NO.

BASIC DESIGN STUDY REPORT
ON
THE PROJECT FOR IMPROVEMENT OF DUSTY-NIJINY PYANDZH ROAD
IN
REPUBLIC OF TAJIKISTAN

JUNE 2006

JAPAN INTERNATIONAL COOPERATION AGENCY

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PREFACE

In response to a request from the government of the Republic of Tajikistan, the Government of Japan decided to conduct a basic design study on the Project for Rehabilitation of Dusty-Nijiny Pyandzh Road and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Tajikistan a study team from November 17 to December 17, 2005.

The team held discussions with the officials concerned of the Government of Tajikistan, and conducted a field study at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Tajikistan from March 18 to March 28, 2006 in order to discuss a draft basic design. Following a detailed design level study and cost estimation in Japan, another mission was sent to Tajikistan from May 13 to May 19, 2006 in order to discuss a draft study report, and as this result, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of the Republic of Tajikistan for their close cooperation extended to the terms.

June 2006

Masafumi Kuroki
Vice President
Japan International Cooperation Agency

June 2006

Letter of Transmittal

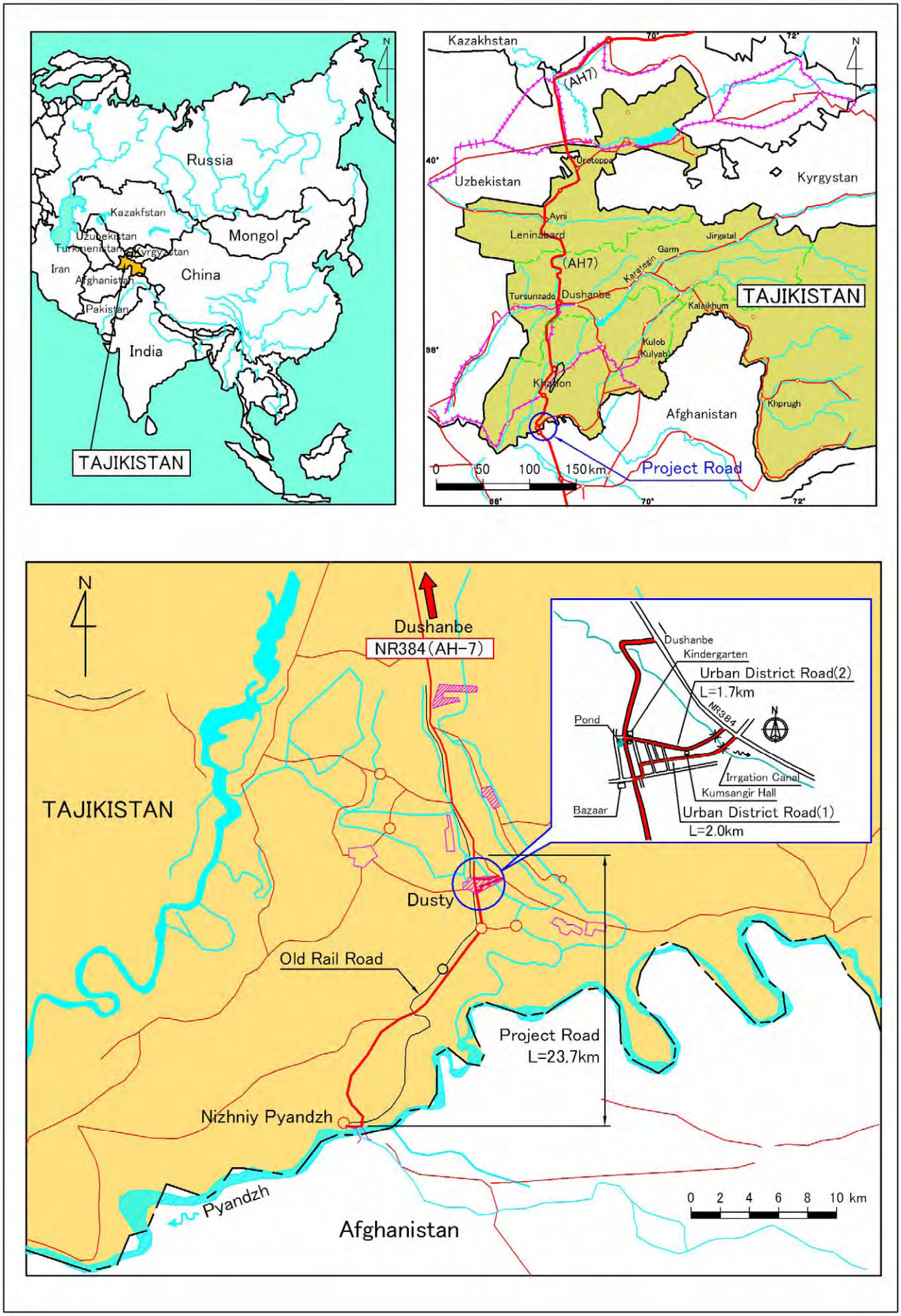
We are pleased to submit to you the basic design study report on the Project for Rehabilitation of Dusty-Nijiny Pyandzh Road in the Republic of Tajikistan.

This study has been conducted by Katahira & Engineers International, under a contract to JICA, for 8 months in the period from November 11, 2005 to July 11, 2006. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Tajikistan and formulated the most appropriate basic design for the project under Japan's grant aid scheme.

Finally, we hope that this report will contribute to further promotion of the project.

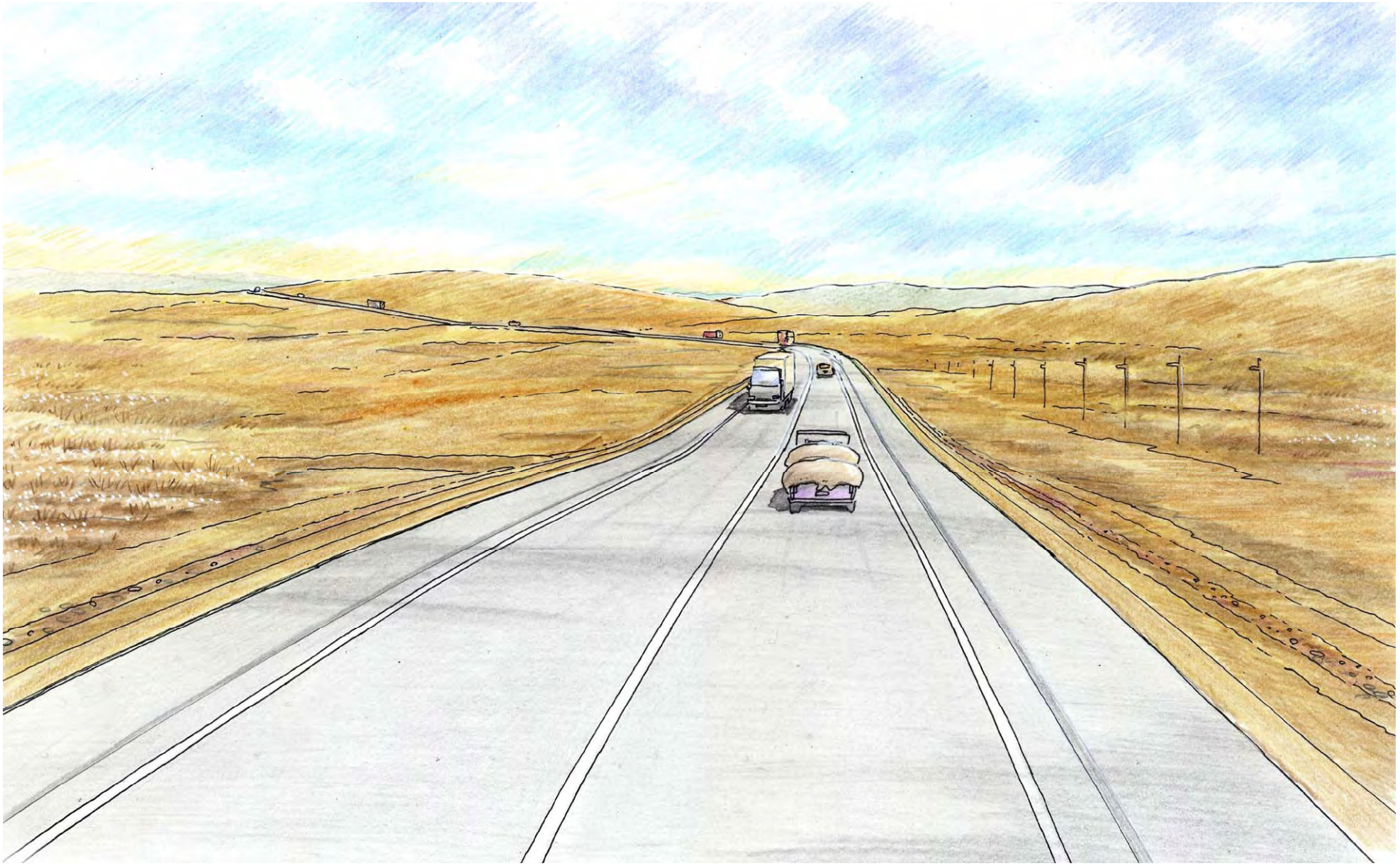
Very truly yours,

Minoru MIURA
Chief Consultant
Katahira & Engineers International
Basic Design Study Team on
the Project for Rehabilitation of Dusty-Nijiny Pyandzh Road in
the Republic of Tajikistan



Location map

Perspective (a section of residential area)



Perspective (a section of high desert)

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ABBREVIATIONS

AASHTO	: American Association of State Highway and Transport Officials
ADB	: Asian Development Bank
AH	: Asian Highway
CIS	: Commonwealth of Independent State
EBRD	: European Bank for Reconstruction and Development
EIA	: Environment Impact Assessment
EU	: European Union
IBRD	: International Bank for Reconstruction and Development
IEE	: Initial Environment Examination
IMF	: International Monetary Fund
IsDB	: Islamic Development Bank
JICA	: Japan International Cooperation Agency
SCEP	: State Committee on Environment Protection and Forest Industry
MOT	: Ministry of Transportation
MOWR	: Ministry of Water Resources
NGO	: Non Government Organization
SCLM	: State Committee for Land Managenent
Somoni	: Currency unit of Tajikistan
TRACECA	: Transport Corridor Europe Caucasus Asia
UN	: United Nations

SUMMARY

Since the Republic of Tajikistan obtained its independence from the rule by the former Soviet Union in 1991, conflicts following the independence, however, have seriously caused national economic struggles in recovering from the long time recession. Peace processes were once done after the election of the National Assembly in 2000. Nevertheless, many problems in the recession, such as lack of government budgeting, rising unemployment rate, and so on, continuously resulted from the long time conflicts.

In Tajikistan, being 90 per cent mountainous areas, wide area trunk roads connecting to neighbouring countries from the Capital, as well as other main cities, are one of the most important infrastructures. Nevertheless, most roads built in the era of the former Soviet Union have been more damaged and decrepit for a long time since the conflicts following the independence. This serious problem obstructs to activate the national economic growth. Under the circumstances, the government of Tajikistan prepares “Program of Socio-Economic Development of Transport Complex of the Republic of Tajikistan” every five years to plan improvement of infrastructures: however, most of the trunk road networks are improved by Foreign Aid Programs due to lack of national budgeting as usual.

This wide area trunk road, as the National Road No.384 connecting both the Capitals of Tajikistan and the neighbouring country of Afghanistan, was built by the former Soviet Union and has been more decrepit for a long time. Furthermore, this route is not only listed as the priority in the above-mentioned five-year plan but also ranked with a wide area trunk road as part of the Asian Highway (AH No.7: 497km in distance within Tajikistan). Therefore, ADB completed the rehabilitation for a part of this route, 93km in distance between Dushanbe and Nijiny Pyandzh. In addition, the US Aid Program is now constructing Nijiny Pyandzh Bridge over the international border. After the inauguration of the bridge, it is expected to activate transportation not only for Tajikistan and Afghanistan but also for other countries in Central Asia. And, also, national agriculture and tourism are expected by increasing transportation of agricultural products and tourists.

On the other hand, a part of this route (National Road No.384), 23.7km in distance between Dusty and Nijiny Pyandzh, has been more damaged and decrepit since the era of the former Soviet Union, as well as other wide area trunk roads. In spite of daily maintenance such as fixing potholes and so on within the limited budget, Through rehabilitation for this part, including the reconstruction of pavement, has not yet be planned due to lack of equipment. After the inauguration of the national

border bridge, it is urgently necessary to secure the function of wide area trunk road. Under such circumstances, the Government of Tajikistan requested a grant aid from Japan for the rehabilitation mentioned above.

In response to the request, the Government of Japan sent a preliminary study team, organized by the Japan International Cooperation Agency (JICA), to examine the feasibility, necessity and urgency of the project. According to a result of this study, serious damages of the project road will obstruct the expected passage of heavy vehicles increasing after the completion of the international border bridge construction, as the bottleneck. The study verified the feasibility, necessity and urgency of the project. While the field surveys were being conducted, the Government of Tajikistan, in addition to this project road, requested to secure safe and smooth traffic of two urban district roads in Dusty Town because of increasing transportation volume by the expected effect of this project. The request was confirmed that the rehabilitation for the urban district roads is necessary to separate functioning as town roads for people living alongside from transit traffic from/to nationwide.

Based on the results of the preliminary study, JICA dispatched a basic design study team to Tajikistan in the period from November 17 to December 17, 2005 to discuss with concerned officials of the Government of Tajikistan, as well as, to conduct field surveys at the study area. After returning to Japan, the study team conducted a basic design with optimum project contents according to outcomes of the field surveys and, thence, prepared the basic design outline based on results of the basic design study. JICA dispatched a team for the presentation and discussion of basic design outline to Tajikistan in the period from March 18 to March 28 2006. Having returned to Japan, a further study for the detailed design was conducted. JICA, again, dispatched another team for the explanation of a draft study report to Tajikistan in the period from May 13 to May 19 2006. As agreed with the Government of Tajikistan, analyses in Japan were conducted to estimate the detailed work quantities and project cost.

