No.

Ministry of Transport and Communications
The Kyrgyz Republic

BASIC DESIGN STUDY REPORT ON THE PROJECT FOR RECONSTRUCTION OF BRIDGES IN CHUI OBLAST IN THE KYRGYZ REPUBLIC

July 2007

JAPAN INTERNATIONAL COOPERATION AGENCY

KATAHIRA & ENGINEERS INTERNATIONAL

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PREFACE

In response to a request from the government of the Kyrgyz Republic, the Government of Japan decided to conduct a basic design study on the Project for Reconstruction of Bridges in Chui Oblast and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Kyrgyz a study team from January 24 to February 19, 2007.

The team held discussions with the officials concerned of the government of Kyrgyz, and conducted a field survey at the study area. After the team returned to Japan, further studies were made. Then, a mission was sent to Kyrgyz in order to discuss a draft basic design, 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 Kyrgyz Republic for their close cooperation extended to the teams.

July 2007

Masahumi Kuroki

Vice-President

Japan International Cooperation Agency

July 2007

Letter of Transmittal

We are pleased to submit to you the basic design study report on the Project for Reconstruction of Bridges in Chui Oblast in the Kyrgyz Republic.

This study was conducted by Katahira & Engineers International, under a contract to JICA, during the period from January 2007 to July 2007. In conducting the study, we have examined the feasibility and rationale of the project with due consideration to the present situation of Kyrgyz 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,

Shingo Gose
Projet manager,
Basic design study team on
the Project for Reconstruction of Bridges in Chui Oblast
Katahira & Engineers International

Summary

1. Outline of the Country

The Kyrgyz republic is located at the southeast of Central Asia and is a landlocked country which borders on China at the southeast side, Kazakhstan at the north side, Uzbekistan at the west side and Tajikistan at the south side. The population is 5.20 million and the land area is 199,900 km^2. Over 90 % of the land is at altitude above 1,500 m and over 48 % is at altitude above 3,000 m. There is little suitable land for agriculture due to the mountain country and the land is used for agriculture, grass and other with 7 %, 42 % and 51 % of the land respectively.

The climate type belongs to continental climate which character is big difference in temperature. The average temperature of July is 16 to 24◦ C in lowland area and 8 to 12◦ C in highland area, and the average temperature of January is minus 4 to 6◦ C in lowland area and minus 14 to 20◦ C in highland area.

Soon after the Soviet Union broke up, sharp price rising and economic deterioration had occurred because of disappearance of the aid from the Soviet Union, which Kyrgyz economy depended on before the independence in 1991, and the deterioration of the exchange condition due to the price deregulation, shortage of imported goods and decreasing of the demand for products made in Kyrgyz from the CIS countries. After that, the promotion of the economic stabilization and the economic reform had been planned but it had difficulties due to the weakness of economic base referred to the shortage of key industries and natural resources.

Under this condition, because the Kyrgyz government went forward with meetings with IMF and the World Bank favorably and expressed aggressive attitude to the transition to market economy, macro economy had become stable gradually and the real GDP growth rate in 1997 achieved 9.9 %. Economic reform in Kyrgyz is the most forward among three countries of Central Asia as the laws of privatization of medium and small enterprises, further price deregulation, restructuring of financial sector and promotion of market economy was made rapidly and the Constitution for demesne was amended in 1998. But the financial crisis in Russia in the same year gave causes for Som falling, consumer price rising, stagnation of mining and manufacturing and external trade and so on. While the inflation fell in 2000 and the situation was out of the worst danger, Kyrgyz cannot help depending on financial aid from foreign country because Kyrgyz has external trade deficit and its external debt rate is still high.

The GDP rates by industry representing the industry structure of Kyrgyz are 34.1 % at primary industry, 20.9 % at secondary and 45.0 % at tertiary and agriculture constitutes approximately 34 % of the GDP. Most of agricultural products are grains in which wheat is main and other products are hay, milk, potatoes, vegetables and so on. GNI of Kyrgyz is 2,300 million US$ and GNI per capita is 440 US$ in 2005 according to the World Bank data.

2. Background of the Project

Country Development Strategy (CDS)(2006-2010) approved in November 2006 in Kyrgyz calls upgrading transportation infrastructures to realize stable economic growth as a main item. Specifically, CDS describes that transportation cost of products and goods should be minimized, roads condition should be upgraded to ensure the accessibility to areas and local markets, and markets of products and service in Central Asia should be connected with industrial and commercial center. Furthermore, international arterial road in Kyrgyz is included in Asian highway and positioned as an international arterial road network to make physical distribution smooth and develop economy in all Asia.

Road traffic in Kyrgyz is a fatal infrastructure because it is the transport with 90 % share of freight and passenger transportation. While freight and passenger transportation depend on the road infrastructures built in Soviet period, they are aging because of insufficient rehabilitation and reconstruction of bridges due to economic stagnation after the independence in 1991. As a result, heavily deteriorated road infrastructure became a major obstacle to transportation which is essential to develop sightseeing, agriculture, mining and so on, that is a blockage against economic growth.

Northern area where Bishkek city and Chui oblast are located is an industrial and economic center with 20 % of all population. While some portion of the road infrastructures in this area are being rehabilitated by other donors, there are many bridges which has a possibility to be collapsed due to their aging without rehabilitation or reconstruction including bridges on Asian Highway. It is urgent problem to ensure safe and smooth traffic by rehabilitating bridges from the point that blockage of traffic in northern area by bridge falling down affects the economy of Kyrgyz deeply and the safety of living road for the neighbors should be ensured.

Kyrgyz Government requested Grant Aid on supply of steel girders for bridge superstructure for 11 bridges with which northern area is spotted to Japan in March 2002. In the preliminary study conducted in September 2006, meetings were held with the other party in accordance with the diagnosis of soundness of the bridges and judgment of priority by emergency and importance of reconstruction of bridges. As the result, the project scope was reviewed and changed to construction of bridges including substructures. The object bridges are Alamedin bridge (Bridge No.1) and Ala-Archa bridge (Bridge No.2) that are located on Asian Highway No.5 (AH5) which is a lifeline of physical distribution in Kyrgyz and outbound bridge of Keng-Burun bridge (Bridge No.14) which is located on AH61, has two bridges separated as inbound and outbound bridge, and has traffic safety problem of a lot of traffic accidents happening. Reconstruction of the bridges which are located on Asian Highway and which structural damages are serious is expected to activate economy by contributing to the goal of CDS and the road upgrade plan. Actual conditions of three bridges are shown below.

・<u>Alamedin bridge (Bridge No.1)</u> (built in 1967)and <u>Ala-Archa bridge</u> (Bridge No.2)(built in 1967)

These bridges are located on Asian Highway AH5 connecting Almati with Bishkek and have much traffic density of large goods vehicle going to adjacent market. But they have a possibility of falling bridge because their structural damages are serious and erosion at their foundation is proceeding. In addition, they are bottlenecks with slow passing speed because their bridge surfaces are bumpy.

Moreover, pedestrian safety is not ensured at Ala-Archa bridge (Bridge No.2) because there are many holes on its footpath.

・Keng-Burun bridge (Bridge No.14)(Outbound bridge: built in 1955, Inbound bridge: built in 1970s)
This bridge has much traffic density because it is located on AH61 connecting Bishkek with China and is living road used by neighbors. However, there is high possibility that the outbound bridge falls because it is already 50 years old and has much damage in superstructure and substructure. In addition, it causes many traffic accidents that two bridges built separately to inbound and outbound are not parallel.

3. Outline of the Survey Result and Contents of the Project

In response to a request from the Government of Kyrgyz and the result of the preliminary study, the Government of Japan decided to conduct a basic design study on reconstruction three bridges (Alamedin bridge (Bridge No.1), Ala-Archa bridge (Bridge No.2), Keng-Burun bridge (Bridge No.14 Outbound)) in Chui Oblast. The Japan International Cooperation Agency (JICA) sent to the site in Kyrgyz a study team from January 22 to February 20, 2007, the team held discussions with the officials concerned of the Government of Kyrgyz and conducted the field survey at the study area. After returning to Japan, based on the survey result, the team carried out the basic design about proper project and made a draft report putting contents of the design together. JICA sent a mission to Kyrgyz from May 24 to May 28, 2007, the mission held discussions, made a confirmation and got a agreement about the contents. Finalized summary of the basic plan of the bridge reconstruction is shown as follows.

①Design Standards

Carrying out the basic design of the bridges and roads of the project, based on AASHTO applied widely to designs in Central Asia, geometric design is based on Kyrgyz road standards 2005, seismic design and revetment design for the protection of bridge are based on Specifications for Highway Bridges (Japan Road Association) and River Management Facilities Structure Law (Japan River Association) respectively applied many times for Japan Grant Aid on the basis of discussion with Kyrgyz side because standards were not uniformed in implemented projects in Kyrgyz. B live load of Specifications for Highway Bridges (Japan Road Association) was applied to the design live load because there is no detail specification of seismic design in AASHTO and to ensure unity between the structures concerned with above mentioned seismic design and the design live load. And 0.1 of design horizontal seismic intensity in Kyrgyz standard was adopted as earthquake load.
At this planning, considering the stream of flooding river, minimizing the impact to natural and social environment, the condition of soil quality and topography, reducing the construction cost, site execution and so on generally, optimum bridge location, structure and span were decided.

②Road Standards

Bridge width is adjusted to the approach road paved width and carriageway width, the length of the approach road is the minimum length which is affected by the bridge construction work for (Alamedin bridge (Bridge No.1) and Ala-Archa bridge (Bridge No.2). And, the approach road of Keng-Burun bridge (Bridge No.14 Outbound) is the minimum length which can be connected with existing road considering the direction of the outbound bridge and the alignment of the approach road because some ten traffic accidents occurs a year at the bridge causing from separated built bridges to inbound and outbound, the bad approach road alignment and the bad direction of bridges.

<u>③Subsidiary facilities</u>

Revetments for bridge protection are planned and designed, applied to Alamedin bridge (Bridge No.1) and Ala-Archa bridge (Bridge No.2) that river bank and river bed erosion are proceeding, considering to protect those erosions.

Summary of the facilities are shown below.

Summary of the facilities

Bridge Name	Bridge length (m)	Span plan (m)	Super-structure Type	Width(m)	Abutment Total	Abutment Structure	Abutment Foundation	Pier Total	Pier Stru-cture	Pier Found-ation	Appr-oach road length (m)
Alamedin bridge (Bridge No.1)	42.0	3-span ×14.0m	3-span Connected Composite PC I type girder	13.1 Carriageway width : 3.75×2-lane Sidewalk width : 1.75×Both side	2	Small reversed T type	Cast in place concrete pile	2	Pile bent concrete multi-colum		60.0
Ala-Archa bridge (Bridge No.2)	28.0	1-span ×28.0m	1-span Composite PC I type girder	13.1 Carriageway width : 3.75×2-lane Sidewalk width : 1.75×Both side	2	Reversed T type	Cast in place concrete pile	0			60.0
Keng-Burun bridge (Bridge No.14 Outbound)	23.4	1-span ×23.4m	1-span PC hollow girder	11.8 Carriageway width : 3.50×2-lane Sidewalk width : 1.50×One side	2	Small reversed T type	Cast in place concrete pile	0			350.1

4. Project Period and Rough Cost Estimate

If this project will be implemented by Japan's Grant Aid, the time for the detailed design will be three and half (3.5) months and for the implementation will be twelve point two (12.2) months. In implementing the Project through Japan's Grant Aid scheme, the total cost of the Project to be implemented in accordance with the Japan's Grant Aid scheme will be determined before concluding the Exchange of Notes (E/N) for the Project.

5. Project Evaluation

The direct beneficiaries by the Project are residents with the populations of 770 thousand along AH5 and AH61 where the object bridges are located and the effects resulted from the implementation of the Project are summarized below.

（1） **Direct Effects**

① Improvement of the safety and stability of the bridges due to the increase of the actual carrying load abilities of the bridges from 23.5 ~ 28.4 t to 40.9 t will remove the risk of bridge falling at usual time. (All bridges)

② The flatness of the bridge will be improved and the speed of passing bridge of 5 ~ 10 km/h will increase to 60 km/h. (Alamedin bridge (Bridge No.1) and Ala-Archa bridge (Bridge No.2))

③ Traffic capacity of 1,900-car/h will increase to 2,270-car/h, resulted from reconstruction of the outbound bridge, and road alignment and road safety facilities will be improved, and then, the factor of inducing traffic accident will be removed. (Keng-Burun bridge (Bridge No.14 Outbound))

④ Holes on the sidewalk will be fixed and safe walk will be ensured. (Ala-Archa bridge (Bridge No.2))

（2） **Indirect Effects**

① It is expected that socio-economic activities will be active and the employment will be created in Kyrgyz because the existing bridges which have the possibility that they fall down will be reconstructed.

② Transportation will be smooth and the economic will develop in the central Asia because of the enhanced function as an international arterial road.

③ It can be possible for the people living near the bridges to pass bridges safely and the stability of living road such as the improvement of the access to educational facilities will be realized.

Adequacy for implementing the Project by Japan’s Grant Aid is confirmed from the view point of expecting many effects mentioned above and contributing improvement of the people’s life widely. And about the management and maintenance of the project bridge, routine maintenance and periodic repair are able to be possible to be carried out because the necessary manpower and fund are retained and there is no technical problem. Moreover, properly carrying out the maintenance of AH5 and AH61 on which the object bridges are located will enhance the effect of the Project.

