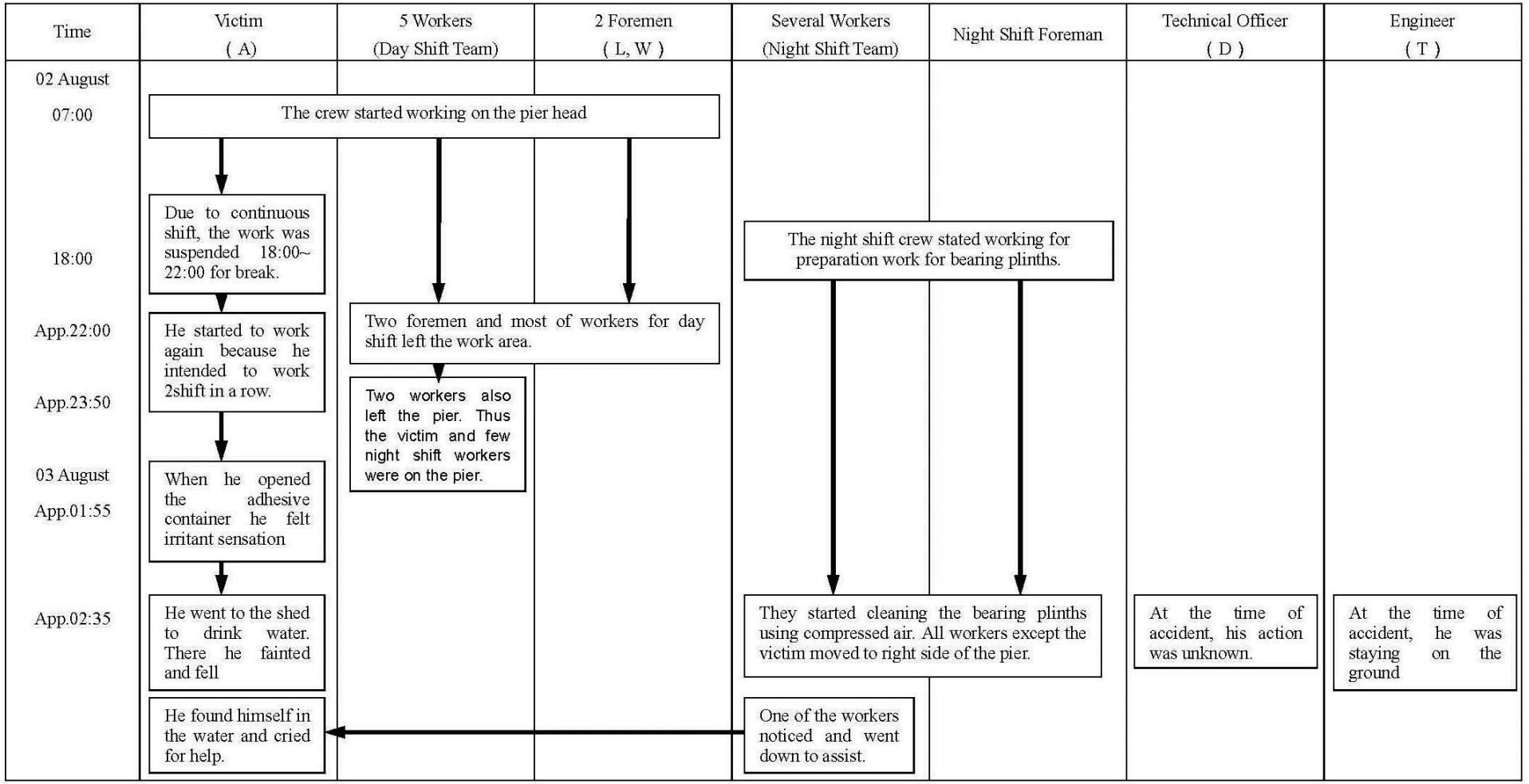


Fig. 4.4.10 [Progress Chart of the Objective Accident]

2) Why-why Analysis

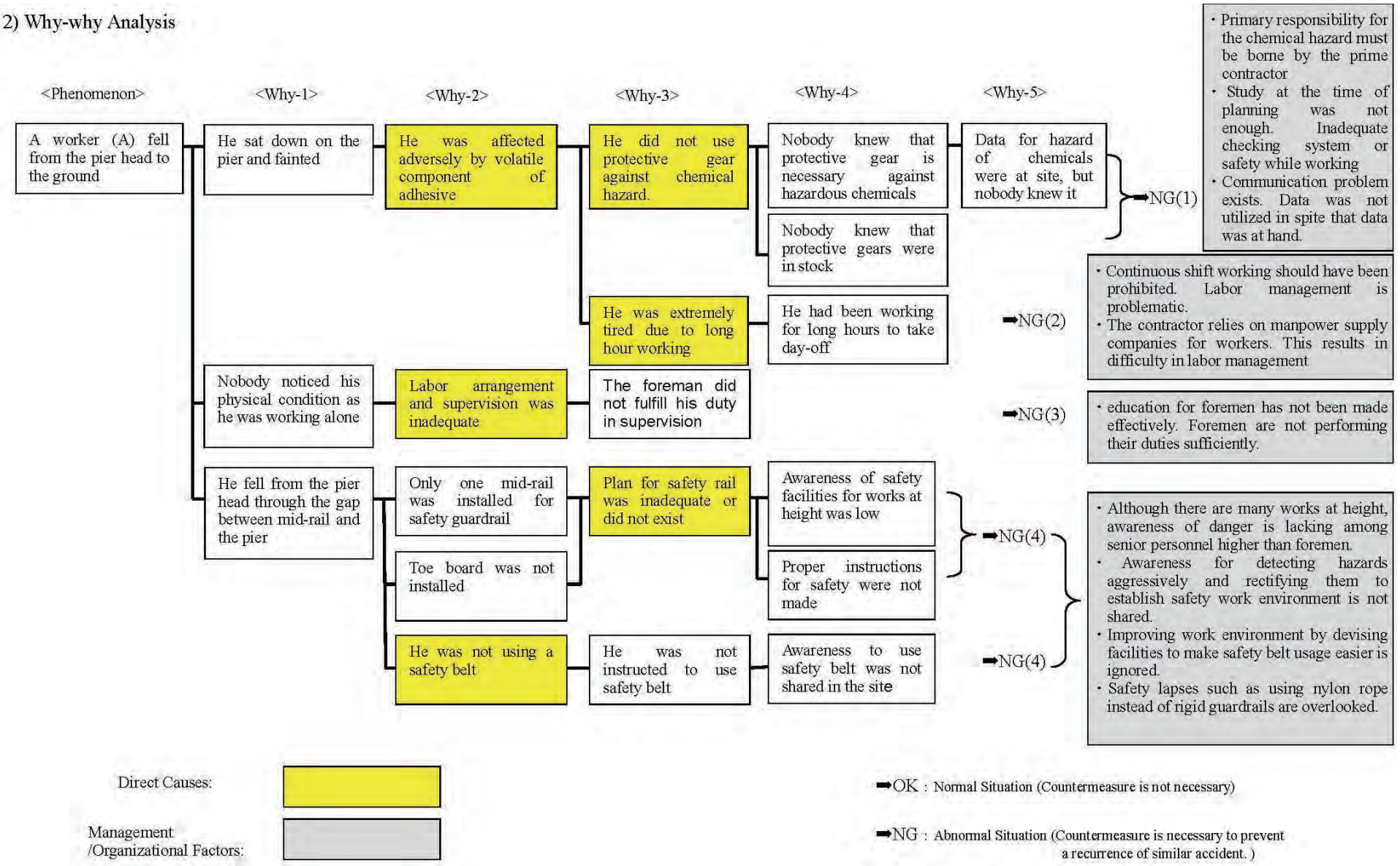


Fig. 4.4.11 Pursuit of Root Causes by the Why-why Analysis Diagram

3) Countermeasures against Direct Cause

Table 4.4.12 Provisional countermeasures to prevent recurrences of similar accidents

Direct Causes derived from Why-why Analysis (shown in yellow in the chart)	Countermeasure 1	Countermeasure 2	Countermeasure 3
1. He was affected adversely by volatile component of adhesive 2. He did not use protective gear against chemical hazard	Correct and update data for chemicals to use and reflect necessary measures to the work plan. In accordance with the work plan, every worker is forced to ware necessary protective gears.	-	-
3. He was extremely tired due to long hour working	Although workers are mostly supplied by manpower supply companies, the prime contractor will take the first responsibilities in labor management. Establish a limit for the work hours a day and observe strictly.	Review the system for labor management at site so that the actual status of site workers can be obtained effectively.	-
4. Labor arrangement and supervision was inadequate	Make foremen understand properly their responsibilities and roles. Make engineers confirm if their foremen are properly performing their jobs.	Establish a systematic foreman education program, and carry out it rightly.	-
5. Plan for safety rail was inadequate or did not exist 6. He was not using a safety belt	Substandard guardrails shall not be overlooked, if exists, rectify it immediately. For the safety patrol, check for safety guardrails shall be made as one of the highest priority. For works at height make using safety belt mandatory and carry out firmly.	Usage of ropes for substitution of guard rails shall be strictly prohibited. If necessary, install detachable guardrails. Devise installation of main rope for safety belts so that it will not interfere with relevant works.	-

4) Developing Management/ Organizational Factors

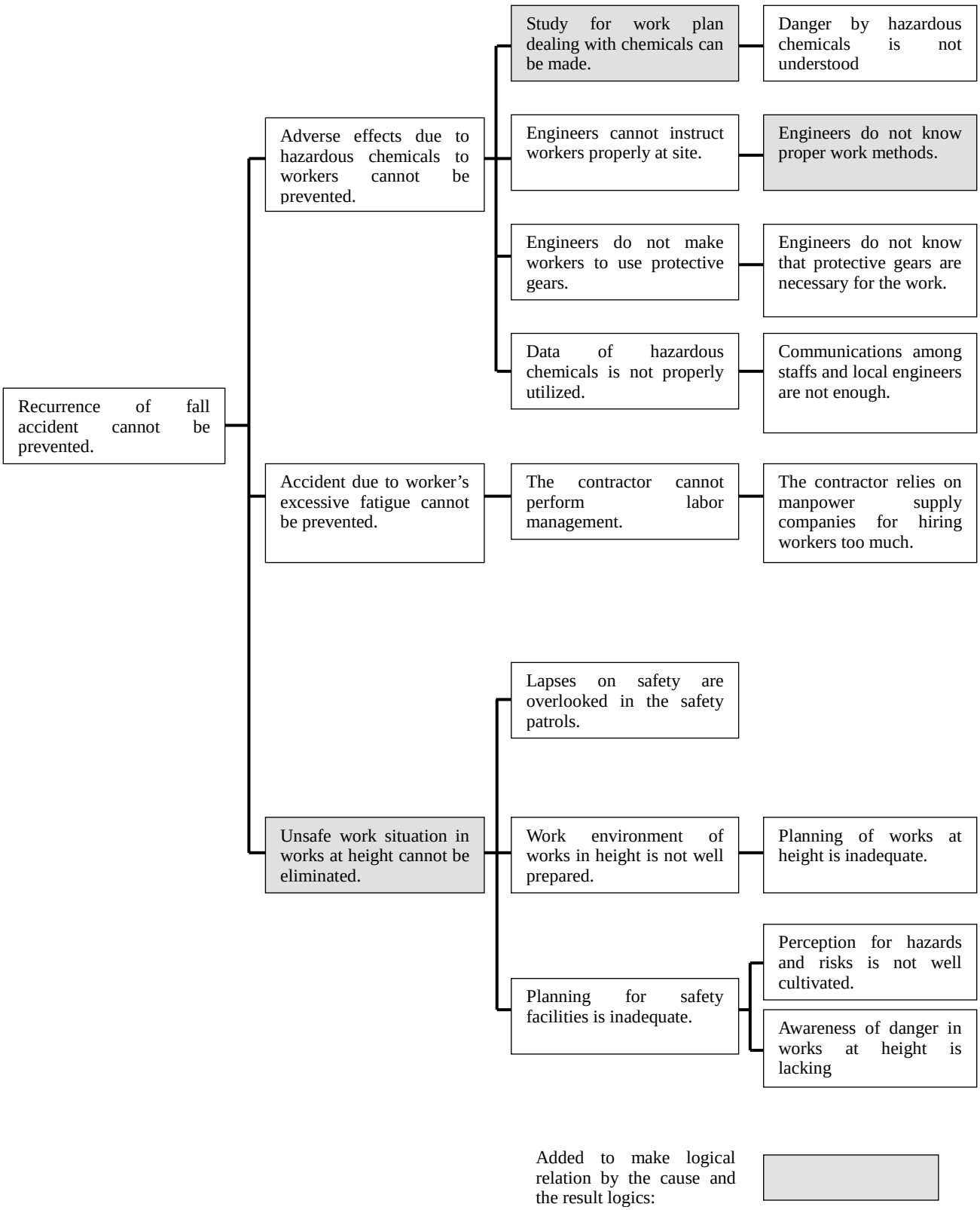


Fig. 4.4.12 [A Problem Tree Leading to the Accident] (Management/Organizational Factors)

5) Countermeasures for Management/Organizational Factors (1)

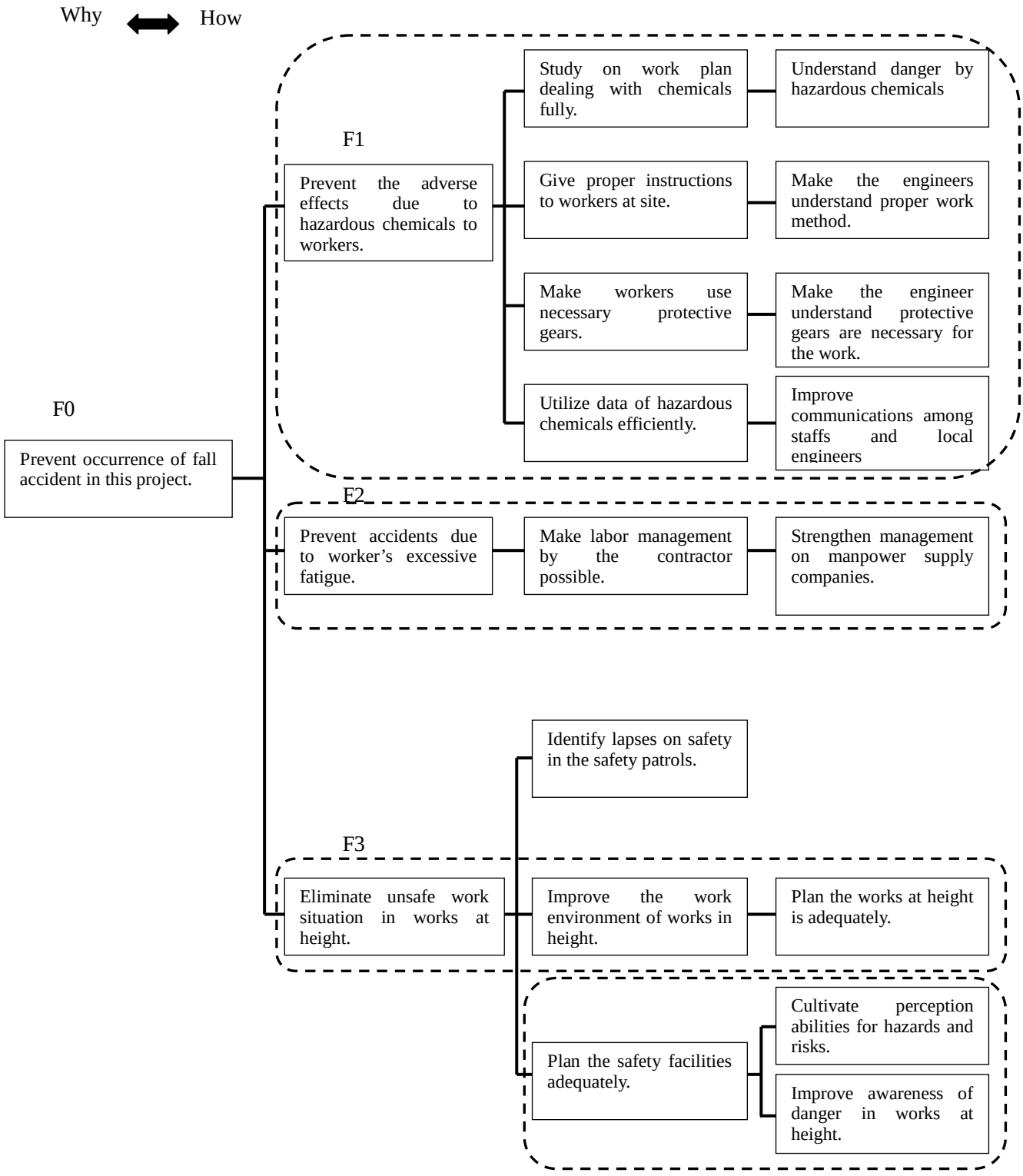


Fig. 4.4.13 [Function Tree to Prevent Grave Accident (Management/Organizational Factor)]

Convert the problems (in Problem Tree) by reversing to functions which are to be performed.

4.4.4 Root Cause Analysis of the Accident Caused by Falling from the Girder

(2014/08/06)

1. The Accident

[Outline, situations and causes of the accident are derived from the Crane Accident Investigation submitted to the Employer by the Consultant.]

[Outline of the Accident]

On August 06, 2014 one worker fell down from 9.0 m high place of the Viaduct No.4 on to the muddy ground. The victim suffered cracked bone injuries of his wrist and backbone but no danger to his life.

A crew of five workers including a foreman was working on the deck slab of the Viaduct. The worker who fell said that he fell through the opening to the ground, because of a sudden movement made by him as he was afraid of being knocked by the crane hook.

Photo 4.4.3 View of the Accident site

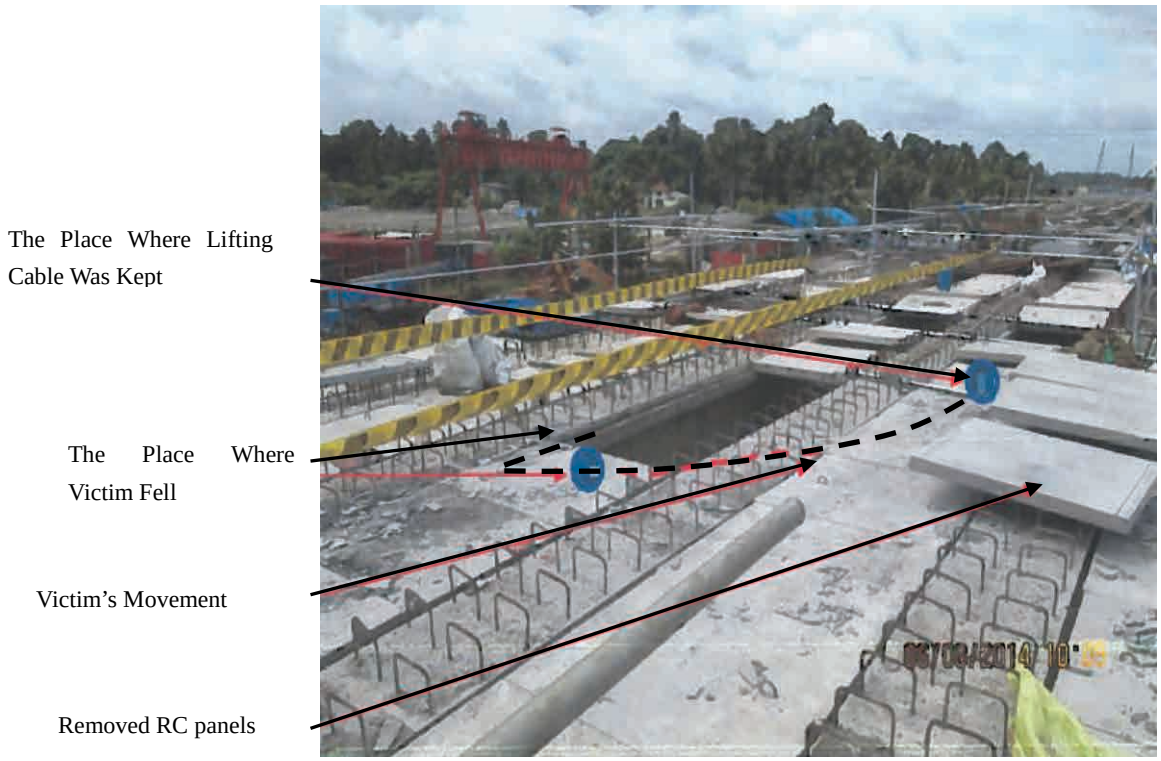


Photo 4.4.4 Accident Location

2. Sequence of Events and Causes of the Accident Stated in the Accident Report by the Consultant

Table 4.4.13 Sequence of Events and Causes of the Accident

1) Sequence of Events	Prior to the accident	(1) On 6th August so14 as usual the contractor started working at site at 07:00. (2) 5 workers incl. a foreman were working RC panel installation work using a 45 t crane. (3) They were suggested to replace the 45 t crane with 25 t crane. (4) 3 pieces of RC panel were moved to the right hand side. Hence the crew could be able to work during the crane mobilization. Then the crane was changed to 25 t crane. (5) 2 workers started to grind the removed RC panel using 2 grinders.
	The Accident	(1) The victim (R) came to the incident location at 08:32, after waiting on the ground. (2) 2 workers were grinding the RC panels. The foreman was giving signals to the crane operator. Other two workers who were allocated for height Adjustment work of the panel installation work, stayed away from the incident location. (3) (R) was requested by the foreman to remove the 4th RC panel. (4) Hence he moved to the location and took two lifting cables. (5) Then he moved to forward the 4th RC panel and tried to attach the lifting cables to the crane hook. (6) The crane hook was hung above the 4th RC panel. (R) launched to the location from right hand side, where the two cables were kept. He was almost standing facing the crane hook. Hence the hole was behind him. (7) With the crane hook swinging he was afraid that his face may get knocked by the hook. Mistakenly he stepped his right leg backward suddenly. (8) He lost his balance and fell through the space to the muddy ground.
2) Findings after the Accident		(1) There was an unprotected opening with no demarcation. (2) There was no designated signalman while crane was working. The foreman himself used to give signal to the crane operator. (3) There were three panels on right side to the opening. There were cut marks and duct on panels. (4) There were two lifting cables attached to a hand glove on the ground where Ramasamy fell.
3) Causes of Accident	Direct Causes	(1) Hurry to get the work done: The victim was in a hurry to get the work done. Hence, he took the shortest way to reach the 4th RC panel from the place where the lifting cables were kept. (2) Negligence of the worker: According to the way the victim reached the incident place he was standing almost facing the crane hook. He had no idea regarding the unprotected opening behind him. (3) No supervision: There was nobody is supervising the work. The foreman himself used to give signals to the crane operator. Hence, nobody identified the unsafe surroundings or an unsafe act.
	Indirect Causes	(1) Lack of signalman: There was no designated signalman while the crane was working. The foreman himself used to give signals to the crane operator. Hence, there was nobody to supervise the work. (2) Unprotected floor opening: The removal of 3 RC panels created a floor opening. The opening was not protected by any means. (3) Inadequate awareness and poor habit of safety belt usage: If the victim had proper awareness or the habit of safety belt usage, he would have at once found a place to hook it. At the incident place he had many anchorage points. (4) Noisy and dusty surroundings: Due to use of grinder at incident time the area was dusty and noisy. Hence, the attention of the victim may not be with his work. Maybe he was not watching where he was going.
	Root Causes	(1) Inadequate safe method of RC panel installation: When performing height adjustment of RC panels or removing and replacing RC panels, it could be done one by one. Then there are not many unsafe floor openings. (2) Inadequate adoption of fall protection: Safe work procedure and safety devices were not adopted adequately on site. (3) Inadequate awareness and supervision on work safety: Unprotected opening; Unfinished access; unsafe work method; Lack of signalman for crane operator; Ignorance of supervisory staff on safety responsibilities: Poor safety belt usage.

3. Root Cause Analysis and Study for Countermeasures

1) Understandings of the Objective Accident

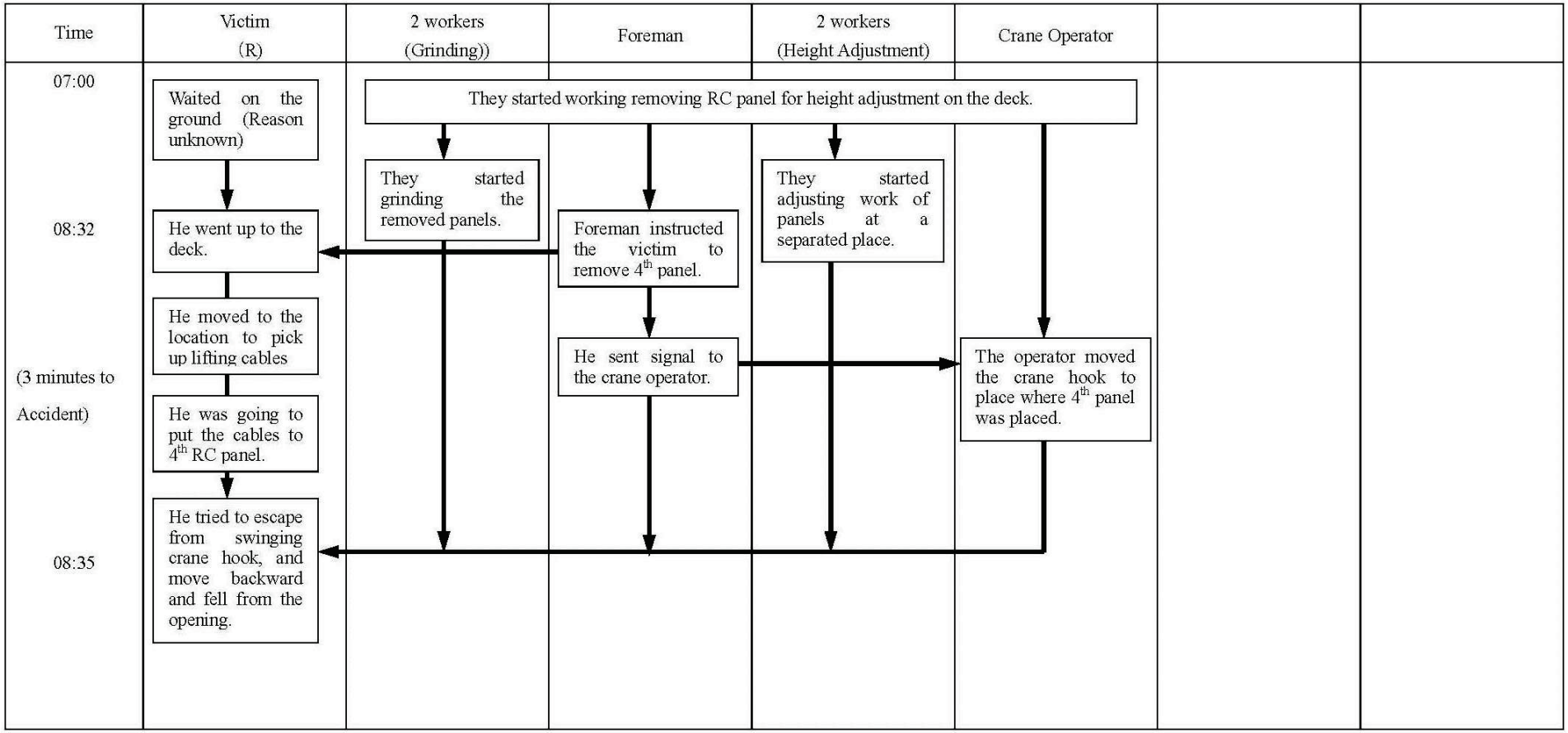


Fig. 4.4.14 [Progress Chart of the Objective Accident]

2) Why-why Analysis

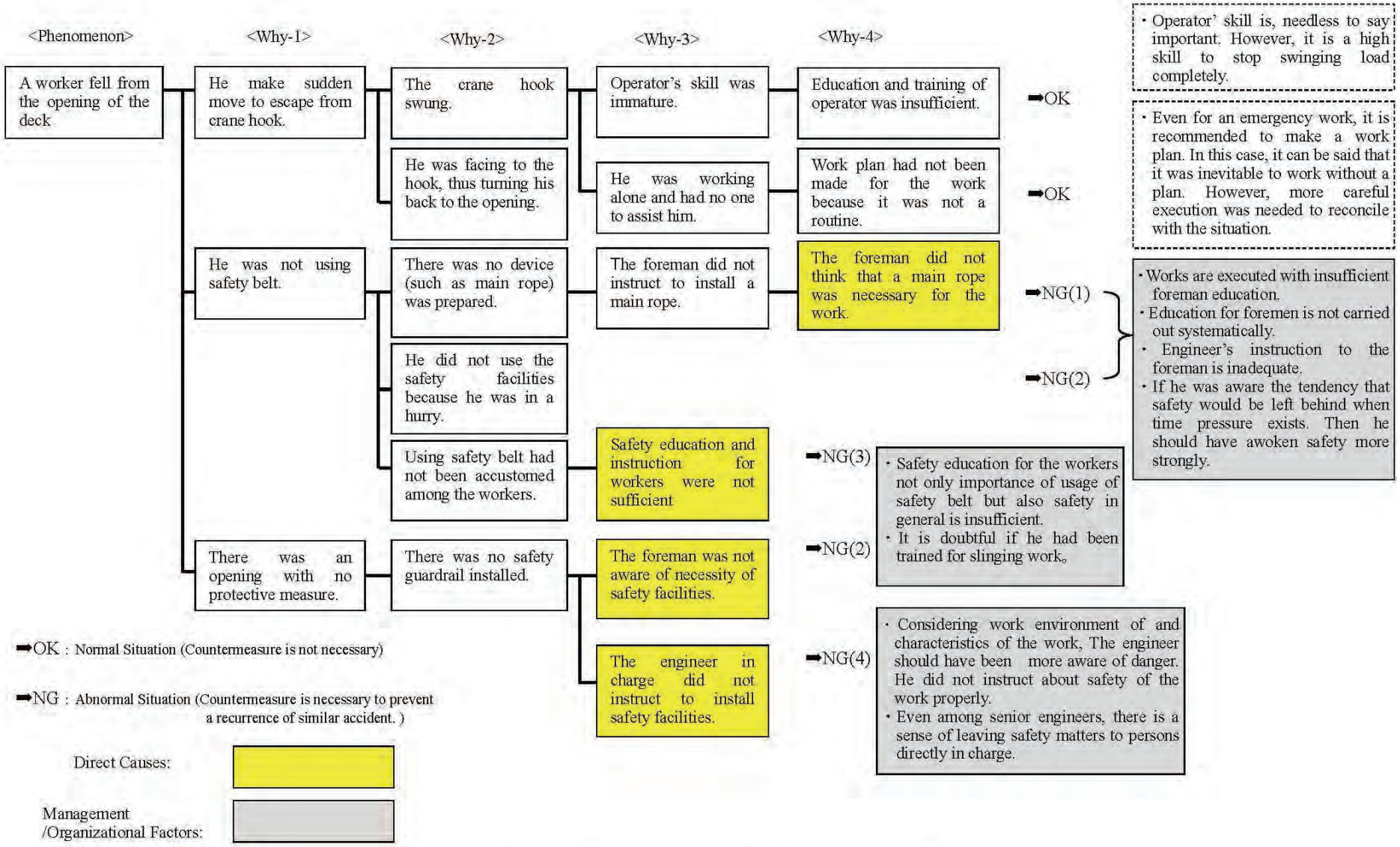


Fig. 4.4.15 Pursuit of Root Causes by the Why-why Analysis Diagram

3) Countermeasures against Direct Cause

Table 4.4.14 Provisional countermeasures to prevent recurrences of similar accidents

Direct Causes derived from Why-why Analysis (shown in yellow in the chart)	Countermeasure 1	Countermeasure 2	Countermeasure 3
1. The foreman did not think that a main rope was necessary for the work. 2. The foreman omitted installation of safety facilities because he was in a hurry.	For dangerous works such as the concerned, take the surest measures foe safety facilities and devices. (At the concerned work site, safety facilities were needed such as temporary cover for the opening using reinforced plywood and reliable main rope using rebar of the RC panel or anything else which would enable the workers move easily on the deck.)	It has been proved by experience that safety tends to be disregarded when time is the restriction. In such a case, everyone from the project manager to engineers and foremen have to take the highest caution for hazards and perform safety activities efficiently.	By improving education for foremen, make them aware of their responsibilities and roles for safety, and make them act so.
3. Safety education and instruction for workers were not sufficient.	Although safety belts are provided for workers, they tend to give priority to easiness of work. This must be changed by overturning their way of thinking.	Everyone from the project manager, engineers to foremen must work on seriously to make safe work conditions which enable to realize ultimate safety. We shall never allow any site conditions such as leaving openings with no preventive measure against falling.	Make it the fundamental rule to use safety belt when working at height. Safety facilities necessary for work must be installed, and confirm by the site patrol. If judged as insufficient, work shall be suspended immediately.
4. The engineer in charge did not instruct to install safety facilities.	It is due to lack of awareness of safety role of engineers. Safety education for engineers must be carried out again.	Efficient actions must be taken so that each one relating the project will have strong consciousness to safety problems.	Establish system that any problem arising from work hazard will be consulted with seniors and agreed, not judging by himself.