As a result of the basic design study, including the detailed design level, a summary of the study can be proposed:

Target Road : (1) Dusty − Nijiny Pyandzh Road of 23.7 km
(2) Two urban district roads of 3.7 km in Dusty Town

Construction of cross section: (1) General section between Dusty and Nijiny Pyandzh
two lanes (2@3.5m, widening if R=1000m) + shoulders (2@3.5m), road width 12.0m (changing cross section if

R>250m)

(2) Urban district road section in Dusty Town

two lanes (2@3.5m), road width 7.0m

(3) Design speed

60km/h (excluding the urban district road sections in Dusty Town)

Major contents of the projects

Items			Contents/scales
Section between Dusty and Pijiny Pyandzh	Earthwork	Widening of road width	Almost all the way
		Raising of road surface	All the way except beginning section at road facilities
		Improvement of vertical alignment	Maximum 9.9% based upon existing road condition
		Replacement	Section (1,100m) submerged with flood water from irrigation canal
	Pavement		All the way (23.7km) for traffic lanes and shoulders
	Culvert	Box culvert	New construction / replacement: 3, extension: 2
		Pipe culvert	New construction / replacement: 31, extension: 41
	Drainage facility		U type concrete side gutter: 4,310m (most residence areas) Side ditch: 15,317m
	Ancillary facility	Road marking	Centerline: 23.70km、lateral lines: 47.40km, pedestrian crossing: 4
		Traffic sign	154
		Guidepost	783
		Access to connecting road	Connecting road: 63 (low cost pavement), driveway: 50
Items			Contents/scales
Urban road	Pavement		All the way: 3.62km, only traffic lane with low cost pavement
	Ancillary facility	Road marking	Centerline: 3.62km、lateral lines: 7.24km, pedestrian crossing: 2

Once the Grant Aid of Japan undertakes the project, the detailed design and construction periods are 3.0 months and 25.5 months, respectively. Total project cost of 1,318 million Japanese yen (Japan Government's payment: 1,312 million Japanese yen and Tajikistan Government's payment: 6 million Japanese yen) are estimated.

Direct beneficiaries of the project are 2.83 million residents in the Khatlon province of Tajikistan and indirect beneficiaries are 35 million people in both of Tajikistan and Afghanistan.

Advantageous effects resulting from the implementation of the project are summarized as follows:

(1) Direct positive effects

① Improving driving performance on the project road, driving time can become 19 minutes faster by allowing the passage all the way. Driving speed can increase 40km/h, in average, from 25km/h at the section between the beginning point and residence area and 60km/h, in average, from 35km/h at the section between the high desert area and end point, respectively.

② Installing adequate lane widths with shoulders (sidewalks), a parking zone near the market, pedestrian crossings and traffic signs all the way, safety and smooth traffic can be secured. Moreover, improving lane widths of the main route and urban district roads in Dusty Town, house carriages and so on in slow speed can be safely separated.

③ Protecting from flooding water leaked from the irrigation canal (total distance: 1,100m; flooded period: approximately 40 days a year; obstructed traffic time: approximately 5 hours a day), smooth and safety traffic for passengers and freights on the project road can be drastically improved. Besides residents alongside can go to commercial areas and public facilities with easy access.

(2) Indirect positive effects

① Exchange of goods and people can be more enhanced by functioning as a wide area trunk road.

② Dust pollution can be alleviated by fixing damages of the traffic lanes and shoulders.

③ Irrigation water distribution can be effective because of improving the existing irrigation canals alongside, as well as, improving this project road.

This project is expected not only to produce significantly positive effects, as mentioned above, but also to function urgently as a wide area trunk road connecting to the international border bridge being constructed by the US Aid and to contribute for a better living and business of the people concerned. Consequently, it can be judged that this project is appropriate to be undertaken by the Grant Aid of Japan. Personnel and funds for management and maintenance of the project are provisionally sufficient. However, another project for procurement of equipment, through the Grant Aid of Japan, is considered necessary to retain the said positive effects as long-term maintenance, such as overlay, is not possible due to lack of equipment, in spite of highly technical level in Tajikistan.

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CHAPTER 1 BACKGROUND OF THE PROJECT

Road networks in Tajikistan were built in the era of the former Soviet Union. In spite of important infrastructure for nationwide transportation, most roads have been damaged and ruined because of the conflicts following the Independence in 1991, lack of maintenance budget caused by long time recession, and, moreover, natural disasters such as avalanche and landslide. Under the circumstances, the road networks hazard effective and safe transportation. Particularly, national economy growth has been remained stagnant due to lack of international freight capability from or to neighboring countries.

Under these circumstances, the government of Tajikistan prepares “Program of Socio-Economic Development of Transport Complex of the Republic of Tajikistan” every five years to plan improvement of trunk road networks as the priority since the independence. However, rehabilitation of trunk road network depends on Foreign Aid Programs due to lack of government budgeting as usual.

The project road, a part of the major trunk road connecting both the Capitols of Tajikistan and the neighboring country of Afghanistan, is not only listed as the priority in “the above-mentioned long-term transportation development program for 2001 – 2005” but also ranked with a wide area trunk road in the concept of Asian Highway.

A part of the National Road No. 384 was improved by ADB in 2001 – 2005. Besides, a new bridge over the Nijiny Pyandzh River designating the international border is under construction and will be completed in May 2007 by the US Aid program. In spite of daily maintenance such as fixing potholes within a limited budget, the project road, 23.7km in distance between Dusty and Nijiny-Pyandzh, has not yet been planned to improve the decrepit condition with more damages since it was built in a era of the former Soviet Union, as the same as other trunk roads, due to lack of equipment for through maintenance such as reconstructing pavement. Urgent rehabilitation of the project road is necessary to secure the function for a wide area trunk road after the inauguration of the international bridge.

Under such circumstances, the Government of Tajikistan requested, in February 2004, for the Grant Aid to the Government of Japan regarding the rehabilitation of the road between Dusty and Nijiny Pyandzh seriously damaged and ruined.

In response to the request, a preliminary study was conducted by JICA in the period from June 28 to

July 23, 2005. As a result of the study, the project has the feasibility, necessity and urgency because the concerned road will obstruct the function of wide area trunk road after the completion of the international border bridge. In addition to the requested national road, the Government of Tajikistan requested to improve two urban district roads in Dusty Town, while the preliminary study is carrying out in Tajikistan. It can be judged that rehabilitation of the two district roads in Dust Town is necessary, as effective upgrading within a limited budget, to secure safety and smooth traffic because of increasing transportation volume. Consequently, contents of the request for this project are:

The original request

- Rehabilitation of Dusty – Nijiny Pyandzh Road of approximately 26 km

The final request

- Rehabilitation of Dusty – Nijiny Pyandzh Road of 23.7 km
- Rehabilitation of two urban district roads in Dusty Town of approximately 3.7 km

CHAPTER 2 CONTENTS OF THE PROJECT

2.1 Basic Concept of the Project

Mr. Safarov R. Chairman of the Hukumat of Kumsangir District

2.1.1 Overall Goal and Objective

Usually, the Government of Tajikistan prepares “Program of Socio-Economic Development of Transport Complex of the Republic of Tajikistan” every five years and sets improvement for the project road as the priority in the above-mentioned long-term transportation development program for 2001 - 2005. In addition, Ministry of Transportation, as the implementation agency, plans “Program of National Investment and Technology for 2005 - 2007” to promote national economic growth so that freights and passengers can move effectively by developing road and rail networks.

This project for Rehabilitation of Dusty-Nijiny Pyandzh Road (the Project) aims at the following achievements:

- Project road is improved to secure effective transportation capability as proposed in “the said Program of National Investment and Technology”.
- This route, a part of important international highway, is ranked with the wide area trunk road (AH7) in the concept of Asian Highway.

This project aims to secure effective transportation for people and merchandise in Tajikistan so that national economy growth can be promoted by activating international passengers and freights not only in Tajikistan but also in Uzbekistan, Afghanistan and other neighboring countries in Central Asia.

- Overall goal of the Project: To promote active economy of Tajikistan.
- Objective of the Project: To secure effective transportation for passengers and freight.

2.1.2 Outline of the Project

Towards the said overall goal and objective, this project implements the rehabilitation of the project road and the urban district roads, approximately 23.7km between Dusty and Nijiny Pyandzh and approximately 3.7km in Dusty Town, respectively

2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

2.2.1.1 Grant Aid Scheme

The Government of Tajikistan requested road rehabilitations between Dusty-Nijiny Pyandzh in April 2004. A preliminary study for the Project in the period from June to August 2005 verified existing road conditions and circumstances alongside the project road. Based on a result of the study, the road rehabilitation, including urban road of 3.7km in Dusty Town, is necessary to be implemented. In the field study, the Government of Tajikistan agreed the road rehabilitation including new construction parts near from the beginning point of the project and on the old railroad site,.

2.2.1.2 Consideration on Natural Conditions

Meteorological conditions can be applied to planning for road drainage facilities and construction. Hydrological conditions can be applied to planning for road construction, road drainage facilities and irrigation canals. Topographic and geological conditions can be practically used for planning bridges and box culverts, decision of bearing layer depth, selection of formation type and construction.

Considerable natural conditions are definitely described as follows:

(1) Meteorology

Meteorological conditions at the project site are mentioned as below.

Particular consideration on rainfalls is not necessary because of only small rainfalls of about 300mm a year (refer to Table 2.2.1.2-1 Rainfall data in Kurgan-Tyube City). The office of the Dusty Town informed that it is generally the coldest season in the period from the end of December to later part of January: however it is warm in daytime in this period: moreover, it snows in several days a year but not continuously (refer to Table 2.2.1.2-2 Temperature data in Kurgan-Tyube City).

Consideration for design work on the meteorological conditions is as follows:

- Asphalt work through the cold season between December and January.

The design policy for the said consideration is described in 2.2.1.11 “Concept for Construction Method and Work Period” and 2.2.4.1 “Implementation Policy”.

Table 2.2.1.2-1 Rainfall data in Kurgan-Tyube City

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Upper frame Rainfall(mm) Below frame Number of rainfall days (days)	2001	44.3	57.2	30.1	0.8	0.7	2.1	0.0	0.0	0.0	12.1	14.4	39.3	201.0
		10	8	6	3	2	1	2	2	2	5	5	11	57
	2002	31.9	71.8	26.1	32.4	38.7	0.0	0.5	0.0	0.0	0.0	14.1	68.1	283.6
		8	12	10	11	9	1	2	0	0	0	7	17	77
	2003	8.5	50.4	72.6	46.4	13.0	0.0	0.0	0.0	0.0	2.5	36.6	59.7	289.7
		8	10	14	12	11	1	1	0	0	3	8	12	80
	2004	35.9	6.7	21.8	20.4	38.9	0.3	11.1	1.4	0.0	1.0	27.2	49.4	214.1
		13	9	7	10	5	2	4	2	0	4	11	13	80
	2005	37.8	85.9	47.2	27.0	34.6	10.8	0.0	0.5	0.0	2.9	21.3	1.5	269.5
		11	16	10	10	7	3	0	1	0	2	7	3	70
	Sum of fall	158.4	272.0	197.8	127.0	125.9	13.2	11.6	1.9	0.0	18.5	113.6	218.0	1,257.9
	Sum of days	50	55	47	46	34	8	9	5	2	14	38	56	364
	Average fall	31.7	54.4	39.6	25.4	25.2	2.6	2.3	0.4	0.0	3.7	22.7	43.6	252
	Average days	10	11	9	9	7	2	2	1	0	3	8	11	72.8
	fall/days	3.2	4.9	4.2	2.8	3.7	1.6	1.3	0.4	0.0	1.3	3.0	3.9	30.3
Observation number of days	2001	31	28	31	30	31	30	31	31	30	31	30	31	365
	2002	31	28	31	30	31	30	31	31	30	31	30	31	365
	2003	31	28	31	30	31	30	31	31	30	31	30	31	365
	2004	31	29	31	30	31	30	31	31	30	31	30	31	366
	2005	31	28	31	30	31	30	31	31	30	31	30	10	344
	Total	155	141	155	150	155	150	155	155	150	155	150	134	1,805
Number of rainfall days over 10mm/day	2001	1	3	1	0	0	0	0	0	0	0	0	1	6
	2002	1	2	1	0	1	0	0	0	0	0	0	2	7
	2003	0	1	3	2	0	0	0	0	0	0	1	2	9
	2004	1	0	1	0	1	0	0	0	0	0	1	1	5
	2005	0	4	2	1	2	0	0	0	0	0	0	0	9
	Sum of 5years	3	10	8	3	4	0	0	0	0	0	2	6	36
	Year average	0.6	2.0	1.6	0.6	0.8	0.0	0.0	0.0	0.0	0.0	0.4	1.2	7.2
Number of rainfall days over 10mm/day		**1**	**2**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**8**

Table 2.2.1.2-2 Temperature data in Kurgan-Tyube City

		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper frame Average minimum temperature(℃) Below frame Average maximum temperature(℃)	2001	-1.3	1.4	6.3	13.5	18.2	20.1	21.0	18.2	14.0	10.8	5.6	3.7
		7.9	11.9	20.7	28.8	35.1	37.7	37.7	35.4	31.3	25.2	19.7	12.5
	2002	1.9	3.7	8.2	13.0	16.4	20.4	20.4	19.5	13.5	11.0	6.1	-0.5
		12.0	12.0	21.1	24.6	29.8	36.1	36.1	36.9	13.5	29.3	19.3	5.4
	2003	2.6	3.5	6.5	11.7	14.0	19.0	21.6	18.7	14.5	9.9	4.7	0.7
		11.2	13.6	17.1	23.3	27.9	35.5	35.5	35.6	32.2	28.5	16.7	9.4
	2004	3.9	5.1	8.3	12.2	16.2	20.1	20.3	18.1	13.7	10.2	7.7	2.4
		11.7	16.8	20.3	24.6	31.7	37.0	37.0	35.7	32.1	23.9	20.8	10.2
	2005	1.4	1.0	9.3	10.9	14.7	20.6	20.6	18.8	14.5	8.3	4.6	2.1
		9.4	9.1	21.3	24.5	28.5	36.3	36.3	35.2	33.4	26.8	18.5	15.1
Average of past 5 years	Min.(℃)	1.7	2.9	7.7	12.3	15.9	20.0	20.8	18.7	14.0	10.0	5.8	1.7
	Max.(℃)	10.4	12.7	20.1	25.1	30.6	36.5	36.5	35.7	28.5	26.7	19.0	10.5

(2) Hydrology

An inventory survey, carried out by the study team with engineers of Ministry of Water Resources, identified existing cross drainages and irrigation canals under and alongside the project road. In addition, the team confirmed flooded sections by rainwater crossing over the road and damaged sections by rainwater eroding around the road. Based on this result, locations of new cross drainages for the project road were confirmed.