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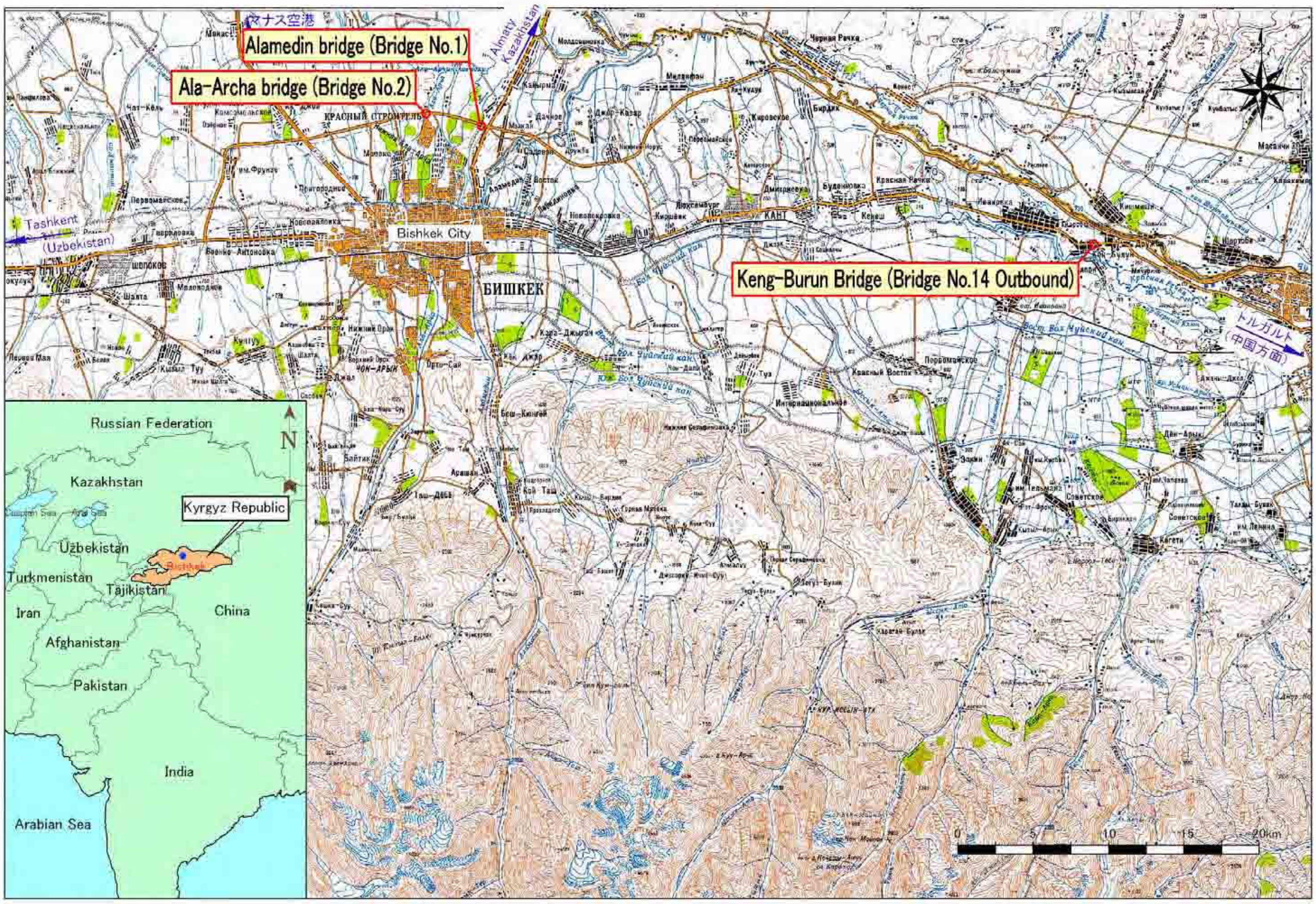

Location Map

※ Bridge Numbers are the bridge names when the Grant Aid was requested.

Perspective（Alamedin bridge (Bridge No.1)）

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Abbreviations

AASHTO	:	American Association of State Highway and Transportation Officials
ADB	:	Asian Development Bank
CDS	:	Country Development Strategy
CIS	:	Commonwealth of Independent States
EIA	:	Environmental Impact Assessment
GDP	:	Gross Domestic Product
GNI	:	Gross National Income
IEE	:	Initial Environmental Examination
IMF	:	International Monetary Fund
MOTC	:	Ministry of Transport and Communications
PC	:	Prestressed Concrete
PVC	:	Polyvinyl Chloride
RC	:	Reinforced Concrete
RMC	:	Road Management Center
SN	:	Structural Number

Chapter 1 Background of the Project

Road infrastructures is Kyrgyz are aging because of insufficient maintenance work after the independence in 1991. Those poor road condition is a blockage against economic growth. Under this situation, Kyrgyz Government gives the highest priority to developing roads to secure the growth of the country and poverty reduction. The Kyrgyz Republic, considering the above situation, made a request for the Grant Aid to the Government of Japan (the GOJ) regarding the superstructure material supply project for 11 bridges but during the preliminary study, the project type should be changed to construction bridges including substructures.

As a result of the preliminary study, the project bridges are Alamedin bridge (Bridge No.1) and Ala-Archa bridge (Bridge No.2) that are located on Asian Highway No.5 (AH5) which is a lifeline of physical distribution in Kyrgyz and down lane bridge of Keng-Burun bridge (Bride No.14) which is located on AH61, has two bridges separated as up and down lane, and has traffic safety problem of high traffic accident point.

Chapter 2 Contents of the Project

2.1 Basic Concept of the Project

2.1.1 Overall Goal and Project Purpose

The Kyrgyz Republic has formulated the following five (5) objectives in the national development plan (CDS:2006-2010) which has been approved by the parliament dated on November 6, 2006.

- Steady economic growth
- Development of conditions for adequate employment
- Gain a high secure income
- Improvement of quality and standard of living based on the above items
- Possibility for the expanded utilization of social services
- High standard living at breeding environment

Steady economic growth causes the improvement of economic potential which is connected with the development of transport infrastructures as follows;

- Upgrading the road standard in order to secure the traffic route to the rural area as the market with the reduction of transportation costs, for products and commodity.
- Connecting betweens rural market and service markets with industry and commercial centers by the international corridors.

The implementation program is as follows;

- Rehabilitation of transport corridors (2006~2010: assuming international financing)
  - Osh – Sary Tash – Irkeshtam Section（Total length: 258km）
  - Suusamyr – Talas – Taraz Section（Total length: 199km）
  - Bishkek – Naryn – Torugart Section（Total length: 539km）
    ※Keng-Burun bridge (Bridge No.14 Outbound) is located on this section
  - Osh – Batken – Isfana Section（Total length: 385km）
- Repair of bumpy road（Total length: 1,000km）
- Promotion of privatization in road maintenance and management office

This project is reconstruction of bridges on the international corridor (Asian Highway). And, Keng-Burun bridge (Bridge No.14 Outbound) will be directly concerned with the rehabilitation of Bishkek – Naryn – Torugart Section and contribute for the accomplishment of National Development Strategy. The overall goad and project purpose are as follows;

Overall Goal: The development of international trunk road network will enhance the economic development in Kyrgyz.

Project Purpose: To secure safety and stable traffic in wide area and improve accessibility of people along the project roads with the replacement of heavy damaged bridges located on international trunk roads.

2.1.2 Basic Concept of the Project

The Project is to construct the bridges under Japan's Grant Aid and to give necessary recommendation regarding the effective implementation and maintenance of the Project.

The Project is expected to accomplish the following Project purpose "To secure safety and stable traffic in wide area and improve accessibility of people along the project roads with the replacement of heavy damaged bridges located on international trunk roads."

The objective bridges to be replaced are Alamedin bridge (Bridge No.1), Ala-Archa bridge (Bridge No.2) and a down lane bridge of Keng-Burun bridge (Bridge No.14).

2.2 Basic Design of the Requested Japanese Assistance

2.2.1 Design Policy

2.2.1.1 Scope of the Japanese Assistance

- Replacement bridges as Alamedin bridge (Bridge No.1), Ala-Archa bridge (Bridge No.2) and a down lane bridge of Keng-Burun bridge (Bridge No.14) (including necessary approach road, road facilities and river bank protection)

2.2.1.2 Consideration for Natural Conditions

Natural condition are utilized for the following design items:

Meteorological Condition (temperature, rainfall, snow cover and earthquake): bridge planning, bridge design, countermeasures for frozen ground on approach road, planning and design of approach road, and construction planning,

River Condition; the necessity of river bank protection and its scale, estimation of local scouring depth, planning of the location of abutments, the heights and length of the bridges, and construction planning,

Topographical and Geographical Conditions; planning of bridge locations and bridge length, estimation of bearing layer and resistance of foundation, selection of foundation type, and construction planning,

Earthquakes; selection of bridge type, determination of the scale of substructures and foundations.

Freeboard and minimum span length

Design high water level is set the past high water level estimated based on the interview survey at sites, because of the difficult calculation due to the river utilization for irrigation and the control of discharge water at upstream by dam.

No observation of the flooding history at the existing bridges. The existing bridges have sufficient freeboard space at present.

Minimum freeboard is adapted 1.0m in height based on the past grant aid bridge projects.

Minimum span length is set as the existing bridge span length. The design span length will be adapted based on the consideration of economical efficiency and constructability factors sue to the confirmation of no floating materials at the flood based on the results of the interview and site survey.

2.2.1.3 Environmental and Social Considerations

The Project does not change natural and social conditions because of the relocation of the existing bridges. The negative impacts by the Project are planned to be minimized at planning, designating and construction period as follows.

- The Project does not give rise to relocation of houses and residents.
- Items of works with vibration, consideration for residents should be made to limit the working time, to minimize the impact to the residents near Keng-Burun bridge (Bridge No.14) which is located beside another lane Bridge.
- During the construction period, a detour should be provided respecting traffic safety.
- During the construction period, pollution of river should be minimize.
- Construction waste should be evacuated and deposited at appropriate sites.

The license of EIA for the Project was approved at the Basic Design Study. The necessary procedures are referred to Appendix-7 Environmental and Social Consideration and the Procedure for the Project approval.

2.2.1.4 Design Guide lines to be applied and Design Requirement

Considering the apply of international standard and the particular meteorology in Kyrgyz, The design guide lines which are rational, safety and economic are applied for setting of design items.

2.2.1.5 Participation of Local Construction Companies and Engineers/Workers

Labor work including materials and engineers can be procured mostly in Kyrgyz. However, these is no experience of construction of prestressed concrete (PC) girder bridge in Kyrgyz.

Therefore, Local contractors/personnel can participate in the procurement of labors to the Project.

2.2.1.6 Consideration on Implementing Agencies Ability in managing and maintenance

The following road management offices under MOTC have responsibility for management and maintenance of 3 bridges.

Alamedin bridge (Bridge No.1) and Ala-Archa bridge (Bridge No.2): Regional Road Maintenance Unit (RRMU) No.1

Keng-Burun bridge (Bridge No.14): The Local Road Maintenance Unit No.39 RCM

Considering the skill level of local engineers and the scale of budget of local office, structures both easy and requiring low cost for maintenance are to be applied.

2.2.1.7 Policy in Construction Plan

High quality bridge should be constructed with adapted of widely use technology and construction method in Japan and International.

Material tests for quality control and (procedures and standard for (construction inspection) are specification. Construction plan should be considered on environment and safety of residents and construction personals. The Project bridges are located on major distribution road in Kyrgyz. Therefore, it is necessary to secure detours during construction work in order to minimize the negative impact for economic activities.

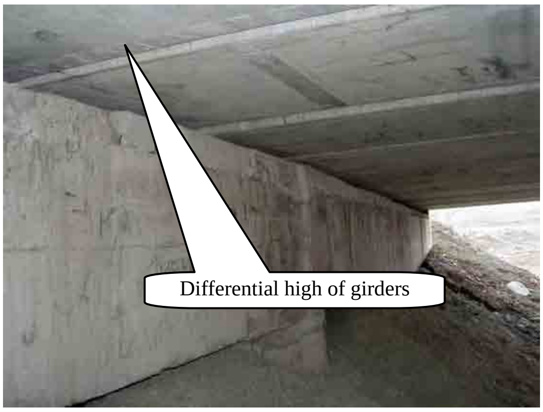
2.2.1.8 Policy in Selection of Bridge Type

The most appropriate type is selected in consideration of various factors including economical efficiency, constructability, maintenance difficulty, environmental impacts, geometrical alignment and durability.

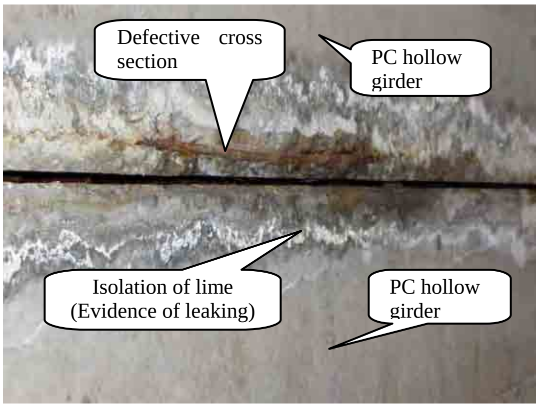
- Economical efficiency: To be constructed with low cost for the Project to be cost-effective.
- Construction Difficulty: To be constructed easily and safely.
- Maintenance Difficulty: To be easily maintained with low cost. Concrete material is preferable for superstructure from this point of view.
- Environmental Impact: To select construction method so as to minimize the impact on natural environment, since there is no housing in the vicinity of the project sites.
- Durability: To be durable enough, particularly for superstructure. Examining the balance of construction method and scale of substructure and river bank protection, it is avoid for over design in consideration of durability with method and scale.