<Supplement>

The accident report pointed out as direct causes as follows.

(1) Hurry to get the work done

(2) Negligence of the worker

(3) No supervision

As long as “Negligence of the worker” is raised as the cause of accident, accident will never be eliminated nor prevented to recur. Because human beings have a nature that it cannot keep concentration for long period of time.

Careless condition suddenly and frequently appears to us, human beings. In order to prevent accident caused by so called “Carelessness or Negligence”, the inherent safety is essential. One of inherent safety is “Fool Proof”. This is to take measures that even if somebody acts erroneously he will not be injured, or that he would be difficult to take such an action. In construction sites, this measure together with improving safety facilities is the most important aspect against human errors which includes the carelessness.

If we apply this concept to the accident concerned, usage of safety belt would have been prevented the fall. And a cover of the opening will, together with safety belt, be double guarantee for safety.

It is conceivable that if the foreman at least supervised the work with clear direction, the possibility of falling must have been much smaller.

4) Developing Management/ Organizational Factors

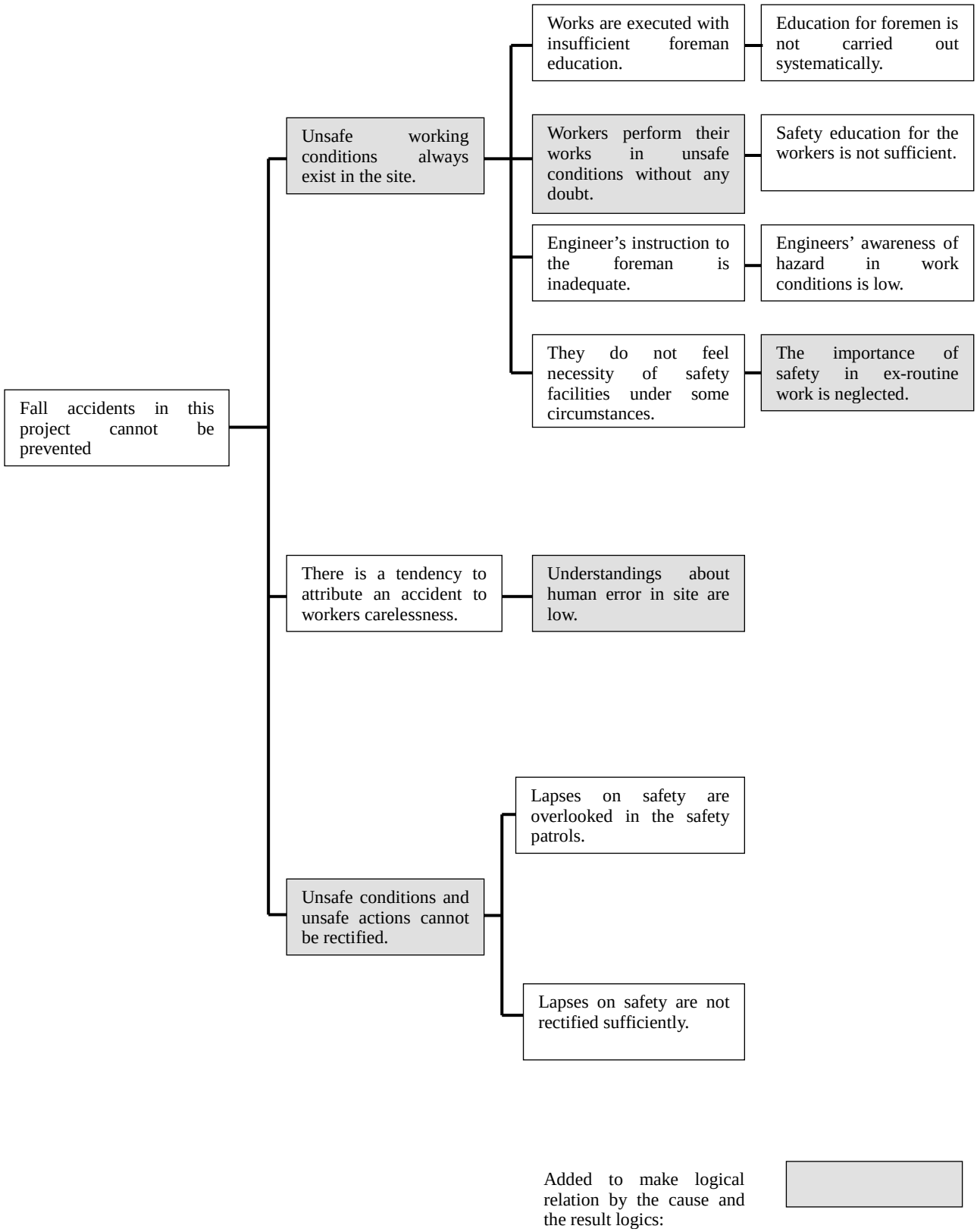


Fig. 4.4.16 [A Problem Tree Leading to the Accident] (Management/Organizational Factors)

5) Countermeasures for Management/Organizational Factors (1)

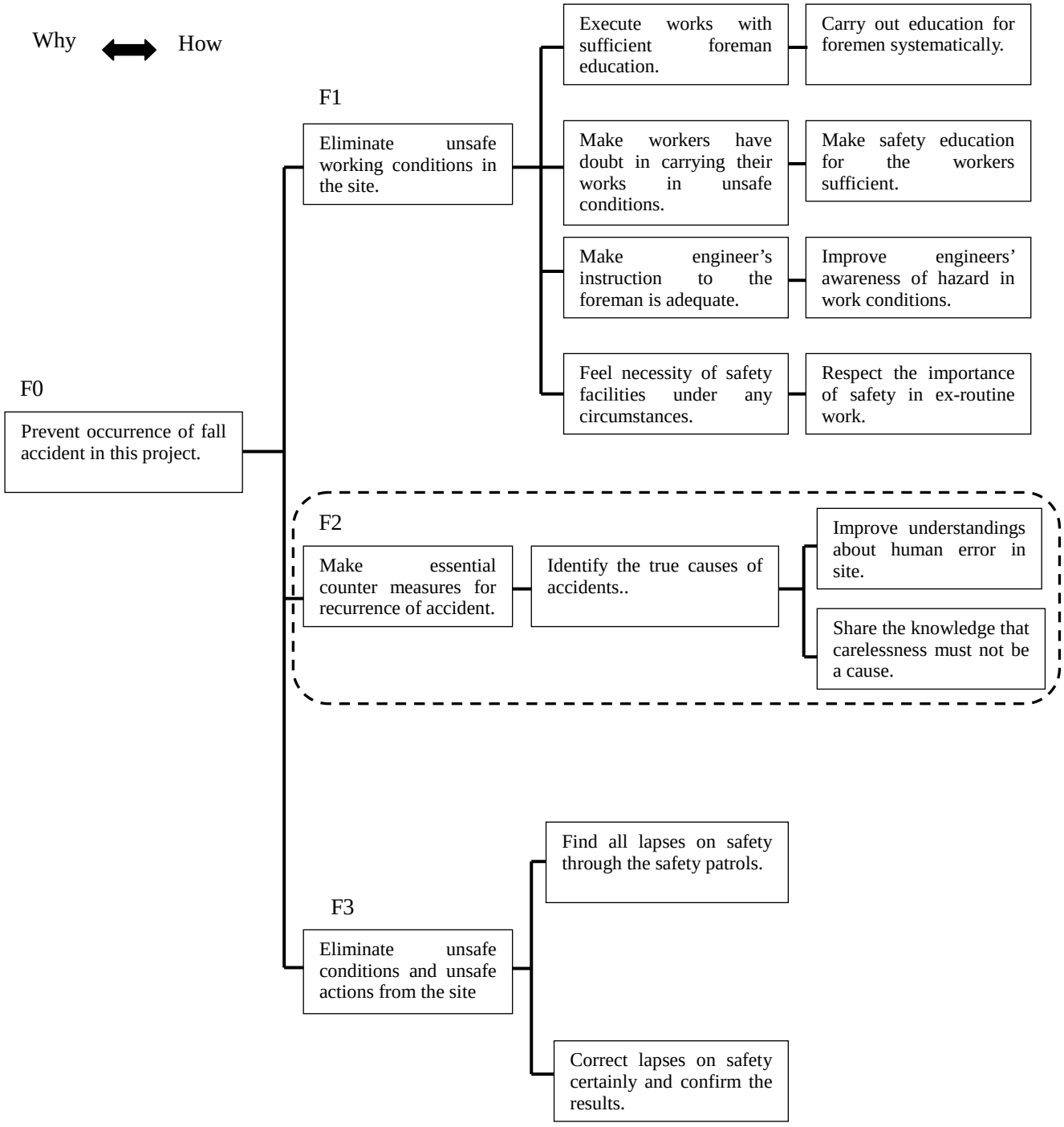


Fig. 4.4.17 [Function Tree to Prevent Grave Accident (Management/Organizational Factor)]

Convert the problems (in Problem Tree) by reversing to functions which are to be performed.

4.4.5 Root Cause Analysis of the Accident Caused by a Toppled Crane

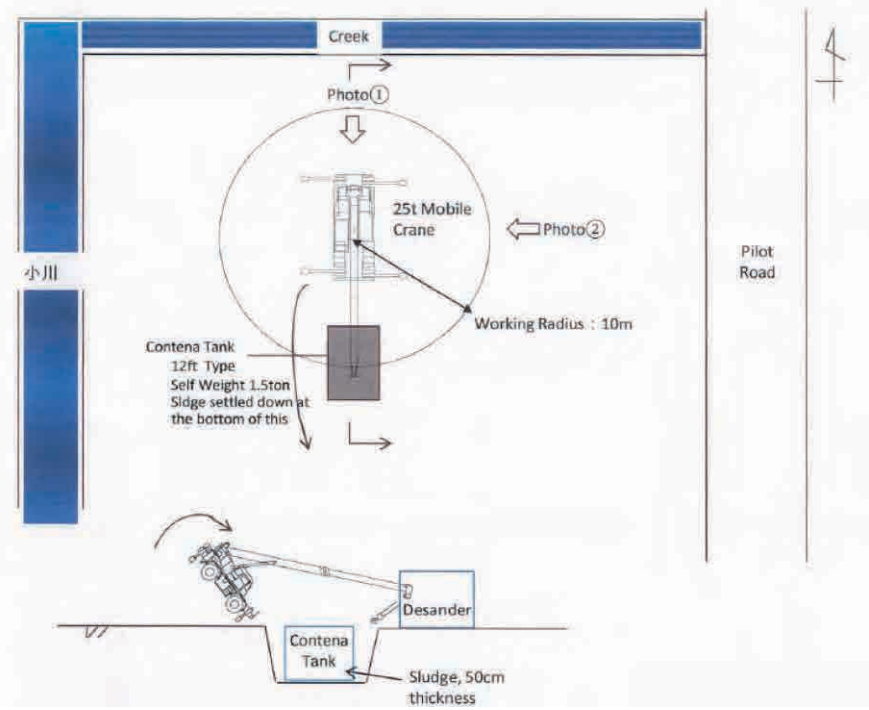
（2013/02/18）

1. The Accident

[Outline, situations and causes of the accident are derived from the Accident Report submitted to the Employer by the Consultant.]

[Outline of the Accident]

A 25 ton mobile crane which is owned by the subcontractor for in situ piles was stumbled down whilst lifting up steel bentonite tank for mobilization to next location. The crane has not parked properly with outrigger pads; especially ground condition under the right side of front outrigger of the crane was pretty bad. As a result, the crane had toppled over. No one was injured.




Photo①


Photo②

Fig. 4.4.18 Accident Caused by a Toppled Crane

The crane removing operation

The crane position after topple

The outrigger arrangement (Timbers were used.)

Photo 4.4.5 Accident Caused by a Toppled Crane

2. Causes and Corrective Measures of the Accident Stated in the Accident Report

1) Direct Cause

(1) Lack of checking for the ground condition.

(2) Not using proper outrigger pads/

2) Corrective Measures

(1) Each engineer and supervisors must check the ground conditions before mobilizing a crane for lifting activities.

(2) Safety education will be performed every week for a month for every subcontractor.

3. Root Cause Analysis and Study for Countermeasures

1) Understandings of the Objective Accident

[Progress Chart of the Objective Accident]: Omitted because of the simplicity of the incident.

2) Why-why Analysis

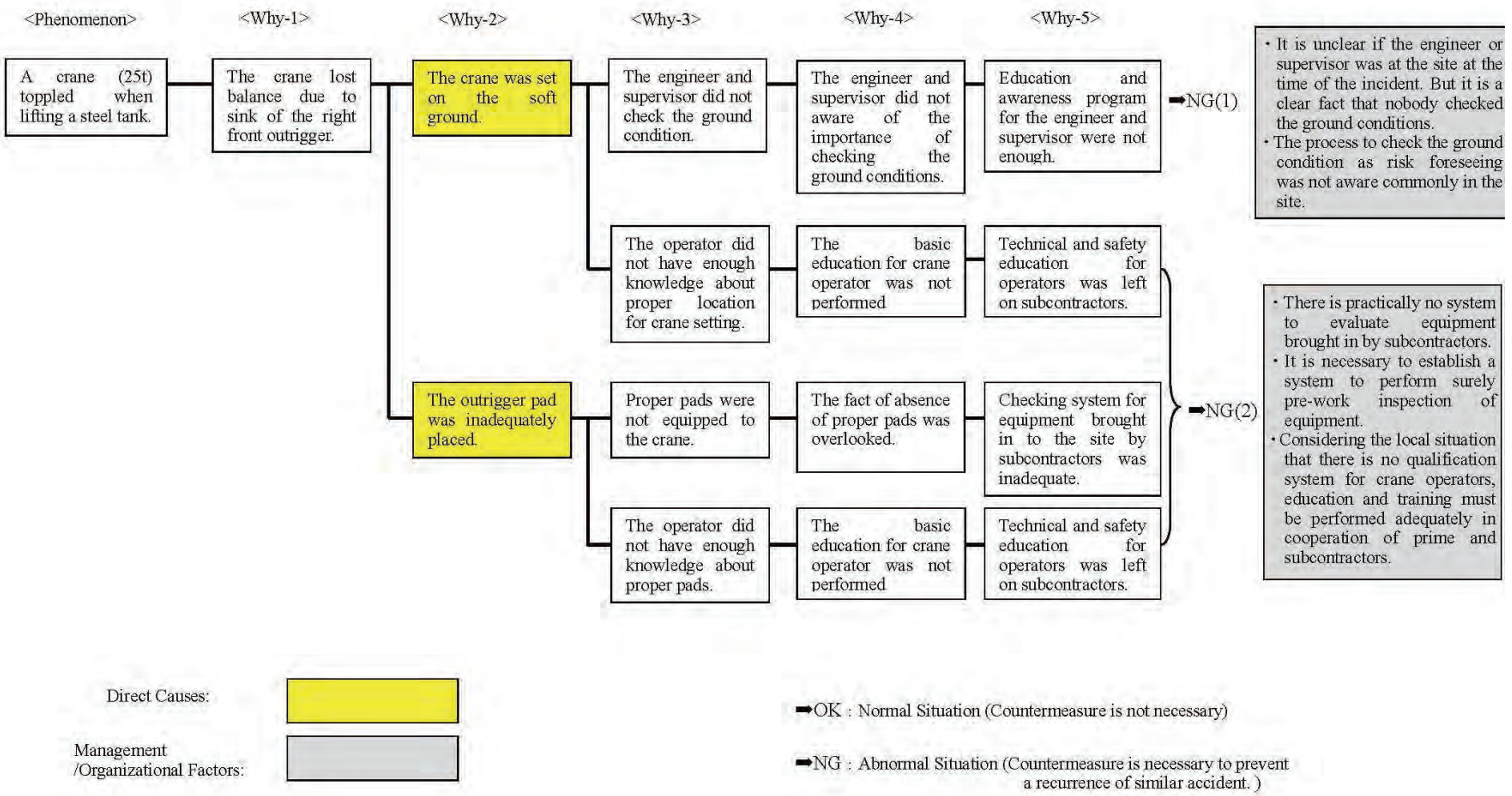


Fig. 4.4.19 Pursuit of Root Causes by the Why-why Analysis Diagram

3) Countermeasures against Direct Cause

Table 4.4.15 Provisional countermeasures to prevent recurrences of similar accidents

Direct Causes derived from Why-why Analysis (shown in yellow in the chart)	Countermeasure 1	Countermeasure 2	Countermeasure 3
1. The crane was set on the soft ground.	Educate crane operators so that they can select proper location to set up the crane.	Engineers/Supervisors confirm the ground conditions to set the crane, and if necessary devise measures to enhance safety.	-
2. The outrigger pad was inadequately placed. (According to the photos taken after the incident, timbers were used instead of ordinary pad.)	Always equip the crane with bearing pads of proper material and adequate size. Educate crane operators how to use outriggers properly.	-	-

4) Developing Management/ Organizational Factors

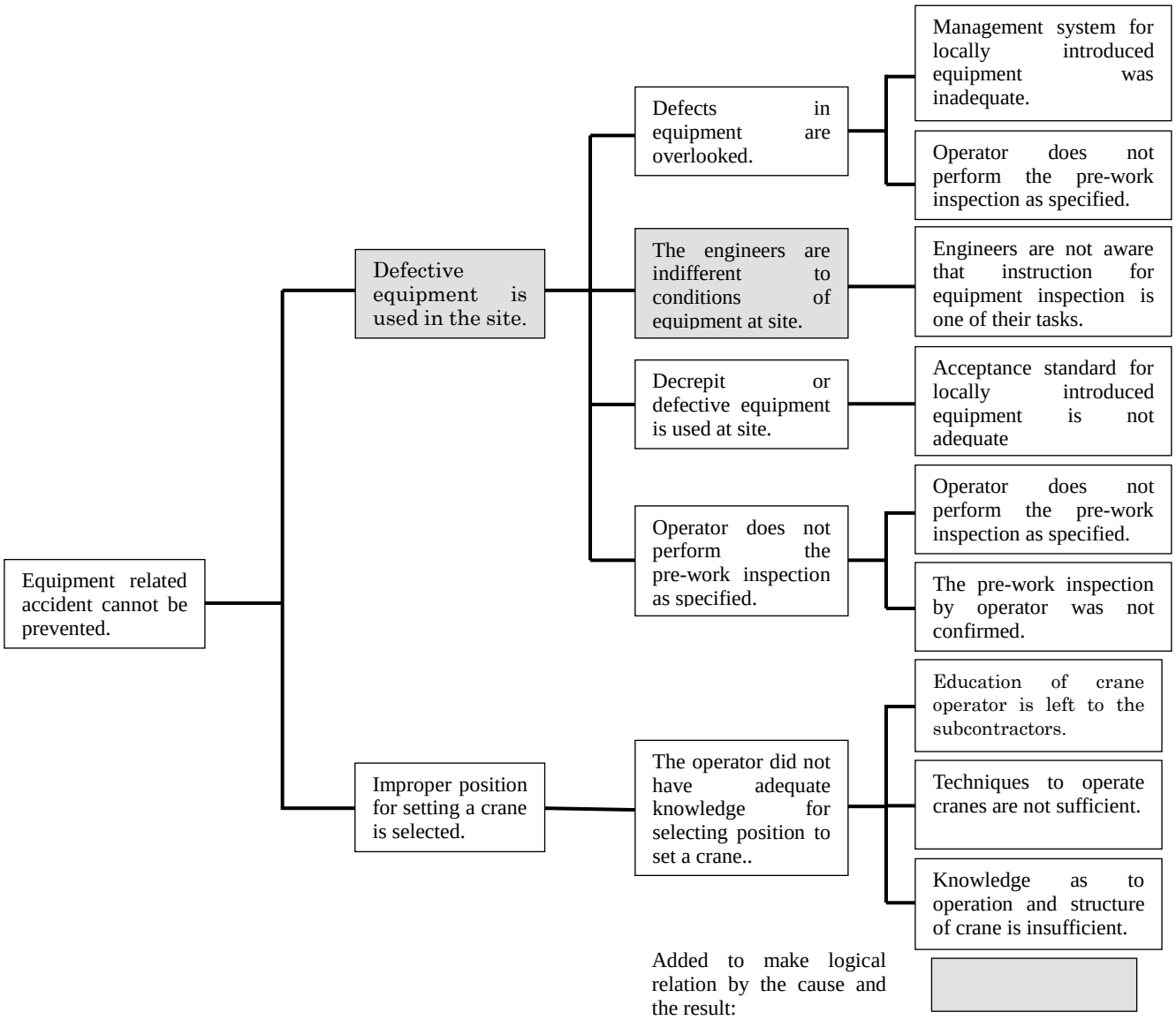


Fig. 4.4.20 [A Problem Tree Leading to the Accident] (Management/Organizational Factors)

5) Countermeasures for Management/Organizational Factors (1)

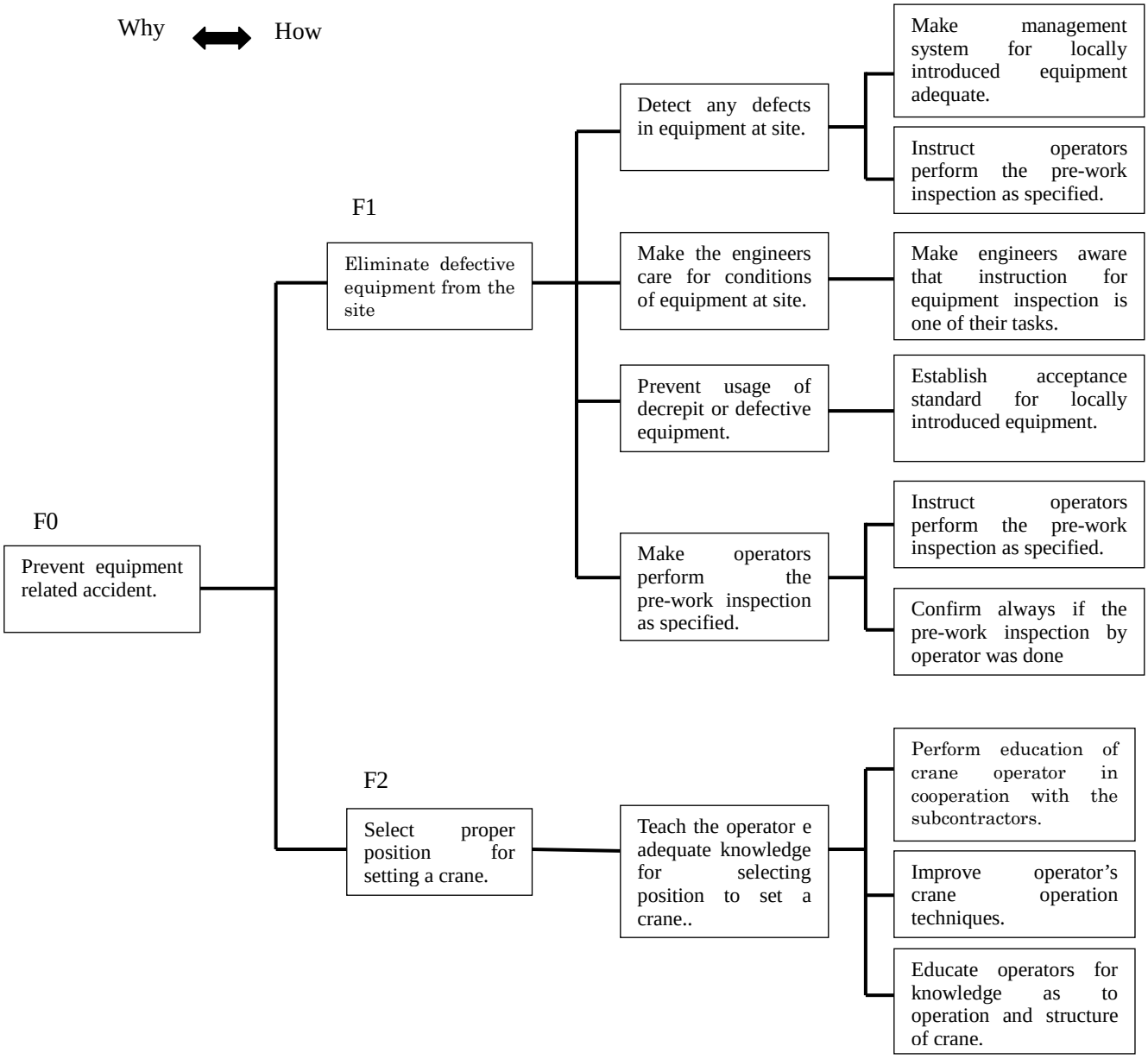


Fig. 4.4.21 [Function Tree to Prevent Grave Accident (Management/Organizational Factor)]

Convert the problems (in Problem Tree) by reversing to functions which are to be performed.

4.4.6 Root Cause Analysis of the Accident Caused by a Bus Falling Due to Engine Trouble

(2013/10/11)

1. The Accident

[Outline, situations and causes of the accident are derived from the Accident Report submitted to the Employer by the Consultant.]

[Outline of the Accident] (Incident outline by witness)

According to the eye witness, the bus was travelling from the direction of Kasawatha toward Mawaramandiya. While the bus was passing on a steep and curved elevation area of diversion road, it stopped suddenly due to engine trouble and moved backward and the driver tried to stop the bus but he could not due to break failure, then he attempted to restart the moving bus by engaging the reverse gear. Meantime, the bus moved further backward and run off the road and collided with the GI pipe guard railings which had been erected along the diversion road. After few minutes the bus went over the guard railings and toppled into the south side excavated area.

There were three passengers including the driver in the bus. One person got down the bus just before the bus fell down. Other two persons (driver and helper) went down with the bus. They had minor injuries.

Photo 4.4.6 View of the Accident

2. Causes and Corrective Measures of the Accident Stated in the Accident Report

1) Direct Cause

(1) Mechanical and brake failure of the bus.

2) Corrective Measures

(1) In addition to the rigid GI pipe guard railings which have been installed at both sides, white color sand bags (Jumbo Bags: 0.1t) placed along both sides of the public diversion roads.

3. Root Cause Analysis and Study for Countermeasures

1) Understandings of the Objective Accident

[Progress Chart of the Objective Accident]: Omitted because of the simplicity of the incident.

2) Why-why Analysis

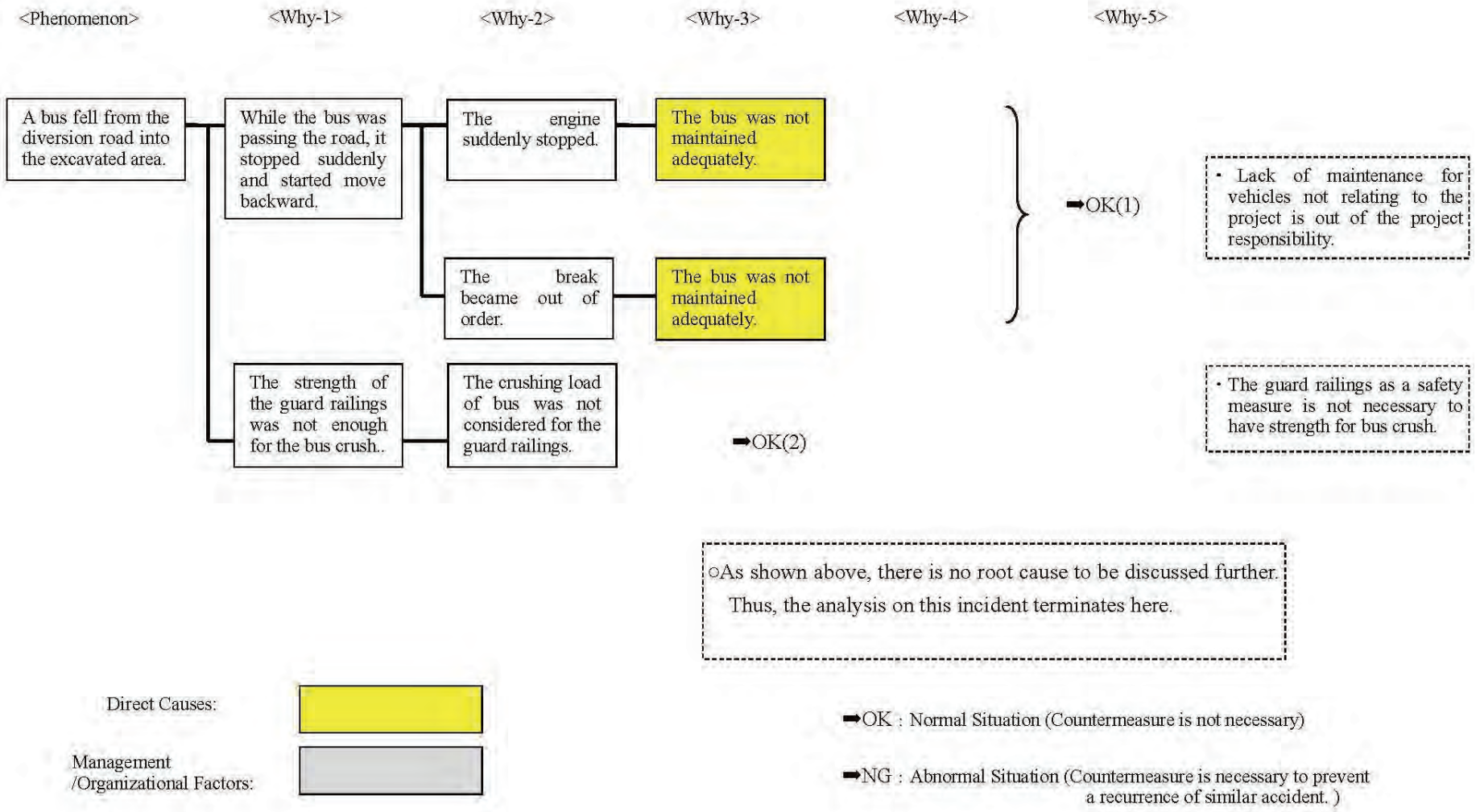


Fig. 4.4.22 Pursuit of Root Causes by the Why-why Analysis Diagram

4.4.7 Root Cause Analysis of Accident by Tilted Pier Rebar Cage

(2013/12/04)

1. The Accident

[Outline, situations, causes and countermeasures of the accident are derived from the Accident Report submitted to the Employer by the Consultant and also the report submitted to JICA by the Consultant.]