Condition of each irrigation canal is as follows:

Irrigation canal at No.1 bridge site

Water depths through farming season between April and October are about 2.0 m but about 0.0 m to 1.0 m in other seasons. Design water capacity and flow speed are 12 m^3/sec and 0.8 m/sec respectively.

Irrigation canal at No.2 bridge site

At the present this canal is not in use. Assuming future use, design water capacity and flow speed are 12m^3/sec and 0.8m/sec respectively.

Irrigation canal at No.3 bridge site

Water depths in farming season are about 0.5m. There is no water in other seasons. Design water capacity and flow speed are 5 m^3/sec and 0.5 m/sec respectively.

Cross drainages of the project road (underground)

The existing cross drainages are in good condition to protect floodwater over the project road in spite of being rusted.

Irrigation canals alongside the project road

Structure of the irrigation canals is a pre-cast concrete type. Increasing irrigating water in the canals while farming season between April and October, the following problems are occurred partially:

- Water leaks from joints and broken parts.
- Water goes over top and floods on the project road.
- Floodwater rises about 20cm depth maximum from the road surface.

Kolkhoz cannot adequately maintain its properties, i.e. irrigation canals and pumps.

Considerations on hydrological conditions for design work are as follows:

- To consider a cost-effective rehabilitation method with certain quality and durability the flooded sections.
- To decide adequate locations of new cross drainages.

The design work upon the above-mentioned considerations is described in 2.2.1.8 “Concepts for designing road structures” and in 2.2.1.10 “Concept for Road Cross Culverts”.

(3) Topography and geology at the work site

The project road is located on hills of approximately 355m – 496m in height and its end point is located near the Pyandzh River.

The results of topographic surveys show that topographic conditions in/around the project site will not cause any problem in the road design work. The results of CBR tests and excavation on the existing road show its pavement structures. The CBR values in subgrade soil are 1.5 – 14.8 and the mean value is 4.7.

The consideration for the design work is as follows:

- Pavement cross section structure for the sections on soft subgrade should be considered to secure certain quality and cost-effective work method.

The design work upon the said consideration is described in 2.2.1.8 “Concepts for Designing Road Structures”.

Boring investigations were carried out at the bridge construction sites. The outline of boring results at the Nos. 1 and 2 bridge sites is as follows:

- Both Nos.1 and 2 bridge sites consist of only soft sand and soil (internal friction angle: ϕ 18° ～25°) down to 20m depth without certain bearing layers

The design work upon the above-mentioned considerations is described in 2.2.1.9 “Concepts for Bridge Design.

2.2.1.3 Consideration on Evironmental and Socio-Economic Condition

Items of environmental impacts, classified in the clearance level C (including impacts with close attention), resulted from scoping for Initial Environment Examination (IEE), and a new item of environmental impact resulted from the Basic Design are mitigated by the following measures:

Table 2.2.1.3-1 Measures for environmental impact mitigation

Results of scoping (classified "C")		Measures for environmental impact mitigation
Item	Consideration	
Soil erosion	Rainwater washing land soil out because of Land & forest development.	There is erosion at part of high filling slops in the desert area (STA.14+920). A new drainage (cross pipe) at effective location can protect the erosion. As planed, forests will not be cut basically.
Biology	Problems in Reproduction & dangerous species due to changes against growing up	Government of Tajikistan will carry out a study for environmental impact to animals and plants prior to the implementation of the project.
Resettlement	Land relocation for site possession	<u>General part of the project road</u> No land relocation is necessary because the existing road is enough wide for the rehabilitation with 16m in width. Some parts of the route, landowners will voluntarily remove existing walls made of concrete brocks as agreed with the Government and Stakeholders. <u>New construction part at the beginning point</u> Proposed route at the beginning point (STA 0+000 – STA 0+950 approximately 950m in distance) is located on cultivate lands (state properties) to improve road alignment. Therefore, land relocation is occurred in this part (refer to 2.2.1.7 "Concept for Improvement Route"). As discussed, Government of Tajikistan has agreed the land relocation. <u>New construction part at old railroad site</u> Proposed route (STA 2+350 – STA 3+100 approximately 750m in distance) is located on the old railroad site (state property) to improve road alignment. Land relocation in this part is occurred but confirmed to make use of the new route without any problem because the railroad is already abandoned.
Traffic and other facilities	Environmental impact caused by traffic jams and accidents against existing traffic systems and school children, etc.	<u>Situation around the kindergarten</u> Safe traffic facilities such as fences, signboards, humps and so on will be installed in order to save children of the kindergarten (left side at STA.2+400) from traffic accidents (refer to 2.2.2.6 "Road Service Facility Design"). <u>Situation around the market</u> 5m wide shoulder will be made along the market (right side at STA.3+200 - STA.3+300) in order to solve congestion in parking lots. Humps on the intersection of urban road (1) will be made (refer to 2.2.2.6 "Road Service Facility Design"). <u>Connecting to access roads</u> The project road is risen up about 40cm by road rehabilitation. Faulty gaps between the project and access roads will be solved with run-off slope of maximum 7% (refer to 2.2.2.6 "Road Service Facility Design").

Table 2.2.1.3-2 New measures for environmental impact mitigation resulted from Basic Design

Item	Consideration	Measures for environmental impact mitigation
Economic Activity	Reduction of Agricultural Production	The farmland is converted to road, at the start 950m, which causes the reduction of approx. 28,500m2 of farmland. But it is still negligible in comparison with the vast farm land remained. At present the farmland to be converted is not cultivated. After the construction of new road, for the farmland will be divided by the road, water pipe shall be lay crossing the road, in order to maintain the water supply/drainage both sides.

Measures to mitigate construction noise, tabulation, dust and so on are described in 2.2.4.2, (2) "Consideration for Environment". An acceptance of the National Committee, as a prerequisite for the implementation, will be given by the end of July 2006.

2.2.1.4 Road Standards and Design Criteria

(1) Road Standards and Design Criteria

Road standards have been decided based on the considerations for the project road as part of Asian Highway (AH7), road standards compatible to the on going rehabilitation for other parts of the same route and horizontal alignments to improve many sharp curves. Comparison with other standards is shown in Table 2.2.1.4-1 Government of Tajikistan has agreed these standards.

Table 2.2.1.4-1 Road geometric structures

Item \ Standard	Design criteria (Asian Highway)	ASSHTO (USA)	Specification (Former USSR)	The standards of the Project	Road standards (Japan)
Road classification	Standard for 2-lane road (class Ⅱ)	Local trunk road	Local trunk road / International highway (class Ⅲ)	2-lane road	Local trunk road (class III)
Daily traffic volume	—	400～1,500	1,000～3,000	Over 1,000	4,000
Design speed (km/h)	60～80	60～80	80～100	60	50～60
Lane width (m)	3.5	3.3 (*3.6*)	3.5	3.5	3.0
Shoulder width (m)	2.5	1.8 (*0.7*)	2.5	2.5	0.75
Total width (m)	12.0	10.2 (*8.6*)	12.0	12.0	7.5
Remarks	ADB trunk road (National highway No.384)	(*Italic values*) is applied to the approach road of Pyanj Bridge	Applied to not trunk road (including ADB)	—	—

(2) Design criteria for road pavement

The following design criteria for road pavement has been agreed with the Government of Tajikistan:

- Applicable standards: AASHTO Guide for Design of Pavement Structure 1993

Design conditions：

・Performance period	:	10 years from 2009 to 2018
・Traffic load (W_{18})	:	Cumulative 18kip ESAL value in the performance period
・Reliability（R）	:	R=80% (Z_R=-0.841, S_o=4.5)
・Performance criteria	:	Original serviceability P_0 = 4.2 (AASHTO road test result) Terminal serviceability P_t = 2.5 (AASHTO value of main route)
・Resilient modulus (MR)	:	MR is caluculated by formula of MR=1,500×CBR (CBR is the factor for basses)
・Layer coefficients	:	Asphalt concrete layer a = 0.39 BTB layer a = 0.30 Base-course (CBR=80) a = 0.135 Sub-base (CBR=30) a = 0.108
・Layer drain coefficients	:	Base-course m = 1.0 Sub-base m = 1.0

(3) Design criteria for box culverts and materials to be used

The following design criteria for box culverts has been agreed with the Government of Tajikistan:

- Applicable standards: Road specification (Japan)
- Live load: Axis load 10t (Russian/Asian highway standards)
- Re-bar: SD295 (yield point: 295N/mm^2)
- Concrete: f'$_{ck}$ = 25N/mm^2 (AASHTO class E)

2.2.1.5 Participation of Local Construction Companies

As a result of field surveys, labor work including materials and engineers can be procured mostly in Tajikistan. According to this information, a Japanese contractor to undertake the implementation procures materials and engineers in Tajikistan as many as possible. The local procurement, however, is not enough in varieties and volumes of materials and engineers. Foreign companies having their offices in Tajikistan may lease the Project materials and engineers, instead. Local contractors can participate mainly for supplying labor work due to lack of the local contractors' experiences and qualities. This means that a Japanese contractor shall organize working procedures by itself directly.

2.2.1.6 Ability of Local Agency for Management and Maintenance

Organizational structure of Ministry of Transportation (MOT) for management and maintenance of the roads in the jurisdiction is show in Figure 2.2.1.6-1.

Provincial offices of MOT are responsible to manage and maintain roads and transportation ways including public buses in each province. In Khatlon Province, Khatlon and Kuriyabu provincial offices have been established. The Khatlon provincial office is in charge of the project road for management and maintenance. Each provincial office administrates Road Management and Maintenance Corporation (RM&MC) in service for each district to manage and maintain roads and service facilities.

Organizational structures of both the Khatlon provincial office and RM&MC of Kumsangir District responsible to manage and maintain of the project road are show in Figure 2.2.1.6-2. RM&MC of Kumsangir District is in charge of national highways and district roads, 73km and 183km in distances, respectively. Ministry of Finance bears the maintenance budget of national roads, upon the application by MOT, and Local government body bears the maintenance cost of provincial roads. The maintenance and management can undertake a small scale repairing such as potholes and so on. Nevertheless, a large scale maintenance cannot be managed by these offices due to lack of both budget and maintenance equipment, as usual. Tables 2.2.1.6.1 shows the budget and expense of MOT in last three years, and Table 2.2.1.6-2 shows annual budget, expenses for national roads and extra-expenses for the project road.

Table 2.2.1.6-1 Maintenance budget and expenses of MOT

Unites: Somni (US Dollar)

Year	Budget	Expense
2003	4,950,000 (1,546,875)	7,950,000 (2,484,375)
2004	12,000,000 (3,750,000)	13,500,000 (4,218,750)
2005	18,100,346 (5,656,358)	15,640,553 (4,887,672)

Unit: 1 US$.=3.2 Somoni (Dec. 2005)

Table 2.2.1.6-2 Maintenance budget, expenses and extra-expenses for the project road bone by RM&MC of Kumsangir District

Unites: Somni (US Dollar)

Year	Budget	Expense	Expense for the project road
2003	35,000 (10,938)	41,000 (12,813)	8,000 (2,500)
2004	75,000 (23,438)	104,000 (32,500)	31,000 (9,688)
2005	180,000 (56,250)	280,000 (87,500)	180,000 (56,250)

Unit: 1 US$.=3.2 Somoni (Dec. 2005)

· MOT pays deficit between the budget and expense, upon the application by RM&MC.
· In 2005, MOT once paid the whole budget to improve all the way due to the use of government officials.

As ADB project ponders maintenance a pending problem, it is recommended that maintenance manuals and technical support be considerable after this.

In future, a certain maintenance system including reinforcement of machinery should be organized urgently in Tajikistan.