Precast concrete girder produced in Kyrgyz

Pre cast concrete girders (RC Girder and PC hollow girder) are factory product in Kyrgyz. They are low cost but low quality and difficult to sustain by heavy vehicles with structural problem. (referred as the Figure 2.2.1-1). Due to above reasons. those products are not adapted for trunk road projects which have lots of heavy traffic.



Differential high of girder (fabrication defects)



Defective cross section and leaking from the spaces between girders at Pre-cast

Figure 2.2.1-1 The condition of Pre-cast girder fabricated in Kyrgyz.
(The bridge on Bishkek~Osh Road Section)

2.2.1.9 Policy in Construction Period

Construction period is formulated according to Japan's Grant Aid Scheme. Implementation schedule is formulated to a single year as follows;

- Detailed design: within 3.5 months
- Preparation for tendering: within 2.5 months
- Construction: within 12.2 months

2.2.2 Basic Plan

2.2.2.1 Examination of safeness and evaluation of the existing bridges

2.2.2.1.1 Examination of safeness and evaluation as a whole of existing bridges

(1) The stability of foundation

The piers and abutments of Alamedin bridge (Bridge No.1) and Ala-Archa bridge (Bridge No.2) are pile foundations. Type of foundation is whole RC pile. Size of pile is 0.30×0.35 (meter) in square. The length of pile is 9m in driven depth at the result of interview survey but the actual length is unidentified.

The heads of those piles are appeared above soil. Those appearances come from the reasons of sinking ground by river erosion and scouring. The friction of pile in vertical and horizontal direction suppose to come down large.

Therefore, the bridge structure should be collapsed if river erosion and scoring proceed more over. Especially Ala-Archa bridge (Bridge No.2) is observed big settlement and inclination which makes the bridge serious condition.

The degree of risk for foundation pile is shown in Table 2.2.2-1 as a coefficient (<1.0) which means the decline of safeness in consideration of vertical sustenance for pile direction and horizontal sustenance for bending moment at pile head. Bending moment is shown as a coefficient of pile section friction. Figure 2.2.2-1 shows this calculation model.

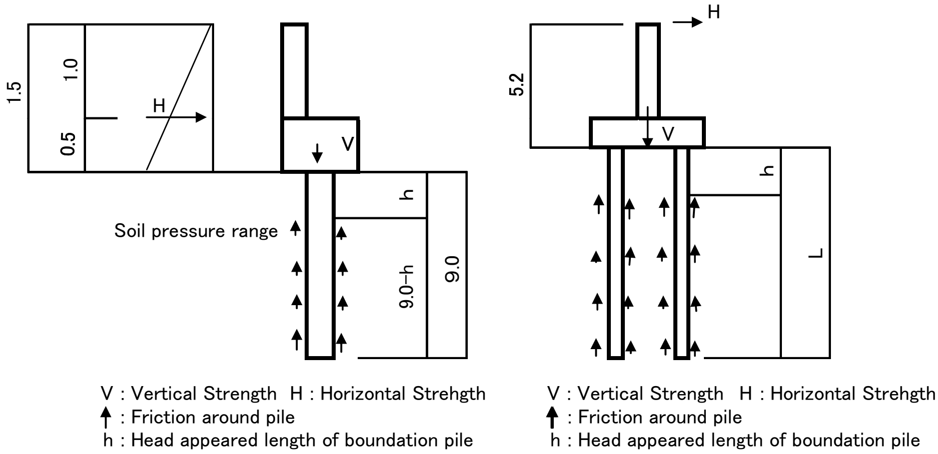


Figure 2.2.2-1 Calculation model for Risk level

Table 2.2.2-1 Maximum projection length of pile head, modification coefficient of pile bearing capacity and section resistance force

Items	Direction	Alamedin bridge (Bridge No.1)				Ala-Archa bridge (Bridge No.2)			Keng-Burun bridge (Bridge No.14)			
		Abut A	Pier 1	Pier 2	Abut B	Abut A	Pier 1	Abut B	Abut A	Pier 1	Pier 2	Abut B
Projection length(m)	Vertical	1.0	1.1	1.5	0.9	0.8	2.5	1.0	(Spread foundation)			
Moditication coefficient for pile bearing capacity	Vertical	0.89	0.88	0.83	0.9	0.87	0.72	0.89	(Bearing capacity of vertical direction to foundation is low due to the settlement of the bridge)			
Modification coefficient for pile section resistence	Horizontal	0.33	0.82	0.77	0.36	0.38	0.67	0.33				

Regarding to the foundation of keng-Burun bridge (Bridge No.14), the deck of up lane bridge is flat but down lane becomes entirely settlement. (Results problem from close-construction)

(2) Hanging length of a girder

Hanging length of a girder is an important factor to be evaluated for seismic resistance of a bridge. Whole the piers of the project are proved to be unsatisfied at the requirement of seismic resistance.

Some abutments also have insufficient value Figure 2.2.2-2 and Figure 2.2.2-3 show the Hanging length of a girder at a pier and an abutment. Table 2.2.2-2 shows actual measurement and required hanging length with the results of evaluation.

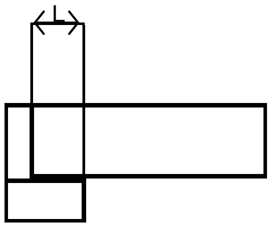


Figure 2.2.2-2 The Hanging length on Abutment: L

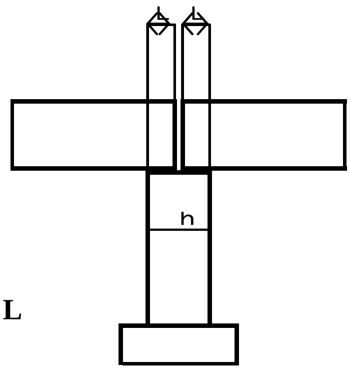


Figure 2.2.2-3 The Hanging length on pier: L

Table 2.2.2-2 The actual measurement and the evaluation of the hanging length on Abutment and pier

	Unit	Alamedin bridge (Bridge No.1)				Ala−Archa bridge (Bridge No.2)			Keng−Burun bridge (Bridge No.14)			
		Abut A	Pier 1	Pier 2	Abut B	Abut A	Pier 1	Abut B	Abut A	Pier 1	Pier 2	Abut B
hanging length on pier	cm	50	37.5	37.5	120	100	37.5	100	60	40	40	60
Requierd length	cm	77	77	77	77	77	77	77	75	75	75	75
Evaluation		×	×	×	○	○	×	○	×	×	×	×

○ : Sufficient × : Poor

(3) Erosion and Scouring

Alamedin bridge (Bridge No.1) and Ala-Archa bridge (Bridge No.2) are observed the settlement of riverbeds. Alamedin bridge (Bridge No.1) has deep scouring at piers and the ground level descents 2.5m since the completion of the bridge. The river bed level of Ala-Archa bridge (Bridge No.2) is supposed to go down at 3.5m.

Heavy erosion is observed at the both sides of riverbank at Ala-Archa bridge (Bridge No.2) and the collapse of riverbank becomes worse. The footing of Abutment B (right side) is sank and decline to down stream side. The amount of settlement is 13cm and the vertical deformation is 8cm. The embankment of front at the abutment is supposed to occur sliding failure. Some cracks are found at the top of embankment of Abutment A and B.

The crack is 40cm width and makes instability. The accentual levels of the deck at superstructure were measured in order to recognize the influence by unequal settlement at pier and abutment. Figure 2.2.2-4 shows the measurement points and Table 2.2.2-3 shows the actual data.

About 10cm unequal settlement is occurred at upstream side of the bridge center portion of Alamedin bridge (Bridge No.1). About 35cm unequal settlement is occurred at downstream side of right bank of Ala-Archa bridge (Bridge No.2). Maximum 35cm settlement is occurred at Keng-Burun bridge (Bridge No.14) compared with the flat new bridge.

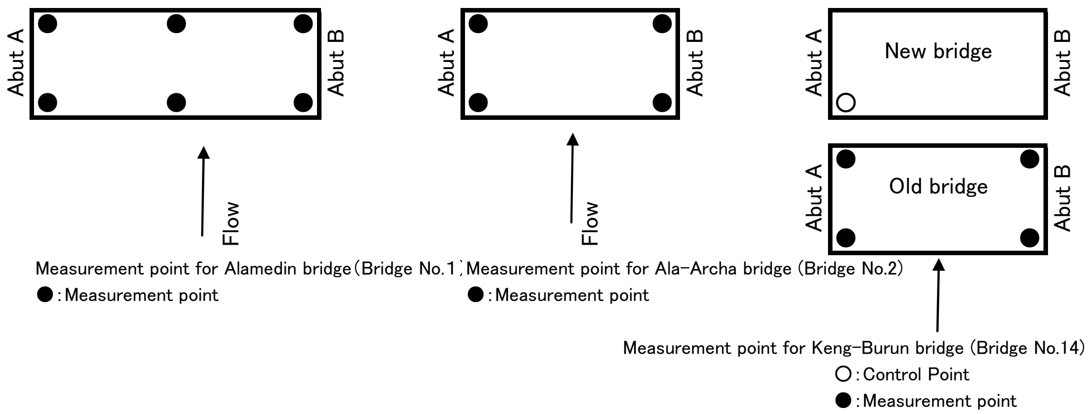


Figure 2.2.2-4 Measurement point for settlement of the deck plate

Table 2.2.2-3 Settlement of deck plate

	Alamedin bridge (Bridge No.1)						Ala-Archa bridge (Bridge No.2)				Keng-Burun bridge (Bridge No.14)			
Location of deck and settlement (cm)	Left bank downstream	-13	Bridge center downstream	-5	Right bank downstream	0	Left bank downstream	-25	Right bank downstream	-60	Left bank downstream	-10	Right bank downstream	-35
	Left bank upstream	-13	Bridge center upstream	-18	Right bank upstream	-6	Left bank upstream	0	Right bank upstream	-25	Left bank upstream	-15	Right bank upstream	-35
	Comments	Differential settlement is quite large even considered of the impact from lontitudinal gradient.					Comments	Differential settlement is quite large even considered of the impact from lontitudinal gradient.			Comments	The deck level of a new bridge is set for the control point (0.0cm). The deck of the new bridge has a level.		

2.2.2.1.2 Safety evaluation on structure

(1) Methodology

The damaged conditions were examined at concrete member. The location of damaged portion was confirmed by the close visual check. The deterioration and construction defects on structural members were tested by beating with a hammer. The strengthen of a member's cross-section was conducted by a Schmitt hammer.

Table 2.2.2-4 shows the test results. The width of cracks were measured for the maximum crack width by a crack scale. Table 2.2.2-5 shows the results of cracks.

Inspection by a Test hammer

Inspection by a Schmitt hammer

Inspection by a classic scale

Table 2.2.2-4 Compressive strength of concrete by Schmitt hammer test（N/mm²）

	Super structure		Sub structure				
			Abut	Pier			
	Main girder	Deck	Footing	Beam	Wall	Footing	Foundation pile
Alamedin bridge（Bridge No.1）	431	n.a	320	350	180	367	320
	n.a	n.a	n.a	n.a	383	n.a	n.a
Ala-Archa bridge（Bridge No.2）	447	n.a	383	335	306	320	367
Keng-Burun bridge（Bridge No.14）	335	260	n.a	n.a	275	n.a	n.a
	140/180	n.a	n.a	n.a	n.a	n.a	n.a
Allowable stress	25	25	25	25	25	25	25

Table 2.2.2-5 Test Results of maximum crack width (mm)

	Super structure	Sub structure			
		Abut		Pier	
	Main girder	Wall	Foundation pile	Footing	Foundation pile
Alamedin bridge（Bridge No.1）	0.45	Shear failure	Shear failure	—	Shear failure
Ala-Archa bridge（Bridge No.2）	0.5	Shear failure	Shear failure	Vartical and Horizontal Peformation	Shear failure
Keng-Burun bridge（Bridge No.14）	0.55	Non	(Invisible)	(Invisible)	(Invisible)

(2) The relationship between the damaged conditions and the risk level of members

The compressive strength of the concrete at superstructure of Alamedin bridge (Bridge No.1) and Ala-Archa bridge (Bridge No.2) shows the value more than 43N/mm². The same index at the bottom of the girder which is upstream side on No.3 span shows low value as 14~18 N/mm². Rain water hits directly to the main girder through the drain pipe from the deck. It makes damaged on concrete and occurs the expose of re-bar which progress the corrosion. 1.5m length of the concrete was peeled at this point. If the thickness of exposed re-bar is 1mm, the strengthen of bending strain comes down to 87%.

Exposure and Rusting of Re-bar (Girder)

Exposure and Rusting of Re-bar (Pier)

The compression strengthen of Abutment footing is more than 32N/mm² which is adequate value for

Alamedin bridge (Bridge No.1) and Ala-Archa bridge (Bridge No.2).

The compression strengthen of almost members is 18N/mm^2 for piers of Ala-Archa bridge (Bridge No.2) and Keng-Burun bridge (Bridge No.14). The condition of the concrete at this portion has honeycombs by poor construction and shows corrosion at exposed re-bar.

The thickness of deteriorated concrete is about 5 cm. It makes the load capacity about 75% down.