[Outline of the Accident]

Whilst correcting the verticality of pier rebar (32mm) of inside the pier reinforcement cylindrical cageφ1.7m, two workers were injured who were inside of the cage due to tilting the whole cage with the workers because of inadequate support.

According to investigation it is revealed that eight support GI pipes had been fixed for keeping the vertical rebar cage stable but two GI pipe supports were removed by the site engineer to have a space for parking a crane and whilst the rebar cage was slowly tilting toward wall of the excavated pit of which height was about 3 meters. The two workers trapped inside of the rebar cage. When they came out from the tilted rebar cage they got minor injuries.

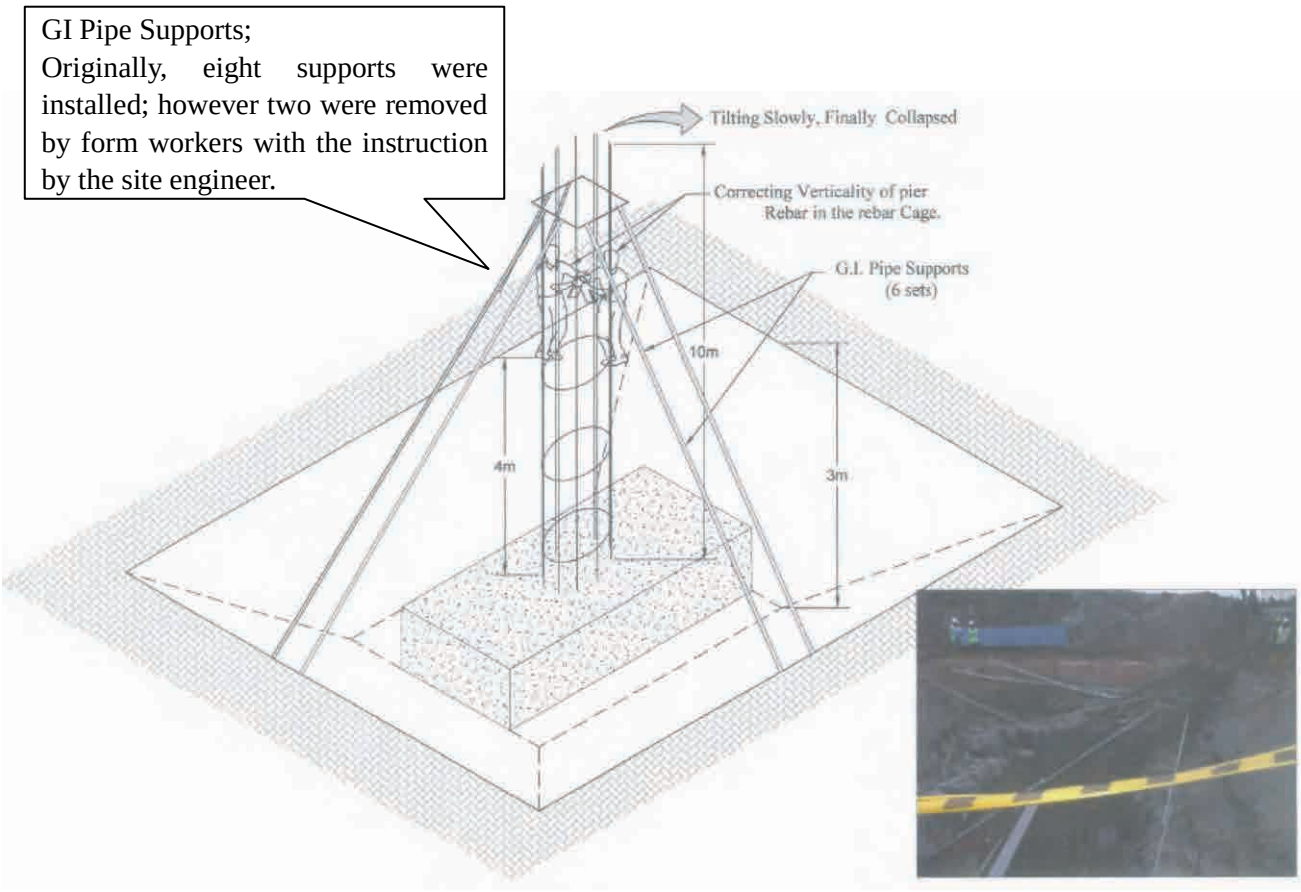


Fig. 4.4.23 Accident Schematic View

Photo 4.4.7 Tilted Rebar Cage

2. Causes and Countermeasures of the Accident Stated in the Accident Report

1) Root Cause

Inadequate GI pipe supports of the rebar cage; two out of eight supports were removed.

2) Countermeasures

(1) Conduct special safety mass ceremony.

(2) Check the similar pier supports and reinforce it if required.

3. Root Cause Analysis and Study for Countermeasures

1) Understandings of the Objective Accident

[Progress Chart of the Objective Accident]: Omitted because of the simplicity of the incident.

2) Why-why Analysis

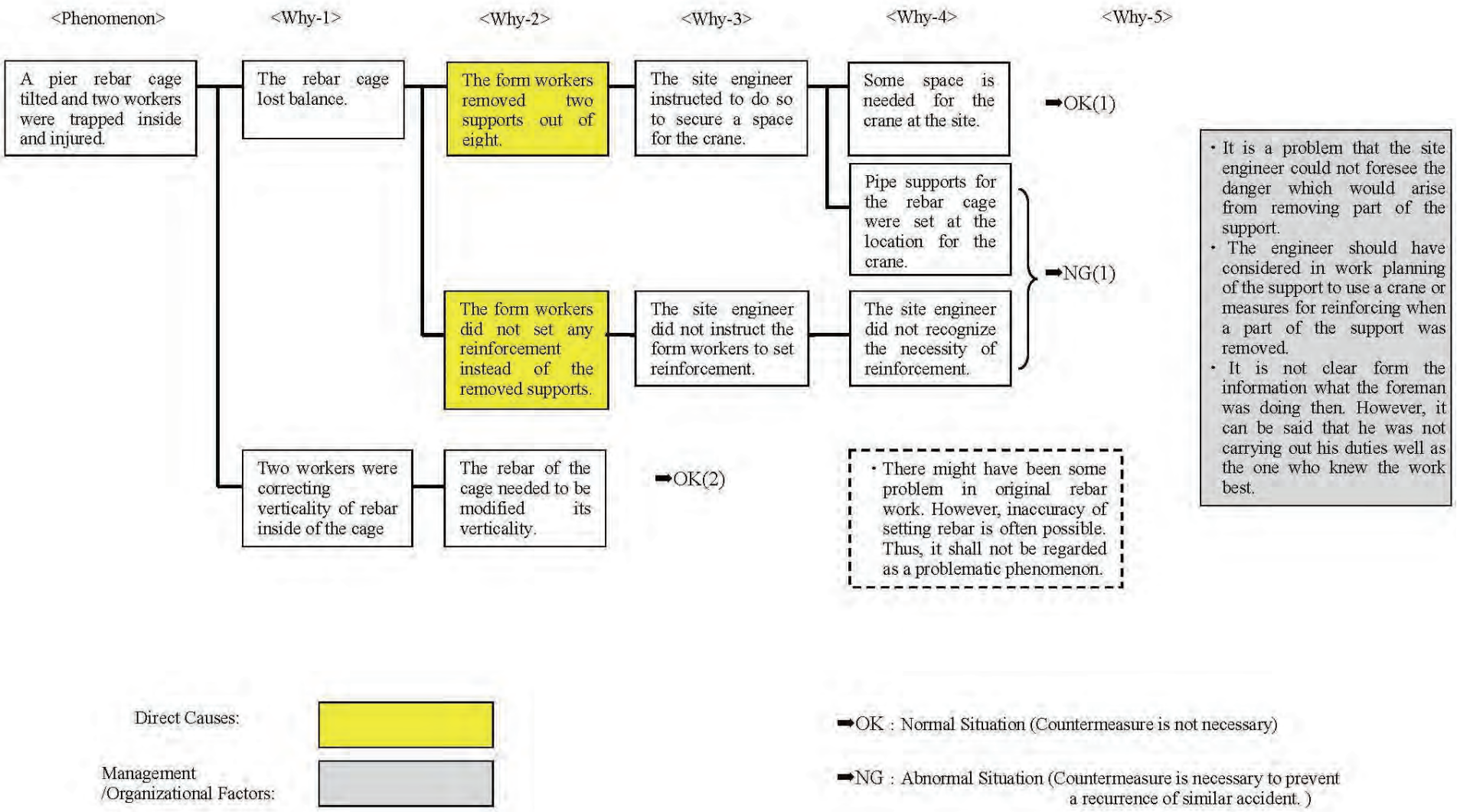


Fig. 4.4.24 Pursuit of Root Causes by the Why-why Analysis Diagram

3) Countermeasures against Direct Cause

Table 4.4.16 Provisional countermeasures to prevent recurrences of similar accidents

Direct Causes derived from Why-why Analysis (shown in yellow in the chart)	Countermeasure 1	Countermeasure 2	Countermeasure 3
1. The form workers removed two supports out of eight.	Notify the foreman and workers the procedures of the proper work thoroughly.	-	-
2. The form workers did not set any reinforcement instead of the removed supports.	Notify the foreman and workers the procedures of the proper work thoroughly.	For similar works, make it sure to study measures for reinforcing and execute as planned. Rebar works of the cylindrical cage including its correction shall start only after confirming stiffness and stability of the support.	-

4) Developing Management/ Organizational Factors

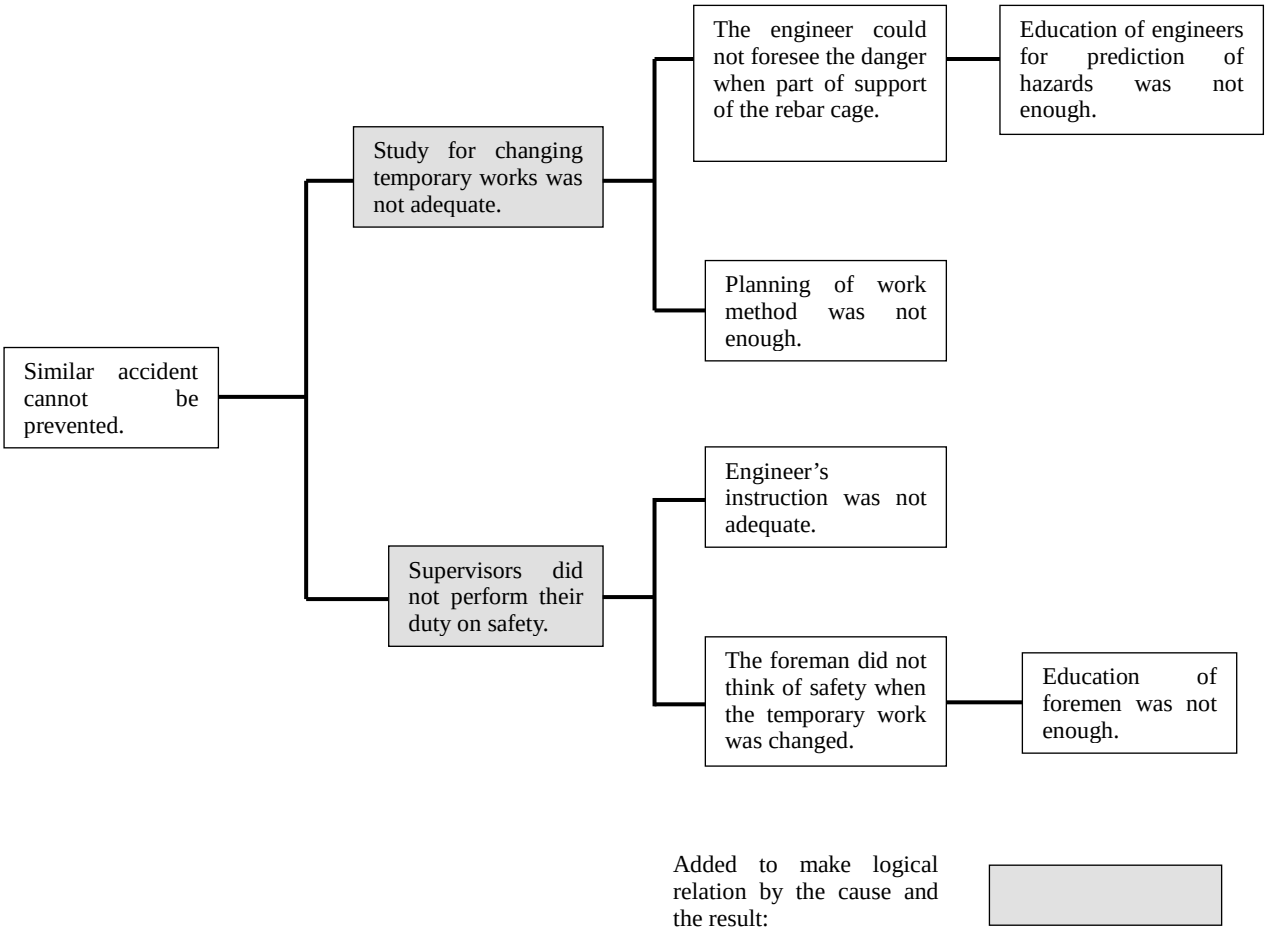


Fig. 4.4.25 [A Problem Tree Leading to the Accident] (Management/Organizational Factors)

5) Countermeasures for Management/Organizational Factors (1)

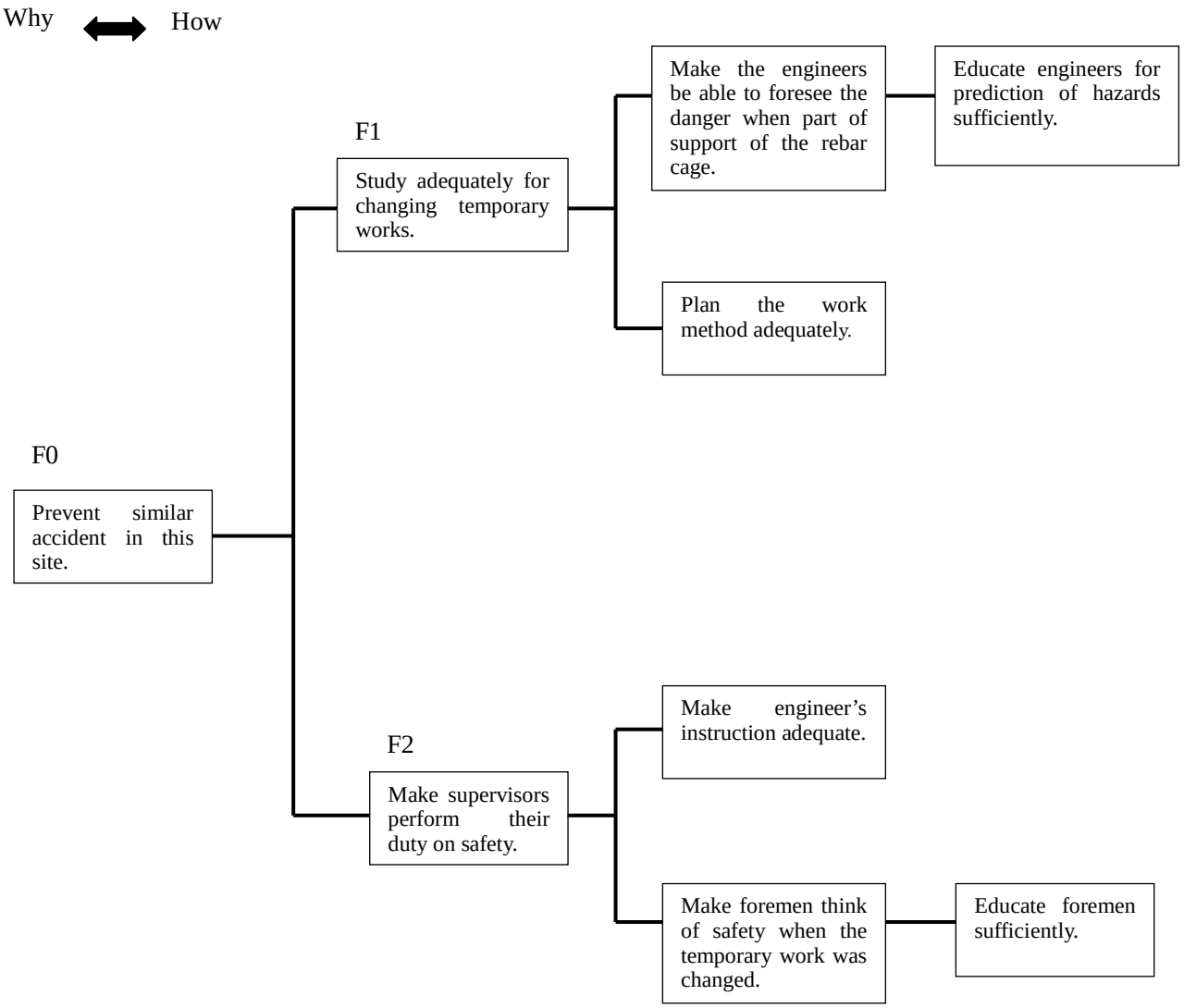


Fig. 4.4.26 [Function Tree to Prevent Grave Accident (Management/Organizational Factor)]

Convert the problems (in Problem Tree) by reversing to functions which are to be performed.

4.4.8 Root Cause Analysis of the Accident of Public Vehicle (Family Car) Fell in the Risen River

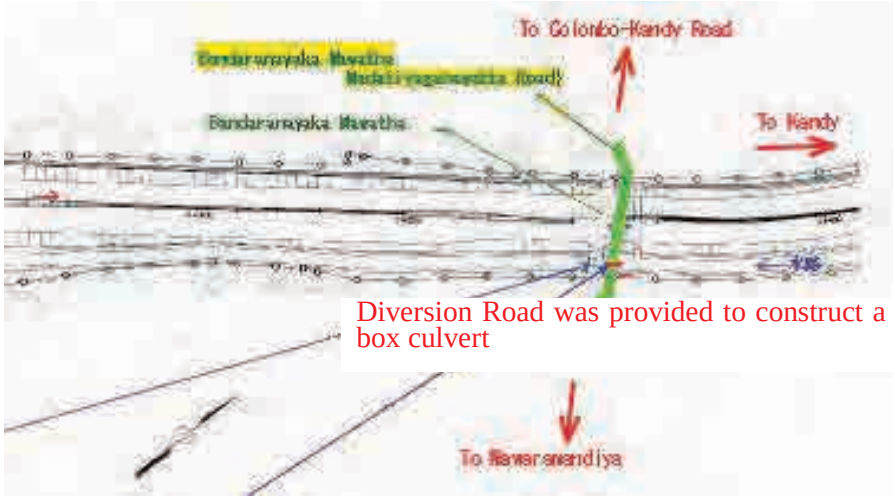
(2014/06/02)

1. The Accident

[Outline, situations, causes and countermeasures of the accident are derived from the Accident Report submitted to the Employer by the Consultant and also the report submitted to JICA by the Consultant.]

[Outline of the Accident]

A private car with three passengers (husband, wife and a daughter) was driving along the diversion road built for construction of a box culvert in an early morning (4 am). When it was passing the first temporary pipe culvert of the two culverts installed in parallel, all of a sudden the asphalt layer collapsed with the car and the car fell down with the asphalt layer due to washing out of all the soil underneath the asphalt layer around the steel pipe culvert. The car rested on the steel pipes. The couple has got out from the car but they could not come out the place due to heavy water flow and washed away in the canal. Meanwhile their daughter shouted for help and a group of people who came in a van behind their car saw the incident and shouted for help to rescue the family. Having heard the shout the villagers who lived around this location rushed the scene and rescued them. The wife had an injury on her forehead which needed eight sutures.



The car which fell on to the pipe culvert.
(The situation 4 hours after the incident)

The box culvert under construction

Fig. 4.4.27 Site Situation of Accident

2. Causes and Countermeasures of the Accident Stated in the Accident Report

1) Root Cause

Heavy water flow due to weather condition (unbearable sudden water collection of the upstream)

2) Countermeasures

(1) Increase the capacity of drain (Numbers of pipe; 2 to 3)

(2) Protection of road for erosion using jumbo bags and concrete.

(3) Allocation of flagmen for 24 hours.

(4) Increase the illumination.

(5) Installation of hand rails.

(6) Closure of abandoned pipe inlet

3. Root Cause Analysis and Study for Countermeasures

1) Understandings of the Objective Accident

[Progress Chart of the Objective Accident]: Omitted because of the simplicity of the incident.

2) Why-why Analysis

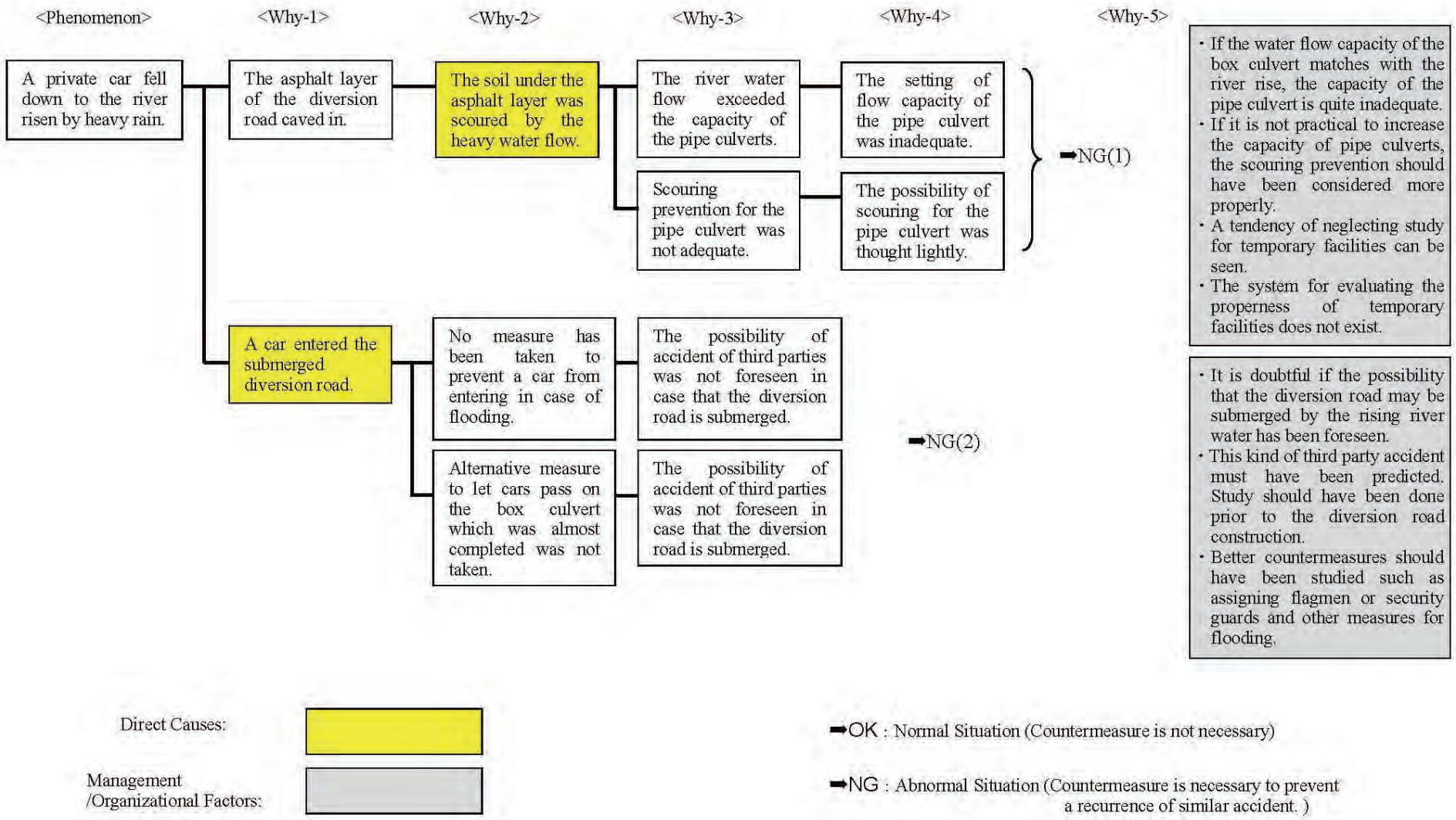


Fig. 4.4.28 Pursuit of Root Causes by the Why-why Analysis Diagram

3) Countermeasures against Direct Cause

Table 4.4.17 Provisional countermeasures to prevent recurrences of similar accidents

Direct Causes derived from Why-why Analysis (shown in yellow in the chart)	Countermeasure 1	Countermeasure 2	Countermeasure 3
1. The soil under the asphalt layer was scoured by the heavy water flow.	Countermeasures against scouring must be taken based on the assumption that the diversion road will be scoured by the heavy river flow.	Increase the flow capacity of pipe culverts (2 nos. → 3 nos.)	–
2. A car entered the submerged diversion road.	When the river water rises and especially when the diversion road is submerged, take measures to prohibit any vehicle or people from passing the road.	–	–

4) Developing Management/ Organizational Factors

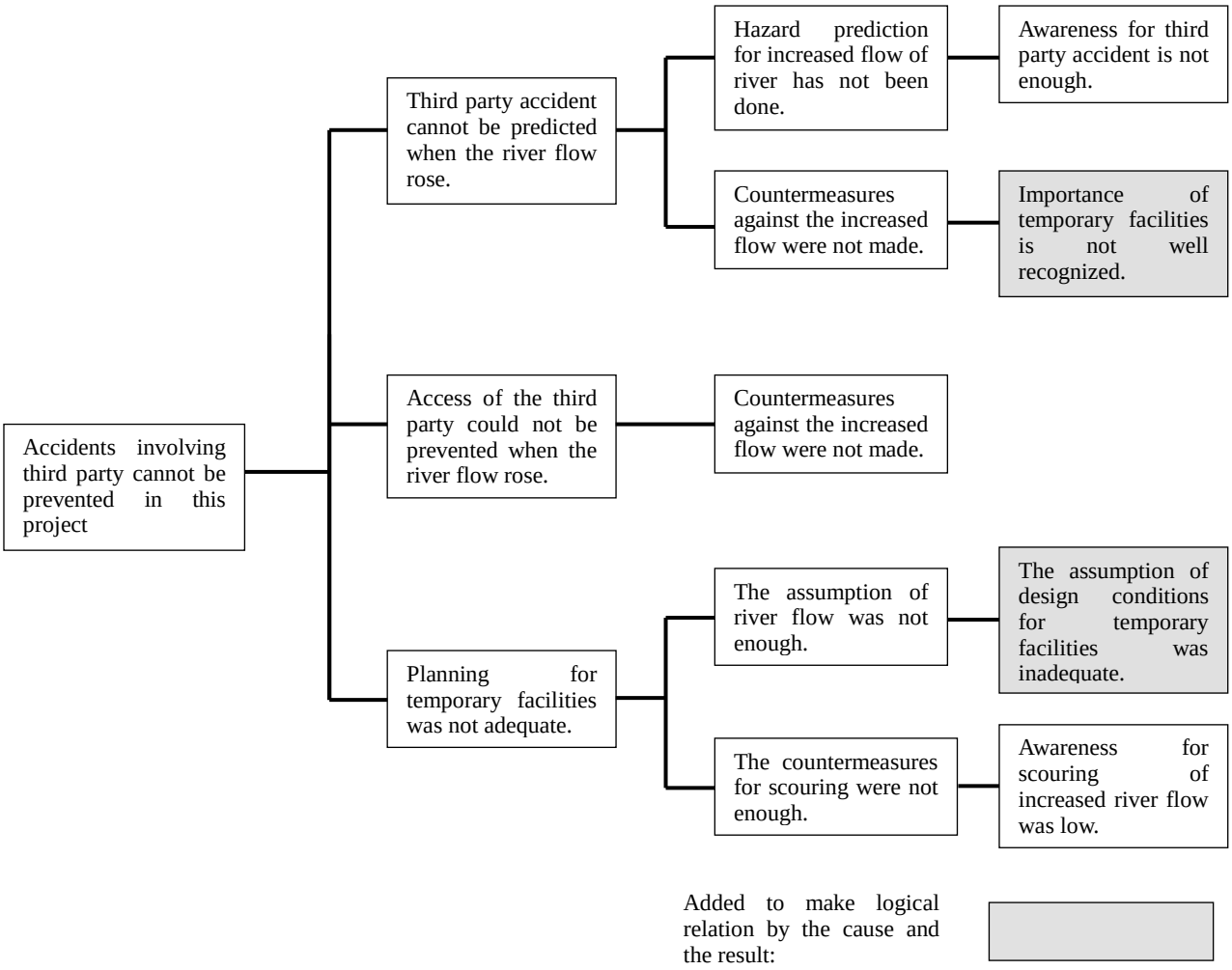


Fig. 4.4.29 [A Problem Tree Leading to the Accident] (Management/Organizational Factors)

5) Countermeasures for Management/Organizational Factors (1)

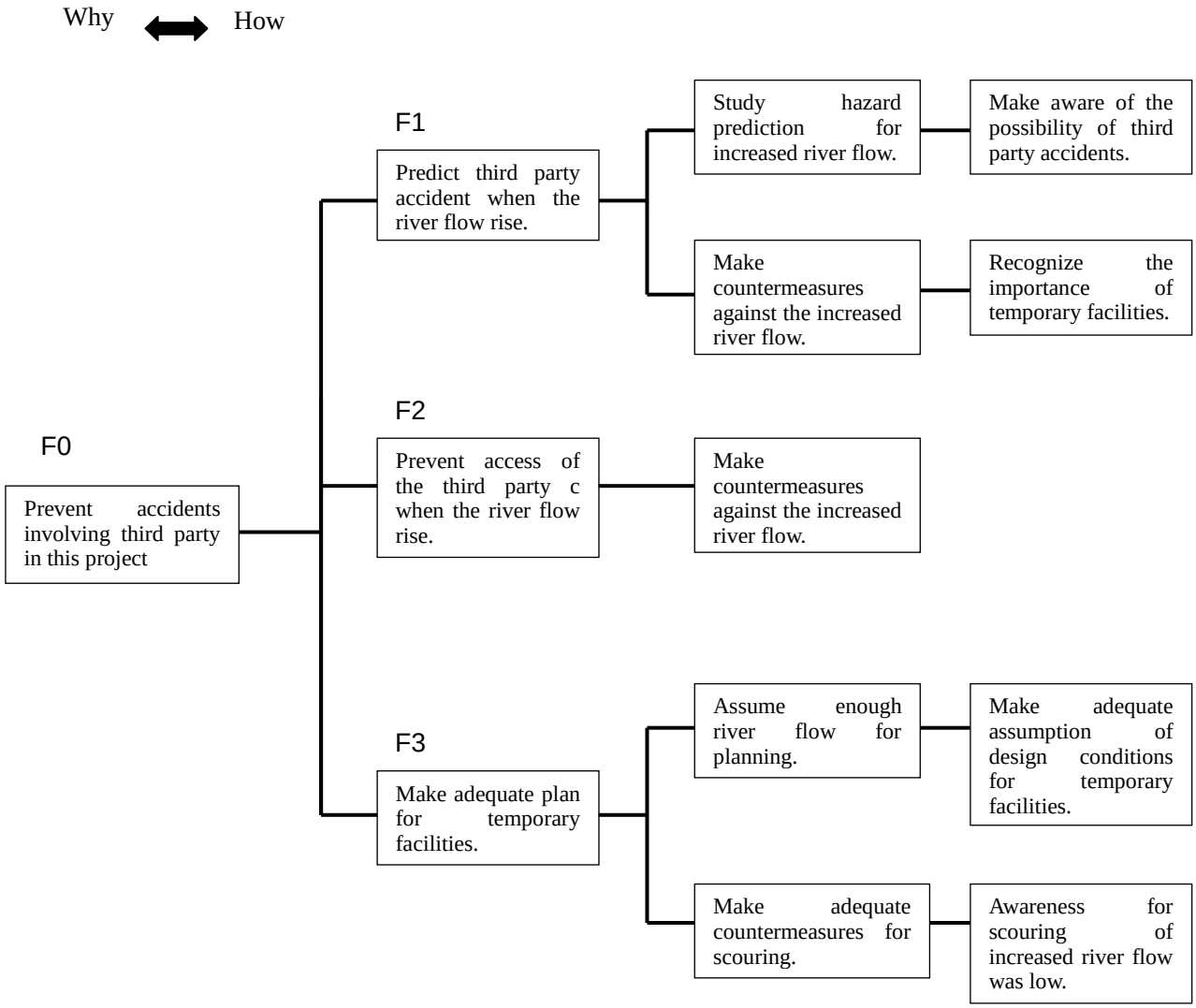


Fig. 4.4.30 [Function Tree to Prevent Grave Accident (Management/Organizational Factor)]

Convert the problems (in Problem Tree) by reversing to functions which are to be performed.