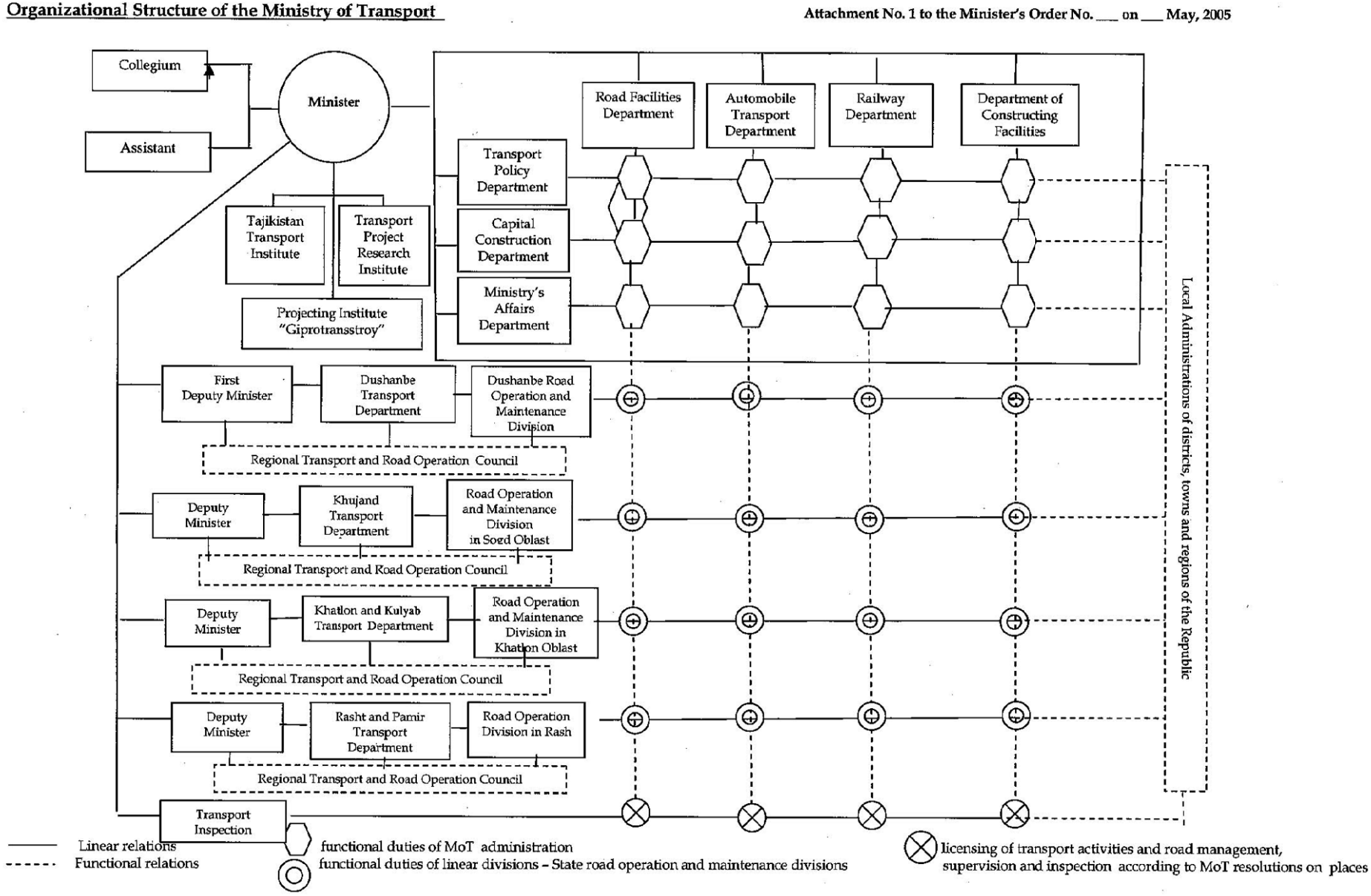


Figure 2.2.1.6-1 MOT organization

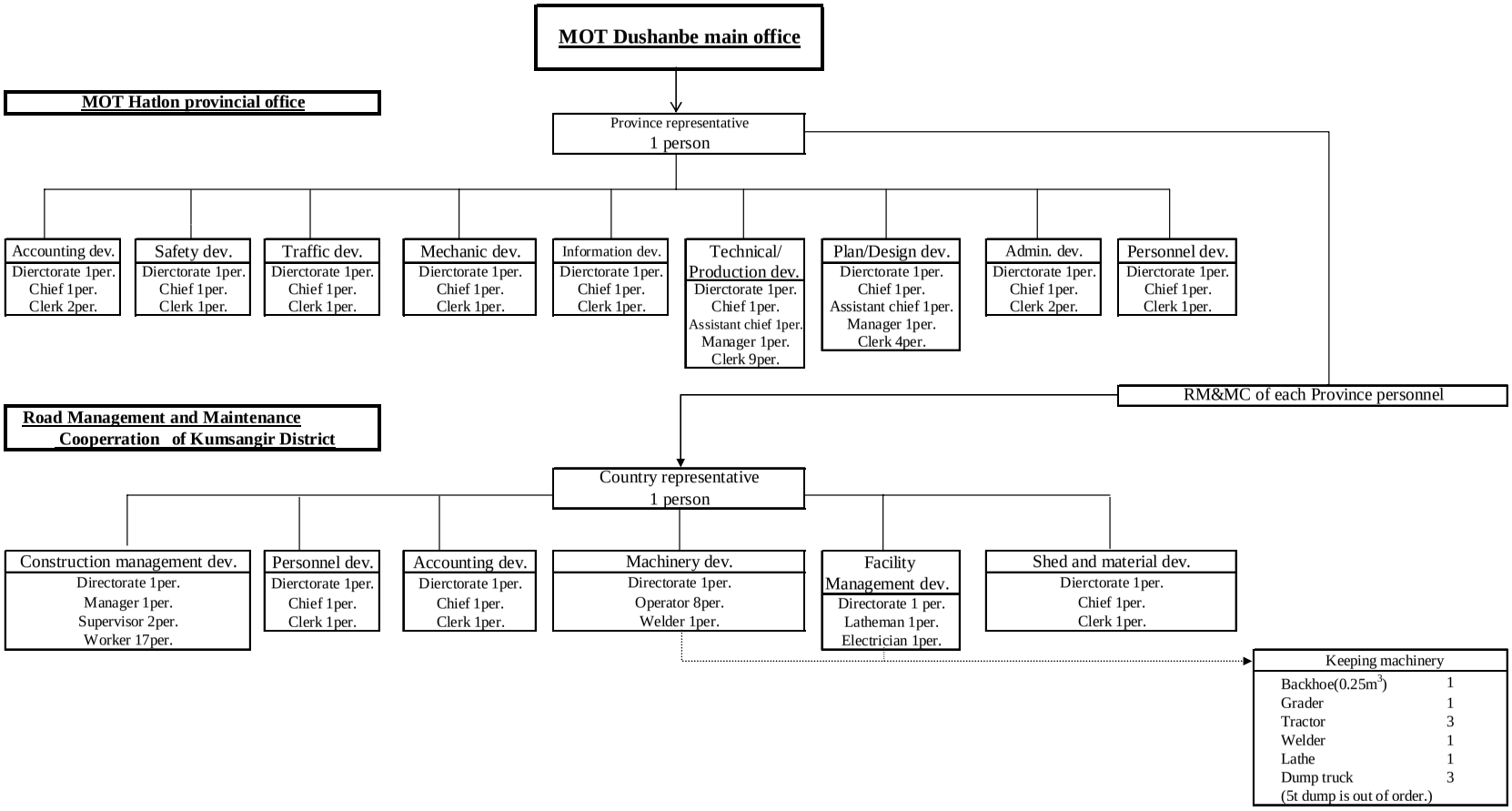


Figure 2.2.1.6-2 Organization structure of both the Khatlon Provincial Office and RM&MC of Kumsangir District

2.2.1.7 Concept for Improvement Route

Main route

Rehabilitation route basically follows the existing route.

Horizontal alignment of the beginning part is drastically improved. The horizontal alignment is based on the road geometric structure standards (refer to 2.2.2.2 (1) "Road geometric standards". Relocation is not occurred because the new route is planed on cultivated lands of state properties.

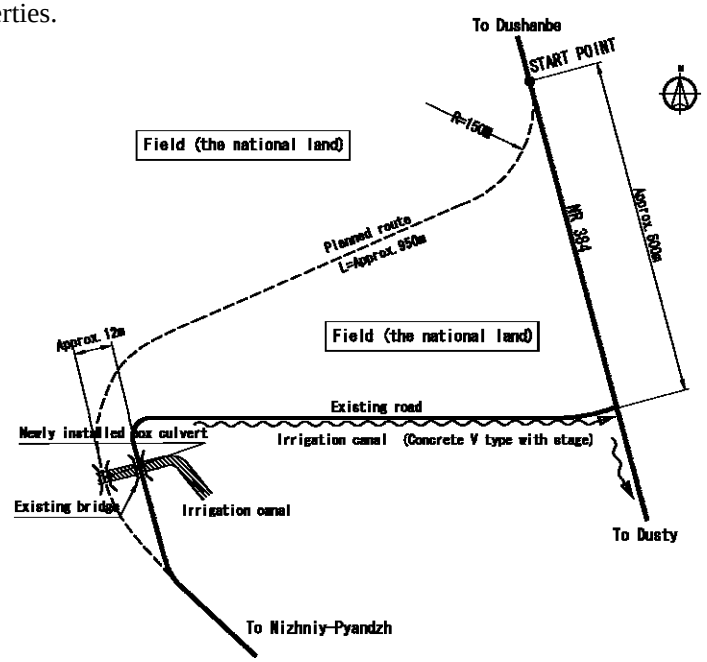


Figure 2.2.1.7-1 Horizontal road alignment of the beginning part

Figure 2.2.1.7-2 shows another new route on the old railroad to improve the horizontal alignment in order to make the straight line. No relocation is occurred as well.

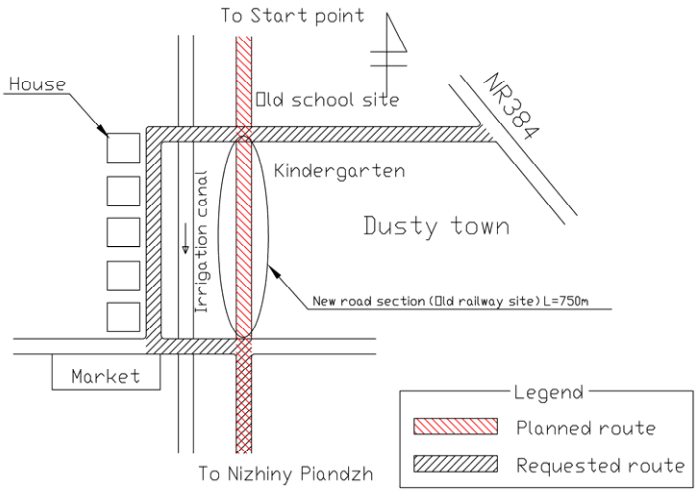


Figure 2.2.1.7-2 Horizontal road alignment on old railroad

According to a meeting between the basic design study team and the US Aid team, the end point of the project road has agreed with the end point of the access road leading to the Nijiny Pyandzh Bridge. Horizontal and vertical alignments around the end point conform to the existing road.

Urban district road in Dusty Town

For the urban district road (1), three alternative routes A, B and C are considerable as shown in Figure 2.2.1.7-3 The route A has been selected because of the following reasons:

The route A is the heaviest traffic among them.

Side drains of the route A function well.

Government of Tajikistan recommends the route A.

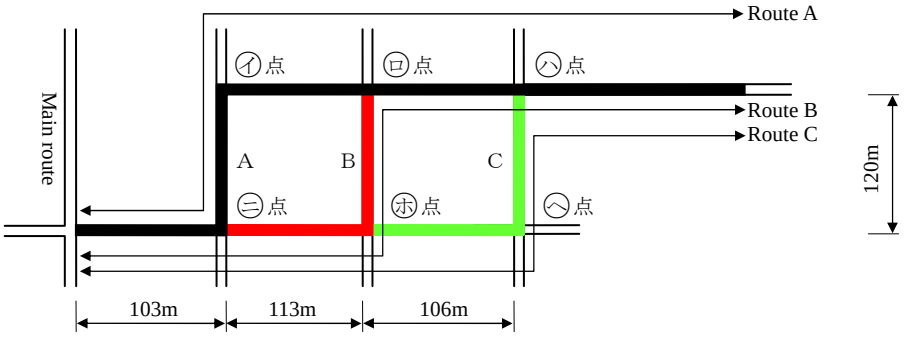


Figure 2.2.1.7-3 Alternative routes of urban district road in Dusty Town

Table 2.2.1.7-1 Comparison of alternative routes for urban district road (1)

Item		Route A	Route B	Route C
Total distance (m)		1,948m	1,955m	1,957m
Condition in crank	Lane width (m)	9.8m	9.4m	9.5m
	Side walk	Both sides are partially broken.	Both sides are continued	Both sides are continued
	Side gutter	Continuous but partially unsupported gutters	Continuous but partially unsupported gutters	Many parts are buried with mud
	Street tree	Few	Many	Many fine trees
	Utility	Electric poles/ sewer pipes (manhole)	Electric poles	Electric poles
	Pavement condition	Partially bad condition	Not bad	Not bad
	Traffic volume	The heaviest traffic among 3 routes	Lighter than route A	The same as route B
	Houses along the road	Residences/ factories	Residence area	Residence area
	Traffic signal	N/A	㉡ ㉢ Installed at the intersection	㉠、㉣ Installed at the intersection
	Landscape	The worst among 3 routes	Satisfactory	The best
Remarks		Requested by Kumsan District	Requested to add between ㉠ and ㉢ points	Requested to add between ㉠ and ㉣ points
Evaluation		○	△	△

2.2.1.8 Concept for Road Structure

Main route

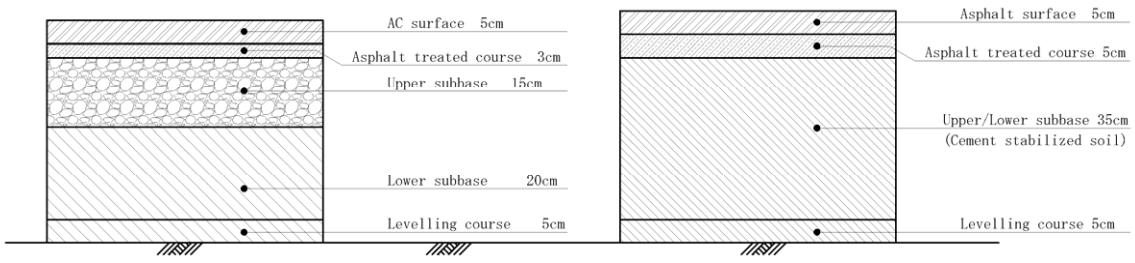
Pavement structure is selected upon conditions of quality specified, good site execution and cost-effective. A pavement structure is generally consist of the following bases:

- Lower base (crusher-run),
- Upper base (mechanical stabilized gravel),
- Asphalt treatment base (if necessary), and
- Surface course (asphalt concrete).

However, the following pavement structure is applied to the Project because cost of gravel procurement is high due to far gravel deposit site.

Sand mostly good quality can be procured from gravel deposit areas in desert along the project road. Hence, sand-cement mixture is to make strong enough as the same as the general lower base (CBR value). The mixture can be used for both lower and upper bases together like one base.

For main route, strength of the existing road bases was comprehensively decided by testing the strength up to existing surface course with CBR values of subgrade and bases in results of geological investigation. Except seriously damaged parts, new bases can be constructed on the existing surface course. It is expected that this pavement design can be apply to the Project to decrease 280 million Yen out of the whole budget. Comparison of both road structures is shown as follows:



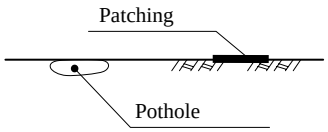
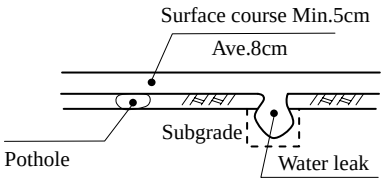
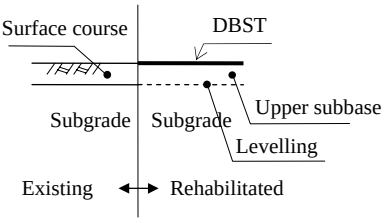
General pavement structure Adopted pavement structure

Figure 2.2.1.8-1 Comparison of both road structures for main route

Urban district road in Dusty Town

Considering appropriate scale, quality and following maintenance as Grant Aid Scheme, the alternative plan 3 among the following three alternative plans shown in Table 2.2.1.8.1 is selected.