The compression strengthen of the concrete at pile head is more than 32N/mm^2 for Alamedin bridge (Bridge No.1) and Ala-Archa bridge (Bridge No.2). Those pile heads have pressing cracks or shear failure. These pile heads become hinge structure. Due to above reasons, in case of earthquake (horizontal force), the bridge becomes heavy vibration and strong stress occurs at pile. It damages pile itself. These is the damager for the bridge to be collapsed at the earthquake in addition the Hanging length of a girder is too short.

Crack of Pile Top

Regarding on cracks, maximum width of crack was measured by a crack scale. Shear cracks are observed at the edge of a main girder. Table 2.2.2-5 shows the maximum crack width. Alamedin bridge (Bridge No.1): 0.45mm, Ala-Archa bridge (Bridge No.2): 0.50mm, Keng-Burun bridge (Bridge No.14): 0.55mm. Those figures are more than allowable figure: 0.3mm. These bridges need to be repaired or reinforced. Regarding on corrosion of re-bar, the corrosion intensity, a diameter and an arrangement were inspected. The diameter of main re-bar is 30mm and utilized at superstructure and substructure with 5cm~10cm interval.

(3) The relationship between the damaged conditions and the risk level of structures

Alamedin bridge (Bridge No.1)

Discontinuous Cross Girder

- Abnormal vibration on deck plate at vehicle driving caused by the lack of total stiffness of the bridge.
- Vertical load stress distribution is unexpected at superstructure because of whole cross beams are discontinuous.
- Consequently, a main girder separately gets load and it produces large vibration.
- Many shear cracks are arised at the edges of main girder. Maximum width is 0.45mm which is over than allowable for rain forced concrete. Future, the concrete strength becomes lower at some member of bottom portion. Exposed and corrosion re-bar are absorbed. The head of foundation pile is appeared on the ground surface. The concrete was damaged by pressure and the structure became weaken because of the pile head is hinged.

Damaged at the bottom of pier

Damaged at the top of pier

Ala-Archa bridge (Bridge No.2)

Damaged at concrete member of the bottom

- The abnormal vibration is occurred on clack plate during vehicle driving as well as Alamedin bridge (Bridge No.1).
- The reason of vibration is caused from the lack of stiffiness of the bridge. Whole cross beams are discontinuous which mean no vertical distribution of load. As a result of above reasons, the main girder has a large vertical vibration. The edges of main girder are observed a lot of shear cracks which is 5mm in maximum. The concrete member at the bottom edge are quite damaged. Some re-bars are exposed with corrosion. The head of foundation pile is appeared above the grand level. The concrete was damaged with pressure. The pile head is hinged. the footing of Abutment B was deformed toward to down stream. The volume of the deformation is 13cm to vertical and 8cm to horizontal.

Keng-Burun bridge (Bridge No.14)

The main girder of No.3 span is the most damaged. Maximum 0.55mm shear crack is observed on the main girder. The resistance of the super structure declines by rusty concrete. The results of the existing bridge evaluation survey is shown in Appendix 8. Table of the existing bridge evaluation.

Deformation of the Abutment

2.2.2.1.3 Conclusion

The safety level of 3 bridges based on the detailed survey, are summarized as follows;

Alamedin bridge (Bridge No.1) and Ala-Archa bridge (Bridge No.2)

- The superstructure of Alamedin bridge becomes about 10cm differential settlement to upstream at the center portion of the deck. It is dangerous for driving vehicles. The superstructure of Ala-Archa bridge (Bridge No.2) inclines to downstream. It is quite dangerous for driving vehicles especially at the down stream side of left bank. The main girder concrete of both bridges become deteriorate and have lots of shear cracks. Cross beam has insufficient function. As reasons above mention, the load resistance of two bridges becomes low level. The bottom ends of pier at the both bridges the concrete becomes deteriorate and re-bar are exposed, so the load resistance becomes low. The foundation piles of Abut and pier are in danger condition because of the pile head are appeared above the ground level. Especially the foundation pile of both bridges have low load resistance which becomes only 33%. It means poor a seism city. The vertical bearing capacity of foundation pile at pier become low level as 83% at Alamedin bridge (Bridge No.1) and 72% at Ala-Archa bridge (Bridge No.2). If the pile length is short, it makes lower resistance for load. As a conclusion of above reasons, the both bridge must be replaced immediately.

Keng-Burun bridge (down lane of Bridge No.14)

The superstructure of Keng-Burun bridge (down lane of Bridge No.14) is not parallel with a up lane of Bridge No.14 (New bridge). This situation is a large factor for the frequency of the traffic accidents at this site (Referred to Figure 2.2.2-5). The bridge be comes differential settlement totally. Especially it inclines to downstream side of the right bank. It is so dangerous for driving vehicles. The free board is lower about 20~45cm than a new bridge. It is necessary for the girder to rise up in order to keep required free board. The concrete of the main girder becomes deteriorated and is observed lots of damaged as shear cracks and exposed corrosion main re-bar. It means the load resistance becomes lower. The abutments and piers which are spread foundation become differential settlement. The width of pier top is too narrow than required a seismic level. Therefore, it is judged that the bridge has totally poor durability. As a conclusion of above reasons, Keng-Burun bridge (Bridge No.14 Outbound) must be replaced immediately.

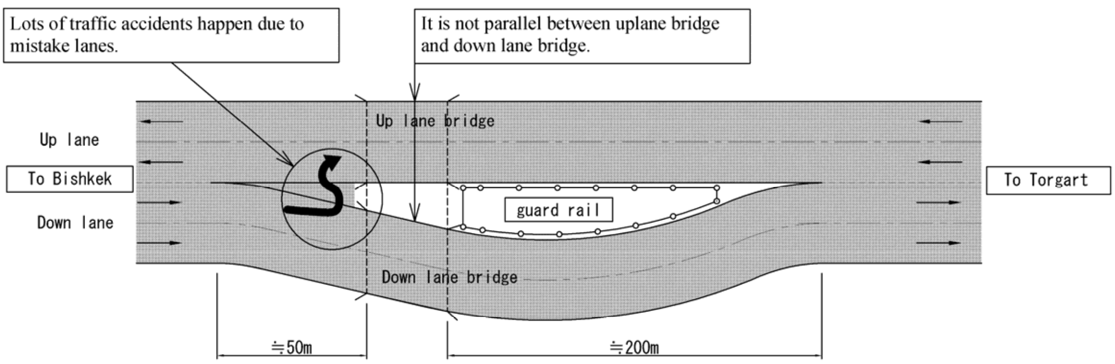


Figure 2.2.2-5 Road alignments plan at Keng-Burun bridge (Bridge No.14)

2.2.2.2 Design Concept

The following design standards are adapted to each design factors in consideration with particular conditions in Kyrgyz based on AASHTO which is well known in Central Asia.

Road Alignment: AASHTO is basically applied together with the consideration of Kyrgyz's Design Standard to match the existing road and natural condition.

Live load on superstructure: AASHTO is basically applied together with the consideration of "B" live load in Japan and armed car load "HK-80".

Design of bridges superstructure and substructure: Seismic design is based on Specifications for Highway Bridges (Japan Road Association) applied many times for Japan Grant Aid on the basis of discussion with Kyrgyz side because standards were not uniformed in implemented projects in Kyrgyz. Therefore, the above standard is adopted as the design of bridges superstructure and substructure to be uniformed with the seismic design. And, 0.1 of design horizontal seismic intensity in Kyrgyz standard was adopted as earthquake load.

(Design Guide lines to be applied)

- Bridge Design Standard in Kyrgyz
- Highway Design Standard in Kyrgyz
- Standard Specification for Highway Bridges (AASHTO, 2002)
- Specifications for Highway Bridges (Japan Road Association, 2002)

Main design conditions are set as follows:

Typical cross sections for each bridges are shown in 2.2.2.3, 2.2.2.4 and 2.2.2.5.

(1) Cross Section

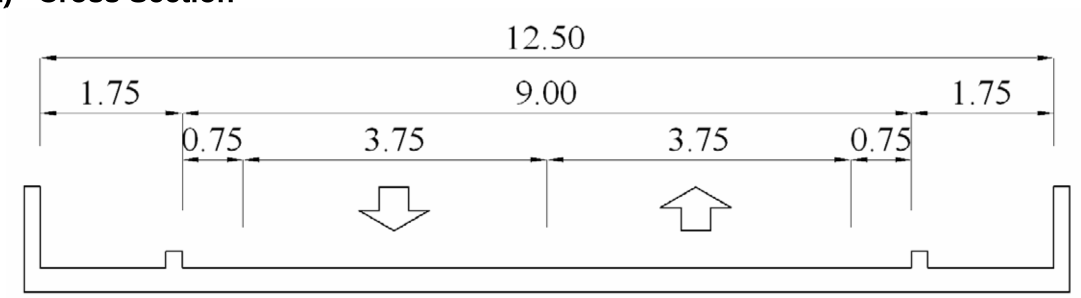


Figure 2.2.2-6 Cross Section of Alamedin Bridge (Bridge No.1) and Ala-Archa bridge (Bridge No.2)

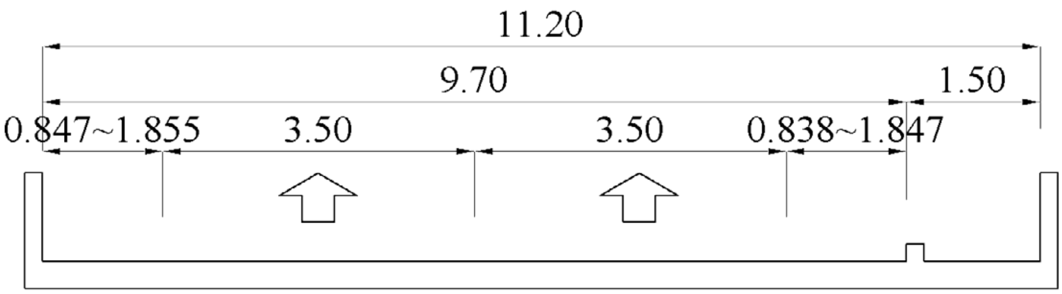


Figure 2.2.2-7 Cross Section of Ken-Burun bridge (Bridge No.14 Outbound)

(2) Design load

- Live load: B Live Load (Specifications in Japan) and HK-80 (Specifications in Kyrgyz)
- Changing range of temperature: 50℃ (-15℃～35℃)(Climate conditions in Kyrgyz)
- Regional seismic factor: kh=0.1 (Specifications in Kyrgyz)

(3) Material Properties

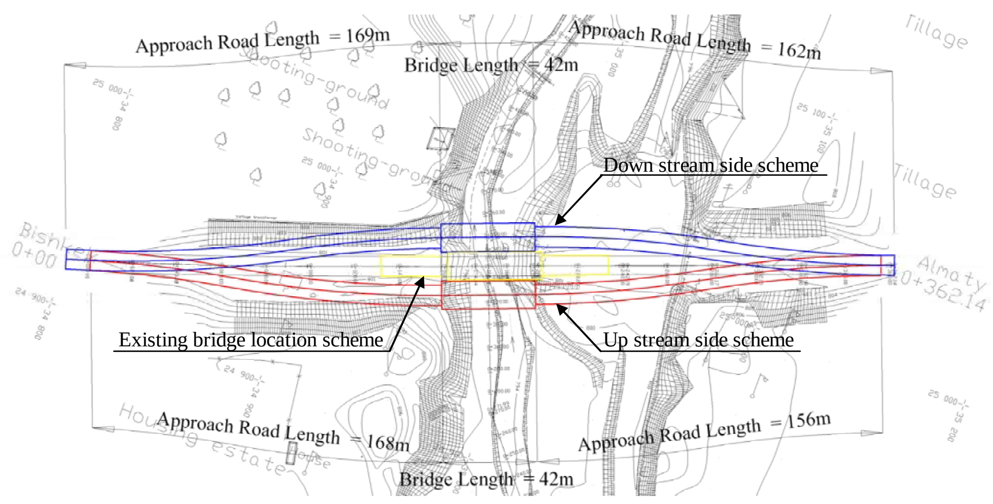
- Concrete structure
  PC Girder/RC Slab: more than 36N/mm^2
  Abutment・Pier・Approach cushion Slab: more than 25N/mm^2
  Cast in place pile: more than 25N/mm^2
- Reinforcement Bar (Re-bar): SD345 or equivalent (Russian made)

2.2.2.3 Design of Alamedin Bridge (Bridge No.1)

2.2.2.3.1 Selection of bridge location

Replacement at the existing bridge position which makes short length of approach roads and unnecessary of land acquisition.Table 2.2.2-6 shows the comparison in cases of upstream, existing and down stream of the bridge location.

Table 2.2.2-6 Analysis of the bridge location for Alamedin bridge (Bridge No.1)

Plan			
Bridge location	Up stream side scheme	Existing bridge location scheme	Down stream side scheme
Bridge length (m)	42	42	42
Total length of approach roads (m)	324	60	331
Removal of the existing bridge	No	Necessary	No
Advantage/ Disadvantage	Advantage: The removal of the existing bridge is the responsibility of Kyrgyz side. Disadvantage: Lot for the approach roads is required. The length of approach roads becomes longer with	Advantage: Unnecessary for approach road lot and the length of approach roads becomes shorter. Disadvantage: Necessary the cosat for the removal of the existing bridge.	Advantage: The removal of the existing bridge is the responsibility of Kyrgyz side. Disadvantage: Lot for the approach roads (including shooting range) is required. The length of approach roads
Evaluation	△	○	×

2.2.2.3.2 Scope of Works for the Project

The Project covers following works;

- Removal of the existing bridge
- New bridge construction
- Bank protection
- Pavement of approach roads
- Road marking

2.2.2.3.3 Bridge planning

(1) Abutment location, Bridge length, Bridge hight

Bridge length is set on 42.0m (14.0m × 3 spans) as same length as the existing bridge. This length is satisfied with the flow capacity.