4.4.9 Root Cause Analysis of Accident of PC Girder Toppled During Transportation

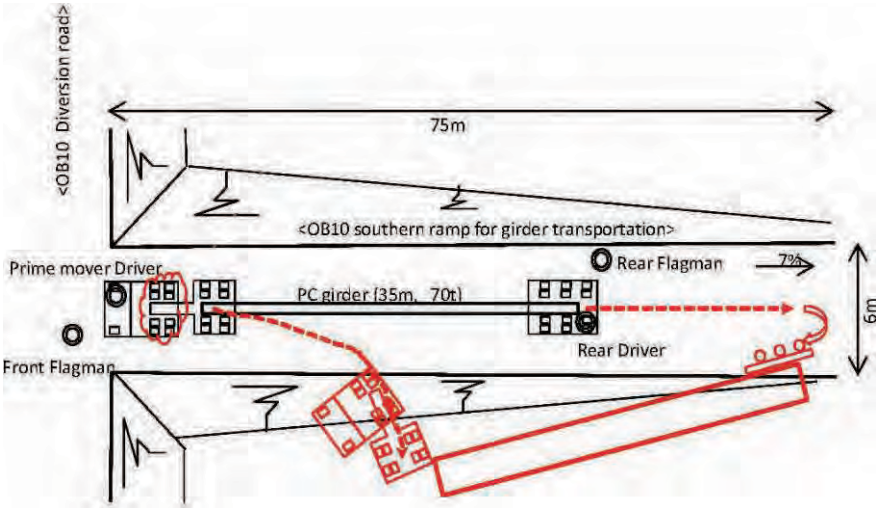
(2014/07/20)

1. The Accident

[Outline, situations, causes and countermeasures of the accident are derived from the Accident Report submitted to the Employer by the Consultant and also the report submitted to JICA by the Consultant.

[Outline of the Accident]

A precast girder was being transporting from the girder stock yard at south side of OB-10 to Viaduct 15 on a prime mover along with a trailer through the ramp road at OB-10 south side which is from the direction of south toward north. At 17:07 on 20th July 2014 a crew of four workers including contractor's flaggers and a prime mover operator were transporting the girder. When the front cabin of the prime mover reached the top of the ramp road, its front wheels skidded and subsequently the prime mover was stopped and dragged down along the ramp road and toppled. The prime mover operator injured slightly with his left knee. Finally, the prime mover has dragged along the ramp road left side slope and has stuck without overturning. Rear trailer has toppled with the girder. The PC girder has toppled to the left side and broken in to two pieces from its middle. And the coupling has detached from the prime mover with the girder holding bars with the girder.



Accident View – looking from the south to the north

Accident View – looking from the north to the south

Fig. 4.4.31 Situation of the Accident

2. Sequence of Events and Causes of the Accident Stated in the Accident Report

Table 4.4.18 Sequence of Events and Causes of the Accident

1) Sequence of Events	(1) At around 17:05, transportation of the PC girder from the stock yard at the south side of OB10 to Viaduct 15 was started. (2) Approximately at 17:07, the front cabin of the prime mover reached the top of the ramp road and its front wheels skidded and stuck. The prime mover operator has accelerated more to move the truck forward but tires have skidded more loosening the surface of the ramp road making hollows. He had been trying to do so for about 3~4 times for an about 1 minute of time. Then suddenly the engine stopped and it could not be started again as it was not neutral gear position and compressed air pressure of the system reduced to zero. (3) Meanwhile the trailer operator got down, put a stone as tire stopper to trailer hindmost wheel and walked toward the prime mover. (4) Since the truck engine stopped whole unit was dragging down along the ramp road about 10~12m for another 5~6 minutes of time. Flaggers and the trailer operator have put few stones at wheel as no tire stopper is available at the vehicle. But they couldn't stop dragging down of the unit. (5) At about 17:14, suddenly whole unit dragged fast and the operator could not control the prime mover. Prime mover hindmost wheels were suddenly shifted to the right side about 1~2m so the front cabin of the prime mover has shifted to the left side. Due to these sudden movements the trailer with the girder was tilting gradually dragging prime mover cabin to the left side slope of the ramp road. Suddenly the trailer and girder toppled. The coupling consists holding bars, was detached from the prime mover with the PC girder.
2) Facts Revealed by Investigation	(1) The ramp road was 70m in length and the average angle was about 8%. (2) The prime mover was driven by front 2-wheel because of the defective system originally modified to 4-wheel driven mechanism. (3) In a 2-wheel drive mode the load carrying capacity of the vehicle is less than 4-wheel drive mode due to the heavy load of the girder. (4) It was reported the compressed air system of the trailer continued a failure of leaking of compressed air at air brake line since few days back. (5) At the time of the accident, one foreman was absent that day and another foreman was waiting at V15 the previous girder transportation location.
3) Direct Causes and Indirect Causes	(1) Girder transportation along the ramp road was not safe due to use of an inefficient load carrying capacity "2-wheel drive" prime mover with modification. (2) Continuous leaking of compressed air both in the trailer and the prime mover has enlarged forming unsafe situation worse. However, the prime mover owner has acquired a valid fitness certificate. (3) The surface of the ramp road was not properly compacted. (4) Proper tire stoppers were not available with the prime mover truck. (5) The bars and chains to tighten the girder on the trailer were loosened due to the few timbers they used with the chains came off during transportation.
4) Root Causes	(1) Inadequate Site Supervision and Inspection: Girder transportation at the incident day has not supervised properly. On incident day particular transportation crew foremen also were not participate for girder transportation. Neither any girder transport supervisory personnel nor safety officers had inspected girder transportation activities. (2) Inadequate Training on Emergency: Proper awareness has not done to the working crew how they should act on an emergency situation. Since the vehicle stuck until it toppled, no proper action has not been taken by any personnel. (3) Inadequate Risk Analysis on Girder Transportation: Proper risk analysis was not done for girder transportation activities. Due to various reason a prime mover with a girder can be stuck in a ramp road. A risk analysis should also be sufficiently addressed this kind of contingencies and remedial.
5) Comments for Safe Girder Transportation	(1) Proper risk analysis on girder transportation should be done immediately. (2) Check all machinery immediately by a competent person and find load carrying capacity and fitness of the vehicle. (3) All the deficiency such as air leakages, brake system malfunctioning and alignment of girder placing wheels etc. should be corrected and put the machinery in proper working order before send to the site.

	(4) A check list covering all safety aspect of girder transporting process and monitoring each and every girder transport time should be prepared by an appointed person. This check list may include availability of supervision, condition of machinery, availability of required material, resources and personnel, condition of road and any correction of loaded girder on truck. (5) Any girder transportation activity should be stopped without proper supervision. (6) Road use for transport girders should maintain properly. These road should be inspected daily and immediately should repair the uneven surface or loosen areas. Especially on ramp road there should be periodic maintenance session with leveling the surface watering and proper compaction. (7) Monitor the process of preventing distortion of ramp road by protecting unauthorized entries for ramp road which have allocated for girder transportation. Check all the ramp road alignment and slope angles and attend to do required adjustment if any. (8) Tighten the girder in holding bars properly. Additionally chain ropes can be used. When using timber pieces make sure those will not loosened and removed throughout the transportation. (9) Traffic arrangement for girder transportation is required as stated in Method Statement. While transporting girder especially along ramp roads for continuous movement of vehicle should not be obstructed by traffic at site or public road. (10) Once a girder loaded to the truck properly allow some time and confirm there are no compressed air leakages. Air line connections should also be checked for air leaks. (11) Awareness programs, toolbox talks should be made frequently covering alla personnel who take part for girder transportation. Awareness should be included how to act on such emergencies. (12) Make every worker a habit to foresee hazards. And take keen effort to eliminate those immediately. And aware them how should they act when find a hazard or on an emergency.

3. Root Cause Analysis and Study for Countermeasures

1) Understandings of the Objective Accident

[Progress Chart of the Objective Accident]: Omitted because of the simplicity of the incident.

2) Why-why Analysis

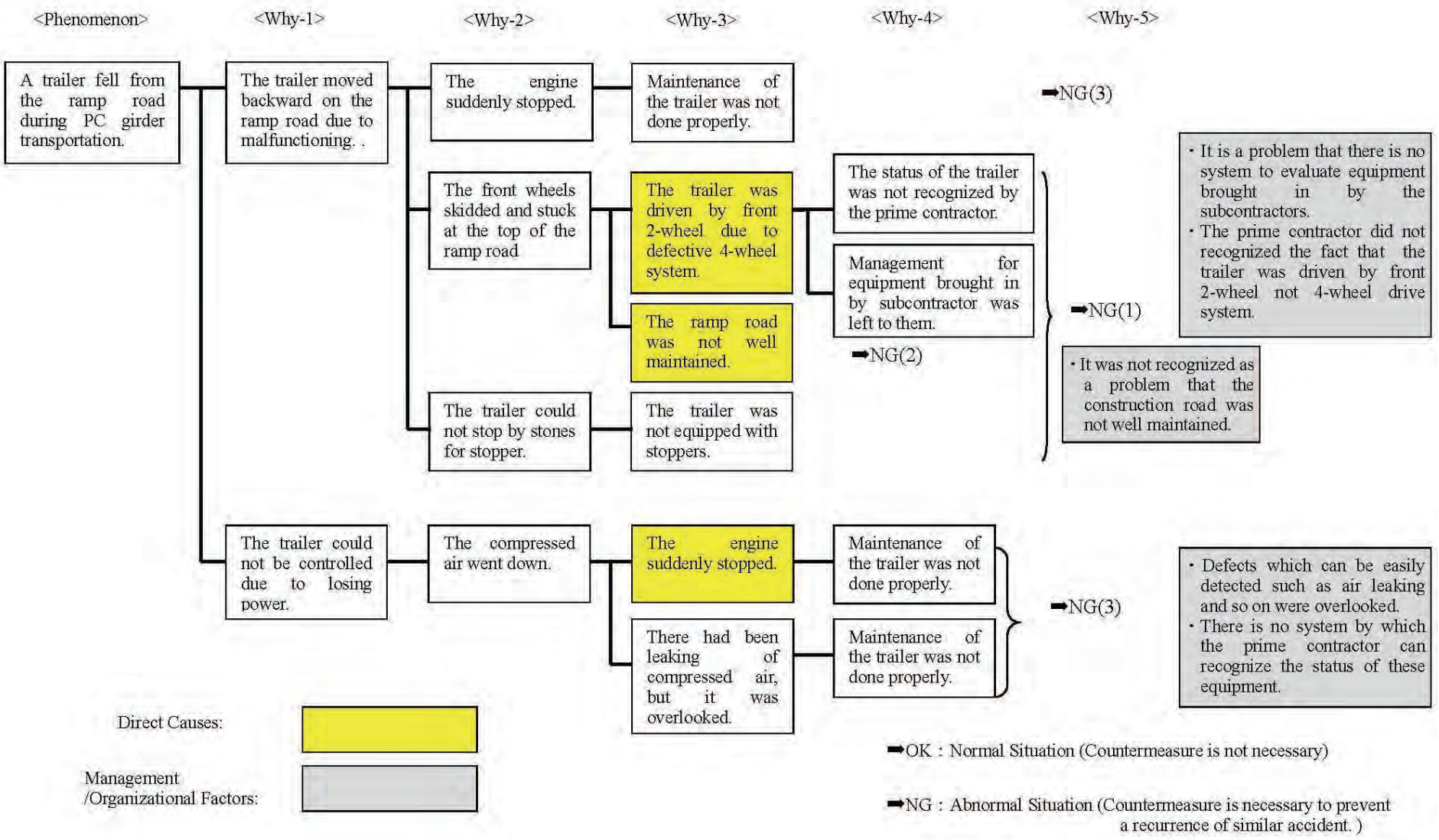


Fig. 4.4.32 Pursuit of Root Causes by the Why-why Analysis Diagram

3) Countermeasures against Direct Cause

Table 4.4.19 Provisional countermeasures to prevent recurrences of similar accidents

Direct Causes derived from Why-why Analysis (shown in yellow in the chart)	Countermeasure 1	Countermeasure 2	Countermeasure 3
1. The trailer was driven by front 2-wheel due to defective 4-wheel system.	As it is safer to use trailer with 4-wheel drive system for transport heavy items, make it sure to confirm the trailer can be driven by 4-wheel drive. Maintenance of equipment must be performed properly. Always confirm that everything is in order for the equipment such as stoppers.	-	-
2. The ramp road was not well maintained	Determine standard for maintenance of construction road, and execute as determined.	-	-
3. The engine suddenly stopped.	Make operators informed how to act in case of an emergency such as a sudden engine stop. Check defect of equipment such as air leakage and repair them surely.	-	-

4) Developing Management/ Organizational Factors

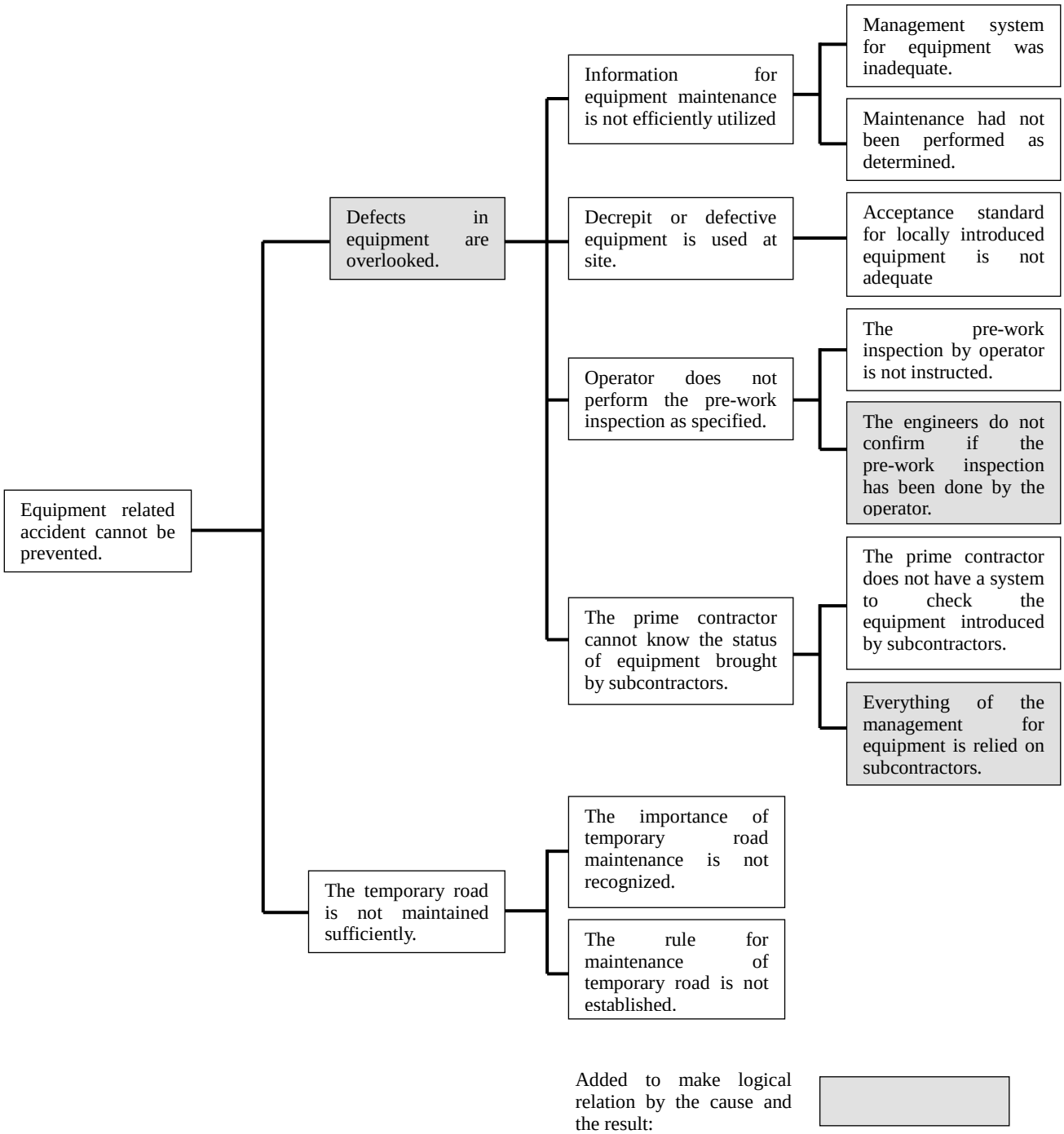


Fig. 4.4.33 [A Problem Tree Leading to the Accident] (Management/Organizational Factors)

5) Countermeasures for Management/Organizational Factors (1)

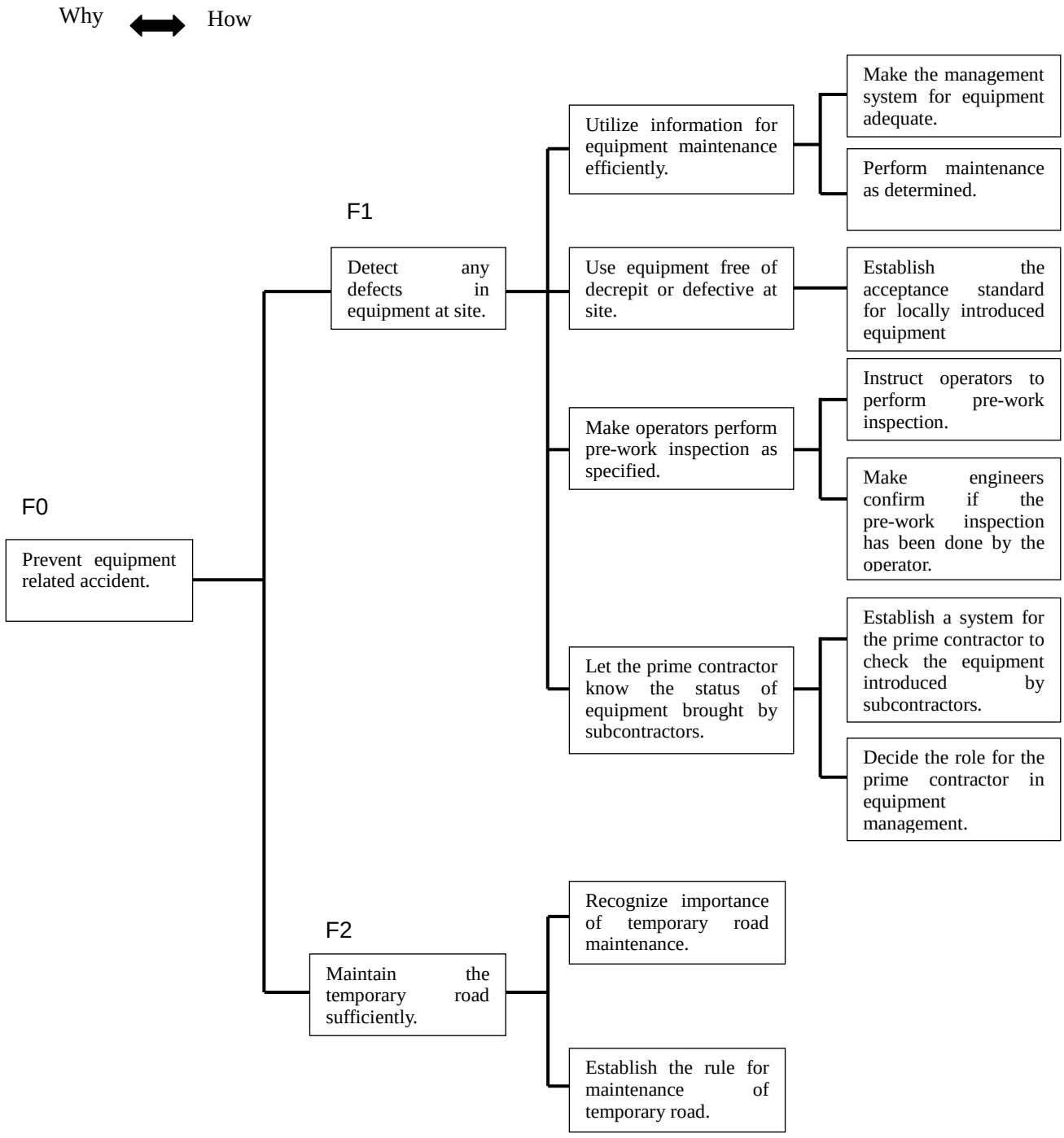


Fig. 4.4.34 [Function Tree to Prevent Grave Accident (Management/Organizational Factor)]

Convert the problems (in Problem Tree) by reversing to functions which are to be performed.

4.4.4 Root Cause Analysis of the Accident Caused by Falling from the Girder

(2014/08/06)

1. The Accident

[Outline, situations and causes of the accident are derived from the Crane Accident Investigation submitted to the Employer by the Consultant.]

[Outline of the Accident]

On August 06, 2014 one worker fell down from 9.0 m high place of the Viaduct No.4 on to the muddy ground. The victim suffered cracked bone injuries of his wrist and backbone but no danger to his life.

A crew of five workers including a foreman was working on the deck slab of the Viaduct. The worker who fell said that he fell through the opening to the ground, because of a sudden movement made by him as he was afraid of being knocked by the crane hook.

Photo 4.4.3 View of the Accident site

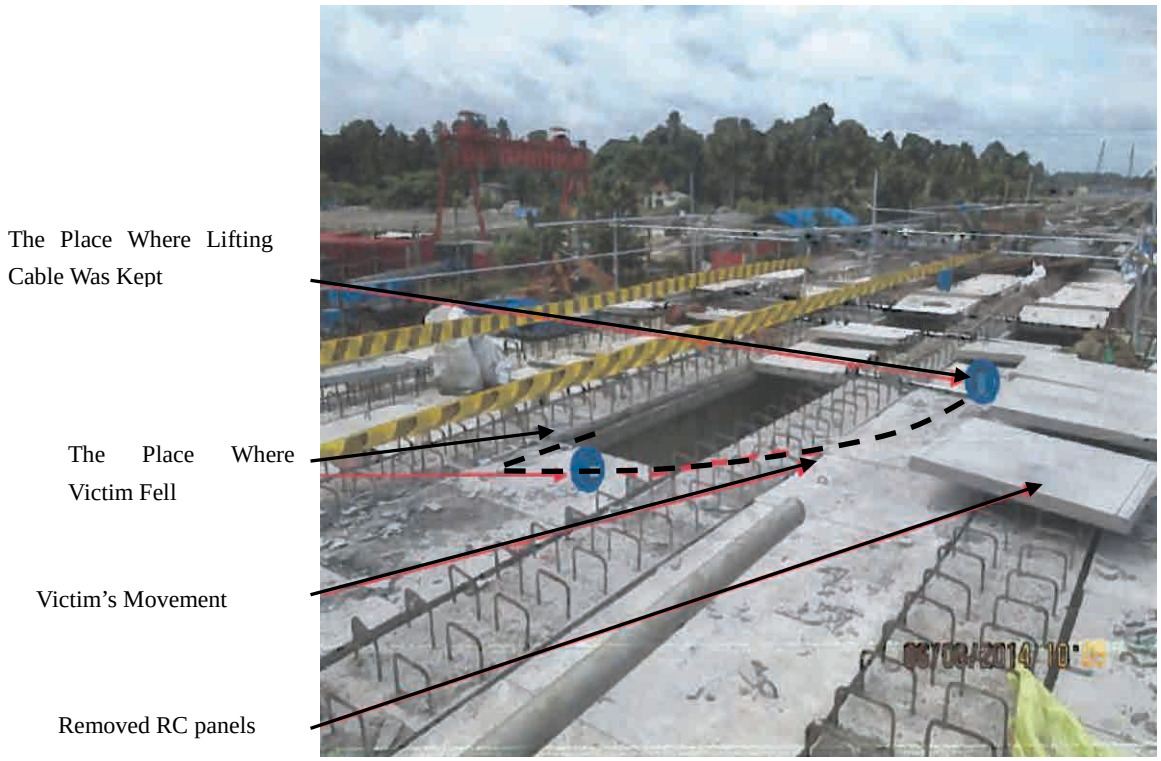


Photo 4.4.4 Accident Location

4.5 Root Cause Analysis－Integral Analysis

1) Concept and Procedure of Integral Analysis

In the previous chapter, the individual accident was studied for its root causes.

Through the analysis flow of Why-why Analysis ~ Problem Tree ~ Function Tree, it has been clarified what kind of management and/or organizational factors must be solved in order to prevent recurrence of similar kind of the accident.

In the next step, Integral Analysis, the countermeasures for securing safety and preventing accidents in this project shall be discussed by seeing the management/organizational factors objectively.

Many countermeasures and recommendations obtained in this study are expected to be able to apply to other projects which may have similarities in construction conditions and local characteristics.

Procedure of the integral analysis is as follows;

(1) Integral Function Tree (It shows the activities necessary to prevent accidents in the project.)

The integral function tree can be made by superposing the function groups (a group of functions which have relations each other when these functions have a certain common purpose.) which are shown on some individual function trees. By doing so, functions to be achieved in order to solve the problem in the concerned project can be shown visually.

↓

(2) Sorting out the management and organizational factors derived from the individual accident.

↓

(3) Classification of the factors and evaluation of those by their significances.

↓

(4) Presenting measures to solve those factors, countermeasures to prevent recurrence of accidents and recommendations.