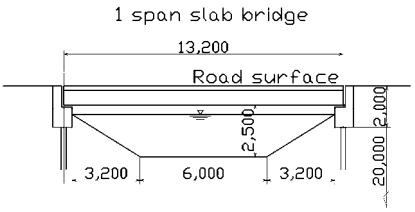
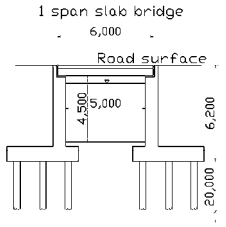
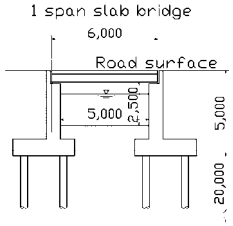
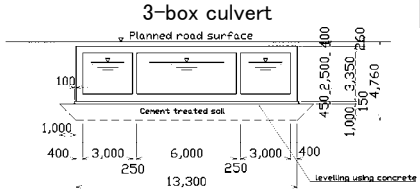
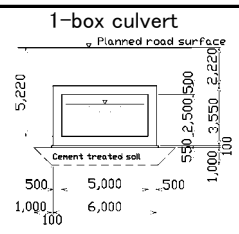
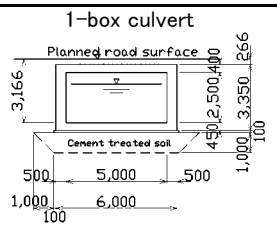
Table 2.2.1.8-1 Comparison of rehabilitation methods for urban district road

Alternative	Pavement structure	Characteristic & work cost
Alternative 1: Only to patch potholes and seriously damaged parts of the existing road.		Work cost is reasonable: however, deformation is remaining: moreover, durability is the lowest.
Alternative 2: After repairing/ patching potholes, 8 cm surface overlay is to be done for only traffic lanes of 7.0m wide. Approximately 10 Cavities caused by leaking drinking water are to be reconstruct from subgrade.		Deformation is almost fixed and durability is secure. Work cost is high.
Alternative 3: Removing existing surface course, upper base is constructed and low cost pavement (DBST) of 7m wide is done in order to fix deformation. The cavities are reconstructed as well as the alternative 2.Reparing		Deformation can be fixed but durability is not secure. Due to the formation of road base, AC overlay is possible in future, and the cost is cheap.

2.2.1.9 Concept for Bridge Types

Comparison of bridge rehabilitation methods is shown in Table 2.2.1.9-1 Box culvert structure can be selected because of advantages to make work period shorter and project budget lower. No.1 bridge is new construction without removal the existing bridge because of the new route.

Table 2.2.1.9-1 Comparison of bridge rehabilitation methods

		Structure	Characteristic	Work period	Cost	Evaluation
Bridge	No.1 Br.		(Structural characteristic) ・Stable due to be 1 span simple bridge ・Large scale foundation in case of soft soil foundation ground (Work characteristic) ・No necessity of river relocation during the work ・Work period is long due to the long pile work	Longer than the work period of box culvert	Higher than the cost of box culvert	△
	No.2 Br.					
	No.3 Br.					
Box Culvert	No.1 Br.		(Structural characteristic) ・Stable against deformation and displacement due to rigid frame ・Stable against settlement due to small contact pressure (Work characteristic) ・Necessity of available river replacement ・Normal work period as same as RC structure	Short	Low	○
	No.2 Br.					
	No.3 Br.					

2.2.1.10 Concept for Rehabilitation of Road Cross Culverts

Existing cross culvers are mostly in good condition. Therefore, rehabilitation of cross culverts is only to extend pipes due to widening. Rehabilitation method of cross culverts can be imagen as follows:

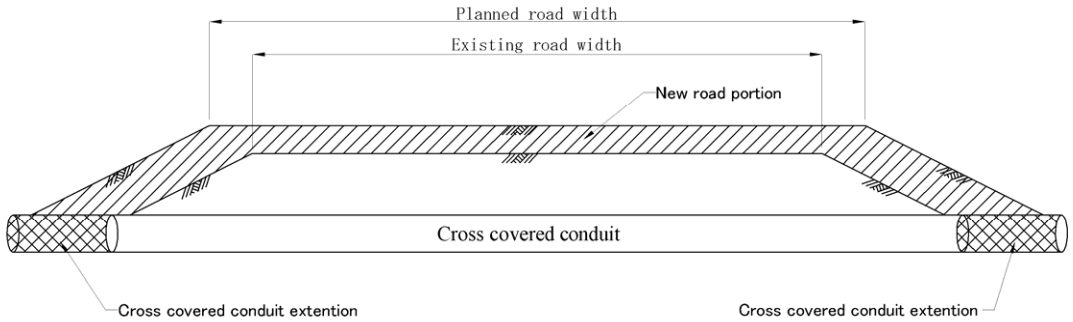


Figure 2.2.1.10-1 Rehabilitation method of cross culverts

2.2.1.11 Concept for Construction Method and Work Period

Technology and construction method generally used in not only Japan but also most foreign countries are adopted in order to construct high quality road. Design documents and specifications describe procedures and standards for material and work progress testing to secure qualities required. Considering not only safety for residents around the project site and for construction workers of the Project but also environmental impact for surroundings of the project site, construction work is always executed.

Cold season in December and January mentioned in 2.2.1.2 “Consideration on Natural Condition” shall be considered to decide work period. Consideration about the cold season leads the following opinions:

- Tajikistan usually does not execute construction work in the cold season.
- ADB project also stops asphalt work in the period between middle of December and later part of January.
- MOT does not accept to execute asphalt work on condition in cold temperature below 5 degrees Cels. according to the Tajikistan Standards, SNIP.

Based upon the above opinions, work schedule of the Project is considered to avoid the cold season for site execution as much as possible. For quality control, asphalt work should stop in the period between middle of December and later part of January from a point of view of ADB project.

Implementation schedule is divided into two terms as follows:

- First term includes main route of 8.29km and urban district road of 3.62km.
- Second term includes main route of 15.36km.

Work periods are set up as follows:

- Design review and tender: 1st term is 4.0 months and 2nd term is 4.0 months
- Site execution: 1st term is 11.5 months and 2nd term is 15.5 months

2.2.2 Basic Plan

2.2.2.1 General Plan

General plan referred to 2.2.2.1 “Grant Aid Scheme” is as follows:

- Main route: 23.65km
  New construction: STA.0+000～STA.0+950（0.95km）and STA.2+350～STA.3+100（0.75km）Total 1.70km
  Rehabilitation: STA.0+950～STA.2+350（1.40km） and STA.3+100～STA.23+650（20.55km）Total 21.95km
- Urban road in Dusty Town: Urban road (1) 1.950km、Urban road (2) 1.670km Total 3.62km
  Rehabilitation: 3.62km

Horizontal alignment referred to 2.2.1.7 “Concept for Improvement of Existing Road” is as follows:

- Horizontal alignments of the main route are basically on the same route of the existing road.
- Horizontal alignments of the new routes for the parts around the beginning point and on the old railroad are constructed.

Vertical alignment is not drastically changed but the minor changes are as follows:

- Road surfaces are risen about 0.4m up because of asphalt structure resurfacing on the existing road surfaces.
- Part of flooding on road surfaces, at the present, is risen 0.6m up, i.e. 0.2m higher than normal overlays.
- Difference of 0.2m between normal and flooding parts is smoothly run-of.

Road section structure referred to 2.2.1.8 “Concept of Road Structure” is as follows:

- Lower base structure of the main route is made of the mixture with sand and cement.
- Road structure of the urban district road in Dusty Town is constructed as the same structure of the main road after the existing road surface course is removed.
- Road surface course of urban district road in Dusty Town is low cost road pavement (DBST).

Road standards and design criteria referred to 2.2.14 “Road Standards and Design Criteria” are

as follows:

- Road geometric structure and design criteria

Table 2.2.2.1-1 Road geometric structure and design criteria

Items \ Standard	Adopted plan
Traffic Lane	2-lane
Basic traffic capacity (Vehicle/day)	Over 1,000
Design speed (km/h)	60
Lane width (m)	3.5
Shoulder width (m)	2.5
Total width (m)	12.0

- Design criteria of box culverts

  Standards：Road Specifications (Japan)

  Live load: axis load 10t (Russian standards for Asian Highway)

  Re-bar：SD295(yield point: 295N/mm^2)

  Concrete: f'_{ck} = 25N/mm^2 (AASHTO Class E)

Map of general plan is shown in Figure 2.2.2.1-1.

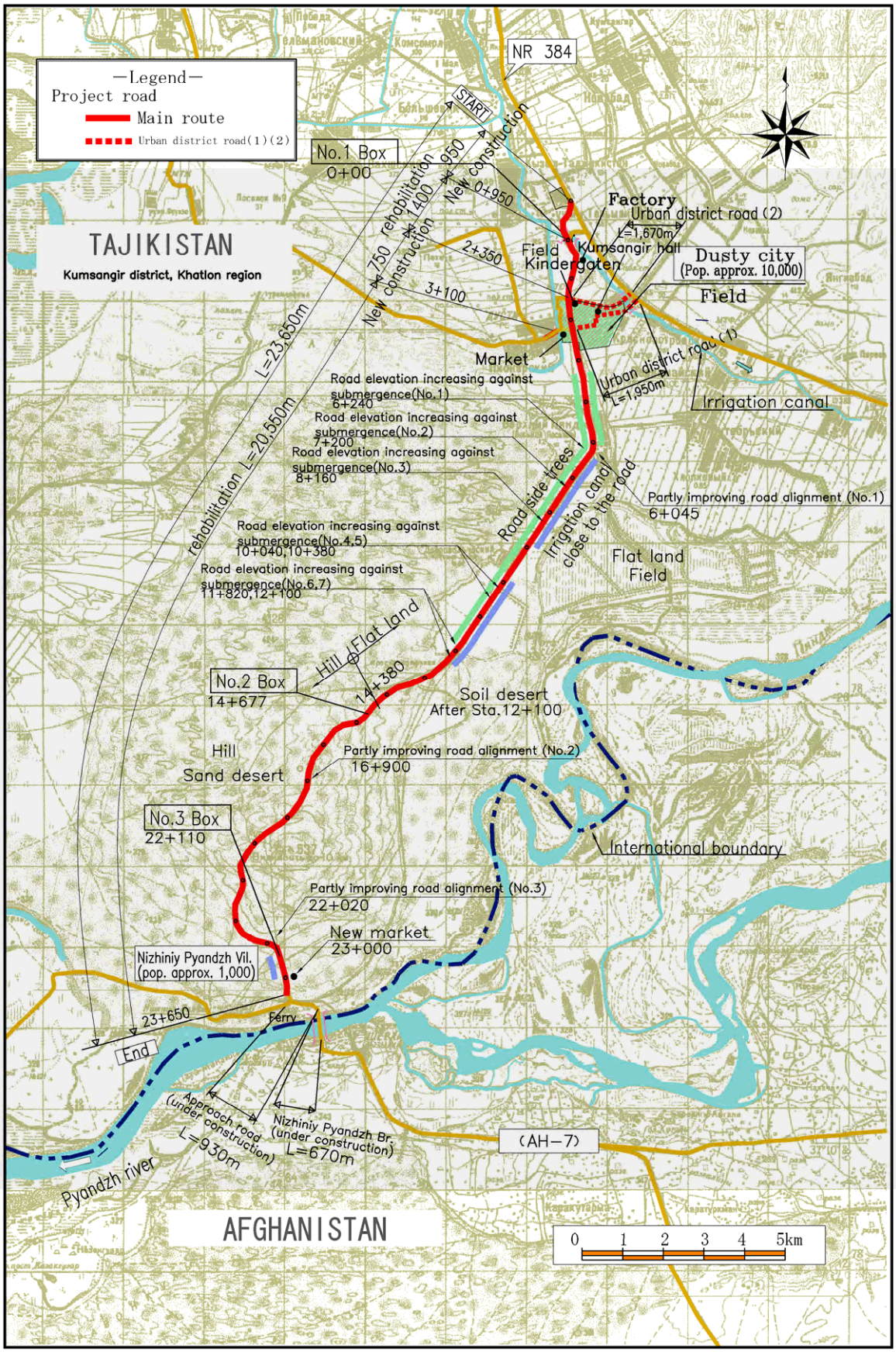


Figure 2.2.2.1-1 General plan map

2.2.2.2 Road Design

(1) Road geometric structure

Based on the Road Standards in 2.2.1.4 “Road Standards and Design Criteria”, as well as, the considerations on AASHTO and SNIP, Standards of road geometric structure adopted for this basic design are as follows:

- Design speed: 60km/h
- Traffic lanes: 2 lanes
- Lane width: 3.5m
- Shoulder width: 2.5m
- Lane cross slope: 2%
- Shoulder cross slope: 4%
- Maximum cant (e): 4%
- Minimum horizontal curve radius: 150m
- Maximum vertical slope: 9.9%

(2) Cross sectional structure

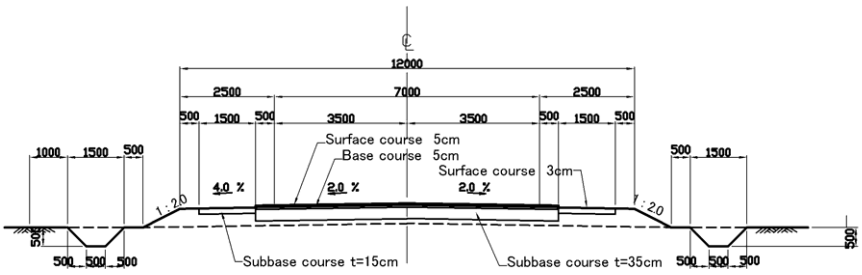
Typical cross sections based on the design concept and geometric structure standards are shown in Figures 2.2.2.2-1 and 2.2.2.2-2.