The location of Abutment is set at 3.0m to right bank side for both Abutments to avoid the foundation piles of the existing bridge.

(2) Design high water level and vertical clearance

Design high water level is determined based on the interview survey of maximum water level and normal water level. Vertical clearance is 2.5m which is satisfied with minimum vertical clearance (1.0m).

(3) Cross section

The cross section for Alamedin bridge is shown in Figure 2.2.2-8. The Plan for the bridge is shown in Figure 2.2.2-9. The road which the bridge is located on is classified as Category Ⅱ in Road Specification in Kyrgyz. The road width of the existing road is 9.0m (Shoulder width: 0.75m + traffic lane width: 2 × 3.75m + shoulder width: 0.75m) with an unpaved shoulder 3.0m for both sides.

The design bridge cross section is set as the same as the existing road one.

The shoulder width is set as the minimum width (2.5m = 0.75 + 1.75) to ensure the traffic safety.

Concrete block is set as meted vided between side walk and traffic lane for pedestrian's safety.

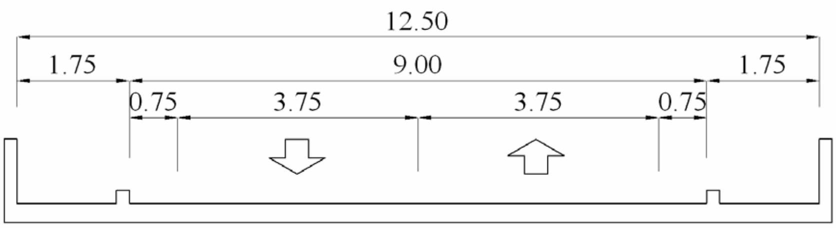


Figure 2.2.2-8 Cross section of Alamedin bridge (Bridge No.1)

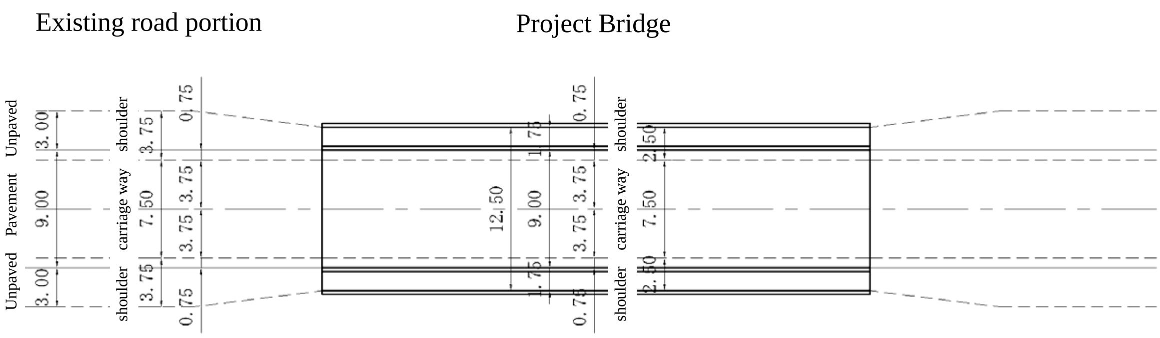


Figure 2.2.2-9 Plan of Alamedin bridge (Bridge No.1)

(4) Span length

The span length is set as the same as the existing bridge span (14.0m) due to no obstacles like driftwood result on the interview survey.

(5) Superstructures

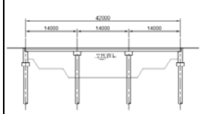
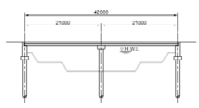
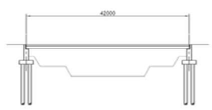
The most appropriate type is selected in consideration of various factors including economical efficiency, constructability, maintenance difficulty, environmental impacts, geometrical alignment and durability. The candidate of bridge type are shown in followings.
Pre-cast RCT girder and pre-tension concrete hollow girder fabricated in Kyrgyz are excluded from the comparison because of the poor reliability which is the result of the survey at the bridge sites and the factory.

- Scheme-1: 3 spans, simple PC-I Girder
- Scheme-2: 2 spans, simple PC-I Girder
- Scheme-3: 2 spans, simple Steel Plate Girder
- Scheme-4: Simple PC-I Girder
- Scheme-5: Simple Steel Truss Bridge

Table 2.2.2-7 shows the comparison of the bridge type. Scheme-1 is the best in the comparison. The superstructure type is set as follows:

The most appropriate superstructure type: 3 spans, simple PC-I Girder
Span interval: 3 × 14.0m = 42.0m

Table 2.2.2-7 Comparison of Bridge Type for Alamedin bridge (Bridge No.1)

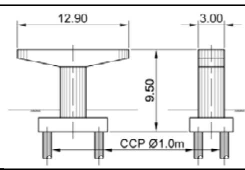
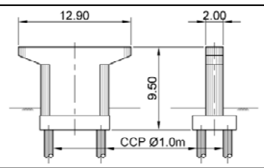
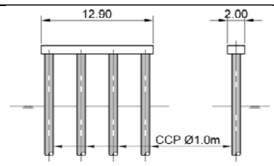
Superstructure Type	Scheme 1: 3 Span	Scheme 2: 2 Span		Scheme3: Single Span	
	PC I Girder 14.0+14.0+14.0=42.0m	2-1: PC I Girder 2@21.0=42.0m	2-2: Steel Plate Girder 2@21.0=42.0m	3-1: Simple PC Hollow Girder 42.0m	3-2: Simple Steel Truss 42.0m
Side View	 	 		 	
Bridge Location	The location of a new bridge replacement is got just about the existing bridge.				
Structural Characteristics	・Reduction load for substructure by short span ・High aseismicity with connecting bridges ・Adaptable to AASHTO typical cross section ・Low height of girder	・Reduction load for substructure by short span ・High aseismicity with connecting bridges ・Adaptable to AASHTO typical cross section	・Low net weight, reduction load to substructure ・Advantage for aseismicity	・Large net weight, large load to substructure ・Disadvantage for aseismicity ・Strong for bending moment and twisting moment	・Light structure member ・Advantage for aseismicity ・Long span constructed with small amount of steel
	Result: ○	Result: ○	Result: ○	Result: △	Result: ○
Hydrological Characteristics	・Securing clearance at flood ・Minimum span (15m), improvement of the present bridge ・Blocking rate of flow at food is 5 %.	・Securing clearance at flood ・Satisfy for minimum span spec. ・Blocking rate of flow at food is 3 %.	・Securing clearance at flood ・Satisfy for minimum span spec. ・Blocking rate of flow at food is 3 %.	・Securing clearance at flood ・Blocking rate of flow at food is 0 %.	・Securing clearance at flood ・Blocking rate of flow at food is 0 %.
	Result: △	Result: △	Result: △	Result: ×	Result: ○
Constructability	・Utilization of truck crane ・No difficulty on construction	・Utilization of truck crane ・No difficulty on construction	・Utilization of truck crane ・No difficulty on construction	・Fixed supporting ・Difficulty of bridge work at rainy season	・Bent method with track crane ・Small scale facility for bridge work, easy transportation ・Much fabrication work at site
	Result: ○	Result: ○	Result: ○	Result: ×	Result: ○
Procurement	・Concrete at local procurement ・PC strand and re-bar in Japan or third country	・Concrete at local procurement ・PC strand and re-bar in Japan or third country	・Concrete at local procurement ・PC strand and re-bar in Japan or third country	・Concrete at local procurement ・PC strand and re-bar in Japan or third country	・Concrete at local procurement ・PC strand and re-bar in Japan or third country
	Result: △	Result: △	Result: △	Result: △	Result: △
Environmental impacts as detour road	・Setting a detour bridge during construction ・Few natural destruction, no resettlement	・Setting a detour bridge during construction ・Few natural destruction, no resettlement	・Setting a detour bridge during construction ・Few natural destruction, no resettlement	・Setting a detour bridge during construction ・Few natural destruction, no resettlement	・Setting a detour bridge during construction ・Few natural destruction, no resettlement
	Result: ○	Result: ○	Result: ○	Result: ○	Result: ○
Maintenance Requirement	・Required maintenance is free due to concrete structure	・Required maintenance is free due to concrete structure	・Atmospheric-corrosion-resistance Steel is adapted.	・Required maintenance is free due to concrete structure	・Atmospheric-corrosion-resistance Steel is adapted.
	Result: ○	Result: ○	Result: △	Result: ○	Result: △
Construction Duration	・Site work is shorter than Scheme 3-1.	・Site work is the shortest.	・Site work is the shortest.	・Site work is the longest.	・Site work is a little longer than Scheme 1.
	Result: ○	Result: ○	Result: ○	Result: ×	Result: △
Cost	・Most economical (1.0)	・Economical (1.05)	・More costly than Scheme 1 (1.1)	・Most costly (1.5)	・Costly (1.4)
	Result: ◎	Result: △	Result: △	Result: ×	Result: ×
Total Evaluation	◎	○	△	×	△

2.2.2.3.4 Substructures

- Abutment Type: Inverted-T type abutment is adapted in considering with economy and popular.
- Pier type: 3 types are compared as Pile type.
  - Scheme-1: T type pier
  - Scheme-2: Wall type pier
  - Scheme-3: Pile bent pier

Table 2.2.2-8 shows the comparison of pier type. The pile bent pier, which is considering with the scale of the bridge, structural characteristic and construction cost, is the best in the comparison.

Table 2.2.2-8 Comparison of pier type for Alamedin bridge (Bridge No.1)

	Scheme 1: T type pier	Scheme 2: Wall type pier	Scheme 3: Pile bent pier
Cross Section			
Structural Feature	・Diameter of colum is more than the thickness of wall type pier (Diameter: large) ・Overhanging length is large, girder height is high, required large amount of re-bar ・Adapted to narrow width bridge	・Possible to be thin of wall thickness (Wall thickness: medium) ・Overhanging length is short, girder height is low, required small amount of re-bar ・Adapted to large scale bridge due to large amount of concrete and re-bar ・Adapted to wide width bridge	・Upper portion of pile is utilized for a girder. (Diameter: small) ・Overhanging length is short, girder height is low, required small amount of re-bar. ・Commutation wall between piers ・Adapted to small or medium scale bridge ・Responsibility of aseismicity in spite of pile top horizontal displacement
	Result: ×	Result: ×	Result: ○
Hidrological Characteristics	・Adapted to inconstant flow river ・Blocking rate of flow at flood is large (app. 15%)	・Adapted to constant flow river ・Blocking rate of flow at flood is medium (app. 10%)	・Setting commutation wall to make smooth flow ・Blocking rate of flow is minimum (app. 5%)
	Result: ×	Result: △	Result: △
Constructability	・Required coffering at construction ・Supporting, form, bar-arrangement are complecated due to long overhanging ・Large scale excavation for footing	・Required coffering at construction ・Large amount of construction materials ・Large scale excavation for footing	・Unnecessary coffering at construction ・Small amount of construction materials ・High construction accuracy required for pile ・No excavation due to no footing
	Result: △	Result: △	Result: ○
Procurement	・Concrete at local procurement ・Required imported re-bar	・Same as Scheme 1	・Same as Scheme 1
	Result: ○	Result: ○	Result: ○
Environmental Impacts	・No river contamination ・Attention to incidence of noise and vibration	・Same as Scheme 1	・Same as Scheme 1
	Result: ○	Result: ○	Result: ○
Construction Duration	・Work duration is long.	・Work duration is long.	・Work duration is short.
	Result: ×	Result: ×	Result: ○
Cost	・Costly (3.2)	・Costly (3.0)	・Most economical (1.0)
	Result: ×	Result: ×	Result: ○
Total Evaluation	△	○	◎

- Foundation type

  Foundation type is selected in consideration of the scale of bridge, soil conditions, economical efficiency. Square type RC pile (30cm × 35cm), which is fabricated in Kyrgyz, is excluded from the candidates due to the poor quality and reliability.
  - Scheme-1: Cast in place concrete pile

– Scheme-2: Pile bent
– Scheme-3: Board pile

Table 2.2.2-9 shows the comparison of pile type. Cast in place concrete pile is the best in consideration of low pollution and economic efficiency.

2.2.2.3.5 Revetment

- Revetment type

Revetment is set for the reinforcement to prevent the river from further eroding and meandering. The revetments around the bridge is proposed to protect the abutments.

Table 2.2.2-10 shows the comparison of revetment type. Grouted riprap, which is economical and durable, is adapted around abutments. Gabion is adopted for the protection of river erosion.