(1) Integrated Function Tree

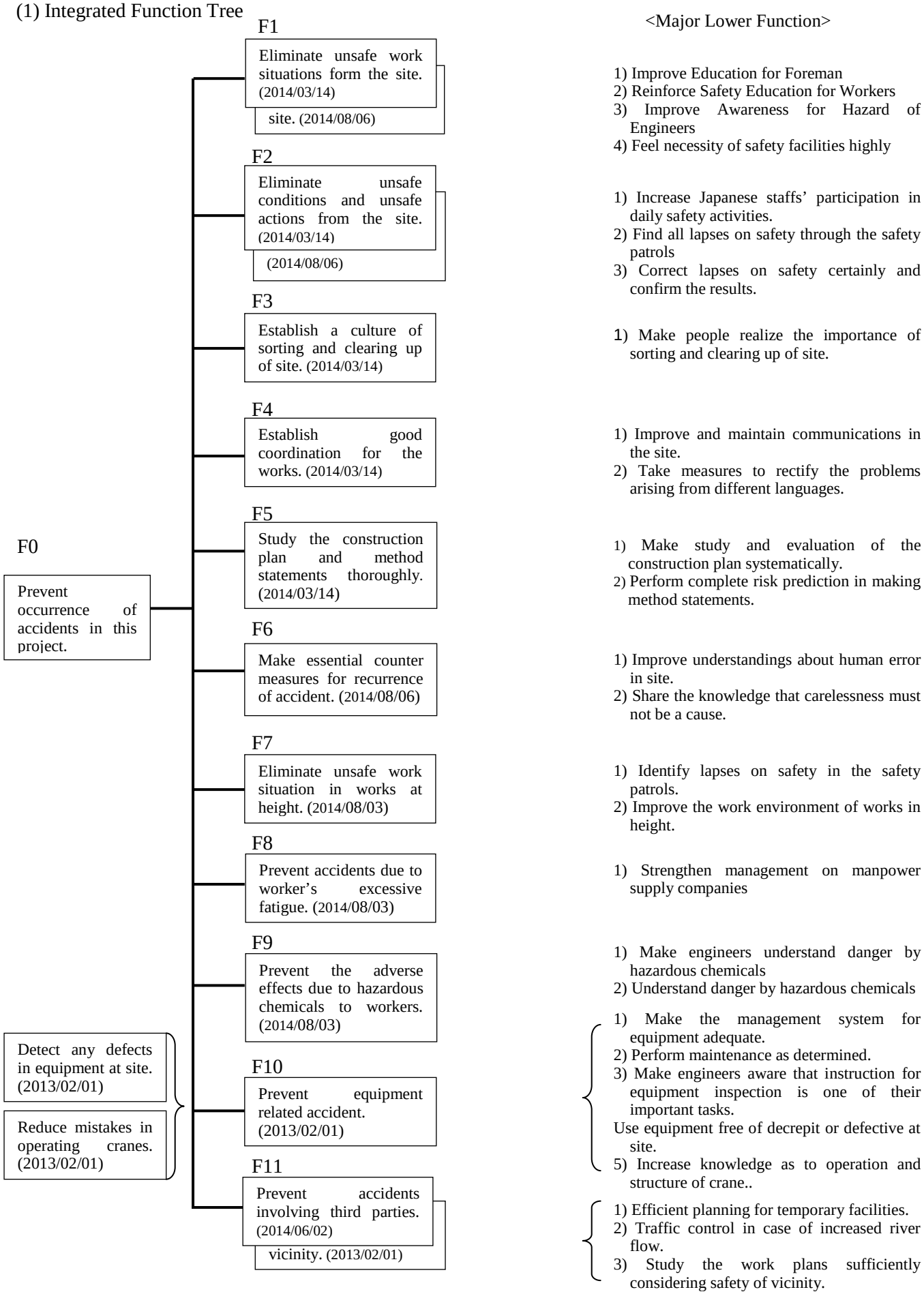


Fig. 4.5.1 The Integral Function Tree as the Ideal State of Safety Activities in OCH2

As explained, the integral function tree as the ideal state of safety activities in OCH2 shows items to be done in order to prevent accident in the project. There are some function groups common in some accidents and those exceptional due to the peculiarity of the accident as well.
The relationships between function groups in the integral function tree and the accidents form which the functions were derived are shown in the table below.
"◎" represents the relationship that is recognized based on the analysis and "○" represents relationship that is interpreted from the situation of the accident and the lower level function in the function groups.

Table 4.5.1 The relationships between function groups in the integral function tree and the accidents form

Function Group	Accidents Analyzed				
	Accident Caused by Broken Boom of Crane (2013/02/01)	Accident Caused by Toppling of PC Girder (2014/03/14)	Accident Caused by Falling by Passing Out (2014/08/03)	Accident Caused by Falling from the Girder (2014/08/06)	Accident of Public Vehicle Fell in the Risen River (2014/06/02)
F1: Eliminate unsafe work situations form the site	○	◎	○	◎	
F2: Eliminate unsafe conditions and unsafe actions from the site		◎	○	◎	○
F3: Establish a culture of sorting and clearing up of site		◎			
F4: Establish good coordination for the works		◎		○	
F5: Study the construction plan and method statements thoroughly		◎		○	○
F6: Make essential counter measures for recurrence of accident		○	○	◎	
F7: Eliminate unsafe work situation in works at height			◎	○	
F8: Prevent accidents due to worker's excessive fatigue			◎		
F9: Prevent the adverse effects due to hazardous chemicals to workers			◎		
F10: Prevent equipment related accidents	◎				
F11: Prevent accidents involving third parties	◎				◎

The five accidents analyzed herein occurred under various circumstances and have peculiar characteristics each other. Thus, most of the required functions (F1~F11) shown in the function tree can be applied for other projects that have common points of the conditions and the construction object with OCH2 project.

For example, "F1: Eliminate unsafe work situations form the site" has four lower level functions such as 1) Improve education for foreman, 2) Reinforce safety education for workers, 3) Improve awareness for hazard of engineers, 4) Feel necessity of safety facilities highly.
These lower functions point out that foremen's capability has important effect in the developing countries, safety awareness of workers is low, improvement of engineer's capability for hazard prediction is needed and reinforcing safety facilities and safety gears is important.

Thus, many of recommendations developed by this study for management/ organizational factors can be applied effectively for other projects even in other countries with some modifications if necessary.

(2) Sorting out the Management and Organizational Factors

Table 4.5.2 Management and Organizational Factors

Accident	Management Factors	Organizational Factors
Accident by Broken Boom of Crane (2013/02/01)	1) Evaluation system for locally introduced equipment together with operator did not exist. 2) Maintenance of equipment had not been performed properly. 3) There was not a system supervisors could obtain information as to equipment maintenance. 4) Instruction to operators to carry out pre-work inspection was not given nor was it not confirmed.	1) Supervisors and engineers did not think of inspecting themselves the condition of equipment. 2) Knowledge of engineers and foremen regarding setting and operating cranes was not enough.
Accident by Toppling of PC Girder (2014/03/14)	1) Safety patrol did not function; thus, unsafe conditions at site were overlooked. 2) Safety activities were not able to cover whole construction site due to its size. 3) Engineer's instruction to foremen was not sufficient. (Particularly at night shift work.)	1) Importance of good coordination between different work teams was not well recognized. 2) Awareness of sorting and clearing up the site thoroughly was not shared through the site. 3) Awareness for importance of foreman education was low. 4) Awareness of necessity for participating in site works and safety management was not enough. 5) The necessity to include safety plan in the method statement was not recognized.
Accident of Falling from Pier by Passing Out (2014/08/03)	1) Work hours of workers at site were not monitored and controlled. 2) Safety measures for works at height are left to supervisors' discretion and were not adequate. 3) There was no safety plan for works using hazardous chemicals.	1) Because of direct hiring system, it was difficult to control manpower supply companies for management of working hours. 2) Awareness of hazard in a work at height prior to start of the work was low.
Accident of Falling from the Girder (2014/08/06)	1) Safety facilities were not enough. 2) Usage of safety gear such as safety belt was not recognized as mandatory by foremen. 3) The foreman did not perform his primary duty of supervision as he was acting as signalman.	1) Awareness for importance of foreman education was low. 2) Among engineers and foremen, awareness of the tendency that accident would increase under time restriction was low.
Accident involving Third Party When the River Water Rose. (2014/06/02)	1) Planning of temporary facilities (the river flow) was not adequate. 2) Due to inadequate prediction of possibility of third party accident.	

(3) Classification and Evaluation of Management/Organizational Factors for Safety

Table 4.5.3 Classification and Evaluation of Management/Organizational Factors for Safety

Management Factors	Signifi-cance	Organizational Factors	Signifi-cance
1. Factors in Safety Management at Site		1. Factors As to Safety Awareness and System	
1) Safety patrol did not function; thus, unsafe conditions at site were overlooked.	◎	1) Awareness of necessity for participating in site works and safety management was not enough.	◎
2) Safety activities were not able to cover whole construction site due to its size.	○	2) The necessity to include safety plan in the method statement was not recognized.	◎
3) Safety measures for works at height are left to supervisors' discretion and were not adequate.	◎	3) Among engineers and foremen, awareness of the tendency that accident would increase under time restriction was low.	○
4) Usage of safety gear such as safety belt was not recognized as mandatory by foremen.	◎	4) Supervisors and engineers did not think of inspecting themselves the condition of equipment.	○
5) There was no safety plan for works using hazardous chemicals.	○		
2. Factors As to Engineers and Foremen		2. Factors As to Hiring System	
1) Engineer's instruction to foremen was not sufficient. (Particularly at night shift work.)	◎	1) Because of direct hiring system, it was difficult to control manpower supply companies for management of working hours.	◎
2) The foreman did not perform his primary duty of supervision as he was acting as signalman.	◎	3. Factors As to Roles and Abilities of Engineers and Foremen	
3. Factors in Equipment Management		1) Awareness for importance of foreman education was low.	◎
1) Evaluation system for locally introduced equipment together with operator did not exist.	◎	2) Awareness of hazard in a work at height prior to start of the work was low.	◎
2) Maintenance of equipment had not been performed properly.	◎	4. Other Factors for Work Execution	
3) There was not a system supervisors could obtain information as to equipment maintenance.	○	1) Importance of good coordination between different work teams was not well recognized.	◎
4) Instruction to operators to carry out pre-work inspection was not given nor was it not confirmed.	○	2) Awareness of sorting and clearing up the site thoroughly was not shared through the site.	◎
4. Other Factors for Work Execution		3) Knowledge of engineers and foremen regarding setting and operating cranes was not enough.	○
1) Work hours of workers at site were not monitored and controlled.	○		

◎ : Very Important, ○ : Important

4.6 Recommendation for Preventing Recurrence of Accidents

(Management/Organizational Factor in Safety Management)

Recommendations stated hereinafter are at the period prior to the accident which was caused by toppled PC girder occurred on 14th March 2014. There have been various improvements taken by the parties related to the Project since then. Those improvements and the present status are shown in the table below comparing with the recommendations.

Table 4.6.1 Recommendation for Preventing Recurrence of Accidents
(Management/Organizational Factor in Safety Management)

Item	Content of Recommendations	Comparison with the Present
1. Awareness of Safety	1) The top management (the Contractor, the Owner and the Consultant) exercises a strong leadership in enhancing safety awareness, and took initiative in acting to materialize the principle; "Safety First". 2) Promote education and enlightenment program which agree with the present situation of education and safety awareness level of the local workers' to ensure the safety works. 3) Establish a structure for the supervisory personnel (foremen and supervisors) who are either foreign or local can gain professional knowledge from Japanese safety experts in order to improve their ability of foreseeing danger. 4) Considering absolutely most of accidents are caused by human errors (the lack of coordination and communication is one of the human errors), enhance understanding of the human errors and work on preventing accidents based on it.	
2. Organization for Safety Management	1) The safety management section must be under the direct control of the Project Director. Give the section strong authority to instruct other sections for safety improvement. 2) Clarify the roles and authority of the Safety Manager and Safety Officers to pursue parallel execution of the project and safety of the works. 3) The Owner clarifies the principle of safety of the Project. The Consultant establishes the organization for safety management and the system to cooperate with the Contractor's safety management organization to materialize the effective safety activities.	1) After March 2014, the safety management organization was reviewed and positioned directly under the Project Director. The safety section was also reinforced with additional safety personnel together with a permanent Japanese safety engineer. A safety expert was also dispatched from Taisei's Tokyo head office in August and has been helping safety management activities effectively. 3) The Owner, RDA has a great interest in safety management in the Project designating safety personnel.

3. Safety Plan and Execution	1) Make a concrete and detailed safety plan which agrees with the present situation that many workers are unskilled when studying the Method Statement. In addition, establish the structure in which inspections by the Consultant prior to the start of the work includes inspection of safety measures, and perform inspection as determined. 2) In future STEP projects, the above shall be clearly stipulated in the contract document. 3) In the study of the above safety plan, involve not only the engineer in charge for the section/work but also foremen to make the plan suitable to the actual work conditions. In addition, this is an effective way to enhance the sense of responsibilities of foremen in their roles. 4) Establish the system of executing and confirming the safety measures as planned. The present Safety Plan is merely a general content, and not a plan to guarantee the safety of a specific work in the specific construction site.	3) Studies of construction methods for the selected six hazardous works have been done involving foremen. An effective result of the education for foremen has been recognized.
4. Safety Management Activities	1) Share the idea that the one of the major purpose of daily site patrol is safety management among all staff and personnel. 2) Give the priority to safety measures even if it may causes delay of the work in order to establish “Safety First” and practice it in the site. 3) In order to improve the effectiveness of the safety patrol by the Consultant, strengthen coordination and cooperation between the Consultant and the Contractor. 4) Improve daily safety activities such as the morning meeting and the tool box meeting. 5) Spend half minutes or less for the silent prayer at the end of the meeting exampled above for the safety of the day.	3) These safety activities have been practiced diligently since March 2014.
5.Education and Enlightenment of Safety	1) Make much of the education specifically for foremen considering the status of the local work force, perform it systematically. 2) Give the workers an education for	1) Although a systematic education program is not available yet, the importance of the education of foremen is well recognized, and the education is conducted as needed.

	basic matters of safety. Make foremen always instruct them through the site work about safety repeatedly. (Usage of safety gears and avoiding unsafe acts, etc.)	2) The basic education of safety for the workers has been conducted; however, it has not been producing affirmative effects. (an issue to be noted)
6. Hiring and Management of Labor Force	1) Due to the situation that subcontractors in this country have not grown enough yet, the direct hiring of work force is inevitable. However, the Contractor has to exercise any necessary management such as the working time of workers to prevent accidents due to excessive fatigue. 2) Considering the situation of the local workers that there are many unskilled or unqualified workers, provide fundamental/practical education agreeing with their skill levels, work environment and work methods.	1) According to the contract of the manpower supply, the confirmation of the status of workers' working attitudes and so on is on the Contractor. However, that role has not been done well by Taisei so far. 2) According to the contract of the manpower supply, the education of workers for the safety rules at the site is to be done by the manpower supply companies. (an issue to be noted)
7. Others	1) Make all personnel and workers understand that sorting and clearing up are the fundamental factors to ensure the safety. Promote the movement of sorting and clearing up the site. 2) Eliminate defective equipment from the site by evaluate the status of the equipment especially brought in by supplier based on the evaluation standard.	1) Presently the site condition has been quite improved from the tidiness point of view by designating special team for cleaning and other measures. The movement of sorting and clearing up, however, has not matured yet to the level of 5S movement in Japan.

Chapter 5 The Guidance for the Management of Safety for Construction Work in Japanese ODA Project

5.1 Background

JICA conducted a project research named “study Report on the Guidelines for the Management of Safety for Construction Works in Japanese ODA Projects - July 2013”, by which “The Guidance for the Management of Safety for Construction Work in Japanese ODA Project” (hereinafter called “the Safety Guidance”) was prepared/published in September 2014. With a view to introducing the Safety Guidance to Japanese ODA projects in the fiscal year of 2014, JICA has been carrying out dissemination in/outside Japan (a seminar was conducted in Japan on September 19, 2014). The contents of the Safety Guidance are as follows:

Table 5.1 Table of Contents of the Safety Guidance

Chapter 1: General Rules	1.1	Purpose
	1.2	Scope of Application
	1.3	Plans for Safety Management
	1.4	Roles and Responsibilities of Project Stakeholders
Chapter 2: Basic Policies for Safety Management	2.1	Basic Principles of Safety Management
	2.2	Compliance with Relevant Laws and Regulations
	2.3	PDCA for Safety Management
Chapter 3: Contents of the “Safety Plan”	3.1	Composition of the Safety Plan
	3.2	Basic Policies for Safety Management
	3.3	Internal Organizational Structure for Safety Management
	3.4	Promotion of the PDCA Cycle
	3.5	Monitoring
	3.6	Safety Education and Training
	3.7	Voluntary Safety Management Activities
	3.8	Sharing Information
	3.9	Response to Emergencies and Unforeseen Circumstances
Chapter 4: Contents of the “Method Statements on Safety”	4.1	Composition of the “Method Statements on Safety”
	4.2	Applicable Standards for the "Technical Guidance for Safe Execution of Works"
Chapter 5: Technical Guidance for Safe Execution (by the Type of Work)	5.1	Excavation Work
	5.2	Pile Foundation Work
	5.3	Formwork and Form Shoring System Work
	5.4	Reinforcing Bar Work
	5.5	Concrete Work
	5.6	Work over Water
	5.7	Demolition Work
	5.8	Work where there is danger of oxygen deficiency
	5.9	Slinging Work
Chapter 6: Technical Guidance for Safe Execution (by the Type of Accident)	6.1	Measures for Prevention of Fall Accidents
	6.2	Measures for Prevention of Accidents Involving Flying or Falling Objects
	6.3	Measures for Prevention of Accidents Involving Collapse of Structures
	6.4	Measures for Prevention of Accidents Involving Construction Machinery
	6.5	Measures for Prevention of Explosion Accidents
	6.6	Measures for Fire Prevention
	6.7	Measures for Prevention of Public Accidents
	6.8	Measures for Prevention of Traffic Accidents
	6.9	Protective Gear

As part of dissemination of the Safety Guidance, the following tasks were implemented in this study:

- To compare the contents of the safety plan submitted by the contractor with those of the Safety Guidance,
- To conduct a seminar on “The Safety Guidance”, and
- Through exchange of opinions with stakeholders in the seminar, etc., to extract effects and problems in application of the Safety Guidance assuming the guidance is applied to the Outer Circular Highway Phase II project

5.2 Comparison of the Contractor’s Safety Plan with the Safety Guidance

Table 3.3.12 shows the comparison between the Contractor’s safety plan with the Safety Guidance. Compared therein is not the safety plan submitted at the tender, but the plan submitted during the construction stage and being actually used.
Since the contract documents for the Outer Circular Highway Phase II project prepared by the Employer and the Consultant contains substantial information on the safety, those are also compared in the table together.
It was found that each of the contract documents and the Contractor’s prepared safety-related documents contain sufficient information regarding Safety (Safety of Works and Occupational Safety and Health).

5.3 Seminar

As a part of the program of “Safety Seminar”, a seminar on “The Guidance for the Management of Safety for Construction Work in Japanese ODA Project” was conducted in Colombo, Sri Lanka on November 11, 2014 inviting those who are involved in the Outer Circular Highway Phase II project.
Details of the seminar are described in Chapter 6.

5.4 Discussions on “The Safety Guidance”

The discussions on the Safety Guidance held between the seminar attendees and the study team in the seminar are summarized in the following table.

Table 5.2 Discussions on “The Safety Guidance”

Comments from Seminar Attendees	Responses by the Study Team
We have already submitted a safety plan for this project and in comparing with the guidance presented, basically the outline of the guidance is same. But in details there are some differences. This is a basic plan of safety. It should be changed country to country and location to location.	First of all, I would like to emphasize that the guidance presented can be applied for new projects but not for ongoing projects. Therefore the guidelines will not be applied for the OCH Phase II project. Further he said the guidance should go along with the prevailing law and regulations of the relevant country and it should not exceed the law of the country. And also, JICA does not expect to prepare a totally changed guidance with the existing one. But there are changes in PDCA cycle.
If we try to implement the safety guidance completely in this country, some practical problems will arise due to the existing construction law of the country.	The level of construction management of TAISEI is high comparing to the other construction companies. So, you may feel awkward for imposing this guidance on the company like yours. But since all the other contractors are not like TAISEI, JICA wants to standardize the safety management practices for all the projects they fund.
I believe that the cost for the safety should be included in the BOQ.	As far as I understand the information from JICA it is under consideration. There are some countries that safety management cost prevails as a separate BOQ item. There are opinions that the safety cost should be included in the overhead. But in some countries such as Hong Kong and Singapore, the safety cost is itemized as independent cost to be fair among the competitors.
If the guidance would say that the site must be surrounded by a fence, we have to include the cost in the bid price. So, if the guidance will be incorporated in the contract document, it should clearly state what included and what not included.	
This is very important issue not only for JICA but also for Japanese Contractors; we had better clearly include it in BOQ. Unless otherwise, say, Chinese or Korean companies have different understanding for safety and they participate in JICA’s bid, a big confusion will occur.	
I have some comments to make not only regarding the guidance. We established a safety plan and a PDCA cycle but it is sometime difficult to continue. Because for an example in Japan the operator gets a license and he is well trained for his job and he is taught about safety based on this license. But there is no such system here in this country. So I hope in the future JICA will take steps to activate a similar system here in this country and train them well enough to minimize accidents. Before that I think it is more important to activate a cultural safety concept and educate people working there. But we have to gradually develop a system like that and assist them in fulfilling it.	
Today, I understand this session we discussed about the rule or regulations. But the important thing the contractor said is how to change the real attitude or to develop the real capacities of the people. But so far JICA has not provided the technical cooperation or the Sri Lankan government to conduct the capacity building of the construction industry. It could be one of the targets of JICA. But before that I would like to hear based on the result of the root cause analysis what would be the	

problem, difficulties or obstacles to be overcome by not only the contractors but also the employer and the donor. I would like to know understand what we should do together to break the situation of this country. I'm a bit doubtful that even though the ministry will introduce the regulations, but in order to make them workable out we have to give more effort to do together.	

Chapter 6 Safety Seminar

A seminar was conducted in Sri Lanka in the following manner:

6.1 Seminar Outline

a. Date/Time: November 11, 2014; 14:00 - 17:00
b. Venue: Waters Edge Hotel
c. Attendees: JICA Sri Lanka Office, RDA, Consultant, Contractor – Total 33 persons
d. Programme:

13:30～14:00： Registration
14:00～14:10： Opening Address (Mrs. T. S. H. Abewickrema, Project Director, RDA)
14:10～14.30： Mission of the Study
14:30～15:15： Explanation and Discussions on “The Guidance for the Management of Safety for Construction Work in Japanese ODA Project”
15:15～15:30： Coffee Break
15:30～16:50： Interim Report of Safety Study on OCH II Project
16:50～17:00： Closing Remarks (Mr. Kiyoshi Amada)

6.2 Presentation by the Study Team

a. Explanation on “The Guidance for the Management of Safety for Construction Work in Japanese ODA Project”
- ODA policies
- “The Guidance for the Management of Safety for Construction Work in Japanese ODA Project”
- Q&A in the seminar conducted on September 19, 2014 in Japan

b. Root Cause Analysis of the Accidents at OCH II
- Purpose and Procedure of the Root Cause Analysis
- Root Cause Analysis of 4 accidents at OCH II
- Development of Management/Organizational Factors, Evaluation Results
- Recommendations on the Safety Management of OCH II based on the Analysis

c. Presentation Materials

Please see the attachment.








Photo 6.1 Seminar Scenery

6.3 Summary of Questions and Answers

a. Re. “The Guidance for the Management of Safety for Construction Work in Japanese ODA Project”
Please refer to Chapter 5.

b. Re. Root Cause Analysis of the Accidents at OCH II
The questions and answers in the seminar are summarized below:

Table 6.1 Q&A on Root Cause Analysis of the Accidents at OCH II

Speaker	Comment
MOHPS	This presentation was very systematical and methodical. I appreciated valuable presentation. And I would like to ask about any recommendation on safety audits especially audits by the consultant? In the past audits, there have been not many results given from them.
Study Team	I don’t think that it is necessary to have a safety audit because already Mr. Perera of RDA is doing that. And I think it would be more important to appreciate the effort and improvement for the safety or better actions by the contractor and the consultant rather than only pointing out defects and lapses on safety.
MOHPS	Did you study team prepare any checklist to check the safety?
Study Team	I think it is not matter of a form or a list but the attitude of each other. In other word, trusting each other is more important to go with.
Contractor (PD)	I want say something about working together. OC doesn’t do safety patrols with the company of TAISEI intentionally. And THAISEI check the safety every day by safety manager and other personnel and if we do it together, sometimes we might have conflicts.
Employer (PD)	My understanding is according to the consultant agreement there is no specific part for safety. So my request is please include this in the future. There are no local safety engineers who are specially trained for this purpose. Most of them are specialized in the mechanical field so I feel that they are not technically capable enough to carry out the process done by safety engineers.
Study Team	I agree with your opinion completely. It is very important to have qualified safety engineers in this country and I would like JICA to introduce a program for safety. In order to become a good safety engineer he/she has to be well experienced in construction work. We must always encourage civil engineers to become safety engineers because I find it very important especially in this country.
Employer (PD)	I think it’s good if we can include training on safety to local engineers in the construction agreement.
JICA	I would like to thank MOHPS and RDA and other participants to join today’s seminar. I personally learned a lot about the guidance and safety matters today. In the future I would like to work more with the government and others to improve this country. In addition to that, some people suggested that JICA has some role for helping to build safety in construction projects in this country. In OCH2 project, I believe all people concerned try to build safety measures to prevent accidents. So, I wish no accident would happen in the future. For that purpose, today’s presentation will be helpful for us to make what kind of measures should be taken. Finally I would like to say thank you for the study team for the valuable presentation.

Chapter 7 Recommendations

The lessons and recommendations extracted from a series of accident cause analyses described in Chapter 4 mainly focus on the contractor. Bearing the above analysis results in mind, this chapter summarizes the lessons and recommendations focusing on the general situation of Sri Lanka and the project.

7.1 Lessons

It is virtually impossible to prepare a universal and systematic manual for construction management which can be used repetitively due to the basic features of construction works in ODA projects. Hence, in many cases it is necessary to prepare a set of construction management plans for individual projects taking account of various external factors and finally to take such measures as the occasion demands on site.

Table 7.1 Characteristics of Construction Works in ODA Projects

Characteristics of Construction Works in ODA Projects	
Basic Features	# Single Production: Even if the donor, recipient country, employer and project scale are the same, due to the variety of site conditions, the structure and dimensions of the works turn to be unique. # On-Site Production: Since the works are carried out on site, works are often implemented under severe environmental conditions and temporary conditions. Since the project sites are abroad, it is often more difficult than in Japan for the contractor to grasp the site conditions in advance. # Production By-Order: Unlike manufacturers, the construction works start only after getting an order from the employer in a recipient county. Prior to making the contract, the contractor should agree with the employer on the construction method and cost worked out based on the terms of reference prepared by the employer. Further details of construction method including the organization are determined after the award of the contract.
Influential External Factors	The primary objective of the work is to properly execute the contract between the employer and the contractor, where the contractor tries to maximize the profit under the constraints imposed by various external factors. ① Natural Conditions (topography, geology, weather, hydrology, etc.) ② Social Conditions (local laws & regulations, rights, living environment, markets, transaction, transportation, communication, social facilities, construction resources, labor employment, insurance system, etc.) ③ Technical Conditions (local materials quality/function/standards, construction standards, measurement standards, scientific knowledge on pollution/environment/safety, construction equipment, etc.) ④ Employer Conditions (contract documents, specifications/construction period/cost of works, construction method, equipment/materials, etc.) ⑤ In-house Conditions (organization, rules & regulations, construction experience, preceding work results, approved policies/plans, etc.)

(Source: prepared by the Consultant with reference to "System & Procedure of Civil Construction Works")

Considering the characteristics of construction works in ODA projects mentioned above, lessons obtained in the project are summarized in five categories, such as Local Situation, Planning/Design, Tender/Contract, Construction, Accident Report.

(1) Local Situation

a. It appears that in Sri Lanka the binding effect of the act on occupational safety and health is weak, and consequently safety in construction works should rely on the site management framework of each project.
b. The construction industry has been booming after the end of island ethnic war in 2009, which has been making procurement of construction workers difficult. The quality of workers is problematic, and contractors cannot help training workers after screening.
c. No reliable local subcontractors are available in this region. Hence, in case of projects with tight schedule and/or technical difficulties cannot help relying on the direct employment system wherein the contractor can supervise workers directly.

(2) Planning/Design

a. The natural conditions of the project site are hard, i.e. the geology of the project significantly varies from place to place, the project includes flood-prone sections, etc.
b. Significant changes were made to the plan during the detailed design period (e.g. a part of concrete bridge was changed to steel bridge, Kelani bridge design was changed to differ the span layout and to have side spans), and it was difficult to cope with such changes within the design contract period.

(3) Tender/Contract

a. A large-scale project was awarded to the contractor on a blanket order basis.
b. The bridges & viaducts (16 nos.) located on the main line had not been designed and the soil investigation required for the bridge design had not been conducted at the time of the tender/contract, and the contractor was responsible for execution of those activities after the commencement of works.
c. The consultant's role on safety is not clearly described in the TOR for construction supervision consultant.
d. Additional measures for safety always require additional expenditures. It is appreciated that the specifications and BOQ for the project respectively specify the contractor's duties on safety and the corresponding payments. However, quantitative and financial ambiguities left in such contract documents may have made the consultant reluctant to instruct the contractor to enhance the safety measures.

(4) Construction

＜Re. Consultant＞

a. It appears that due to the organizational limit all the consultant could do is to be involved in the safety management from an audit standpoint (2 safety patrols/month, surprise check) rather than to keep taking accident-preventive measures together with the contractor on a daily basis.
b. There appears to be nothing basically wrong in the consultancy contract. However, due to the above limitation it is observed that the consultant's local safety engineer looks rather focusing on detecting the contractor's defects than maintaining safety-consciousness on accident prevention. Improvements to the

contract system by which the contractor and the consultant are encouraged to cooperate with each other in accident prevention is required.

c. Usually the safety patrol is conducted weekly or monthly on a spot check basis and not continuous monitoring on a daily basis, and consequently only possible direct causes of accident which can be easily spotted tend to be picked up. It is considered necessary to use another approach to become aware of management & organizational factors which may constitute the background of accident.

＜Re. Contractor＞

a. The frequency rate of casualties (= (casualties by occupational accident) / (total working hours) x 1,000,000) of OCH2 is 1.72 in 2013 and 1.42 in 2014 respectively, while the same of the contractor's all overseas civil works projects is 1.78 in 2014, the one of all industries in Japan is 1.58 in 2013 and the one of all construction projects in Japan is 1.25 in 2013. Hence, it is not necessarily possible to conclude that there more accidents in Sri Lanka than other countries. On the other hand, it is statistically possible to state that more casualties could be found on OCH2 where the project scale is large and the annual total working hours is extraordinarily big. Nonetheless, it is regrettable to have had a fatal accident in OCH2.

b. While the project management system and documentation are tidy and well in order including the contract documents prepared by the Employer and various plans/documents prepared by the contractor, accidents occurred frequently. It could be said that safety on site cannot necessarily be secured only by the adequacy and sufficiency of system and documentation.

c. Though the original contract period was three years, since it took one year for the contractor to carry out the bridge designs including soil investigation, the net construction period was curtailed to two years. (It is noted that extension of time of six months had been granted as of October 2014) Consequently, combined with the large scale of the project, it has resulted in significant increase of the number of work places, work volumes and the number of workers (ave. around 2,000 workers/day), which has made the site management difficult.

d. Regardless of the contractor's safety measures conformance with the contract and/or the ordinary industrial requirements, it is the fact that serious accidents started occurring when the project reached the peak time and finally a fatal accident occurred in March 2014. The contractor failed to achieve what he had believed he could, and in other words, the contractor's initial safety measures were proven inadequate by the fact. Moreover, serious accidents have not occurred after August 2014 when the contractor took drastic measures, which is also an relative evidence that the initial safety measures were insufficient.

e. Since there is not full repeatability in construction sites, it is inevitable, on one level or another, to have occasions where the contractor's action is forestalled by the actual situation at the beginning of the project, and is catching up through trials & errors and learning as the project progresses. In this project, it cannot be denied that the contractor's action on safety management took a back seat to advancing the project due to the scale and the period on the project. In other works, it is probable that the relative

priority of safety in both the contractor's and the consultant's minds deteriorated unintentionally despite the safety first slogan.

f. The site organizations changed after the fatal accident on 14th March 2014. After the accident, the contractor's safety management group was put directly under the PM, which enabled the PM to give direct instruction to the group. The number of safety engineers increased from 2 to 9. Before the accident, workers demanding the safety on site were dismissed. However, it is no longer the case, and the atmosphere of the site has changed to respect the safety as well as the progress and the quality. This could be evidence of improvement of workers' safety awareness after the fatal accident.

g. Having a direct hiring arrangement, since it is not easy for a foreign contractor to screen local workers, actually workers are hired through worker dispatching companies. Although the demarcation of responsibilities of each party on the occupational safety & health matters was clearly described in the contracts between the contractor and the worker dispatching companies, such arrangement did not work on site and the contractor had to take over the duties of worker dispatching companies.