(3) Horizontal alignment

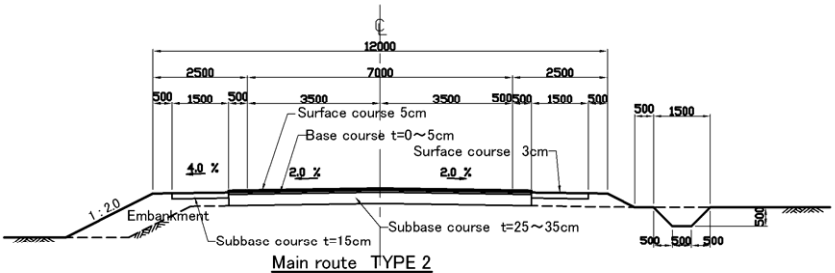
Horizontal road alignments basically following the existing road are designed in addition to alignment elements based on geometric structure standards. New construction sections also satisfy the geometric structure standards. In the section where curve radius to be equal or less than 250 to 1000m, inside carriage curve line is to be widened by 0.5m, in conformity with the Standards of the former Soviet Union Sections, respecting traffic safety, with reduction of the shoulder by 0.5m in the same section, that is, the total width of the road being maintained the same. Sections that the alignments are changed are as follows:

Table 2.2.2.2-1 Sections of alignment and contents changed

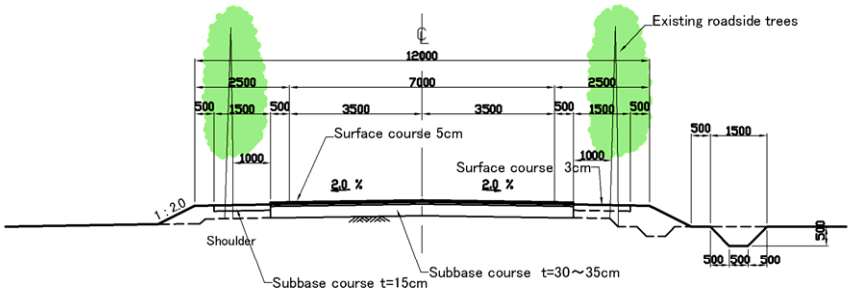
Section	Length(m)	Contents changed
STA. 4+500～STA. 4+560	60	Shift the center line 0.12m to avoid cutting roadside tree
STA. 4+600～STA. 4+700	100	Shift the center line 1.00m to avoid cutting roadside tree
STA. 4+980～STA. 5+060	80	Shift the center line 0.25m to avoid cutting roadside tree
STA. 5+100～STA. 5+180	80	Shift the center line 0.40m to avoid cutting roadside tree
STA. 5+300～STA. 5+500	200	Shift the center line 1.50m to avoid cutting roadside tree
STA. 5+982～STA. 6+105	123	Change Existing R=110m to specified R=150m
STA. 7+360～STA. 7+460	100	Shift the center line 0.60m to avoid cutting roadside tree
STA. 7+720～STA. 7+980	260	Shift the center line 1.00m to avoid cutting roadside tree
STA. 8+320～STA. 8+420	100	Shift the center line 0.50m to avoid cutting roadside tree
STA. 9+580～STA. 9+880	300	Shift the center line 1.00m to avoid cutting roadside tree
STA.16+838～STA.16+973	135	Change Existing R=120m to specified R=150m
STA.21+969～STA.22+066	97	Change Existing R=70m to specified R=150m



Main route TYPE 1
Sta.0+00～Sta.0+950 (New construction : Field)
Sta.2+350～Sta.3+100 (New construction : Old railway site / Wasteland)

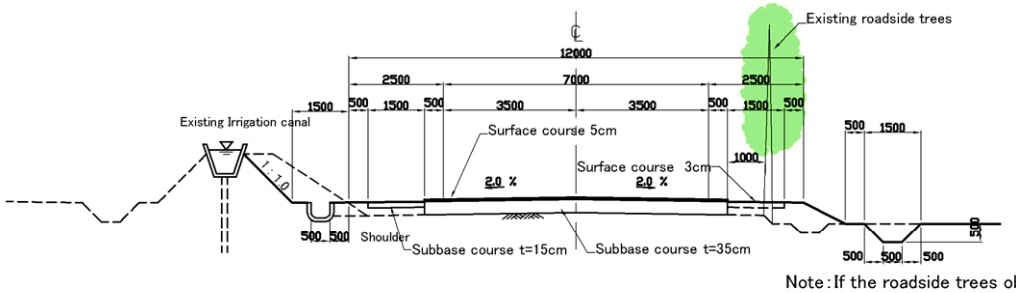


Main route TYPE 2
Sta.0+950～Sta.2+350 (Typical flat land section : Field／Factory)
Sta.3+100～Sta.12+200 (Typical flat land section : Field／Private house)
Sta.22+000～Sta.23+650 (Typical flat land section : Field／Wasteland)



Main route TYPE 3 (Both side existing roadside trees)
Sta.4+500～Sta.5+200 (Flat land)
Sta.9+000～Sta.9+300 (Flat land)

Note : If the distance between trees is shoter than carrige way width, one side tree shall be relocated or cut on Tajik side obligation.



Note : If the roadside trees obstacles, they shall be relocated or cut on Tajik side obligation.

Main route TYPE 4
Sta.10+080～Sta.11+780 (Flat land)
(Protecting the embankment for irrigation canal and existing roadside trees)

Figure 2.2.2.2-1 Typical cross sections (Types 1 to 4 for main route)

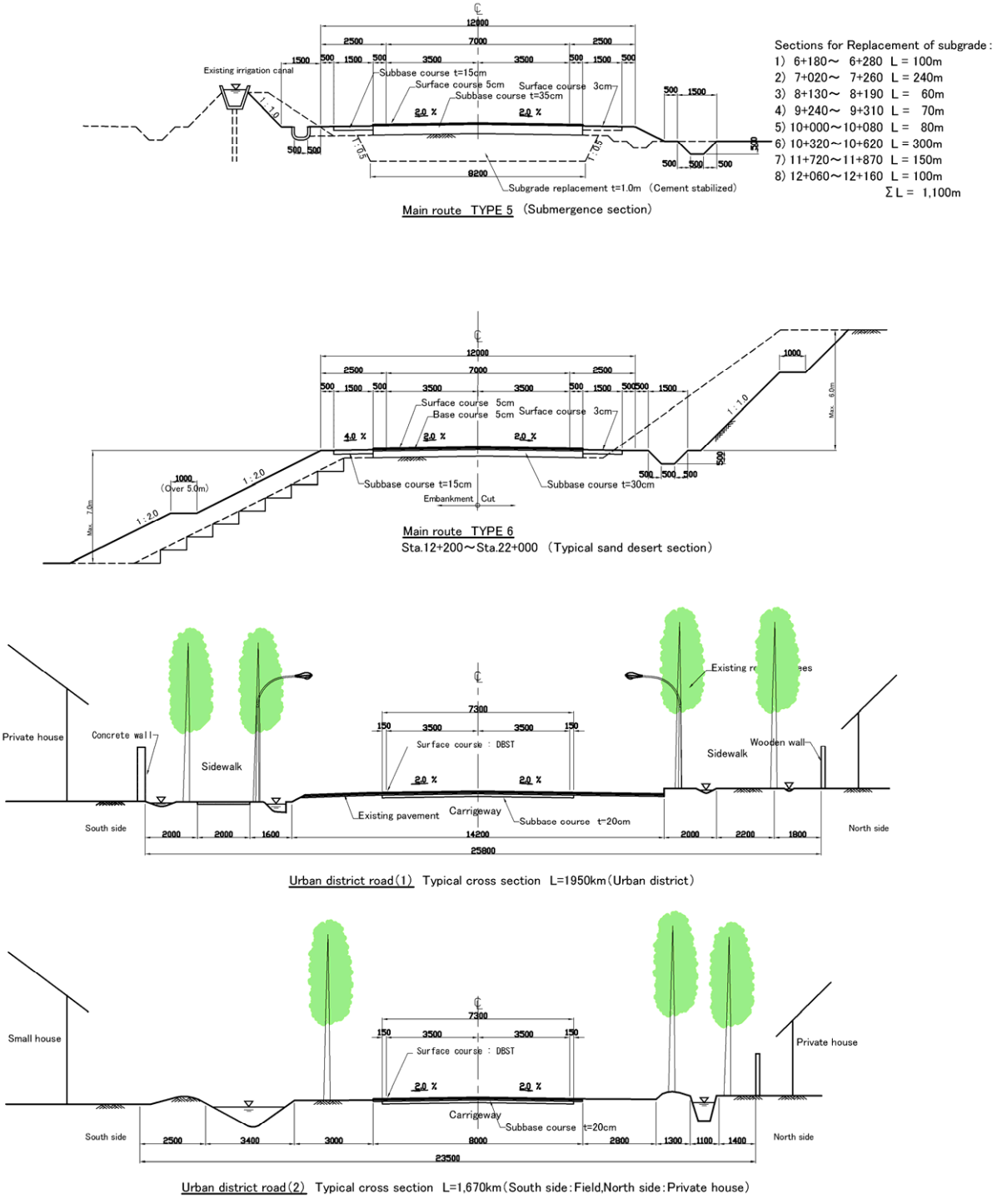


Figure 2.2.2.2-2 Typical cross sections (Types 5 and 6 for main route, urban district roads (1) & (2))

(4) Vertical alignment

Road vertical alignments are designed based on the concept of asphalt structure resurfacing to be risen on the existing road surface. Vertical alignments of the flooding areas in farming season are improved. The vertical alignments are as follows:

Table 2.2.2.2-2 Sections of improved vertical alignments

Section	Distance (m)	Max. rising up (m)
STA. 6+180～STA. 6+300	120	0.75
STA. 7+060～STA. 7+280	220	0.70
STA. 8+060～STA. 8+220	120	0.68
STA. 9+960～STA.10+100	140	0.71
STA.10+300～STA.10+420	120	0.70
STA.10+640～STA.10+840	200	0.79
STA.12+040～STA.12+140	100	0.68

(5) Pavement design

According to AASHTO Guide for the Design of Pavement Structures 1993, USA, pavement design shall be adopted as the same Standards as the constructed part by ADB and the approach road to the international bridge.

a) Design conditions

Conditions for the pavement design are as follows:

・Performance period : 10 yeas from 2009 to 2018

・Traffic load (W_{18}) : Cumulative 18kip ESAL value in performance period

・Reliability（R） : R=80%（Z_R = -0.841 、S_0 = 0.45）

・Performance criteria : Original serviceability P_0 = 4.2 （AASHTO road test result）
Terminal serviceability P_t = 2.5 (AASHTO value of main route)

・Resilient modulus（MR） : MR is caluculated by formula of MR=1,500xCBR (CBR is the factor for bases)

・Layer coefficients : Ashalt concrete layer a = 0.39
BTB layer a = 0.30
Base-course（CBR=80） a = 0.135
Sub-base（CBR=30） a = 0.108

・Layer drain coefficients : Base-course m = 1.0
Sub-base m = 1.0

b) Traffic load (W_{18})

Traffic load (W_{18}) is the same load value as the access road of the Nijiny Pyandzh Bridge Project (the inauguration in 2005) connecting to the end point of the Project.

Traffic volume after the bridge inauguration：1,000 vehicles/day

Percentage of heavy vehicles：7%→1,000×7%＝70 vehicles/day

Cumulative 18kip ESAL value of heavy vehicles：0.931

Therefore,

W_{18}＝70／2×0.931×365days×10 years＝118,940

c) Required pavement structure numbers

Required pavement structure numbers (SN) are calculated by basic formula for the directional pavement in AASHTO Guide. Results of the calculation are as follows:

Table 2.2.2.2-3 Required pavement structure numbers (SNs)

Section / Condition	1	2	3	4	5	6	7
Cumulative 18kip ESAL value (W_{18})	118,940						
Standard deviation (Z_0)	-0.841						
Residual (S_0)	0.45						
Deference between original and terminal serviceability ($\triangle PSI=P_0-P_t$)	1.7						
Resilient modulus (MR)	4.500	7,800	4,500	13,050	8,850	5,700	6,150
CBR	3.0	5.2	3.0	8.7	5.9	3.8	4.1
Required pavement structure numbers (SN)	2.755	2.288	2.755	1.819	2.121	2.515	2.442

Sections in this table:

1 : STA. 0+000～STA. 0+950
2 : STA. 0+950～STA. 2+350
3 : STA. 2+350～STA. 3+100
4 : STA. 3+100～STA. 7+000
5：STA. 7+000～STA.14+000
6：STA.14+000～STA.22+000
7：STA.22+000～STA.23+650

d) Pavement structures

As mentioned in 2.2.1.8 “Concept for Road Structure”, structure made of stable sand-cement mixture is adopted because sand is procurable in the project area instead of high cost grave. Pavement structures each section are shown as follows:

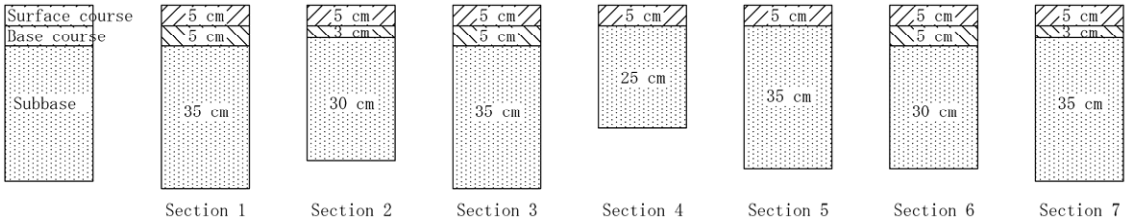


Figure 2.2.2.2-3 Pavement structures

Pavement structure indexe each section is as follows:

Table 2.2.2.2-4 pavement structure indexes

	Layer indexe (a)	Dranage indexs (m)	Sections 1,3		Section 2		Section 4	
			Thickness (cm)(D)	SN=aDm	Thickness (cm)(D)	SN=aDm	Thickness (cm)(D)	SN=aDm
Asphalt surface course	0.390	—	5	0.768	5	0.768	5	0.768
Asphalt base course	0.300	—	5	0.591	3	0.354	0	0
Sub-base course	0.108	1.0	35	1.488	30	1.276	25	1.063
Total	—	—	45	2.846 >2.755	38	2.398 >2.288	30	1.831 >1.819

	Layer indexe (a)	Dranage indexs (m)	Section 5		Section 6		Section 7	
			Thickness (cm)(D)	SN=aDm	Thickness (cm)(D)	SN=aDm	Thickness (cm)(D)	SN=aDm
Asphalt surface course	0.390	—	5	0.768	5	0.768	5	0.768
Base-course	0.300	—	0	0	5	0.591	3	0.354
Sub-base	0.108	1.0	35	1.488	30	1.276	35	1.488
Total			40	2.256 >2.121	40	2.634 >2.515	43	2.610 >2.442

Pavement structure index every section is higher than the required pavement structure numbers.