Table 2.2.2-9 Comparison of foundation type for Alamedin bridge (Bridge No.1)

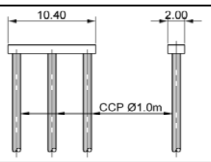
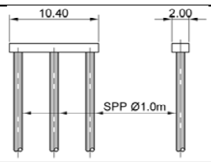
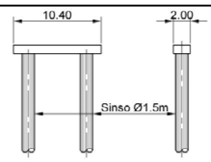
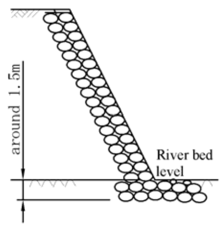
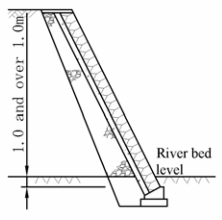
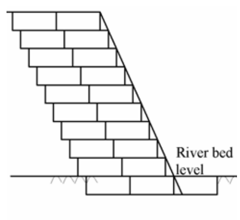
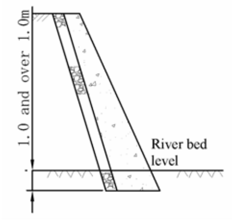
	Scheme 1: Cast in place foundation	Scheme 2: Pile bent foundation	Scheme 3: Caisson type pile foundation
Cross Section			
Structural Charactalistics	・Lange bore hole excavation pile (diameter: more than 1m) ・Large vertical bearing capacity and horizontal resistance force ・Adapted to friction pile due to large skin friction pile due to large skin friction resistance ・Quality of pile depends on working ability by contractor	・Medium bore hole driving pile (diameter: more than 0.8m) ・Medium vertical bearing capacity and horizontal resistance force ・Large resistance at tip of pile, adapted to bearing pile ・Suitable quality due to factory product	・Large bore hole excavation pile by man power ・Large vertical bearing capacity and horizontal resistance force ・Excellent resistance at tip of pile ・Direct observation at bearing stratum
	Result： ○	Result： ○	Result： ○
Constructability	・Importance for construction supervision at excavation work ・Necessity for fabrication yard to temporary fatilities and re-bar basket ・High safety during construction ・Unnecessary of large yard for construction	・Importance for penetration control at pile driving ・Necessity for working yard of driving machine and space for pile keeping ・High safety due to much achievement ・necessity for large yard due to big construction equipment	・Importance for submerging work control at construction ・Necessity for working yard to temporary facilities and re-bar basket ・High safety during construction, unsuitable to ground surting ground wate
	Result： ○	Result： ○	Result： △
Procurement	・Pile excavation machine and construction facilities are procured from Japan or third country ・Pile foundation fabricated by cast in place concrete ・Available local concrete ・utilizing imported re-bar	・Pile excavation machine and construction facilities are procured from Japan or third country ・Pile foundation fabricated by cast in place concrete ・Pile bent is a factory product in Japan ・Available local concrete or third country	・Construction facilities are procured from Japan or third country ・Caisson fabricated by cast in place concrete ・Available local concrete ・Imported re-bar
	Result： △	Result： △	Result： △
Environmental Impacts	・Low negative impacts due to a little noise and vabration during construction ・Required treatment against water pollution and industrial waste at excavation work (soluble)	・High negative impacts by large noise and vibration during construction ・Unnecessary treatment against induserial waste due to few soil excavation	・Low negative impacts due to a little noise and vabration during construction ・Required treatment against industrial wast due to large soil excavation
	Result： ○	Result： ×	Result： △
Construction Duration	・Working period is short due to small number of piles. Work is done during summer season	・Working period is short due to small number of piles. Work is done during summer season	・Working period is longer due to inner excavation system and submery method. Working is not done during summer season
	Result： ○	Result： ○	Result： ×
Cost	・Most Economical (1.0)	・Little costly than Scheme 1 (1.0)	・Costly (4.4)
	Result： ○	Result： ×	Result： ×
Total Evaluation	◎	△	×

Table 2.2.2-10　Comparison of revetment type for Alamedin bridge (Bridge No.1)

<table>
<tr><td colspan="2"></td><td colspan="2">Dry masonry</td><td colspan="2">Grouted riprap</td><td colspan="2">Gabion</td><td colspan="2">Leaning type retaining wall</td></tr>
<tr><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">Cost</td><td colspan="2">1.0</td><td colspan="2">1.4</td><td colspan="2">1.3</td><td colspan="2">1.8</td></tr>
<tr><td colspan="2">Construction Duration</td><td colspan="2">1.0</td><td colspan="2">1.8</td><td colspan="2">1.5</td><td colspan="2">1.7</td></tr>
<tr><td colspan="2">Constructability</td><td colspan="2">・Necessity of same large size stones
・Difficulty at workmanship control</td><td colspan="2">・Necessity of sufficient compaction control</td><td colspan="2">・Easy construction due to much achievement</td><td colspan="2">・Ordinary concrete structure</td></tr>
<tr><td colspan="2">Durability</td><td colspan="2">・Easy damaged by the movement of stones
・Most dangerous for backfill soil during water reducing
・Less durable</td><td colspan="2">・Very durable due to less damaged to back fill soil
・Solid structure</td><td colspan="2">・Dangerous for back fill soil during water reducing
・Easy corrosion of steel wire</td><td colspan="2">・Most solid structure
・Very durable</td></tr>
<tr><td colspan="2">Environmental Impacts</td><td colspan="2">・Various kinds of life can grow inside due to much opening</td><td colspan="2">noting particular</td><td colspan="2">Nothing particular</td><td colspan="2">Nothing particular</td></tr>
<tr><td rowspan="2">maintenance</td><td>Checking points</td><td colspan="2">・Flowing out of back fill soil
・Movement and lack of stones</td><td colspan="2">・Troubles or changes like cracks, peeling, sliding</td><td colspan="2">・Flowing out of back fill soil
・Deformation of basket
・Lack of stone
・Corrosion of steel wire</td><td colspan="2">・Troubles or changes like cracks, inclination, sliding</td></tr>
<tr><td>Repair Method</td><td colspan="2">・Reset, repair</td><td colspan="2">・Removal of trouble portion and reconstruction</td><td colspan="2">・Reset, repair</td><td colspan="2">・Removal of trouble portion and reconstruction</td></tr>
<tr><td rowspan="2">Adaptability for the Project</td><td>Abutment and surround</td><td>・Strength poverty due to present river bed erosion</td><td>×</td><td>・Costly than Gabion
・Most appropriate scheme due to very durable and large strength</td><td>○</td><td>・Costly</td><td>△</td><td>・Costly</td><td>△</td></tr>
<tr><td>River bank erosion control</td><td>・Strength poverty due to present river bank erosion</td><td>×</td><td>・Economical but less durable and strength poverty</td><td>△</td><td>・Most appropriate scheme due to large strength, durable and economical</td><td>○</td><td>・Costly</td><td>×</td></tr>
</table>

2.2.2.3.6　Approach roads and ancillary facilities design

(1)　Approach roads design

It is unnecessary to improve the road alignment due to the replaced new bridge will be located at the existing road and the bridge high will be the same high of the existing road.

The working limits of approach roads is set the area (Left bank side 30m + Right bank side 30m = Total 60m) which is the back fill are a for the abutment and has a possibility road to be damaged during construction with heavy equipment.

The traffics lane width and the cross fall is adapted to the existing road.

(2)　Pavement design

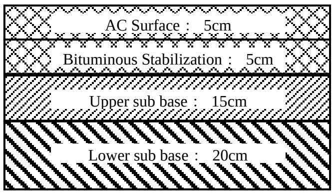
Pavement structures are decided based on the required pavement structure numbers (SN) which are calculated from the results of the traffic survey by WB and the axial load survey at JICA's preliminary study.

Condition for the pavement design are as follows:

- Performance period: 10 years
- Traffic load: 0.087 (the calculation from the results of the preliminary study)
- Reliability: 80％

- Sub grade CBR: 3 (Sub grade materials will be replaced. The design CBR of the existing road is 2.)

Required pavement structure numbers (SN) are calculated by the above conditions. 2,990 is the result of the calculation and the following pavement structures is adapted to SN = 2,990.

<table>
<tr><th>Pavement structure</th><th colspan="6">Pavement structure number</th></tr>
<tr><td rowspan="6">
</td><td colspan="2">Layer</td><td>Thickness
D
(inch)</td><td>Layer coefficient
a</td><td>Drainage coefficient
m</td><td>Structure number
SN=Dam</td></tr>
<tr><td>AC Surface</td><td>5cm</td><td>1.968</td><td>0.390</td><td>－</td><td>0.768</td></tr>
<tr><td>Bituminous Stabilization</td><td>5cm</td><td>1.968</td><td>0.390</td><td>－</td><td>0.591</td></tr>
<tr><td>Upper sub base</td><td>15cm</td><td>5.906</td><td>0.135</td><td>1.0</td><td>0.797</td></tr>
<tr><td>Lower sub base</td><td>20cm</td><td>7.874</td><td>0.108</td><td>1.0</td><td>0.850</td></tr>
<tr><td colspan="2">Total</td><td></td><td></td><td></td><td>3.006</td></tr>
</table>

Road shoulders have gravel pavement as the existing road.
The sub grade materials are adapted to crushed stone (60cm thickness) up to 1m depth due to frozen soil.

(3) Road marking

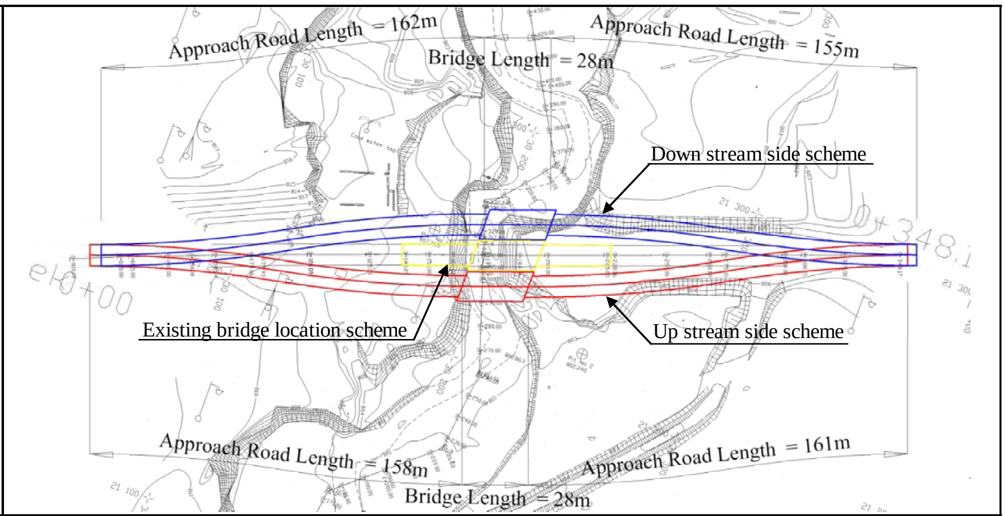
Side line is set on the approach roads and the bridge deck. The centerline is not marked due to no marking on the existing road and bridge.

2.2.2.4 Design of Ala-Archa bridge (Bridge No.2)

2.2.2.4.1 Selection of the bridge location

Replacement at the existing bridge location which makes short length of approach roads and unnecessary of land acquisition.
Table 2.2.2-11 shows the comparison of the bridge locations in the cases of upstream side, existing location and downstream side.

Table 2.2.2-11 Analysis of the bridge location for Ala-Archa bridge (Bridge No.2)

Plan			
Bridge location	Up stream side scheme	Existing bridge location scheme	Down stream side scheme
Bridge length (m)	28	28	28
Total length of approach roads (m)	319	60	317
Removal of the existing bridge	No	Necessary	No
Advantage/ Disadvantage	Advantage: The removal of the existing bridge is the responsibility of Kyrgyz side. Disadvantage: Lot for the approach roads is required. The length of approach roads becomes longer with large amount of cutting.	Advantage: Unnecessary for approach road lot and the length of approach roads becomes shorter. Disadvantage: Necessary the cost for the removal of the existing bridge.	Advantage: The removal of the existing bridge is the responsibility of Kyrgyz side. Disadvantage: Lot for the approach roads (including shooting range) is required. The length of approach roads becomes longer with large amount of embankment.
Evaluation	×	○	△

2.2.2.4.2 Scope of works

The Project covers following works;

- Removal of the existing bridge
- New bridge construction
- Revetment
- Pavement of approach roads
- Road marking

2.2.2.4.3 Bridge planning

(1) Abutment location, Bridge length, Bridge height

Bridge length is set on 28.0m (single span) as the same length as the existing bridge. This length is satisfied with the flow capacity.

The location of the Abutment is set at about 10.0m to right bank side in considering with the erosion at surrounding river bank not to disturb the river flow.

The height of the bridge deck is the same as the existing one.

(2) Design high water level and vertical clearance

Design high water level is determined based on the interview survey of previous maximum water level and normal water level. Vertical clearance is 2.5m which is satisfied with minimum vertical clearance (1.0m).

(3) Cross section

The cross section of Ala-Archa bridge (Bridge No.2) is shown in Figure 2.2.2-10. The Plan for the bridge is shown in Figure 2.2.2-11.

The road, which the bridge is located on, is classified as Category Ⅱ as well as Alamedin bridge (Bridge No.1) in Road Specification in Kyrgyz.

The road width of the existing road is 9.0m (shoulder width: 0.75m + traffic lane width: 2 × 3.75m + shoulder width: 0.75m) with an unpaved shoulder 3.0m for both sides.

The design bridge cross section is set as the same as the existing one. The shoulder width is set as the minimum width (2.5m = 0.75 + 1.75).

To ensure the traffic safety. Concrete blocks are set as mete divided between side walk and traffic lane for pedestrian’s safety.