(5) Accident Report

a. There are nine accidents officially reported as of October 2014, while there are minor accidents/incidents/ near-miss found in monthly reports which were reported to only the consultant and the Employer.

7.2 Recommendations

(1) Local Situation

a. With regard to the safety management in construction works, it is necessary to have not only a contractual framework project by project, but also a national legislative framework like the occupational safety & health law in Japan. Moreover, it is recommended to make the occupational safety & health law consistent with the construction and the tender laws compatible to enhance the effectiveness of the laws.

b. There are a number of occupational safety and health management system, such as an internationally well recognized OHSAS18001, COHSMS (Construction Occupational Health and Safety management System) tailor-made for contractors in Japan, and "the Guidance for the Management of Safety for Construction Works in Japanese ODA Projects" prepared by JICA. It is recommended that the relevant agencies make use of these systems to supplement the national legislative framework and contractual framework, as/if necessary, getting assistance from ODA donors.

c. It is recommended that the relevant agencies collect various data on the construction industry, such as project states, demand& supply state of construction workers, etc., to establish a system which allows donors, contractors, consultants, etc. to access to those data any time.

d. With regard to capacity enhancement of local contractors and workers, it is recommended to develop a mechanism to siphon foreign contractors' relevant contribution in ODA projects into the national vocational training system.

(2) Planning/Design

a. It is not advised that in planning of the project the recipient country/the consultant impose conditions which may hinder implementation of works with safety and health for workers (ex. with a crash program under hard natural/social conditions).
b. In case it becomes necessary to change the project plan during the detailed design stage, it is advised the recipient country carefully study the impact of the change to the subsequent activities (tender, contract signing & construction) discussing with the donor and the design consultant, and if necessary, change the overall design schedule to avoid undue pressure to the subsequent activities.

(3) Tender/Contract

a. In an ODA construction project in a country where the legislative system on construction safety is not well developed cannot help relying on the FIDIC framework to deal with safety on site. There, since the project management is based on the three parties structure (Client, Engineer, Contractor), it is desirable to best utilize the consultant rather than only relying on the contractor concerning safety management. Hence, it is recommended to precisely describe the consultant role on the safety management in the TOR and also specify the consultant's organization and the contractor's contract conditions, to make the consultant get proactively involved in the safety on site, but keeping the check & balance relationship. The consultant role mentioned above assumes the activities stated in Article 4.5 (Checking) of OHSAS18001 or in Sub-Clause 5.2.12 (Routine Inspections and Improvements, etc.) of COHSMS Guideline.
b. Preparation of standard specifications thoroughly describing the system, plans, works, etc. necessary for safety management by each employer in advance could lessen the burden at the time of preparation of tender/contract documents.
c. In the tender/contract documents (incl. construction methods, period, specifications, etc.) the Employer/the consultant should not impose conditions which may hinder implementation of works with safety and health for workers.
d. With regard to the plans and actions required for safety management, it is advisable to include the relevant work items in BOQ in a format corresponding to the specifications to ensure the contractor's execution of such works. It is also advisable to minimize the vagueness on the contractor's duties by quantifying the items as much as possible rather than utilizing a lump sum/provisional sum. It is envisaged that improvement of basic contract conditions/payment conditions on safety could secure the safety budget independent from the contract negotiation which would result in effective management of safety.
e. To require in the tender documents the contractor's safety management unit to be set up directly under the project manager independently from the other site operation groups could avoid deteriorating the priority of safety affected by daily operation.

(4) Construction

a. It is necessary to establish/activate the project management system "sufficiently" incorporating the safety management mechanism and safety awareness activities during the initial period, by which making efforts to prevent a whack-a mole/too little too late situation. Since this approach significantly affects the organizations and costs, the Employer and the consultant is advised to take the initiative rather than relying on the contractor.
b. It is necessary to establish a system synchronizing the construction plan and safety. Specifically, the contractor should submit a method statement together with a relevant detailed safety plan to the consultant and commence the work after getting its approval. In turn, the consultant should check the safety situation at the inspection for RFI (Request for Inspection) in addition to the safety patrols.
c. It is considered necessary to make the stakeholders aware of management & organizational factors which may constitute the background of accident. Reference to the root cause analysis technique and sample analysis results may be a way to cope with it. (see "The Guidebook of Root Cause Analysis" in the attachment)
d. It is necessary for the contractor to make all workers at the end of command line aware of the importance of safety. In its implementation on site, the contractor should not only rely on subcontractors or worker dispatching companies, but also monitor the situation by itself daily to keep guiding them toward improvement.

(5) Accident Report

a. The consultant & the contractor should be obliged to report even minor accidents/incidents/near-miss. Furthermore, it is advisable to make it a practice to always conduct cause analysis to take countermeasures.
b. Attaching detailed data such as a time series chart and relevant organization charts to an accident report could make not only the accident cause analysis but also implementation of countermeasures easy.

The aforementioned consultant's recommendations are summarized in comparison with JICA's recent practice in the following table. The following documents are referred to on JICA's recent practice.

- ✓ Seminar on "Study on the safety management for construction works in ODA projects" (23rd March 2012)
- ✓ "Approach to the safety management for construction works in ODA projects" JICA Home Page

Table 7.2 Recommendations

Item	JICA's Main Approaches & Relevant Systems on Safety Management of Construction Work		Recommendations by the consultant
	March 2012	September 2014	March 2015
A. Local Situation	A1. It will be confirmed in (Yen loan exchange of notes (E/N) that the recipient country takes necessary measures to ensure the safety of stakeholders and public. A2. JICA International Cooperation experts will review the management of safety for ongoing construction works in Japanese ODA projects, report the review results, and introduce safety practice in Japan to the counter-part, the consultant and the contractor. A3. Conduct safety seminars (ex. in Cambodia in 2011 fiscal year, etc., dispatch experts for advice, etc. A4. Implement technical cooperation, such as technical assistance projects (ex. Vietnam), training course, etc.		a. With regard to the safety management in construction works, it is necessary to have not only a contractual framework project by project, but also a national legislative framework like the occupational safety & health law in Japan. Moreover, it is recommended to make the occupational safety & health law consistent with the construction and the tender laws compatible to enhance the effectiveness of the laws. b. There are a number of occupational safety and health management system, such as an internationally well recognized OHSAS18001, COHSMS (Construction Occupational Health and Safety management System) tailor-made for contractors in Japan, and "the Guidance for the Management of Safety for Construction Works in Japanese ODA Projects" prepared by JICA. It is recommended that the relevant agencies make use of these systems to supplement the national legislative framework and contractual framework, as/if necessary, getting assistance from ODA donors. c. It is recommended that the relevant agencies collect various data on the construction industry, such as project states, demand& supply state of construction workers, etc., to establish a system which allows donors, contractors, consultants, etc. to access to those data any time. d. With regard to capacity enhancement of local contractors and workers, it is recommended to develop a mechanism to siphon foreign contractors' relevant contribution in ODA projects into the national vocational training system.
B. Planning / Design	B1. Specify the contractor's duties on construction plan to include a safety plan, to prevent occupational accidents and to care the safety of neighbors and third parties such as pedestrians, etc. Include in the project cost the safety management costs (common temporary works cost – traffic management, safety facilities, safety control, etc.; site management cost –workers' safety & health, training, etc.) B2. Select the construction supervision consultant by the QBS method for projects which are large-scaled/complicated requiring utmost safety care. As necessary, the consultant confirms the contents of the safety plan prepared by the contractor. B3. Include the safety issue for application of "JICA Guidelines for Environmental and Social Considerations" (April 2010).		a. It is not advised that in planning of the project the recipient country/the consultant impose conditions which may hinder implementation of works with safety and health for workers (ex. with a crash program under hard natural/social conditions). b. In case it becomes necessary to change the project plan during the detailed design stage, it is advised the recipient country carefully study the impact of the change to the subsequent activities (tender, contract signing & construction) discussing with the donor and the design consultant, and if necessary, change the overall design schedule to avoid undue pressure to the subsequent activities.
C. Tender/ Contract	C1. The bidders (contractors) shall ① include a "safety plan" in the tender submissions、and ② include a "safety expert" as the main site staff. C2. The following points shall be confirmed/agreed upon with the counterpart at the appraisal. # include in the tender documents for civil works and plant construction the statements: "include a safety expert as the main site staff", "submit a safety plan" and "include practical safety measures in method statements (submit before the commencement of works)" # describe in the TOR for the consultant "confirm if the above statements are properly included", "review the safety plan", "review method statements" and "confirm if works are being executed properly in accordance with the method statements, etc. and if any problems, require the contractor to improve". C3. For "construction projects in a large scale and/or requiring special construction method", specify the number of first class construction managers in the qualified engineers to be proposed. Confirm the safety management system of bidders at PQ evaluation (For grant projects) C4. Specify the contractor has the primary responsibility for safety management for construction works. Specify the contractor is responsible for safety management for installation and operation guide in plant/equipment projects. C5. As common requirements, specify compliance with safety regulations, safety for workers, removal of obstacles, (hereinafter for facility construction) fencing around the site, lighting, security, temporary works to protect neighbors and pedestrians.	C6. "the Guidance for the Management of Safety for Construction Works in Japanese ODA Projects" was prepared compiling basic principles for safety management, technical guides on safe construction, etc. The projects to which the Guidance is applied will be selected from technical assistance, yen-loan and grant projects which have infrastructure construction works.	a. In an ODA construction project in a country where the legislative system on construction safety is not well developed cannot help relying on the FIDIC framework to deal with safety on site. There, since the project management is based on the three parties structure (Client, Engineer, Contractor), it is desirable to best utilize the consultant rather than only relying on the contractor concerning safety management. Hence, it is recommended to precisely describe the consultant role on the safety management in the TOR and also specify the consultant's organization and the contractor's contract conditions, to make the consultant get proactively involved in the safety on site, but keeping the check & balance relationship. The consultant role mentioned above assumes the activities stated in Article 4.5 (Checking) of OHSAS18001 or in Sub-Clause 5.2.12 (Routine Inspections and Improvements, etc.) of COHSMS Guideline. b. Preparation of standard specifications thoroughly describing the system, plans, works, etc. necessary for safety management by each employer in advance could lessen the burden at the time of preparation of tender/contract documents. c. In the tender/contract documents (incl. construction methods, period, specifications, etc.) the Employer/the consultant should not impose conditions which may hinder implementation of works with safety and health for workers. d. With regard to the plans and actions required for safety management, it is advisable to include the relevant work items in BOQ in a format corresponding to the specifications to ensure the contractor's execution of such works. It is also advisable to minimize the vagueness on the contractor's duties by quantifying the items as much as possible rather than utilizing a lump sum/provisional sum. It is envisaged that improvement of basic contract conditions/payment conditions on safety could secure the safety budget independent from the contract negotiation which would result in effective management of safety. e. To require in the tender documents the contractor's safety management unit to be set up directly under the project manager independently from the other site operation groups could avoid deteriorating the priority of safety affected by daily operation.
D. Const-ruction	D1. Discussing with the executing agency and the contractor, promote the implementation of safety management by taking due safety measures, notifying the stakeholders of those safety measures, conducting daily safety patrol, etc. D2. Financial assistance technical advisor will make advice on progress reports of grant projects on technical & safety aspects. D3. The consultant will confirm the contents of the safety plan for the project prepared by the contractor. D4. Review of safety management for ongoing construction works in Yen loan (STEP) projects (entrusting consultants): study of legislative/administrative system of the country, recommendations on future projects, lessons for similar projects	D5. Prepare/disseminate reference materials for practical use in construction works in Japanese ODA projects: # "Workers Training Materials for Hazard Prediction" # "Samples of Practical Tool for Safety Construction Management on Site"	a. It is necessary to establish/activate the project management system "sufficiently" incorporating the safety management mechanism and safety awareness activities during the initial period, by which making efforts to prevent a whack-a mole/too little too late situation. Since this approach significantly affects the organizations and costs, the Employer and the consultant is advised to take the initiative rather than relying on the contractor. b. It is necessary to establish a system synchronizing the construction plan and safety. Specifically, the contractor should submit a method statement together with a relevant detailed safety plan to the consultant and commence the work after getting its approval. In turn, the consultant should check the safety situation at the inspection for RFI (Request for Inspection) in addition to the safety patrols. c. It is considered necessary to make the stakeholders aware of management & organizational factors which may constitute the background of accident. Reference to the root cause analysis technique and sample analysis results may be a way to cope with it. (see "The Guidebook of Root Cause Analysis" in the attachment) d. It is necessary for the contractor to make all workers at the end of command line aware of the importance of safety. In its implementation on site, the contractor should not only rely on subcontractors or worker dispatching companies, but also monitor the situation by itself daily to keep guiding them toward improvement.
E. Accident Report	E1. Confirm and agreed with the executing agencies of recipient countries that they will report JICA as soon as possible upon occurrence of serious accidents. E2. Upon receipt of accident report, JICA resident office will investigate the site and report to HQ, who will make comment from a technical point of view as necessary. E3. Establish a safety management committee consisting of external experts, who will make an inquiry into serious accidents, as necessary.		a. The consultant & the contractor should be obliged to report even minor accidents/incidents/near-miss. Furthermore, it is advisable to make it a practice to always conduct cause analysis to take countermeasures. b. Attaching detailed data such as a time series chart and relevant organization charts to an accident report could make not only the accident cause analysis but also implementation of countermeasures easy.
F. Sanction	F1. Consider the company's track records on the safety/accidents upon selection of the contractor.		

Appendices

Appendix-1 Minutes of Meeting

No. 01

Meeting Minutes	
Date/Time	29/Sep/2014, 13:50-14:40
Venue	Taisei Corporation 17F Meeting Space
Attendees	Taisei: Counsellor, Safety Admin. & Environmental Dept. Study Team
Subject	Commencement of Study

1. From Study Team:
   1) Explained the study outline and schedule (temp.) based on the TOR.
   2) Handed TAISEI a list of information to be collected, and asked for cooperation.
   3) Handed TAISEI a questionnaire and asked to respond.
2. From TAISEI:
   1) TAISEI will fully cooperate on the study and submit all necessary information.
   2) TAISEI will submit all requested information in pdf by 10/Oct/2014 together with the response to the questionnaire.
   3) TAISEI will visit the OCH project from 7/Oct to 10/Oct/214 together with General Manager of Safety Admin. & Environmental Dept.
   4) OCH is the biggest civil works project which TAISEI is currently implementing, and 25 Japanese staffs are engaged in the project. A senior safety manager is also assigned.
3. E-mail from the Study Team to TAISE after the meeting:
   1) Sending a soft copy of documents handed to TAISEI in the meeting.
   2) Requesting all accident reports from the commencement of the project
   3) Requesting a full copy of the accident report dated 25/Mar/2014.
   4) Requesting information on the documents and process required prior to the commencement of each part of works.

No. 04

Meeting Minutes	
Date/Time	15/Oct/2014, 14:50-15:50
Venue	OCAJI Meeting Room
Attendees	OCAJI: International Affairs & Planning Div. Study Team
Subject	Safety Guidance

1. From Study Team:
   1) Explained the study outline and schedule (temp.) based on the TOR.
   2) Showed draft presentation materials on the Safety Guidance prepared by the Study Team to explain it is an English translation of the materials prepared by OCAJI asking OCAJI's permission to use it.
   3) Inquired OCAJI's view on the Safety Guidance seminar.
2. From OCAJI:
   1) OCAJI has no objection to the Study Team's using the presentation materials prepared by OCAJI.
   2) OCAJI is of the view that in order to achieve effective safety management in ODA construction projects the construction contract stipulate safety management is the contractor's duty together with the corresponding payment mechanism. Otherwise, safety management efforts including application of the Safety Guidance will end up with an armchair theory.
   The approach taken in Singapore, to include safety cost of 2.5% and to release the payment only when due safety management is done, is worthwhile to consider.
   3) OCAJI is willing to cooperate in the study. Please feel free to contact, if anything.

No. 05

Meeting Minutes	
Date/Time	20/Oct/2014, 11-12:00
Venue	Oriental Consultants Global (OC) 6F Meeting Room
Attendees	OC: Road Dept. Quality Management Div. Study Team
Subject	Commencement of Study

1. From Study Team

1) Confirmed receipt of the following documents:

a) OCH Contract (Original, Latest)
b) Organization Chart (Original, Latest)
c) Monthly Progress Report, Dec/12 – Aug/14 (12 sets)
d) Answer to Questionnaire (main)
e) Attachments -1 to 5-3 (7 sets)
f) Accident Reports (Employer to JICA) (9 sets)
g) Policy of preventing recurrence of accidents in OCH

2) Informed that preliminary root cause analysis considering management factor is being conducted based on the accident reports received so fa.

2. From OC

1) Requested additional root cause analysis after site visit. In OCH there are a number of subcontractors and sub-subcontractors without coordination, and workers under different command chains are working in the same project. A cause of the fatal accident occurred on 14/Mar/2014 could be attributable to such situation.

a) Many labors can speak only Sinhala and cannot communicate with foreign foremen with superior education. The chain of command is incomplete.

2) After encountering many accidents on site, labors have been understanding the importance of safety. The progress had the highest priority a half year ago, but such atmosphere has been changing.

3) The contractor will introduce a system evaluating the contribution of labors to the safety to give incentives from October.

4) OC is more than willing to cooperate in the study.

No. 06

Meeting Minutes	
Date/Time	23/Oct/2014, 14:00-15:45
Venue	JICA 4F Meeting Room
Attendees	JICA: Deputy Director General Director Senior Assistant Director Senior Advisor to the Director General Deputy Director A Deputy Director B Deputy Director C Deputy Director D Study Team: Team Leader / Safety Management Accident Analysis / Preventive Measures Safety Management
Subject	"Safety Review of On-Going ODA Loan Project in Sri Lanka" Meeting prior to Field Survey

1. The Study Team explained the study in the following items with Power Point.

1) Basic Principle of the study
2) Work Plan
3) Results of the study conducted in Japan
4) Field Study Schedule
5) Seminar
6) Status of information collection
7) Questionnaires
8) "Root Cause Analysis" and results of preliminary analysis

2. JICA provided the following comments:

1) The explanation was intelligible. This is the first time for JICA to approach safety and accidents in this kind of manner. Hopefully any common matters could be extracted from the two projects and disseminated to all ODA projects.

2) In Japan compliance with the occupational safety & health regulations is strictly demanded, by which safety in construction works is ensured, while in developing countries legal restriction is weak and human lives tend to be neglected, which makes it difficult to ensure the safety like in Japan. We wonder if we cannot help relying on the contractors' efforts on site.

－ The Study Team responded that stipulating the requirements for safety in the contract is an option.

3) There were a little too many accidents (9 accidents in 19 months) which might be attributable to the contractor's honest attitude to make accidents reports.

－ The Study Team pointed out that there are a number of minor accidents/ incidents which were not necessarily included in accident reports.

4) It would be good if the results of the accident analysis conducted in Sri Lanka are disseminated in Indonesia (hiding proper names) as well.

5) It is noted that information on the project in Indonesia was uncollectable due to the Project Employer's strict information control. We hope the analysis on the project in Indonesia could be conducted as deeply as possible during the study team's stay in Indonesia.

6) As much work as possible should be done during the stays in Sri Lanka and Indonesia.

7) The reason why there are so many accidents in the project in Sri Lanka should be clarified.

8) The history of the authority in charge of occupational safety may not be long enough. If it is the case, the Study Team may try to input them necessary information.

9) JICA has just started looking into the "Safety & Health" issue, and the outcome of this study will be referred to.

10) It was learnt that the project had been under pressure to expedite the works. If handling the safety matter in the contract is a way to ensure the safety, would it be possible to enforce such mechanism to the competent agency?

11) Please collect information as to what will happen to the project if the JICA's Safety Guidance is applied.

12) If any common factors can be extracted from the analyses of 9 accidents in the project in Sri Lanka, it might be useful for future projects.

13) Please discuss the consultant in the study such as contribution to the safety, the significance of the consultant on site, etc.

14) It could be said that dealing with the safety in the contract is a short-term measure, and doing it in the laws and regulations is a long-term measure.

Meeting Minutes	
Date/Time	27/Oct/2014, 11:30-12:45
Venue	JICA Sri Lanka Office
Attendees	JICA Sri Lanka Office: Chief Representative Representative A Representative B Study Team: A B
Subject	"Safety Review of On-Going ODA Loan Project in Sri Lanka" Inception Report

The Study Team explain the inception report in the following items:

1) Basic Principle of the study

2) Results of the study conducted in Japan

3) Field Study Schedule

4) Seminar (with Power Point)

・JICA Safety Guidance

・Root Cause Analysis

No. 08

Meeting Minutes	
Date/Time	27/Oct/2014, 14:30-
Venue	OCH II PD office (RDA) at Udurnulla road, Baththaramulla
Attendees	RDA - PD, OCH phase 11, RDA - DPD, OCH phase II, RDA - SPD,OCH phase II,RDA - PE, OCH phase II, RDA - CE, RDA JICA Sri Lanka office - JICA SL officer JICA Mission - Study team leader / Study team member / Study team member / Translator
Subject	"Safety Review of On-Going ODA Loan Project in Sri Lanka" Inception Report

JICA started the meeting by giving an introduction for the discussion.

Study team explained the background of the safety study that JICA is going to do and the outline of the whole work.

JICA pointed out the guidance as an output from the survey will be used for the future projects.

Study team explained some historical accident data related to Japan and the methods that will be used in the study with a power point presentation, mainly the root cause analysis.

JICA stated that it is much better if RDA can recommend invitees for the Seminar that will be held after the study.

Study team explained again about the applicability of guidance for future projects'

RDA proposed to apply the guidance for the upcoming bridge projects because cost can be increased if the guidance is imposed on the ongoing projects. Further they pointed out the government should agree if the guidance is implemented in the existing projects.
RDA officer stated that there are lot of guidelines and adequate rules and regulations, but the problems arise in the implementation.
PD (RDA) pointed out about the provisions in the BOQ to maintain the safety at site operations (7million rupees per month). And also she explained about the fatal accident occurred in the project. As reasons for the happening of the accident she stated, improper material usage, lack of coordination and lack of supervision.

Study team explained'the importance in a detail study about the accidents and compromise of costs in the implementation stage of safety measures.
Study team pointed out the importance of value engineering.

RDA suggested educating the contractor and auditing the safety procedures. But they further stated that it will be a difficult process in implementation.
PD (RDA) stated contractor has to select skill people for the construction work other than using unskilled people from man power agencies considering the cost factor.

Study team pointed out that the qualification and experience of the contractor should be checked.

RDA stated it is better to check the past records in particular contractor. Further they emphasized on the issue in communication between labors and technical staff and lack of relationship since they are from different countries (Pakistan, Philippine etc.). And most of the accidents are taken place by subcontractors because they set tight targets to labors. Therefore .they neglect the correct procedures. Furthermore RDA stated that the main contractor does not supervise the gangs of subcontractors properly which leads to lack of communication between gangs.
RDA pointed out about the labor law violations due to long working hours of labors which lead to accidents due to fatigue.
Study team stated it's a management failure.
RDA stated that the labor department of Sri Lanka does not have enough staff strength to go to sites and inspect the violations. After an accident occurs a representative of labor department should come to the location. But it's not happening always due to the lack of staff strength. And RDA further stated that the contractor always bound to maintain the safety at site.

Study team asked for his participation of the safety patrols at site and discussed about the site visit on 28.10.2014.

No. 09

Meeting Minutes	
Date/Time	28/Oct/2014, 09:30-
Venue	Taisei Project Office, Biyagama Village
Attendees	Taisei (TC): Project director Deputy project director A Deputy project director B Construction manager Senior administration manager) Administration manager JICA Sri Lanka office: JICA SL officer JICA Mission: Study team leader Study team member A Study team member B Translator
Subject	"Safety Review of On-Going ODA Loan Project in Sri Lanka"

JICA started the meeting by explaining the purpose and the background of the safety survey. Study team stated that they are doing this study under the request of JICA. And the guidance as the output of study will be helpful to prevent accidents in future.

TC explained the situation of the construction work force they are facing in the project as follows

a) Capability of workmen in general is a big problem. Our policy for work force is to screen workers gathered locally and bring up ones who are left on the screen. Direct hiring makes worker screening difficult, so we rely on manpower supply companies for hiring.

b) In other countries, subcontractors have already had enough abilities but it is not the case here

c) There would be another way, for example, bringing skilled workers from abroad. However, it would contradict ODA purposes. Basically, we cannot success in this country unless we bring up people here.

d) We do not have many choices to select workers from the list given by the manpower supply companies, because skilled workers are already taken by subcontractors and we need 2,000 workers.

e) Presently, there is a scarcity of workers because construction is on rise in the country. It may be one of the reasons that the prolonged civil war ended.

JICA stated that through the safety survey, it will be our pleasure if we could find something that we couldn't see before. JICA will appreciate TC's cooperation for the survey. Regarding the Seminar, range of attendees and the contents of the seminar is still under consideration.

TC (Taisei Corporation) questioned whether the seminar is on the above fatal accident. And further said, it will be a problem for them, if somebody tries to reinvestigate the problem after the seminar. We would like to request TC to express their request as we do not intend embarrass anybody with the presentation.

TC stated that if we would be informed the contents, we would like to ask our request if anything we have to object.

Study team said this should not attempt to embarrass TAISEI in seminar or after the seminar.

Study team went back to the fatal accident & incident again. And he asked whether the incident occurred due to the poor lighting condition.

TC said there was enough lighting at that time and that cannot be the reason.

Study team said communication can be the other reason for safety issues because the staff is from different countries

TC said that English can be used as the communication language. And further said 2,000 labors and

300 foremen are working at site. More than half of the foremen are from countries like Vietnam, Philippines, and Pakistan etc. And they are doing a really good job with local foremen there.

Study team explained some historical accident data related to Japan and the methods that will be used in the study with a power point presentation, mainly the Root cause analysis.

During above presentation, TC said that the method statement stated that H-beam should be used for filler.

Study team mentioned that the phrase is not clear enough to direct. It should have stated that nothing else but H-beam shall be used for filler.

TC stated that girder erection work 1s almost over. We have taken various safety countermeasures based on our experience. However, we appreciate if the survey team could point anything still insufficient.

TC also stated that it is a fact that the Engineer is pointing out safety lapse but they are rectified immediately. The construction site is different from a factory. It is in quite broad and always changing, so similar lapses emerge repeatedly nevertheless our efforts.

TC continued that as essential countermeasures, we have been carrying out education and making safety rules. Actually, it is hard to stop unsafe situation. We think only one measure we should take is to continue. The safety education has to start form telling the

workers from manpower supply companies the reason why they have to wear hard hats. Education is been carried out by dividing the site into six sections.
We are emphasizing on the foremen education.
TC stated that as a part of foremen education, we involved them to a study for making method statement for the six specifically hazardous works. We believe that leading them to think themselves is important matter for improve their capabilities.
TC continued that most workers are not on the level of expressing their own ideas. Thus it is effective way to educate foremen respecting their self-discipline.
Study team questioned about the police investigations about the fatal accident.
TC replied that they did investigations about 2-3 weeks. But nothing happened against them.
Study team asked about the safety fence to prevent the third party's intrusion into construction sites, illustrating some incidents happened in Southern expressway construction.
TC said practically it is very difficult to barricade the whole working premises. But they have erected notice boards, distributed leaflets and kept security guards where ever necessary.
Study team asked about the activities of the safety manager (OC).
TC said they come to the site for safety inspections, take photographs of safety problems and discuss those in safety meetings.
Study team asked for his participation of the safety patrols at site and discussed about the site visit on 28.10.2014.

Meeting Minutes	
Date/Time	29/Oct/2014, 09:30-
Venue	Commissioner's office, Industrial safety division (ISD), Ministry of labor
Attendees	ISD • Commissioner of labor • Specialist Factory Inspecting engineer • Specialist Factory Inspecting engineer) JICA Mission • Study team leader • Study team member • Translator of study team
Subject	"Safety Review of On-Going ODA Loan Project in Sri Lanka"

Study team explained an introduction on the safety study and the inception report.

ISD asked about the procedure of study and about the study team.

Study team explained about the study method (Root cause analysis) along with the accidents occurred in the OCH phase II project.

ISD explained the reasons for the difficulty of handling safety issues since the contractors recruit new people time to time. Therefore giving training to all of them is not possible. And further she proposed to employ more supervisors to maintain safety as a solution.

Study team asked about the nature of the actions taken by the industrial safety division in case of accidents at construction sites. And the difference between the functionality between Industry safety division and National Institute of Occupational Safety and Health (NIOSH)

ISD explained about the Health and safety law in Sri Lanka and explained the difference between the functionality between Industry safety division and National Institute of Occupational Safety and Health (NIOSH). She pointed out that Industrial safety division is the enforcement body of safety and health. But the National Institute of Occupational Safety and Health (NIOSH) is for education and research purpose.
ISD explained their authority is under Factory ordinance. As per the ordinance there are no enough provisions directly to check the construction plans of a project prior to work or to prosecute in a construction safety problem. Further he pointed out that the ordinance provisions have been given to

check the safety of machinery (cranes, hoists, etc.).

Study team asked about the action taken by ISD against the fatal accident happen in TAISEI.

ISD said no prosecution report was done since there was no direct contradiction with the Sri Lankan Law clauses regarding that accident. Further he explained about prosecution reports and charge sheets and samples were shown (see Attachment-1).

Study team asked about routine inspections and number of staff members ISD have.

ISD said they do inspections as routine inspections and do inspections after an accident occur. And further he pointed out that they have only 30 inspection engineers to cover Sri Lanka.
ISD said that generally they give warnings for 3 times if they found any violation of law in safety measures in factories or sites. If they failed to fulfill the safety requirements even after that, legal measures will be taken. Further he stated new regulations will be prepared for the construction safety at sites, fulfilling current gaps by next year, and send it to the parliament for the approval.

Prosecution report:

1. Hydraulic lift for service vehicles had not been checked by a qualified person and not documented with valid reports.
2. The exhaustive fans of the factory had not been checked by an authorized person and not documented the valid reports.

At Magistrate Court
Sue under factory ordinance

Number:

(Name)…….
District factory inspection engineer,
District factory inspection engineer's office,
Labor department,
Right round road, Gattuwana,
Kurunagala.

Prosecutor:

Against

1. *(Address)*……
……
……

Accused person:

On…… *(date)*……

I'm ……*(name)*……As the district factory inspection engineer, herewith I'm reporting to the court under the sentence no 136(1)(A) of 1979 No 15 Criminal Procedure Code.