(6) Confirmation of strength of cement stabilized base

The CBR test has been carried out to the filling material to be utilized for cement stabilized base, which was sampled from the planned borrow pit and mixed with cement by 4% as described in the plan under the present project. The followings are the test method and the result :

a) Employed Standards

ASTM D1883

Tamping of 56 times for each layer (5 layers) will make compaction 100 %.

b) Test order

At 25 and 56 tamping (100% of compaction), the compaction test has been performed and measured the density. Based upon this dry density, estimated the dry density at the compaction degree of 95%, and tested the CBR of the cement stabilized material by 4%, with the required numbers of tamping. Curing was made 3 days in air and 4 days in water.

c) Result

The result of CBR test was 90%, which is far beyond the target CBR value of 30%.

d) Consideration

Though the result of the test is three times higher than the target value, it is not recommendable to reduce the mixing ratio of cement from 4%, because of weakness against shear force, and no recovery expected once destroy took place, which were brought from mono-size sand to be adopted, and non-uniformity of field mixing etc, in terms of maintaining long durability.

In addition to the test already carried out, prior to the commencement of construction, the same test should be performed again.

2.2.2.3 Box Culvert Design

Three bridges on the project road are chosen as a box culvert type instead of a bridge type (refer to 2.2.1.9 “Concept for bridge type”). The bridges are rehabilitated as follows:

Bridge No.1（STA.0+744）

A new box culvert is constructed 12m upper stream from the existing bridge (not removed) as route is changed.

Bridge No.2（STA.14+677）

A new box culvert is constructed in the canal 150m away from the existing bridge to the beginning point. The existing bridge is removed and the canal is filled back.

Bridge No.3（STA.22+110）

A box culvert is constructed instead of the existing bridge.

The canal section and design water level of the above irrigation canals are specified by Ministry of Water Resource (MOWR). The inner section of box culvert is applied to the specifications of MOWR. The design conditions are as follows:

Design live load： Axis load 10t（Tajikistan Standards）

Design water level： Design water level of the irrigation canal

Clearance beneath girder： 0.5m

Cross sections of the box culverts are as follows:

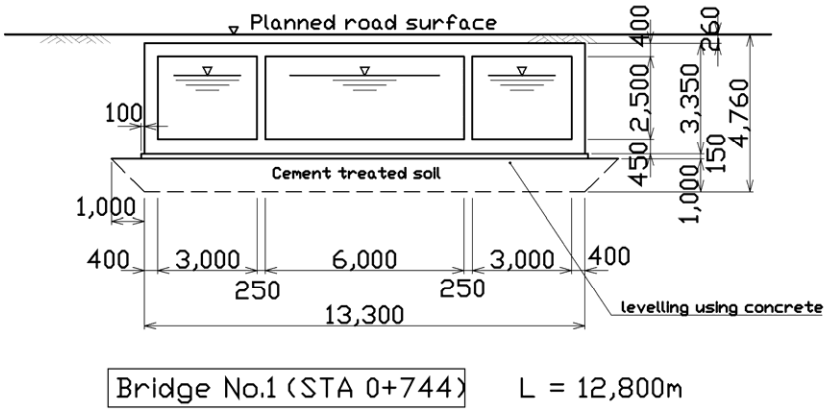


Figure 2.2.2.3-1 Box culvert cross section（Bridge No.1）

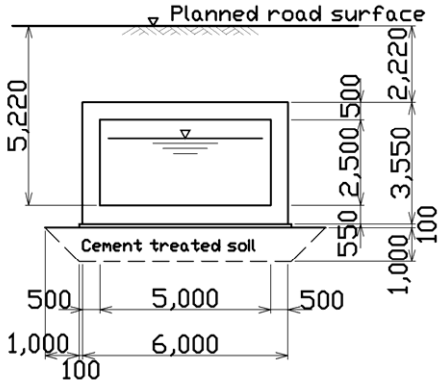


Figure 2.2.2.3-2 Box culvert cross section（Bridge No.2）

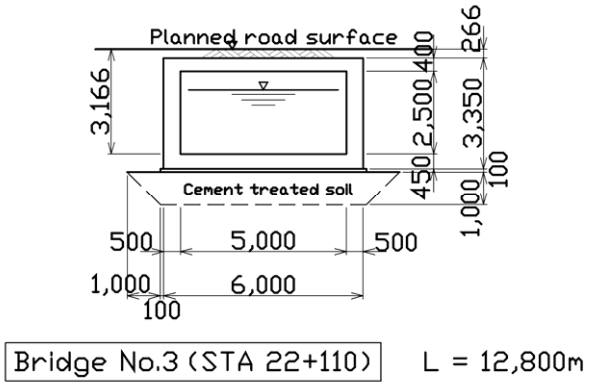


Figure 2.2.2.3-3

Figure 2.2.2.3-3 Box culvert cross section（Bridge No.3）

2.2.2.4 Road Cross Culvert Design

As mentioned in 2.2.2.1.10 “Concept of Road Cross Culvert Rehabilitation”, existing cross culverts are to extend. New culverts are constructed at necessary parts to drain rainwater. Culverts improved are listed as follows:

Table 2.2.2.4-1 Improved culverts

NO	Chainage	Material and shape	Purpose			Installation				NO	Chainage	Material and shape	Purpose			Installation			
			Irrigation		Rain	New	Replac-ement	Exte-nsion	Use				Irrigation		Rain	New	Replac-ement	Exte-nsion	Use
	STA		Watering	Dewatering	Drainage						STA		Watering	Dewatering	Drainage				
1	0+097.5	RC−φ700	○			○				40	9+490.0	RC−φ500		○		○			
2	0+221.3	RC−φ450	○			○				41	9+840.0	RC−φ700	○					○	
3	0+296.0	RC−φ500		○		○				42	10+040.0	RC−φ500		○		○			
4	0+368.5	RC−φ450	○			○				43	10+380.0	RC−φ500		○		○			
5	0+604.4	RC−φ500	○			○				44	10+520.0	RC−φ500		○		○			
6	0+673.0	RC−φ500		○		○				45	10+623.2	RC−φ230	○					○	
7	0+700.0	RC−φ500	○			○				46	11+120.0	RC−φ200	○					○	
8	0+744.0	3*6*3*2.5	○			○	Box-No.1			47	11+341.0	RC−φ500	○					○	
9	0+930.0	RC−φ500			○	○				48	11+541.0	SP−φ210	○					○	
10	2+210.0	RC−φ500			○	○				49	11+627.6	SP−φ160	○					○	
11	2+220.0	SP−φ450	○					○		50	11+820.0	RC−φ500		○		○			
12	2+592.0	RC−φ500			○	○				51	11+992.8	RC−φ200	○					○	
13	3+080.0	RC−φ500			○	○				52	12+100.0	RC−φ500		○		○			
14	3+130.0	SP−φ500			○			○		53	12+217.3	RC−φ900		○				○	
15	3+916.8	RC−φ400	○					○		54	13+067.7	RC−φ350			○			○	
16	4+481.6	SP−φ150	○					○		55	13+523.5	RC−φ1200			○			○	
17	4+802.3	SP−φ150	○					○		56	14+677.0	RC−5.0*2.5	○			○	Box-No.2		
18	5+177.2	RC−φ500	○					○		57	14+730.0	RC−φ1000			○			○	
19	5+280.0	RC−φ500	○			Siphon			○	58	14+827.5	3@6.0				Removal of the bridge			
20	5+818.4	RC−φ300	○					○		59	14+945.0	RC−φ1000			○			○	
21	5+818.9	RC−φ400	○					○		60	15+080.0	RC−φ1000			○	○			
22	6+196.7	RC−φ800	○					○		61	15+890.0	RC−φ1000			○			○	
23	6+204.6	RC−φ400	○					○		62	16+152.0	RC−φ1000			○			○	
24	6+240.0	RC−φ500		○		○				63	16+677.0	RC−φ1000			○			○	
25	6+892.5	RC−φ1000	○					○		64	17+165.0	RC−φ1000			○			○	
26	6+906.5	SP−φ400	○					○		65	17+580.0	RC−φ1000			○	○			
27	7+200.0	RC−φ500		○		○				66	18+752.0	RC−φ1000			○			○	
28	7+600.0	RC−φ500		○		○				67	19+231.0	RC−φ1000			○			○	
29	7+811.8	SP−φ120	○					○		68	19+775.1	RC−φ1000			○			○	
30	8+116.6	RC−φ300	○					○		69	20+520.0	RC−φ1000			○			○	
31	8+122.1	RC−1.0*1.0	○					○		70	21+000.0	RC−φ1000			○	○			
32	8+160.0	RC−φ500		○		○				71	21+540.0	RC−φ1000			○	○			
33	8+386.2	RC−φ500		○			○			72	22+110.6	RC−5.0*2.5	○				○	Box-No.3	
34	8+710.1	RC−φ200	○					○		73	22+155.4	RC−φ1000			○			○	
35	8+840.0	RC−φ500		○		○				74	22+576.3	SP−φ1500				Removal of the pipe			
36	8+977.0	RC−φ200	○					○		75	22+624.1	RC−φ1500			○				○
37	9+280.0	RC−φ500		○		○				76	23+182.0	RC−φ200	○					○	
38	9+340.0	RC−0.5*0.6		○				○		Sub total			34	17	23	29	2	41	2
39	9+464.2	RC−φ200	○					○		Total				74			74		

2.2.2.5 Road Drainage Design

For road drainages, concrete side gutters and ditches are to be installed at plat sections. The concrete side gutters are countermeasures for leaking water from aqueducts of irrigation canals at the following sections:

Sta, 6+890 ~8+980 (left side): 2,090 m

Sta. 9*980~12+200 (left side): 2,220 m, Total: 4,310 m

Road sections to be installed side ditches are strictly divided due to topographic undulations. The total distance of left and right side ditches is 15,317 m.

2.2.2.6 Road Service Facility Design

As mentioned in 2.2.1.3 “Consideration on Environmental and Socio-Economic Conditions”, connection to existing road and installation around kindergarten and alongside market are as follows:

(1) Connection to existing road

Main route is risen 40cm up by road rehabilitation. Connecting existing roads are run-off to the project road with maximum 7% slop in order to solve the gaps between them.

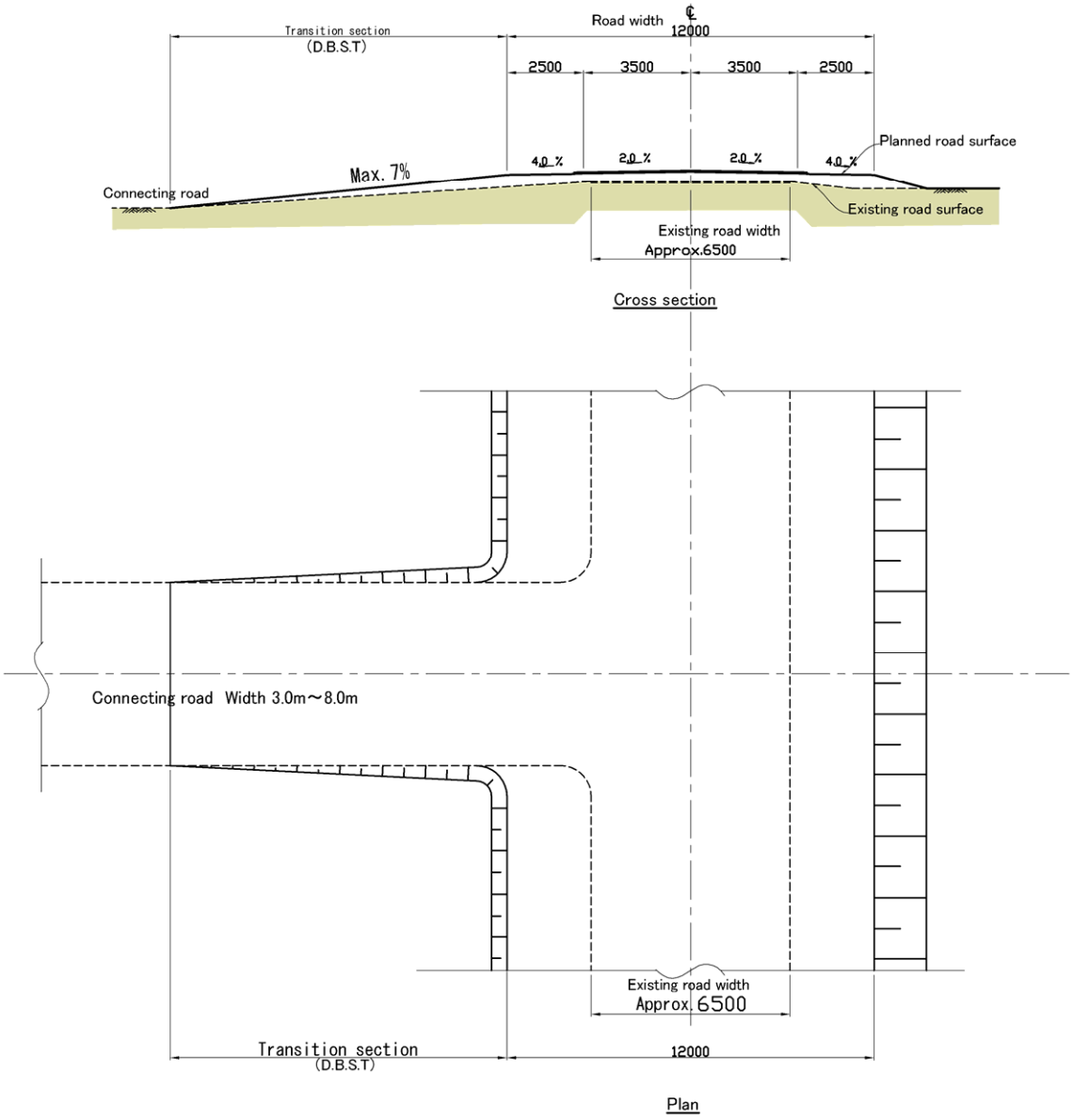


Figure 2.2.2.6-1 Method to connect existing road

Connecting points to existing roads and private driveways/parking lots are listed as follows:

Table 2.2.2.6-1 List of connecting roads

Access road

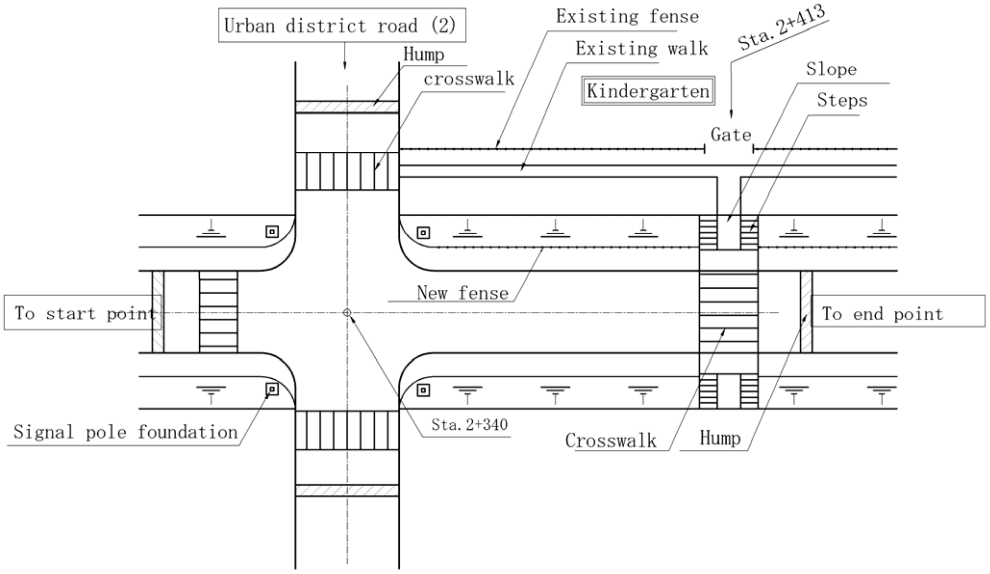
NO	Location	Side	Width (m)	Pavement Type	Note
1	0＋686	R	5.0	Gravel	
2	0＋694	L	6.0	Gravel	
2	0＋694	R	6.0	Gravel	
2	0＋755	L	4.5	Earth	
3	0＋755	R	4.5	Earth	
3	0＋960	L	6.0	Asphalt	Existing Main road
4	2＋350	R	6.5	Asphalt	Requested Road
5	2＋350	L	6.5	Asphalt	Requested Road
6	2＋415	L	1.5	Concrete	Kindergarten
7	2＋415	R	1.5	Concrete	Kindergarten
8	2＋730	R	3.8	Earth	
9	2＋740	L	3.0	Earth	
10	3＋125	L	8.0	Asphalt	Urban district road (1)
11	3＋125	R	8.0	Asphalt	Urban district road (1)
12	3＋430	L	5.0	Asphalt	
13	4＋710	L	4.5	Earth	
14	4＋325	L	4.0	Earth	
15	4＋600	R	3.0	Earth	
16	5＋275	R	4.5	Earth	
17	5＋290	L	7.0	Earth	
18	5＋478	R	3.0	Earth	
19	5＋750	R	2.5	Earth	
20	5＋757	L	4.5	Asphalt	
21	5＋924	L	3.0	Earth	
22	6＋050	L	3.5	Earth	
23	6＋060	L	3.5	Earth	
24	6＋285	L	6.5	Earth	
25	6＋290	R	6.0	Earth	
26	6＋400	L	3.5	Earth	
27	6＋575	L	4.5	Earth	
28	6＋895	R	2.5	Earth	
29	7＋330	L	9.0	Earth	
30	7＋349	L	3.5	Earth	
31	7＋850	L	9.0	Earth	Farm road
32	8＋130	L	9.0	Earth	Farm road
33	8＋140	R	3.0	Earth	Farm road
34	8＋610	R	3.0	Earth	Farm road
35	8＋940	R	6.0	Asphalt	
36	8＋988	L	5.0	Earth	
37	9＋345	L	5.0	Earth	Farm road
38	9＋470	R	4.5	Earth	
39	9＋845	R	4.0	Earth	
40	9＋865	L	5.0	Earth	
41	10＋350	L	5.0	Earth	
42	10＋723	R	4.0	Earth	Farm road
43	11＋050	L	5.0	Earth	
44	11＋320	L	4.0	Earth	
45	11＋717	L	6.0	Earth	
46	12＋240	L	3.5	Earth	
47	12＋195	R	3.0	Earth	
48	12＋646	L	3.0	Earth	
49	13＋370	L	3.5	Gravel	
50	14＋865	R	5.0	Earth	
51	15＋000	R	3.5	Earth	
52	15＋795	R	3.0	Earth	
53	16＋280	R	3.0	Earth	
54	16＋670	L	3.0	Earth	
55	16＋670	R	3.0	Earth	
56	16＋990	L	3.0	Earth	
57	17＋000	R	3.0	Earth	
58	20＋760	R	5.5	Earth	
59	20＋785	L	3.0	Earth	
60	20＋965	R	3.0	Earth	
61	22＋360	R	6.0	Asphalt	
62	22＋950	R	3.5	Earth	
63	23＋180	R	3.0	Earth	

Private house road

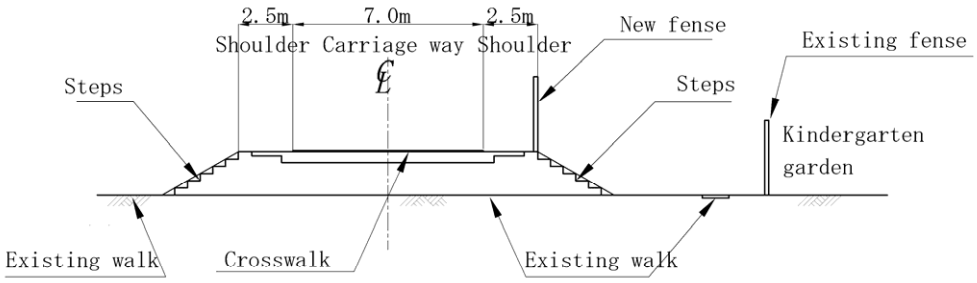
NO	Location	Side	Width (m)	Pavement Type	Note
1	1＋005	L	6.0	Earth	Factory entrance
2	1＋220	L	5.5	Asphalt	
3	1＋394	L	9.0	Asphalt	
4	2＋100	L	5.5	Earth	
5	2＋698	L	3.0	Earth	
6	2＋785	L	4.0	Earth	
7	3＋176	L	5.0	Earth	
8	3＋190	L	3.0	Earth	
9	3＋190	R	10.0	Earth	Market
10	3＋217	L	4.0	Earth	
11	3＋240	L	3.0	Earth	
12	3＋262	L	3.0	Earth	
13	3＋300	L	4.5	Earth	
14	3＋318	L	3.0	Earth	
15	3＋328	L	5.0	Earth	
16	3＋330	R	3.0	Earth	
17	3＋365	R	4.5	Earth	
18	3＋387	R	3.0	Earth	
19	3＋412	R	3.0	Earth	
20	4＋653	L	4.0	Earth	Factory entrance
21	4＋720	L	4.0	Earth	
22	4＋885	L	4.0	Asphalt	
23	4＋895	L	3.0	Asphalt	
24	4＋903	L	4.0	Earth	
25	4＋975	L	3.5	Earth	
26	5＋046	L	4.5	Earth	Pump station entrance
27	5＋125	R	3.5	Earth	
28	5＋315	L	4.0	Earth	
29	5＋346	L	3.0	Earth	
30	5＋357	L	4.5	Earth	
31	5＋386	L	5.0	Earth	
32	5＋440	L	4.0	Earth	
33	5＋550	L	3.5	Earth	
34	5＋587	L	3.0	Earth	
35	5＋596	L	3.0	Earth	
36	5＋630	L	4.0	Earth	
37	5＋810	L	4.0	Earth	
38	5＋830	L	4.0	Earth	
39	5＋860	L	4.0	Earth	
40	5＋890	L	4.0	Earth	
41	5＋960	L	2.0	Earth	
42	5＋970	L	3.0	Earth	
43	6＋000	L	2.5	Earth	
44	6＋090	L	5.5	Earth	
45	9＋175	R	2.0	Earth	
46	9＋390	R	2.5	Earth	
47	9＋400	R	2.5	Earth	
48	9＋475	L	3.5	Earth	Pump station entrance
49	22＋990	L	8.5	Concrete	New market entrance
50	23＋040	L	4.0	Concrete	New market entrance

(2) Installation around the kindergarten

Safe traffic facilities including fences, traffic signboards, humps will be installed in order to protect children of the kindergarten (left side along STA.2+400) from traffic. The installation plan and cross section around the kindergarten are as follows:



Plan



Cross section

Figure 2.2.2.6-2 Installation plan and cross section around the kindergarten

(3) Installation along the market

Sidewalk along the market (right side from STA.2+400 to STA.3+300) is required to solve problems in crowded parking lots in/around the market. The installation plan around the market is as follows:

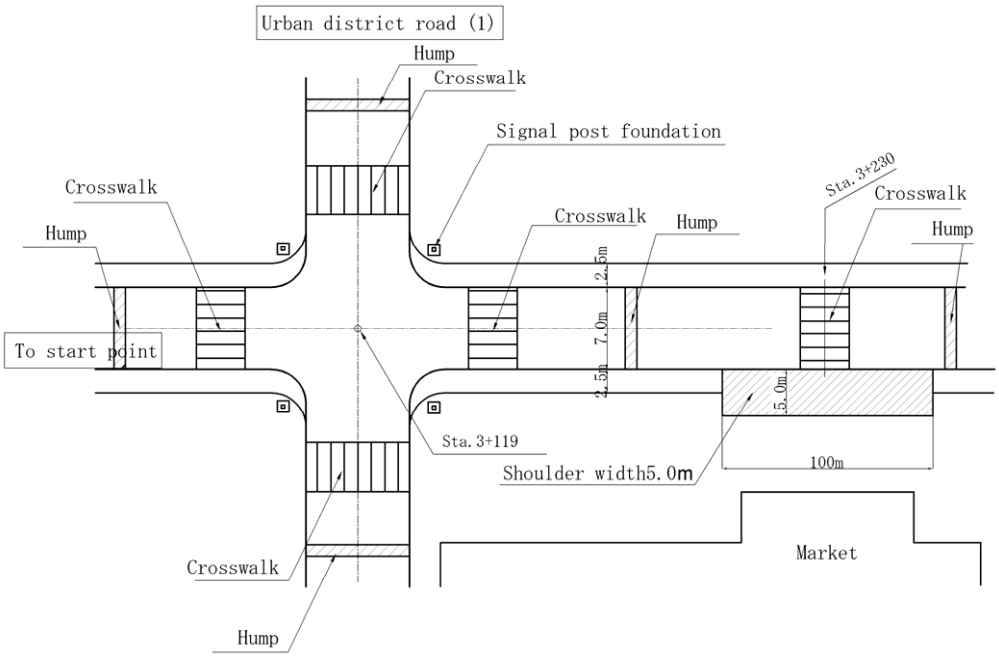


Figure 2.2.2.6-3 Installation plan section around the market

2.2.2.7 Road Subsidiary Work Design

(1) Signal post foundation

Signal post foundations are installed at the following locations:

Table 2.2.2.7-1 Locations of signal post foundations

Intersection	Station	No. of post
Urban road (1) intersection	STA.3+119	4
Urban road (2) intersection	STA.2+340	4

Structural plan of signal post foundation is as follows:

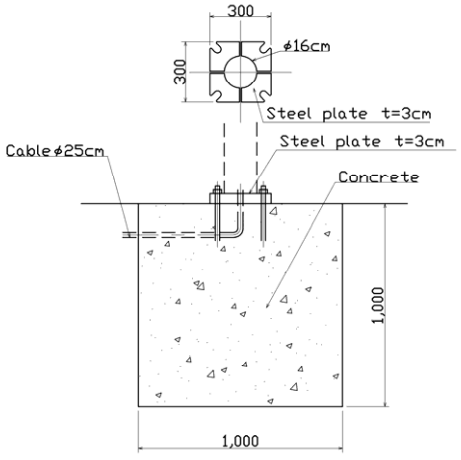


Figure 2.2.2.7-1 Structural plan of signal post

(2) Traffic signs and provisional markings

As road provisional markings, center lines, edge lines and stop lines of connecting roads are installed. Center and edge lines are set on whole route and stop lines are set on connecting/crossing roads.

As traffic signs, regulatory signs (speed limitation, etc.) and warning signs (curve ahead, etc.) are only installed. The installation method is road edge type. Locations of installations are 15 points of informatory signs, 40 points of regulatory signs and 99 points of warning signs.

(3) Guideposts

Guideposts are installed at beginning/end points of culverts, horizontal curve radiuses over R=250m and embankments higher than 4m in order to protect vehicles out of traffic lanes. Locations of the installations are as follows:

Table 2.2.2.7-2 Locations of guidepost installations

Purpose	Chainage (STA.)	Length (m)
Sharp curve point	0+090~ 0+280	190
	0+464~ 0+683	219
	0+802~ 0+944	142
	5+982~ 6+105	123
	14+084~14+227	143
	15+751~15+921	170
	16+838~16+973	135
	17+480~17+627	147
	19+940~20+221	281
	21+561~21+685	124
	21+969~22+066	97
	22+515~22+565	50
	22+572~22+613	41
	22+764~22+866	102
Total 14 points		1,964

Purpose	Chainage (STA.)	Side	Length (m)
High embankment	18+400~18+470	R	70
	18+720~18+780	L	60
	18+720~18+830	R	110
	19+210~19+250	R	40
	19+550~19+580	R	30
	20+440~20+480	L	40
	20+450~20+510	R	60
Total 7points			410

* Installing At 4 corners of culverts of 72 locations as well