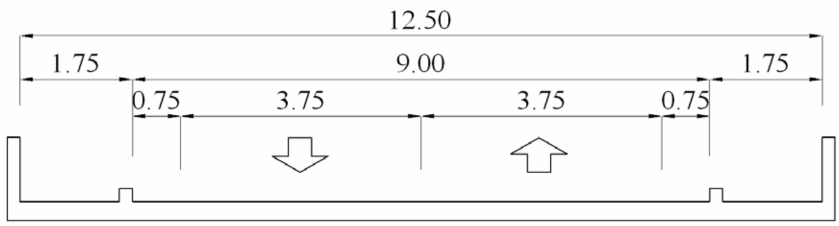


Figure 2.2.2-10 Cross section of Ala-Archa bridge (Bridge No.2)

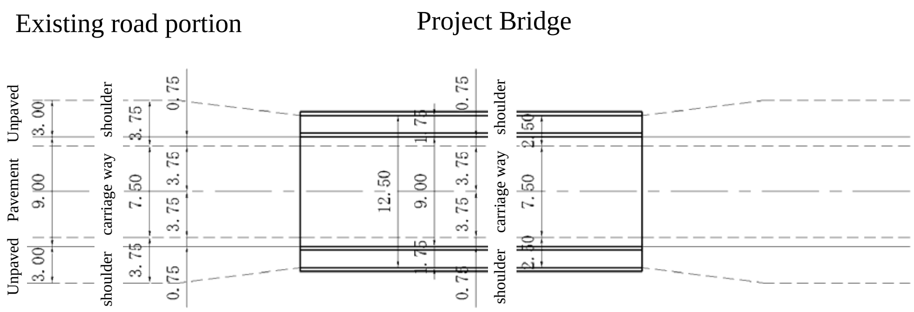


Figure 2.2.2-11 Plan of Ala-Archa bridge (Bridge No.2)

(4) Span length

The span length is set as the same as the existing bridge span (28.0m).

(5) Superstructures

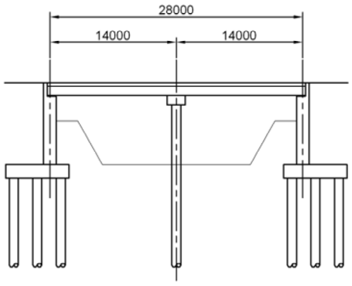
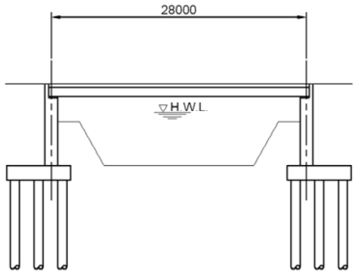
The most appropriate type is selected in consideration of various factors including economical efficiency, constructability, maintenance difficulty, environmental impacts, geometrical alignment and durability. The candidate of bridge type are shown in followings.
Pre-cast RCT girder and pre-tension concrete hollow girder fabricated in Kyrgyz are excluded from the comparison because of the same reason as Alamedin bridge (Bridge No.1).

- Scheme-1: 2 spans, simple PC-I Girder
- Scheme-2: Single span
- Scheme-3: Single span

Table 2.2.2-12 shows the comparison of the bridge type. Scheme-2 is the best in the comparison. The superstructure type is set as follows:

The most appropriate superstructure type: Single span PC-I Girder
Span interval: 28.0m

Table 2.2.2-12　Comparison of Bridge Type for Ala-Archa bridge (Bridge No.2)

	2 Spans	Single Span	
	Scheme 1: PC-I Girder 2@14.0=28.0m	Scheme 2: PC-I Girder 28.0m	Scheme 3: Steel Plate Girder 28.0m
Side View			
Bridge Location	Bridge location is set on 10m towards Almaty side in consideration with the river condition		
Structural Feature	･Reduction load for substructure by standard span ･High aseismicity with bridge connecting ･Adaptable to AASHTO typical cross section ･low height of girder	･Structural members are relatively heavy weight ･No problem with aseismicity ･Adaptable to AASHTO typical cross section ･High height of girder but keeping sufficient clearance	･Structural members are light weight ･Advantage with a seismicity ･Atmospheric-corrosion-resistance steel is required
	Result: ○	Result: ○	Result: ○
Hydrological Characteristics	･Scoaring abutments and collapsing revetment are occurred due to the bridge crosses the narrow and curved point. River channel improvement and revetment is required due to some flood is recorded once out of every several years.		
	･Securing clearance during floods ･Blocking rate of flow is 5%	･Securing clearance during floods ･better flow capability due to no pier ･Blocking rate of flow is 0%	･Securing clearance during floods ･Better flow capability due to no pier ･Blocking rate of flow is 0%
	Result: ○	Result: ○	Result: ○
Constructability	･Utilization of truck crane ･Necessity of cofferdam during pier construction	･Utilization of truck crane ･No difficulty on construction	･Utilization of truck crane ･No difficulty on construction
	Result: △	Result: ○	Result: ○
Procurement	･Concrete at local procurement ･PC steel materials and re-bar in Japan or third country	･Concreate at local procurement ･PC steel materials and re-bar in Japan or third country	･Concrete at local procurement ･PC steel materials and re-bar in Japan or third country
	Result: △	Result: △	Result: △
Environmental Impacts	･Setting a detour bridg during construction ･Minimal natural destruction and no resettlement	･Setting a detour bridg during construction ･Minimal natural destruction and no resettlement	･Setting a detour bridg during construction ･Minimal natural destruction and no resettlement
	Result: ○	Result: ○	Result: ○
Maintenance Requirement	･Required maintenance is free due to concrete structure	･Required maintenance is free due to concrete structure	･Corrosion control is required
	Result: ○	Result: ○	Result: △
Construction Duration	･A little longer than a single span scheme	･Shorter than 2 spans scheme	･Shorter than 2 spans scheme
	Result: △	Result: ○	Result: ○
Cost	･Economical (1.0)	･Economical (1.0)	･More costly than scheme 2 (1.1)
	Result: ○	Result: ○	Result: ×
Total Evaluation	△	◎	×

(6) Substructure

- Abutment type: Inverted-T type abutment is adapted in considering with economical.

- Foundation type:

  Foundation type is selected in consideration of the scale of bridge, soil conditions, economical efficiency. Square type RC pile (30cm × 35cm), which is fabricated in Kyrgyz, is excluded from the candidates due to the poor quality and less reliability.

  - Scheme-1: Cast in place concrete pile
  - Scheme-2: Pile bent
  - Scheme-3: Board pile

  Table 2.2.2-13 shows the comparison of pile type. Cast in place concrete pile is the best in consideration of low pollution and economic efficiency.

(7) Revetment

- Revetment is set for the reinforcement to prevent the river from further eroding and meandering. The river channel near the river bank at the Abutment is improved to get smooth flow.

  It has a little disturbance to flow due to avoid longer bridge length in consideration with economical efficiency.

  Table 2.2.2-14 shows the comparison of revetment types. Grouted riprap is adapted to the around of Abutment, Leaving type retailing wall is especially adapted to the portion of flow disturbance. Gabion is adapted to erosion control of river bank.

Table 2.2.2-13 Comparison of foundation type for Ala-Archa bridge (Bridge No.2)

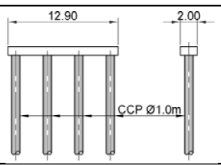
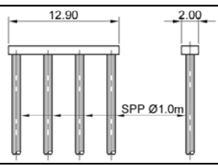
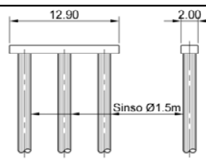
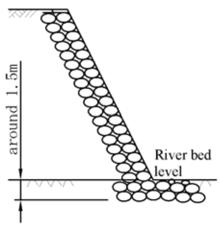
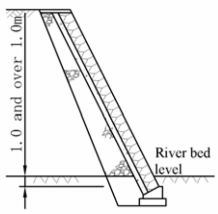
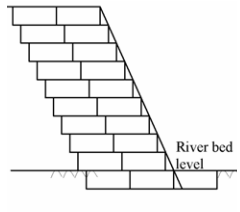
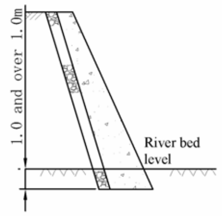
	Scheme 1: Cast in place foundation	Scheme 2: Pile bent foundation	Scheme 3: Caisson type pile foundation
Cross Section			
Structural Characteristics	・Large bore hole excavation pile (diamoter: more than 1m) ・Large vertical bearing capacity and horizontal resistance force ・Adapted to friction pile due to large skin friction resistence ・Quality of pile depends on working a bility by contractor	・Medium bore hole driving pile (diamoter: more than 0.8m) ・Medium vertical bearing capacity and horizontal resistence force ・Large resistence at tip of pile, adapted to bearing pile ・Suitable quality due to factory product	・Large bore hole excavation pile by man power (diameter: more than 1.5m) ・Large vertical hearing capacity and horizontal resistence force ・Fabrication of foundation at field (cast in place) ・Direct observation at bearing stratum
	Result: ○	Result: ○	Result: ○
Constructability	・Importance for construction supervision st excavation work ・Necessity for fabrication yard to temporary facilities and re-bar basket ・High safety during construction	・Importance for penetration control at pile driving ・Necessary for working yard of driving machine and space for pile keeping ・High safety during construction ・Necessity for large yard due to big construction equipment	・Importance for submerging work control at construction ・Necessity for working yard to temporary facilities and re-bar basket ・High safety during construction, unsuitable to ground spurting ground water
	Result: ○	Result: ○	Result: ○
Procurement	・Pile excavation machine and construction facilities are procured from Japan or third country ・Pile foundation fabricated by cast in place concrete ・Arailable local concrete ・Utilizing imported re-bar	・Pile excavation machine and construction facilities are procured from Japan or third country ・Pile bent is a factory proclict in Japan or third country ・Arailable local concrete ・Utilizing imported re-bar	・Construction facilities are procured from Japan or third country ・Cassion fabricated by cast in place concrete ・Available local concrete ・Utilizing imported re-bar
	Result: △	Result: △	Result: △
Environmental Impacts	・Low negative impacts due to a little noise and vabration at ・Required treatment against water pollution and industrial waste at excavation work (soluble)	・High negative impacts by large noise and vibration during construction ・Unnecessary treatment against industrial waste due to few soil excavation	・Low negative impacts due to a little noise and vabration during construction ・Required treatment against imdustrial waste due to large soil excavation
	Result: ○	Result: ×	Result: △
Construction Duration	・Working period in short due to small number of piles. Work is done during summer season	・Working period in short due to small number of piles. Work is done during summer season	・Working period is longer due to inner excavation systme and submerged method. Working is not done during summer season
	Result: ○	Result: ○	Result: ×
Cost	・Most economical (1.0)	・Almost same as scheme 1 (1.0)	・Costly (3.3)
	Result: ○	Result: ×	Result: ×
Total Evaluation	◎	△	×

Table 2.2.2-14 Comparison of revetment type for Ala-Archa bridge (Bridge No.2)

		Dry masonry	Grouted riprap	Gabion	Leaning type retaining wall
					
Cost		1.0	1.4	1.3	1.8
Construction Duration		1.0	1.8	1.5	1.7
Constructability		・Necessity of same large size stones ・Difficulty at workmanship control	・Necessity of sufficient compaction control	・Easy construction due to much achievement	・Ordinary concrete structure
Durability		・Easy damaged by the movement of stones ・Most dangerous for backfill soil during water reducing	・Solid structure and less damaged to back fill soil	・Dangerous for back fill soil during water reducing ・Easy corrosion of steel wire	・Most solid structure ・Very durable
Environmental Impacts		・Various kinds of life can grow inside due to much opening	noting particular	Nothing particular	Nothing particular
maintenance	Checking points	・Flowing out of back fill soil ・Movement and lack of stones	・Troubles or changes like cracks, peeling, sliding	・Flowing out of back fill soil ・Deformation of basket ・Lack of stone ・Corrosion of steel wire	・Troubles or changes like cracks, inclination, sliding
	Repair Method	・Reset, repair	・Removal of trouble portion and reconstruction	・Reset, repair	・Removal of trouble portion and reconstruction
Adaptability for the Project	Abutment and surround	・Strength poverty due to present river bed erosion ×	・Costly than Gabion ・Most appropriate scheme due to very durable and large strength ○	・Costly △	・Costly △
	River bank erosion control	・Strength poverty due to present river bank erosion ×	・Economical but less durable and strength poverty △	・Most appropriate scheme due to large strength, durable and economical ○	・Costly ×

2.2.2.4.4 Approach roads and ancillary facilities design

(1) Approach road design

It is unnecessary to improve the road alignment due to the replaced new bridge will be located at the existing road and the bridge high will be the same high of the existing road.

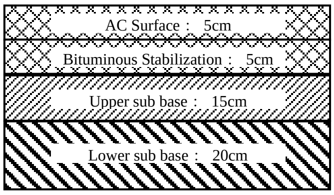
The working limits of approach roads is set the area (Left bank side 30m + right bank side 30m = Total 60m) which is the back fill are a for the abutment and has a possibility road to be damaged during construction with heavy equipment.

The traffic lane width and the cross fall is adapted to the existing road.

(2) Pavement design

The pavement structures are decided based on the same conditions as Alamedin bridge (Bridge No.1) with the traffic volume data at Ala-Archa bridge (Bridge No.2).

The required structure number (SN) is 2,766 and the following pavement structures is adapted to SN = 2,766.

Pavement structure	Pavement structure number				
	Layer	Thickness D (inch)	Layer coefficient a	Drainage coefficient m	Structure number SN=Dam
	AC Surface 5cm	1.968	0.390	―	0.768
	Bituminous Stabilization 5cm	1.968	0.390	―	0.591
	Upper sub base 15cm	5.906	0.135	1.0	0.797
	Lower sub base 20cm	7.874	0.108	1.0	0.850
	Total				3.006

Road shoulders have gravel pavement as the existing road.