Under the definition of 128th authority of factory ordinance which was amended with 1961 No 54, 1976 No 12 ,1998 No 18, 2000 No 33 and 2002 No 19 under factory act amendments, the factory situated at …….. , accused person being lived there, on or about 2014.05.12,

1. As per the violation of sentence 27 of ordinance with above amendments,

- Hydraulic lift for service vehicles had not been checked by a qualified person and not documented with valid reports.

Because of that, by the factory ordinance with above amendments can be prosecuted under the sentence 108 and 109.

3. As per the violation of sentence 36 of ordinance with above amendments,

The exhaustive fans of the factory had not been checked by an authorized person and not documented the valid reports.

Because of that, by the factory ordinance with above amendments can be prosecuted under the sentence 108 and 109.

……*(name)*……

District factory inspection engineer

(North West division)

Witnesses

1……*(Name)*……

District factory inspection engineer,

District factory inspection engineer's office,

Right round road,

Gattuwana,

Kurunagala.

No. 11

Meeting Minutes	
Date/Time	29/Oct/2014, 14:00-
Venue	OCH Project office, Udumulla Road, Baththaramulla
Attendees	OC • Team leader • Deputy Team Leader • Senior Highway Engineer • Safety Engineer • Senior Bridge Engineer • Quality Management Division OCG. Tokyo JICA Mission • Study team leader • Study team member • Translator of study team
Subject	"Safety Review of On-Going ODA Loan Project in Sri Lanka"

JICA Study team started the meeting giving an introduction of the study. And further he stated about the mission of the study team.

JICA Study team explained the purpose of the seminar that will be taken place on 11.11.2014. Then he started the presentation on the safety guidance for the construction projects and root course analysis.

Then the discussion session was started.

JICA Study team started the discussion with the fatal accident occurred in OCH phase II and the mission of the study team on it.

JICA Study team asked about the activities towards construction safety of the subcontractors from OC members.

OC Team Leader expressed that lack of knowledge on safety, difficulty of educating in safety systems, tight time targets and negligence of subcontractors will lead to construction safety accidents.

OC Senior Bridge Engineer said TAISEI Japanese engineers inspect the safety in every morning.

JICA Study team asked whether the safety procedures are included in the method statements. Further he said those are not included in method statements according to the information from TAISEI.

OC Senior Bridge Engineer accepted that.

OC Safety Engineer explained about a near miss accident occurred on 04.09.2014 in grinding of girders of a bridge. And he presented the root ca use analysis for the particular accident.
JICA Study team said th is incident should be studied in more detail.

OC Safety Engineer explained the incident in more detail and further explained about the remedial actions taken.
OC Deputy Team Leader said the contractor mainly focus on the progress but not on the safety.
OC Team Leader said all the engineers in the project should get aware of the safety issues identified in a certain location.
JICA Study team said JICA believes safety should be given the first priority.

OC Senior Highway Engineer said after the fatal accident TAISEI safety procedures and concern on safety have been improved to a certain extent.
OC Team Leader appreciated the attempt of JICA towards the improvement of safety in the construction. And he appreciated the presentation done by JICA Study team on the root cause analysis and said that will be a powerful tool in analysis of accidents in future.

Meeting Minutes	
Date/Time	30/Oct/2014, 14:00-
Venue	Office of the Deputy Inspector General of police (Western province), Mihindu Mawatha, Colombo
Attendees	Police • DIG Traffic • ASP traffic (WPN) • OIC Kadawatha • OIC Athurugiriya • AOIC Sapugaskanda • Security Consultant JICA JICA • JICA SL officer JICA Mission • Study team leader • Study team member
Subject	"Safety Review of On-Going ODA Loan Project in Sri Lanka"

JICA Sri Lanka started the meeting by giving an explanation on the vision of the study team.

JICA Study team explained about the accidents occurred in the OCH Phase II project. And he questioned about no prosecution on the accidents and the interventions of the department of police in such safety accidents. Further he explained about the importance of the detail study of construction safety accidents, root course analysis and the questioner.

DIG said they were informed only about the fatal accident but not any other accident. He said the police can act under penal code, section 298 for fatal accidents and section 328 for other accidents.

A Police officer explained about the fatal accident that had occurred in the OCH Phase II project. As he said the site investigations were done by magistrate and decided that as a sudden death.

DIG asked the study team to make a mechanism to inform such accidents to police for further investigations and to implement the law. And further said, he can inform with this regarding to the RDA.

JICA Study team said there is less provisions in law of Sri Lanka for this type of accidents as per the explanations by the Industrial Safety Division. And further pointed out this study is not an attempt to accuse any party but to prepare necessary guide lines to prevent future construction safety accidents.

Safety and Quality Control System Checklist

Country: **Sri Lanka**

Project Name: **Colombo Outer Circular Highway (OCH)**

To be filled by Police,

Items to Confirm	Items to be confirmed	Confirmation Result
1. Police's standard action plan for occurrence of construction accidents	1) Laws/regulation to be abided by	1.Penal Code • Section 298-Accidental death-Punishable • Section 328-Accidental injuries-Punishable
	2) Contact and Information system	2.Contact Numbers in case of accidents –Police Emergency • 119 • 0112433333 • Or local police station of the area(See the Attachment-1)
	3) Preparation for dispatching the investigation team	3.Police OIC, SOCO (Scene of crime officers) team, Magistrate, Inquirer sudden death
	4) Recording method 5) Investigation method (how to secure the scene of accident, and how to interview/inquire, etc.)	4&5. When information of an accident(fatal) receives; • OIC of police and the SOCO team will reach to the accident location, secure the location and statements are recorded if required. • Inform to Magistrate for further investigations. • Magistrate will refer to Inquirer sudden death for the incident and other relevant party if there any. • Inquirer Sudden Death will record the statements from relevant parties (In charge of the site, Consultants, eye witnesses etc) and present Death Investigation Report.
	6) What kind of investigation is to be done? Any difference if (if not) any casualty	6. Casualty construction accidents are not informed to police.

Items to Confirm	Items to be confirmed	Confirmation Result
2. Police's actual action to the accidents at Colombo Outer Circular Highway (OCH)	1) Laws/regulation to be abided by	1.Penal Code • Section 298-Accidental death-Punishable
	2) Contact system	2. Police was informed by Ragama hospital with regarding the accident.
	3) Preparation for dispatch the investigation team	3. Police OIC, SOCO (Scene of crime officers) team, Magistrate, Inquirer Sudden Death
	4) Recording method 5) Investigation method (how to secure the scene of accident, how to interview/inquire, etc.)	4&5. Investigations had been done for the accident following the same investigation method mentioned above but they have mentioned the three deaths as sudden deaths due to a toppling of a concrete girder.
	6) What kind of investigation is to be done? Any difference if (if not) any casualty	(Mr Senarathna DIG Traffic (see the note at the last page said that the reasons for three deaths should have been investigated further)
3. Results of investigation on the accidents at Colombo Outer Circular Highway (OCH)	Please give us the report, if possible	One fatal accident has been reported. Inquirer Sudden Death has declared the deaths from the accident as sudden deaths.
4. Conclusions on Colombo Outer Circular Highway (OCH)	1) Causes of accidents	1. Not further investigated since it has been declared as sudden death. (But the police say that the incident occurred due to the negligence of the contractors and subcontractors.)
	2) Police's reaction/approval to the corrective/preventive measures proposed by the contractor	2. Mr. Senarathna (DIG traffic) said that it's the role of the consultant of the project. Because it's a technical matter.

Items to Confirm	Items to be confirmed	Confirmation Result
5. Advice and/or comments from Police on safety management of construction works	1) On Japanese Yen-loan projects (general) 2) On Colombo Outer Circular Highway (OCH) 3) On other JICA Projects such as water supply and port projects	• Contractors must attend the road safety meeting which is held once a month at SSP's office at Peliyagoda. (Mr. Senarathna (DIG traffic) said that currently only RDA is participating for that meeting which is conducted with regarding the existing roads improvement projects) • Organize monthly meeting with police and workers at site if possible.

Date: 05.11.2014

Time: 09:30

Venue: Office of the Deputy Inspector General of police (Western province), Mihindu Mawatha, Colombo 12

Participants: 2nd meeting;

- Mr. Senarathna (DIG traffic)
- Mr. Haruo Sakashita (Study team leader)
- Mr. D.N Gunasekara (Study team member)

Note:

- In the death investigation report, the three deaths have been mentioned as sudden deaths. Mr Senarathna (DIG Traffic) said that the reasons for three deaths should have been investigated further(See the Attachment-2). And further he said if consultant party stated/highlighted the responsibility of the engineers and supervisors regarding the accident, when the enquiry was done by the inquirer sudden death, they could have done further investigations regarding the accident. In other words the statements form relevant parties may not strong enough to do further investigations.

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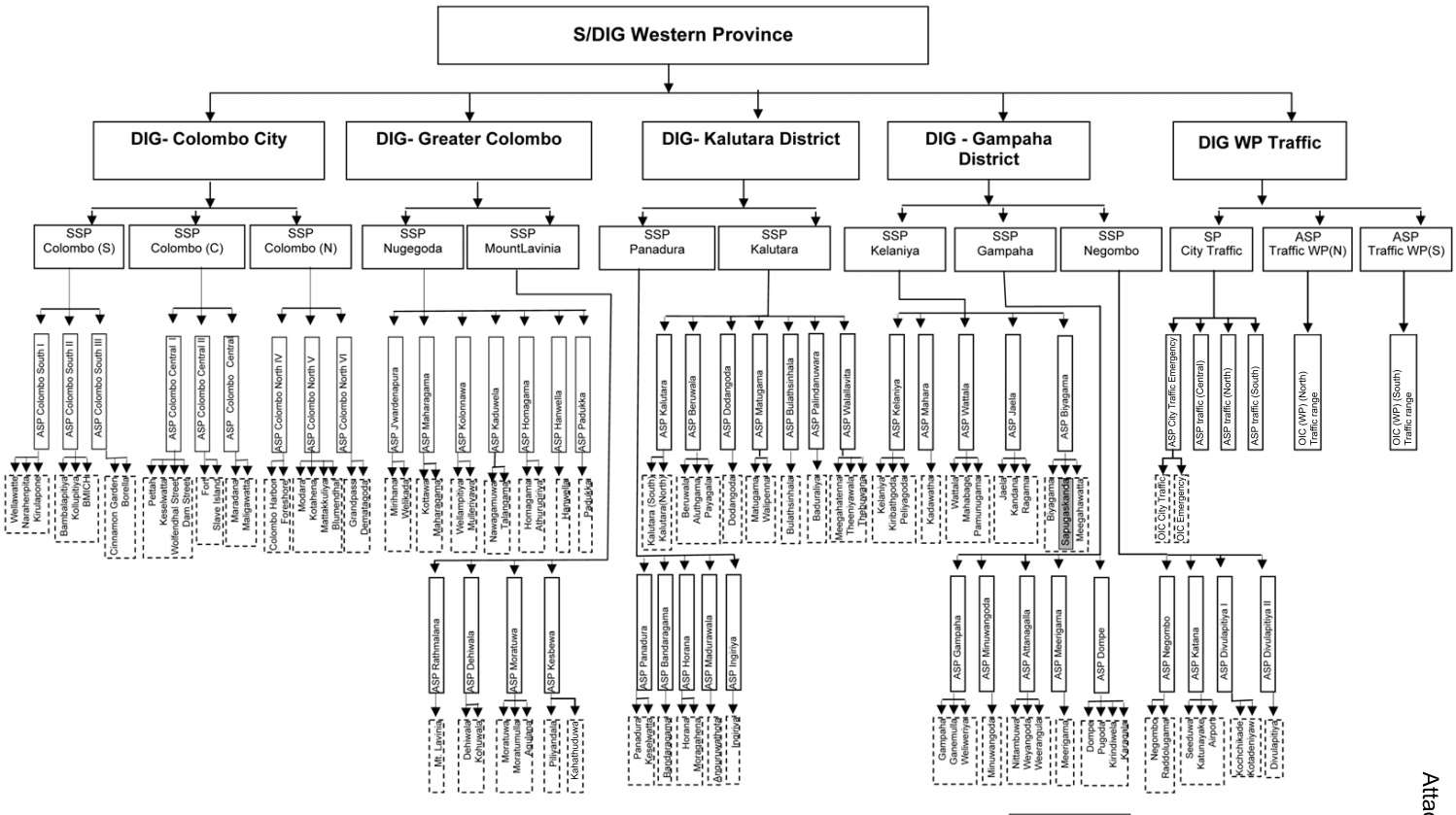

Attachment-1

Sri Lanka Police

Magistrate,
Magistrate court,
Mahara
2014.03.15

Inquirer Sudden Death,
Sudden death inquiry office,
Ragama.

Court order of case of Mahara x/x case number B.1298/14

As per the information reported to me by Police OIC Sapugahawatta, due to a toppling of a heavy weight concrete girder on to the body of under named workers at OCH Phase II project at Rathgahawatta area related to Sapugahawatta police division was seriously injured and died when they were admitted to the hospital. With regarding the above incident, magistrate investigation shall be done by me. Meanwhile with regarding the death bodies I order to do a sudden death inquiry and a post mortem to the judicial medical officer and report with regarding the causes for the death. Further I order only to bury the death bodies after the post mortem.

Names of the victims:

1. Kosgallana Durage Rathnasiri, Awasa Junction, Uragasmanhandiya
2. Nishantha Kumara, Palugamuwa, Dummalasuriya
3. Rathanapurahewage Sandun Sampath Kumara, No 542, Hipankanda, Nawadagala, Alpitiya

Sri Lanka Police

M.Priyankara Lal (Justice of peace),

Inquirer Sudden Death,

Teaching hospital-Ragama

2014.03.24

Investigation No: 2981

Death Investigation Report

Date: 2014.03.24

Time: 13:00

Name of the victim: Rathepura Hewage Sandun Sampath Kumara

Address of the victim: No 542, Hipankanda, Nawadagala, Nawadagala, Uragasmanhandiya

Date of death and venue: 2014.03.14, Ragama hospital

Date of bury and venue: Granted for burial at Nawadagala, Hipankanda family cemetery on 2014.03.17

Death: Due to the toppling of Heavy weight concrete girder on to the body and serious damages to pelvis, neck and chest-Sudden death

Signature

Inquirer Sudden Death

Attachment 2(3/3)

Sri Lanka Police

M.Priyankara Lal (Justice of peace),

Inquirer Sudden Death,

Teaching hospital-Ragama

2014.03.24

Investigation No: 2980

Death Investigation Report

Date: 2014.03.24

Time: 13:00

Name of the victim: Kosgallana Durage Rathnasiti

Address of the victim: Awasa Junction, Uragsmanhandiya

Date of death and venue: 2014.03.14, Ragama hospital

Date of bury and venue: Granted for burial at Awasa Junction family cemetery on 2014.03.17

Death: Due to the toppling of Heavy weight concrete girder on to the body and serious damages to pelvis, neck and chest-Sudden death

Signature

Inquirer Sudden Death

No. 13

Meeting Minutes	
Date/Time	30/Oct/2014, 14:00-15:00
Venue	JICA Sri Lanka Office
Attendees	JICA Sri Lanka Office: Representative Local Staff Study Team
Subject	"Safety Review of On-Going ODA Loan Project in Sri Lanka" Discussion on the seminar on 11/Nov/2014

The following were discussed on the seminar:

No change to the date, but the venue is changed to "Waters Edge Hotel"

Attendees to be limited to the project people (RDA, OC, TC)

Invitation

Opening and Closing Remarks

Safety and Quality Control System Checklist

Country: **Sri Lanka**
Project Name: **Colombo Outer Circular Highway, Phase II (OCH II)**

To be filled by Industrial Safety Division,
Ministry of Labor (MOL)

Items to Confirm	Items to be Confirmed	Confirmation Result
1. Laws and various Regulations related to occupational safety and health	Availability of laws and various Regulations related to occupational safety and health, as well as the names of those laws and contents of related provisions 1. Names of laws 2. Contents of related provisions	1. Factories ordinance No 45 of 1942 and it's subsequent amendments. 2. Please refer http://labourdept.gov.lk, the detail of factories ordinance with relevant regulations can be obtained from this internet address (see Attachment-1 and Attachment-2)
	Do you undertake the following based on the lows and regulations in the above ? ● Is the method of patrolling the sites (frequency of such patrols, etc.) indicated as reference? ● Is the frequency with which consultants and contractors are consulted indicated as reference? ● Are the rules and regulations (or manuals) governing occupational safety and health included?	1.Yes I. Inspections are carried out on regular manner and advices are given verbally and documentary after routine inspection. II. Special inspections are carried out in case of accidents and complaints and advices are given verbally and documentary after special inspection. Note: As per the discussion safety patrols are done twice a year/once a year/after an accident occur/under a complain.

Items to Confirm	Items to be Confirmed	Confirmation Result
2. Assigned missions of the INDUSTRIAL SAFETY DIVISON in the executing agency in charge of occupational safety and health, and assigned tasks of the staffs	Identification of the occupational safety and health department and number of staff members	● No. of total staff members at the executing agency (Directorate general): 30 persons ● Name of the occupational safety and health department: Industrial safety division ● No. of staff members in the department above: 30 persons
	Details of the assigned missions of the department in charge of occupational safety and health (Industrial safety division) 1. Current status of implementation of site patrols 2. Availability of accident statistics related to all projects under jurisdiction of the executing agency(Attach accident data for the past three years) 3. Guidance and instructions for consultants and contractors	1 . As per the discussion safety patrols are done twice a year/once a year/after an accident occur/under a complain. 2. Accident statistics

Year	All industries-Total	
	Fatal	All accidents in non-fatal accidents
2007	77	1832
2008	49	1574
2009	76	1282
2010	64	1456
2011	60	1245
2012	80	1319
2013	71	1344

3. After the inspections were done advices are given verbally and documentary.

Mr.Asoka said powers of the inspection engineers are given under section 101 and provisions for building and other construction works have been given under section 84 of factory ordinance.

Items to Confirm	Items to be Confirmed	Confirmation Result
	4. Documents on the mandates of the department in charge of occupational safety and health (Attach the document) 5. Others (Describe specifically)	4. No.45 of 1942 (section 27)-form 1 and No.45 of 1942 (section 34)-form 2 5. Non
	Information concerning past accidents in construction, etc. (1) Has the information concerning past accidents been accumulated? In addition, ascertain what the policy is for accumulating accident information (e.g., recording information on only accidents resulting in death in accordance with the organizational rules). (2) Components and contents of accident information (Reference) ● No. of accidents ● Situation in which accidents occur ● Scale of accident (amount, number of casualties, existence or nonexistence of third-party injuries) ● Emergency response ● Cause of accident ● Future prevention method ● Others (Describe specifically)	Mr.Asoka said they don't maintain comprehensive summaries of accidents. But he provided accident statistics for last 7 years (mentioned above).
6.	Do you check and approve construction plans and methods applied by contractors prior to the construction?	No.

Items to Confirm	Items to be Confirmed	Confirmation Result
7.	Do you check and advise the construction plans and methods undertaken by contractors during the construction?	Not for every construction work. But especially for factory buildings. Under section 5A & 84 any authority such as provincial and local authorities can't give any approval for factories until they register in ISD. Mr.Rohitha said they check the plans for health & safety facilities in the proposed factory buildings. And further said if the span of work (construction) is more than 6 weeks they should be registered in the ISD.
8.	What kind of actions do you take if accidents took place? - Inspection report? - Stopping or continuing of the construction? - Sanction to contractor? - Giving the accident information to Police?	 - Yes - Relevant part of construction - A penalty charge - Yes, If required
9.	Did you work together with the Police office after sharing the accident information?	Mr .Ashoka said investigations on the accidents are done separately by Police department and Industrial safety division. But there are cases police need assistance from ISD, especially when they need technical information. The investigations are done as per the provisions under section 64 in factory ordinance. And there are cases ISD need the assistance from Police department. Dealings with police are depending on the case.

Items to Confirm	Items to be Confirmed	Confirmation Result
10.	Did you inspect infrastructure construction works undertaken by Road Development Authority?	Mr. Sakashita asked about the submissions of plans in STDP and the safety inspections. Mrs. W.L.S Wijesundara said they haven't submitted any plan. But did safety inspections. Mr.Sakashitha asked about the submissions of plans in OCH phase II project and the safety inspections. Mr.Asoka said they haven't submitted any plan. But did safety inspections. And construction equipment were checked. Mr.Sakashita asked what type of checks were done for the equipment. Mr.Asoka said testings were done as per the forms format given in the ordinance. Mr.Sakashita asked about the provisions given in the factory ordinance for construction equipment (cranes, hoists, lifting machines etc.) Mr. Rohitha said provisions have been given under section 27,28,29.
11.	Did you inspect infrastructure work accidents such as Outer Circular Highway construction project, Phase 2 and others, financially assisted by Japanese Government?	Yes, more than three times.
	- Please show the inspection results and the reports	Reports were not available in the head office. Since the investigations were done by Gampaha divisional office.
	- How about sharing information of the inspection results with Road Development Authority.	No deal or sharing information with RDA. As Mr. Asoka said they are not interested.

Date: 03.11.2014

Time:14:00

Venue: Director general's office, Industrial safety division, Ministry of labor (2nd meeting regarding questioner)

Participants:

ISD
- W.L.S Wijesundara (Commissioner of labor)
- Rohitha Fernando (Deputy commissioner of labor)
- D.L Ashoka Peris (Specialist Factory Inspecting engineer)

JICA Mission
- Haruo Sakashita (Study team leader)
- D.N Gunasekara (Study team member)

Note:

As per the discussion with ISD, the provisions for the construction safety in the existing factory ordinance (No 45 of 1942) are not enough for the prosecution in safety accidents. In the above factory ordinance there are provisions for checking construction machinery but not for the construction activities and procedures. Because of that, with the collaboration of ISD and NIOSH have prepared regulations for construction work addressing existing requirements, and will be discussed it at Sri Lankan parliament in 2015 for the approval.

Safety and Quality Control System Checklist

Country: Sri Lanka
Project Name: Colombo Outer Circular Highway Project

To be filled by: National Institute of Occupational safety and Health (NIOSH), Ministry of Labor (MOL)

Items to Confirm	Items to be Confirmed	Confirmation Result
1. Laws and various Regulations related to occupational safety and health	Availability of laws and various Regulations related to occupational safety and health, as well as the names of those laws and contents of related provisions (1) Names of laws (2) Contents of related provisions	1. Factories ordinance No 45 of 1942 and it subsequent amendments. 2. Please refer http://labourdept.gov.lk, the detail of factories ordinance with relevant regulations can be obtained from this internet address 3. The national Occupational safety and health policy, June 2014, Sri Lanka
2. Assigned missions of the National Institute of occupational safety and health in the executing agency in charge of occupational safety and health, and assigned tasks of the staffs	Identification of the occupational safety and health department and number of staff members	• No. of total staff members at the executing agency (Directorate general): 15 persons • Name of the occupational safety and health department: National Institute of Occupational safety and Health (NIOSH) • No. of staff members in the department above: 15 persons
	Current conditions of implementation of training for staff in charge of occupational safety and health (Reference) • Training in the occupational safety and health management system • Training in matters related to laws • Training in developing awareness of the dangers of accidents • Training in the role of occupational safety and health in the executing agency • Training in construction method and method of occupational safety and health	Programmes conducted by NIOSH • One day programmes –tailor made programmes (as per customers requirements) • Certificate in occupational safety and health (NVQ level 4) • Diploma in occupational safety and health. • Advanced training in occupational safety and health for plantation workers. • Advanced training in occupational safety and health for construction industry.

Items to Confirm	Items to be Confirmed	Confirmation Result
	• Training in method of collecting accident statistics and their effective utilization • Training in accident prevention techniques • Others	Dr.Champika Amarasinghe explained about the programmes they are conducting. And all those programmes fulfill the questioned references.

Date: 03.11.2014

Time: 15:30

Venue: Director Generals office, National Institute of Occupational safety and Health (NIOSH), Ministry of Labor (MOL)

Participants :

NIOSH

- Dr.Champika Amarasinghe (Director General, NIOSH)

JICA Mission

- Haruo Sakashita (Study team leader)
- D.N Gunasekara (Study team member)
- Sumith Karunadasa (Translator of study team)

Mr.Sakashita started the meeting by explaining the vision of the JICA study team and asked about the role of NIOSH.

Dr.Champika Amarasinghe explained the role of NIOSH and courses they are conducting. And further she said about the national safety awards conducted this year to promote safety among organizations. She said that they have introduced a National Occupational Safety and Health Policy for the first time in Sri Lank in July of this year

Mr.Sakashita asked about the amendments to existing Factory ordinance, since there is a lack of provisions for the construction projects and asked for the draft copy if there is any.

Dr.Champika Amarasinghe said that they have done relevant amendments as per the current necessities in the construction industry with the assistance of ISD and it has to be get approved in the parliament.

Dr.Champika further asked about the safety study.

Mr.Sakashita explained the background of the study and the root course analysis for the safety issues in OCH Phase II project.

End of the meeting.

No. 16

Meeting Minutes	
Date/Time	12/Nov/2014, 17:30-16:30
Venue	JICA Sri Lanka Office
Attendees	ICA Sri Lanka Office: Chief Representative Senior Representative Representative A Representative B Study Team
Subject	"Safety Review of On-Going ODA Loan Project in Sri Lanka" Field Study Completion Report

The Study Team submitted the field study completion report and explained as follows:

1) Actual Study Schedule
2) Construction Industry and Administration relating to labor safety & health
   # Ministry of Labour (ISD, NIOSH)
   # Police activities to accidents
3) Impressions on the seminar

No. 17

Meeting Minutes	
Date/Time	19/Nov/2014, 15:00-17:00
Venue	JICA Room No. 104
Attendees	JICA: Director Senior Assistant Director Deputy Director A Deputy Director B Study Team: Team Leader / Safety Management Accident Analysis / Preventive Measures
Subject	"Safety Review of On-Going ODA Loan Project in Sri Lanka" Completion Report of Field Study

1. The Study Team submitted the field study completion report and explained the following:
   1) Basic Principle of Study
   2) Actual Schedule in Sri Lanka
   3) The following subjects, including relevant Q&A in the seminar
      # Guidance for the Management of Safety
      # Root Cause Analysis & Preliminary recommendations
   4) Sri Lanka construction industry and Administration of labor safety

2. JICA's comments and the Study Team's responses:

   1) (J) It is reported that in OCH2 workers are directly supervised (employed through worker dispatching agencies). Is it a rare case? What was the case in Southern Expressway Project?
      (S) It would not be so common in other countries. Though Southern Expressway Project was not investigated, it is likely to be direct supervision as well because local subcontractors do not have enough technical capability.

   2) (J) If any new Japanese contractors enter into Sri Lanka market, will they have many accidents as occurred at the initial stage of Taisei?
      (S) If contractors who are not familiar with Sri Lanka come, they may not be able to do safety management as being done by Taisei who has learnt a lot about accidents in Sri Lanka. Hence, application of the Safety Guidance is quite important. To be

considered are, to utilize the contract provisions to include safety fence in BOQ; to instruct to include safety management in method statements; to include safety inspection method, etc.

3) (J) How should the Employer and/or the Consultant incorporate the safety requirements in the contract provisions at the detailed design stage? How to deal with the safety coping with the Employer's requests to construct fast and cheap? What organizations are suitable in case seminars or training are held in Japan? Please advise of Japan Construction Occupational Safety and Health Association (JCOSHA). Legislation on construction safety may be required. As mentioned by Mr. Amada of JICA Sri Lanka Office, a technical assistance project may also be required.
(S) The current contract documentations for the consultant and the contractor look reasonable. However, in reality the local safety engineer is spending time to find faults of the contractor and not trying to prevent accidents. A contractual framework wherein the consultant and the contractor cooperate with each other would be needed. JCOSHA is working for domestic construction projects and does not have much overseas experience.

4) (J) The reason why OCH2 was selected for investigation in this study is to confirm if too many accidents on site are attributable to any special factors, or inadequate site operation, etc. Understanding that it may not be comparable to cases in other countries, please provide the study team's comments on this issue.
(S) The Study Team does not feel there had been too many accidents for the project with a scale of more than JPY30billion in a developing country. Please note that there were only 2 serious accidents out of 9 cases reported. For your information, there is an accident at a 9m-high place without handrails in TjPA project in Indonesia.

5) (J) The preliminary Why-Why analysis has concluded that a solution is to keep the site tidy and in order. Would it be possible to further elaborate on it? You said the contractor's countermeasure is basically a whack-a-mole approach, which worries us that the situation may not change. A systematic approach would be required to bring the problem to an end.
(S) In Value Engineering (VE), we describing the solution intentionally abstracting the thing with a view to stimulating generation of ideas. Your attention is kindly drawn to the Recommendations. Blank spaces at the right side of recommendations indicate that the contractor has not yet taken action to those. However, as already reported, countermeasures to accidents and improvements are ongoing. Actually a whack-a-mole approach requires patience and persistence.

6) (J) Please provide in the final report your recommendations including on the laws & regulations.
(S) Yes, we will do it.

7) (J) Please give us your impression on the consultant's role, standpoint, contribution, significance, etc. in terms of safety management for the project.
(S) The consultant organization consists of only 2 foreigners (Mr. Nishimura of OC and Australian PM) and Sri Lankan engineers. Consequently, it would not be possible to take Japanese approach to the safety management, and only surprise inspection twice a month could be done by the consultant. In other words, they could not actively contribute to prevention of accidents, but could act from a standpoint of audit.

8) (J) Did the contractor's organization have 25 Japanese staffs from the beginning?
(S) We did not confirm if there had been 25 Japanese staffs from the beginning, but did confirm that the organization changed after the fatal accident occurred on 14/Mar/2014. The safety management group was put right under the PM, which has made it possible for the PM to directly give instruction to them. The number of safety engineers has increased from 2 to 9. This is supposed to be a consequence of learning from the accident experience. Moreover, previously if labors complained about safety, they were dismissed. However, after the accident on 14/Mar/2014, the atmosphere of the project has changed to "Safety First" in addition to schedule & quality requirements. It is no longer the case that labors are not dismissed if they talk about the safety. Since the improvement of labor's awareness to the safety is crucial, and this is an evidence of improvement of safety management up to the labor level.

9) (J) Please include in the final report the Why-Why analysis results and the improvement of labor's awareness to the safety after the accident.
(S) Yes, we will.

10) (J) How was the reaction of the Sri Lankan government?

(S) Vice Minister of MOHPS showed an interest on JICA Safety Guidance.
Project Director RDA mentioned though the Guidance is yet to have some points to be improved RDA will apply the Guidance in future projects.

Appendix-2 Questionnaires

Safety and Quality Control System Checklist

Country: **Sri Lanka**

Project Name: **Outer Circular Highway Project – Northern Section 1**

To be filled by the Employer

NOTE: To confirm the following items, you can refer to the sample checklist attached.

Items to Confirm	Items to be Confirmed	Confirmation Result
(1) Laws and various standards related to safety and quality control	Availability of laws and various standards related to safety and quality control, as well as the names of those laws and contents of related provisions (1) Names of laws (2) Contents of related provisions	(1). The applicable laws are ❖ Factories Ordinance no 45 of 1942 and subsequent amendments. • Part ii Clause 6 - Housekeeping. • Part ii Clauses 7 & 33 – Handling Explosive. • Part ii Clause 12 – ventilation and fume Extraction. • Part ii Clause 13 - Lighting • Part ii Clause 15 (1) – Provision of sanitary convenience. • Part ii Clause 17 –Machine Guarding. • Part ii Clause 18 –Power Transmission. • Part ii Clause 23 –Vesels,Pits ,Sumps containing chemicals. • Part ii Clause 24- Auto starting machines. • Part ii Clause 26 – Training of staff. • Part ii Clause 27 -Hoist ,Lift • Part ii Clause 28 – Chain ,Ropes ,Slings • Part ii Clause 29 – Cranes and other lifting machine. • Part ii Clause 30 & 31 - Scaffoldings , Ladders and temporary access equipment.

Items to Confirm	Items to be Confirmed	Confirmation Result
		• Part ii Clause 32- Oxygen deficient places. • Part ii Clause 36(A) - Gas / Air Receivers. • Part ii Clause 39 - Fire Safety. • Part ii Clause 43,44,& 45 -Prevention of Accidents. • Part ii Clause 46 – Provision of Drinking Water. • Part iii Clause 50 – First Aid. • Part iii Clause 53&58(A) – Personal Protective Equipment (PPE). • Part vii Clause – Overtime Employment. ❖ National Environmental Protection Act of 1980 and subsequent amendment. • Part 1 - Issue of Environmental Protection License for Emission or disposal of waste into inland surface waters. • Part iii Schedule 1 – Tolerance limit for discharge of waste into inland surface water.

Items to Confirm	Items to be Confirmed	Confirmation Result
	Availability of safety and quality control manuals at the executing agency (Employer) (1) Names (2) Contents (examples of items to be described) ● Is the method of patrolling the sites (frequency of such patrols, etc.) indicated as reference? ● Is the frequency with which consultants and contractors are consulted indicated as reference? ● Are the rules and regulations (or manuals) governing safety and quality control included?	(1). Safety - Manual in Traffic Control devices Part I & Part II Quality - Standard Specifications for Construction and Maintenance of Roads and Bridges 1989 of Road Development Authority of Sri Lanka , revised in 2009. (2). Part I - Traffic signs & road Marking Part II - Sign Markings for road works ➢ Yes, a system of safety patrolling exist. Safety patrolling requirements are discussed under item 5 of the questionnaire. ➢ Yes, review of safety related issues discussed once a month at the review meeting. Outcomes of the meeting is recorded in minutes. (Few copies of the minutes are attached) Attachment

Items to Confirm	Items to be Confirmed	Confirmation Result
(2) Assigned missions of departments in the executing agency in charge of safety and quality control, and assigned tasks of the staffs	Identification of the safety and quality control department and number of staff members	● No. of total staff members at the executing agency (Employer): *Eight* persons ● Name of the safety and quality control department: - ● No. of staff members in the department above: *Safety-04, Quality Control - 04 persons*
	Details of the assigned missions of the department in charge of safety and quality control (1) Current status of implementation of site patrols (2) Availability of accident statistics related to all projects under jurisdiction of the executing agency (Employer) (Attach accident data for the past three years) (3) Guidance and instructions for consultants and contractors (4) Documents on the mandates of the department in charge of safety and quality control (Attach the document) (5) Others (Describe specifically)	• Project Director, Officer in Charge of both Safety and Quality Control. (1). Once a month walk through observation tours are being performed by - Project Director, Chief Engineer, External Safety Consultant, Project Manager of the Contractor, Safety Manager of the Contractor, Team Leader of the Consultant and Safety Manager of the Consultant. Unnoticed two observation tours including night visits performed by the Project Staff & External Safety Consultant.

Items to Confirm	Items to be Confirmed	Confirmation Result
		(2). (a). While walking through safety and quality related lapses are being discussed and wherever possible the site technical staff of the contractor Informed in order to rectify observed lapses. Significant lapses are being recorded in the form of written report or photographic evidence to be discussed at the Monthly Review Meeting. (b). Safety Department of the Contractor is expected to forward safety related statistics to the Project Director, the Team Leader According to the approved safety plan. The reporting requirements can be reviewed at the discretion of the Project Director. (3). Project Staff discussed remedial action on observed lapses with the Project Director, & Technical Staff, Contractor and the Consulting Engineers for implementation in order to prevent Recurrence of such lapses. (4). Minutes of the Safety Review Meetings and Observation reports with recommendations distributed among the key staff of the contractor and The consultant. (Copies attached)

Items to Confirm	Items to be Confirmed	Confirmation Result
		Quality assurance matters are discussed during Monthly Joint Site Visit and Monthly Progress Review Meetings. Minutes of this meeting distributed among the relevant officials.
	Current conditions of implementation of training for staff in charge of safety and quality control (Reference) ● Training in the safety and quality management system ● Training in matters related to laws ● Training in developing awareness of the dangers of accidents ● Training in the role of safety and quality control in the executing agency (Employer) ● Training in construction method and method of safety and quality control ● Training in method of collecting accident statistics and their effective utilization ● Training in accident prevention techniques ● Others	• The employer and the donor agency conducted four Safety Awareness Sessions for selected number of the Employer, Consultant and the Contractor. The Consultant conducted two half day Awareness Sessions for selected number of staff of Employer, Consultant and the Contractor. • Employer conducted two training sessions on quality assurance/quality control of the project works. • Two brief training sessions were conducted with the assistance of Department of Labour covering applicable laws and regulations of the project. • There are no special provisions in the contract made against for local training of staff engaged in safety and quality assurance of the project. • Expertise knowledge from University of Moratuwa are getting for the improvements of quality control. • Whenever an accident happened the contractor is advised to conduct a root cause investigation. Similarly the external Safety Consultant and Project Staff RDA along with the Consulting Engineer conduct independent root cause investigations and propose measures to be implemented to prevent recurrence of such incidents in future. If it is necessary the contractor is advised to review the approved safety plan to accommodate the

Items to Confirm	Items to be Confirmed	Confirmation Result
		proposed safety improvement action. Based on these information's the contractor is expected to review the methods statements of performing the task associated with the accident and demonstrate the revised method to educate the staff of the project. • There are some lapses ongoing methodology established to identify hazards and risk assessment as per approved safety plan. This is one of the areas to be reinforced by the contractors' management.
	Information concerning past accidents in construction, etc. (1) Has the information concerning past accidents been accumulated? In addition, ascertain what the policy is for accumulating accident information (e.g., recording information on only accidents resulting in death in accordance with the organizational rules). (2) Components and contents of accident information (Reference) ● No. of accidents ● Situation in which accidents occur ● Scale of accident (amount, number of casualties,	**Reported Accidents** **Accident 01 ;** Crane Boom Overturning accident on 01/02/2013. Situation: While the crane was in operation on the north bank of the Kelani river around 06.30 p.m. at 16+150 crane Boom over turned and collapsed on to a adjoining house. Scale: No one injured but the private property (house) on the right hand side was severely damaged. Emergency response : The contractor informed the Project Director promptly about the accident and required measures were taken by the contractor to prevent further losses to the private property. Both the contractor and the Consultant with the External

Items to Confirm	Items to be Confirmed	Confirmation Result
	existence or nonexistence of third-party injuries) ● Emergency response ● Cause of accident ● Future prevention method ● Others (Describe specifically)	Safety Consultant conducted two independent investigations. Cause of accident : (i) Unfit/un-serviced crane deployed on duty without checking mechanical and electrical integrity. (ii) Windy weather at the river bank (iii) Absence of proper inspection certification system for hired equipment from external sources. (iv) Recommended to establish and implement an approved system of certifying equipment before assigning duty. (v) Recommended preventive measures not implemented fully. **Accident 02** Fatal Accident happened at Temporary Girder Stacking yard at OB 12 on 14th March, 2014. Situation: While finishing and transporting of stacked girders by two groups of people, one of the girders overturned crushing three workmen to death. Scale : Three fatalities and extensive damages to one of the finished girders. Two workmen hospitalized with injuries.

Items to Confirm	Items to be Confirmed	Confirmation Result
		Emergency response: Project Director and the Consultant Engineer were informed promptly. Two injured persons were rushed to Biyagama hospital. Cause of Accident : Both the contractor and the Consultant Engineer with the Project Staff, RDA conducted two independent investigations. The major causes are : • No job risk assessment done. • Potential emergency situation not identified by the contractor as per the approved safety plan • Unavailability of essential mechanical equipment to shift girders in required numbers • Permitting two high risk activities on a single item • Inadequate technical supervision • Poor Co-ordination between two gangs

Items to Confirm	Items to be Confirmed	Confirmation Result
		<u>Accident 3 ;</u> Falling down a workman from viaduct 1, pier 2 at A1 By Pass resulting major injuries accident. Situation : Working on an elevated place with very poor edge protection without enforcing fall protection equipment. Scale: One workman was admitted to the hospital with no visible injuries but with pain and aches. Emergency response : Both employer and the consultant were informed and the injured person transferred to the hospital. Cause of Accident : • No risk assessment to identify hazards associated with chemicals • Work fatigue • Lone working on elevated locations • Poor technical supervision • Ignorance on repeated lapses highlighted in safety review meetings • Poor control over sub-contractors • Poor lighting

Items to Confirm	Items to be Confirmed	Confirmation Result
		Accident 4: Falling down a workman from pier 3-4 of the Viaduct 04. Situation : Permitting workmen to perform duty on elevated locations without enforcing use of fall protection equipments in particular close to an opening of the bridge with no rigid edge protection. Scale : Major injury accident which required special medical attention in a hospital due to injured vertebrate. Emergency response : Project Director and the consulting engineer were informed and the injured person admitted to Biyagama hospital then transferred to National hospital. Cause of Accident : • Inadequate technical supervision • Poor enforcement of essential safety rules • Lack of attention given to identify job hazards and risk mitigation. • Working area is not safe
(3) Assignment plan for staff in charge of safety control related to the Japanese ODA loan project	Assignment plan for staff in charge of safety control related to the Japanese ODA loan project (1) No. of staff members in charge of safety control	● No. of the total staff members in the executing agency (Employer): *Eight* persons ● No. of construction management staff: *Four* persons

Items to Confirm	Items to be Confirmed	Confirmation Result
	(2) Is there any specific assignment plan, with a specific job description for each person?	● No. of staff members in charge of contractors: *Four* persons **(Attached separately)** (Enter specific names, attach specific documents on the assignment plan)
(4) Capacity and experience of staff in charge of safety and quality control	Projects in which the staff handled safety and quality control (1) Projects handled (2) Names of positions the staff held or their status therein (3) Details of the service performed	(Describe the result, attach reference data) **(Attached separately)**
(5) System of ensuring safety and quality control in the executing agency	Method of ensuring safety and quality control in the executing agency (Employer) (1) Regular consultative meetings with construction managers and contractors (2) Site patrol (3) Others (Describe specifically)	In order to manage safety related issues of the project. a safety plan was originally received from the contractor and a same plan being reviewed in order to accommodate changes required while the project in progress. In addition , (1). Walkthrough audit findings and root cause investigation of accidents are discussed at the review meetings and recommendations are agreed jointly with the contractor and consultant. (2). Site Patrolling done in both prior arranged and surprised Basis. Minimum of three patrolling done for a Month
(6) Preventive action procedure	Availability of preventive action procedure to prevent occurrence of an accident or an undesirable situation and current situation of implementation of such procedure	Whenever an accident or undesirable situation, the contractor and the consultant are advised to conduct root cause investigation in order to recommend measures to prevent recurrence of such incidents. If it is a significant event the external safety consultant is also requested to conduct independent investigation.

Items to Confirm	Items to be Confirmed	Confirmation Result
(7) Framework for emergency response system to accidents	Specific method of sharing information within the executing agency (Employer) when an accidents occurs * Briefly describe the framework for sharing information when an accident occurs. Attach a phone calling tree, relevant regulations, etc. as needed. (1) The manual for responding to an accident (2) Is the department to contact in the case of an accident described in the manual?	(Phone calling tree to be drawn attached separately) (1). The approved safety plan require the contractor to inform the Project Director (Employer), Team Leader of the consultant promptly verbally and written.
	Method of keeping staff members in the executing agency (Employer) informed about the framework for responding to an accident ● Implementation status of holding a briefing session to inform all staff members about the manual and its contents. ● Submission of an accident report and holding of investigative commissions	On hearing of information the Project Director advise the Chief Engineer on further action to be taken including arrangements for investigation. The Chief Engineer through the Project Director forward the recommended preventive measures to both the contractor and the consultant engineer for implementation and feedback information.
(8) Method adopted by the executing agency to confirm training programs in safety and quality control provided by contractors for workers	Method of confirmation adopted by the executing agency (Employer) ● Method of confirmation of the training schedule before construction (in-house education, qualification training) ● Method of confirmation of the training schedule during construction (safety conventions,	Employer has requested contractor to establish and maintain a methodology for verification of training given to staff, sub-contractors and other stakeholders who are coming under the purview of the contractor. This action is still not fully implemented and no feedback information received so far. This matter has been re-iterated at the last review

Items to Confirm	Items to be Confirmed	Confirmation Result
	consultative meetings to discuss safety, post-accident response conference, etc.)	meeting for action without further delay.

Questionnaire for Safety and Quality Control/Management for Consultant

Country: Democratic Socialist Republic of Sri Lanka
Project Name: Greater Colombo Urban Transport Development Project (OCH)

To be filled by the Consultant,

Items	Points to be Clarified	Answer
1. Review of Design of Permanent Works (before Construction)	1. Internal Review Procedure of Consultant Timing of internal review, qualification of reviewer, process for internal approval etc.	● The Project Manager, at the beginning of a project, shall create a Review Plan. Timing of review shall be included in the Review Plan. In general following 3 stages of review shall be held. 1. Review for basic design conditions at the beginning of the Project. 2. Reviews for detailed design conditions and structural details according to the general drawings before start detailed design. 3. Review for detailed design result after completion of detailed design. ● Design reviewer shall be assigned by the Division Director from the Technical Department who has abundant skill after discussing the selection with the General Manager of the Department. ● Process for internal approval shall be as follows. 1. Design reviewer shall prepare review reports reflecting those results regarding the outputs and shall submit the reports to the PM. 2. The PM shall record the review results and shall apply to the Group Leader / General Manager for approval. 3. The PM shall create the "Design Memorandum" with the necessary information for the construction stage. The "Design Memorandum" shall be handed over to the person in charge of construction supervision.

Questionnaire for Safety and Quality Control/Management for Consultant

Country: Democratic Socialist Republic of Sri Lanka
Project Name: Greater Colombo Urban Transport Development Project (OCH)

To be filled by the Consultant,

Items	Points to be Clarified	Answer
	(Comment Response Procedure to comments given by Independent Design Checker Review of comments given, judgment process for how to handle, amendments of design, internal approval process)	No independent design checker before construction stage.
2. Staffs in charge of Safety and Quality Control/Management in Organization of the Consultant	1. Names and job title of the staffs in charge of Safety and Quality Control/Management 2. Job description of above staffs and power or authority delegated to them including qualifications required 3. Overall Organization Charts (Initial & Latest) be attached as Attachment-1	1. Maintenance/ Road Safety Engineer - Mr. J. C. Tharaka Soil/ Material Engineer – Mr. D. D. S. Chandrasiri 2. Job Description and Authority ● Safety Engineer 1) To organize tripartite to arrange monthly safety committee meeting and prepare minutes 2) To review the project safety plan as submitted by the contractor and recommend TL/DTL for approval 3) To review the Traffic safety management plan as submitted by the contractor and recommend TL/DTL for approval 4) To review the contractor's plan and schedules for maintenance and protection of traffic and recommended TL/DTL for approval 5) Day to day monitoring of ongoing activities and related safety aspects and report to the TL/DTL on lapses 6) Weekly or Random safety surveillance inspections to verify the safety aspect that compliance to approved safety plan and issuance of inspection report 7) Monthly safety audit inspection with the participation of the representatives from Employer, Engineer and the Contractor

Questionnaire for Safety and Quality Control/Management for Consultant

Country: Democratic Socialist Republic of Sri Lanka
Project Name: Greater Colombo Urban Transport Development Project (OCH)

To be filled by the Consultant,

Items	Points to be Clarified	Answer
		8) Preparation of report highlighting the safety lapses as observed with recommendations for corrective action 9) Assisting to the contractor to investigate accident/Incident that related to the project and to recommend corrective and preventive measures to avoid recurrence 10) Recording and list out of all the accidents/incidents as the report received from the contractor and report back to the Employer with format of OC accident report 11) Calculation of Accident Frequency Rate and its graphical representation to assess the site safety situation. Produce report to monthly management meetings 12) To attend Monthly Progress Meeting, Safety & Environmental Meetings and Technical Meetings 13) Required qualification in the Consultancy Contract: Qualified B.Sc. or equivalent with minimum of 5 years of experience in operational & safety expert of road and bridge construction and other related works. ● Material Engineer 1) Supervision of quality control activities related to materials, works and products 2) Inspections of materials, works and products as per the request of the Contractor submitted by RIF (REQUEST FOR INSPECTION FORM) 3) Ad-hoc Inspections of materials, works and products regards to the quality 4) Review and reply to the Contractor's documentary submission relevant to the approvals of materials, products and method statements

Questionnaire for Safety and Quality Control/Management for Consultant

Country: Democratic Socialist Republic of Sri Lanka
Project Name: Greater Colombo Urban Transport Development Project (OCH)

To be filled by the Consultant,

Items	Points to be Clarified	Answer
		5) Review, follow-up and maintain records of the Contractors Non-conformance reports submitted for non-conformities 6) Attending to the meetings for Quality Control/ Quality Assurance issues 7) Inspection, Review and approve the laboratory quality control reports (Test reports, Calibration of plants and equipment, Borrow area investigations) 8) Review and giving instructions related to mix designs for concrete, Job mix formulas for asphalt, trial mixes for concrete, paving and compaction trials and works and other activities. 9) Required qualification in the Consultancy Contract: Professionally qualified B.Sc. Eng. or equivalent with minimum of 15 years of experience, out of which 10 years of experience as Soil/ Material Engineer. 3. Organization Chart - See Attachment- 1
3. Provisions related to Safety and Quality Control/Management in the Consultancy Contract with the Employer	1. Copy of the Contract to be attached as Attachment-2	See Attachment–2
4. Quality Control and/or Quality Assurance Plan prepared/ submitted by the Contractor	1. Copy to be attached as Attachment-3	See Attachment–3
5. Safety Plan prepared/ submitted by the Contractor	1. Copy to be attached as Attachment-4	See Attachment–4
6. Risk Management Plan prepared/ submitted by the Contractor	1. Copy to be attached as Attachment-5	Risk Management Plans for various construction activities are prepared and submitted along with relevant method statement. See Attachement-5

Questionnaire for Safety and Quality Control/Management for Consultant

Country: Democratic Socialist Republic of Sri Lanka
Project Name: Greater Colombo Urban Transport Development Project (OCH)

To be filled by the Consultant,

Items	Points to be Clarified	Answer
7. Review and/or Approval Procedure for Permanent Works (during Construction)	1. Review and/or Approval Procedure Timing of review, qualification of reviewer, process for approval etc. 2. Relation with an Independent Design Checker, if specified	1. Review and approval for the Contractor's Design of permanent works are performed by **Expatriate Senior Structural Design Engineer** (Requirement: Professionally qualified B.Sc. Eng. or equivalent with minimum of 15 years of experience, out of which 10 years of experience as Structural/ Bridge Design Engineer) and **Local Structural Design Engineer** (Requirement: Professionally qualified B.Sc. Eng. or equivalent with minimum of 15 years of experience in Design of Bridge and Structures). They shall reply the Contractor's letter within 21 days from submission. 2. Contractor's Independent Design Checker shall review Contractors design before submission to the Engineer.
8. Roles of the Consultant at the review or approval of design of Temporary Works, Shop Drawing and Method Statement	1. Review and/or Approval Procedure Timing of review, qualification of reviewer, preparation of comments, review of comment reply, process for approval etc. 2. Relation with an Independent Design Checker, if specified	1. **Design of Temporary Works** – **Senior Structural Design Engineer** and **Structural Design Engineer** shall review and confirm it. However, the Engineer shall not approve it and send no objection letter. **Shop Drawing** - Review and approval for the Contractor's Design of permanent works are performed by **Senior Structural Design Engineer** and **Structural Design Engineer**. They shall reply the Contractor's letter within 21 days. **Method Statement** – **Expatriate Senior Highway Engineer** (Requirement: Professionally qualified B.Sc. Eng. or equivalent with minimum of 15 years of experience in construction supervision and Highway Design, out of

Questionnaire for Safety and Quality Control/Management for Consultant

Country: Democratic Socialist Republic of Sri Lanka
Project Name: Greater Colombo Urban Transport Development Project (OCH)

To be filled by the Consultant,

Items	Points to be Clarified	Answer
		which 10 years of experience shall be in contract administration), **Local Highway Engineer Construction** (Requirement: Professionally qualified B.Sc. Eng. or equivalent with minimum of 15 years of experience, out of which 10 years of experience in highway supervision) and **Senior Structural Engineer Construction** (Requirement: Professionally qualified B.Sc. Eng. or equivalent with minimum of 15 years of experience, out of which 10 years of experience as Structural/ Bridge Construction Supervision Engineer) shall review and confirm it. However, the Engineer shall not approve it and send no objection letter. 2. Contractor's Independent Design Checker shall review Contractors design before submission to the Engineer.
9. Inspection by the Consultant	1. Inspection procedure Timing of Inspection, qualification of an inspector, how to carry out inspection, relation with the Consultant's Inspection	**Safety Inspection** Formal Inspection – Twice a month, Informal Inspection – Daily basis **Quality Control Inspection** Regular Inspection- As per the contractor request Ad-hoc inspection - As per the requirement of the engineer **Qualification** **Safety Engineer** – B.Sc. Engineer having six years of experience in construction safety **Material Engineer** - B.Sc. Engineer having 32 years of experience relevant to the soil/material Engineering

Questionnaire for Safety and Quality Control/Management for Contractor

Country: Sri Lanka To be filled by the Contractor,
Project Name: Outer Circular Highway to the City of Colombo Project- North Section 1

Items	Points to be Clarified	Answer
1. Staffs in charge of Safety and Quality Control/Management in Organization of the Contractor	1. Names and job title of the staffs in charge of Safety and Quality Control/Management 2. Job description of above staffs and power or authority delegated to them including qualifications required 3. Overall Organization Charts (Initial & Latest) to be attached as Attachment-1	**K.Sakurai -Safety Manager** **Civil Engineer-** Having experience in Safety Field The Safety Manager has been given authority for advising the Safety Committee on the following matters in respect of the safety requirements in the project site: The prevention of injury to personnel and damage to equipment and materials, including the application of safety procedures. Further improvements to existing safe working methods, including those arising from new developments. The legal requirements affecting safety, health and welfare. The provision, use, suitability and required standards of protective clothing and safety equipment The suitability of new and hired plant equipment and the validity of all appropriate test certificates. Any change in legislation relative to safety, health and welfare. (Current legislation of Scheduled 1 of "Factories Ordinance , 1965", Labour Department) The potential hazards in new sections of work before such work commences.

Questionnaire for Safety and Quality Control/Management for Contractor

Country: Sri Lanka To be filled by the Contractor,
Project Name: Outer Circular Highway to the City of Colombo Project- North Section 1

Items	Points to be Clarified	Answer
		Prepare the Site/work area safety organization and the fire precautions required. Carry out site safety inspections, in conjunction with the Project Manager / Deputy Project Manager, technical and other supervisory staff, Road Development Authority and the subcontractor's safety representatives, to check and ensure that only safe methods of working are in operation and that all regulations are being observed. Determine cause of accident/incident or dangerous occurrences and recommend means of preventing recurrences. Take part in site management/operative discussions on injury, damage and wastage control. Keep updated with recommended codes of practice and new safety literature. Act in accordance with Health and Safety Policy. Report all accidents to the Project Manager. **U.S.Silva - Deputy Safety Manager – Site Activities** Having nearly 30 years of experience in Fire & Safety field including 06 years in road construction **S.Ekanayake - Deputy Safety Manager – Safety Administration**

Questionnaire for Safety and Quality Control/Management for Contractor

Country: Sri Lanka To be filled by the Contractor,
Project Name: Outer Circular Highway to the City of Colombo Project- North Section 1

Items	Points to be Clarified	Answer
		Having nearly 30 years of experience in Fire & Safety field including 08 years in road construction The Deputy Safety Manager has been given authority to assist the Safety Manager on the following matters in respect of the safety requirements in the project site: The prevention of injury to personnel and damage to equipment and materials, including the application of safety procedures. Further improvements to existing safe working methods, including those arising from new developments. The legal requirements affecting safety, health and welfare. The provision, use, suitability and required standards of protective clothing and safety equipment. The suitability of new and hired plant equipment and the validity of all appropriate test certificates. Any change in legislation relative to safety, health and welfare. (Current legislation of Scheduled 1 of "Factories Ordinance , 1965", Labour Department)

Questionnaire for Safety and Quality Control/Management for Contractor

Country: Sri Lanka To be filled by the Contractor,
Project Name: Outer Circular Highway to the City of Colombo Project- North Section 1

Items	Points to be Clarified	Answer
		The potential hazards in new sections of work before such work commences. Prepare the Site/work area safety organization and the fire precautions required. Carry out site safety inspections, in conjunction with the Project Manager / Deputy Project Manager, technical and other supervisory staff, Road Development Authority and the subcontractor's safety representatives, to check and ensure that only safe methods of working are in operation and that all regulations are being observed. Determine cause of accident/incident or dangerous occurrences and recommend means of preventing recurrences. Take part in site management/operative discussions on injury, damage and wastage control. Keep updated with recommended codes of practice and new safety literature. Act in accordance with Health and Safety Policy. Report all accidents to the Project Manager. **Akira OOKA – QAQC Manager–** Responsible for QAQC for the project

Questionnaire for Safety and Quality Control/Management for Contractor

Country: Sri Lanka To be filled by the Contractor,
Project Name: Outer Circular Highway to the City of Colombo Project- North Section 1

Items	Points to be Clarified	Answer
		Khawar Arfeen – QAQC Engineer– Responsible for QAQC for Structure work, namely, preparation of Inspection and Test Plan (ITP) and Nonconformance Report (NCR) and Corrective Action Report (CAR) and others. **Jose Rizalito TJ Tajaros – QAQC Engineer–** Responsible for QAQC for Earth work, namely, preparation of Inspection and Test Plan (ITP) and Nonconformance Report (NCR) and Corrective Action Report (CAR) and others.
2. Provisions related to Safety and Quality Control/Management in the Contract with the Employer	1. Copy of the Contract to be attached as Attachment-2	
3. Quality Control and/or Quality Assurance Plan prepared/ submitted by the Contractor	1. Copy to be attached as Attachment-3	
4.Safety Plan prepared/	1. Copy to be attached as Attachment-4	√

Questionnaire for Safety and Quality Control/Management for Contractor

Country: Sri Lanka To be filled by the Contractor,
Project Name: Outer Circular Highway to the City of Colombo Project- North Section 1

Items	Points to be Clarified	Answer
submitted by the Contractor		
5. Risk Management Plan prepared/ submitted by the Contractor	1. Copy to be attached as Attachment-5	√
6. Review and/or Approval procedure of Detailed Design of Permanent Structure	1. <u>Detailed Design Procedure</u> Timing of commencement of detailed design, qualification of designer, involvement of Subcontractor etc. 2. <u>Review and/or Approval procedure</u> Timing of review, qualification of reviewer, process for internal approval	
7. Roles of the Contractor at the review or approval of design of Temporary Works, Shop Drawing and Method Statement	1. <u>Preparation of Method Statement etc (MS)</u> Timing of preparation of MS, qualification of an engineer for preparing MS, involvement of Subcontractor etc.	1. <u>Preparation of Method Statement</u> **Timing of preparation of MS** ; From Designing stage to beginning of construction activities AND REVIEW **Qualification of an engineer for preparing MS** Having training in health and safety in general and in carrying out Method Statements in particular, experience of the process/ activity, possession of technical knowledge of equipment or plant involved, ability of interpretation of legislation, standards and guidance, communication and reports ability and attention to details

Questionnaire for Safety and Quality Control/Management for Contractor

Country: Sri Lanka To be filled by the Contractor,
Project Name: Outer Circular Highway to the City of Colombo Project- North Section 1

Items	Points to be Clarified	Answer
	2. Review of MS Timing of review, qualification of reviewer, process for internal approval	2. Review of MS **Timing of review** **When,**Increased in accident/incidents, changes in process, changes in materials, changes in premises, changes in legislations, changes in work patterns, compensation clams, prosecutions/ enforcement notices, enforcement action, policy review, professional advice etc.
	3. Communication procedure with the workers When, where, by whom, to whom a briefing of MS is to be carried out. How to check the results of briefing (Is communication successfully made?)	3. Communication procedure with the workers Involving employees in preparation of MS, drawing up safe systems of work and procedures, Organizing information programs and training sessions Team briefings, tool box meetings, induction training, Competitions, Appraisal sessions etc. **How to check the result** Feedback to ensure employee understanding.
8. Inspection by the Contractor	1. Inspection Procedure Timing of Inspection, qualification of an inspector, how to carry out inspection, relation with the Consultant's Inspection	1. Inspection Procedure **Timing of inspection**: Daily, Weekly, Monthly etc. (Routinely and to aim of identifying hazards and assessing the use and effectiveness of control measures)

Questionnaire for Safety and Quality Control/Management for Contractor

Country: Sri Lanka To be filled by the Contractor,
Project Name: Outer Circular Highway to the City of Colombo Project- North Section 1

Items	Points to be Clarified	Answer
		Qualification of the inspector Having , Knowledge in the workplace and hazards associate with the process, knowledge on hazards and control measures in the site, training in inspection techniques, good communication and report ability **How to carryout inspection** Scheduled and unscheduled inspections are carried out jointly with Project Manager, Safety Manager, Section Manager and site engineer/foreman Straightforward observation of the worksites, the activities or equipment using check lists to aim of identifying hazards and assessing use of effectiveness of control measures.

Questionnaire for Safety and Quality Control/Management for Contractor

Country: Sri Lanka To be filled by the Contractor,
Project Name: Outer Circular Highway to the City of Colombo Project- North Section 1

Attachment-1: Organization of the Contractor

Attachment-2: Copy of the Contract Documents

Attachment-3: Copy of the Quality Control and/or Quality Assurance Plan

Attachment-4: Copy of the Safety Plan

Attachment-5: Copy of the Risk Management Plan