The sub grade materials are adapted to crashed stone (60cm thickness) up to 1m depth due to frozen soil.

(3) Road marking

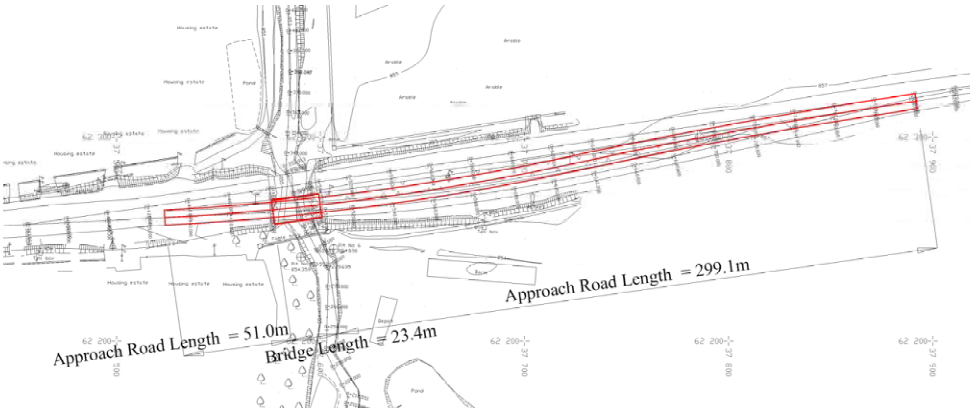
Side line is set on the approach roads and the bridge deck. The center line is not marked due to no marking on the existing road and the bridges.

2.2.2.5 Design for Keng-Burun bridge (Bridge No.14)

2.2.2.5.1 Selection of the bridge location

The down lane bridge at upstream side is replaced among the 2 bridges divided for up and down lanes. The location of the bridge is set on the existing bridge location due to not lane acquisition in considering with the road alignment. A lot of traffic accident happen at the bridge in wrong alignment and poor traffic safety facilities. The bridge for the replacement is set on a parallel with the up lane bridge. The approach roads also are improved. The analysis of the bridge location are shown in Table 2.2.2-15.

Table 2.2.2-15 The analysis of the location for Keng-Burun bridge (Bridge No.14 Outbound)

Plan	
Bridge location	Existing bridge location
Bridge length (m)	23.4
Total length of approach roads (m)	350.1
Removal of the existing bridge	Necessary
Charactaristics	The bridge replacement at the existing bridge location is available in order to utilize the up lane bridge (2 lanes) for a detour during construction the bridge for the replacement is set on a parallel with the up lane bridge. The approach roads also are improved.

2.2.2.5.2 Scope of works

Total replacement of the existing bridge is required based on the survey results. The project covers the following works in order to secure the traffic safety and the replacement location is set at the existing bridge.

- Removal of the existing bridge
- New bridge construction
- Pavement on approach roads
- Road marking
- Other ancillary facilities (guide post, lighting)

2.2.2.5.3 Bridge planning

(1) Abutment location, Bridge length, Bridge height

Bridge length is set on 23.4m as the similar length as the existing bridge (25.5m). This length is satisfied with the flow capacity. The location of the Abutment is set on the inside of the existing Abutment to avoid the foundation of the existing bridge. The height of the bridge deck is raised up 0.35m in order to adjust the up lane bridge.

(2) Design high water level and vertical clearance

Design high water level is determined based on the interview survey of the previous maximum water level and normal water level vertical clearance is 1.2m which is satisfied with minimum vertical clearance (1.0m).

(3) Cross section

The cross section for Keng-Burun bridge (Bridge No.14 Outbound) is shown in Figure 2.2.2-12. The Plan for the bridge is shown in Figure 2.2.2-13.

The road, which the bridge is located on, is classified as Category Ⅲ in Road Specification in Kyrgyz. Pavement width: 8.0m (carriageway width 3.5m×2 lanes ＋ both pavement shoulder width 0.5m) in the specification. The existing pavement width is 14.0m and utilizes for 3 to 4 lanes.

The existing bridges, which are divided up and down lane bridge (2 lanes for one bridge, Total 4 lanes), down stream side bridge (up lane bridge) has pavement width: 9.0m (carriageway width 3.75m × 2 lanes ＋both side shoulder (side clearance): 0.75m), both side walk width: 1.0m, upstream side bridge (down lane bridge) has pavement width: 6.9m (carriageway width: 3.0m × 2 lanes ＋ both side shoulder: 0.45m), both side walk width: 0.65m.

Cross section of the replacement upstream side bridge (down lane bridge):

Number of lanes is 2 lanes and carriage way width is set on 3.5m based on the Category Ⅲ specification. Side clearance width is set on 0.75m as the same as down stream side bridge (up lane bridge). A shoulder width of down stream side is 0.75m and a shoulder width of upstream side is 2.25m as the same shoulder width as the approach road to ensure the safety traffic. This shoulder is divided by border bricks between side walk and carriageway to ensure a side clearance width: 0.75m and side walk width: 1.5m. The bridge alignment is parallel with the existing new bridge to ensure the traffic safety. The approach roads are designed for the minimum length and smooth to the

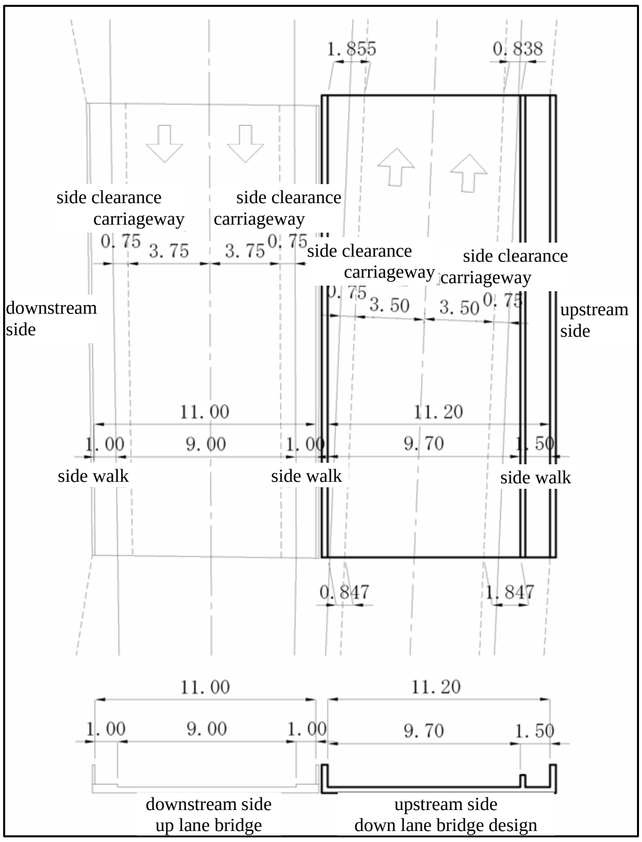


Figure 2.2.2-12 Cross section of Keng-Burun bridge (Bridge No.14 Outbound)

existing bridge. The road alignment on the replacement bridge has a curve not parallel with the bridge. Therefore, it has extra 1.2m as compared with the Total width: 1.0m (carriageway width: 3.5m × 2 lanes + downstream side shoulder width: 0.75m + upstream side shoulder: 2.25m (side clearance width: 0.75m + side walk width: 1.5m). The above reasons, the total width of the replacement bridge is set on 11.2m (carriageway width: 3.5m × 2 lanes + downstream shoulder width: 3.5m × 2 lanes + downstream shoulder width: 0.847~1.855m + upstream shoulder width 2.338~3.347m (side clearance width 0.838~1.847m + side walk width: 1.5m)). It is possible to keep the carriageway width (3.75m × 2 lanes) as the same as the existing upstream bridge in case of the improvement of the road alignment in future.

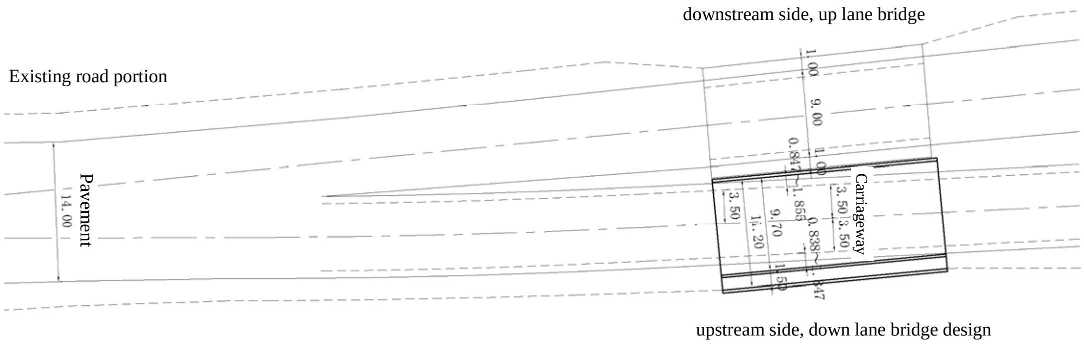


Figure 2.2.2-13 Plan of the existing approach roads for Ken-Burun bridge (Bridge No.14 Outbound)

(4) Span length

The span length is set on 23.4m.

(5) Superstructures

The most appropriate type is selected in consideration of various factors including economical efficiency, constructability, maintenance difficulty, environmental impacts, geometrical alignment and durability. The candidate of bridge type are shown in followings.

Pre-cast RCT girder and pre-tension concrete hollow girder fabricated in Kyrgyz are excluded from the comparison because of the poor reliability which is the result of the survey at the bridge sites and the factory.

- Scheme-1: 2 spans, simple PC-I girder
- Scheme-2: Simple PC hollow slab girder
- Scheme-3: PC-I girder
- Scheme-4: Simple Steel Plate girder

Table 2.2.2-16 shows the comparison of the bridge type. Scheme-2 is the best in the comparison.

The superstructure type is set as follows:

The most appropriate superstructure type: Simple PC hollow slab girder

Span length: 23.4m

(6) Substructures

- Abutment type: Spread foundation type abutment is adapted in consideration with economical.

- Foundation type
  Foundation type is selected in consideration of the scale of bridge, soil conditions, economical efficiency. Square type RC pile (30cm × 35cm), which is fabricated in Kyrgyz, is excluded from the candidates due to the poor quality and reliability.
  - Scheme-1: Cast in place concrete pile
  - Scheme-2: Pile bent
  - Scheme-3: Board pile

Table 2.2.2-16 shows the comparison of pile type. Cast in place concrete pile is the best in consideration of low pollution and economic efficiency.

Table 2.2.2-16 Comparison of bridge type for Keng-Burun bridge (Bridge No.14 Outbound)

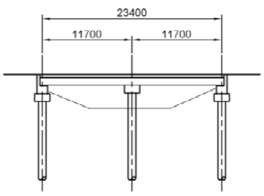
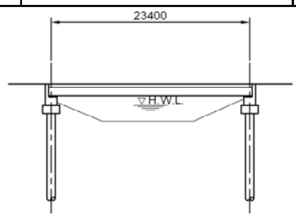
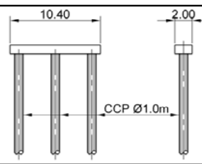
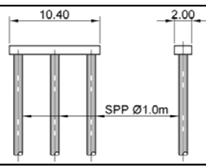
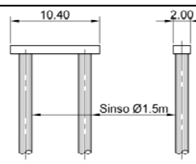
	2 Spans	Single Span		
	Scheme 1: PC-I Girder 2@11.7=23.4m	Scheme 2: Simple PC Hollow Slab 23.4m	Scheme 3: PC-I Girder 23.4m	Scheme 4: Simple Steel Plate Girder 23.4m
Side view				
Bridge Location	The location of a new bridge is set as sthe existing bridge paralleled with the up lane bridge			
Structure Charactalistics	・Reduction load for substructures by short span ・High aseismicity with bridge connecting ・Adaptable to AASHTO typical cross section ・The bridge deck is 20cm higher than an adjacent new bridge	・Bridge weight is lighter and girder height is low ・High aseismicity due to rubber ・Girder height is the lowest bearing ・The bridge cleckis 15cm higher than an adjacent new bridge	・Bridge weight is heavy, large load to substructures ・High aseismicity due to rubbe bearing ・Adaptable to AASHTO typical cross section ・The bridge deck is 65cm higher than an adjacent new bridge	・Structure member is light ・High aseismicity due to light weight ・Girder height is higher ・The bridge deck is 45cm higher than an adjacent new bridge
	Result: △	Result: ○	Result: ×	Result: △
Hydrological Charactalistics	・Bottom level of girder is adjusted to a bottom level of an adajacent new bridge ・Location of a pier is not adapted to narrow river	・Bottom level of girder is adjucted to a bottom level of an adjacent new bridge ・No impact to river due to no pier	・Bottom level of girder is adjucted to a bottom level of an adjacent new bridge ・No impact to river due to no pier	・Bottom level of girder is adjucted to a bottom level of an adjacent new bridge ・No impact to river due to no pier
	Result: ×	Result: ○	Result: ○	Result: ○
Constructability	・Utilization of truck crane ・Necessity of cofferdam during pier construction ・The period of pier construction is during rainy season ・Abutment is required for construction of pier at flow of river	・Fixed supporting ・The construction period is possible to be during winter ・Better constructability due to no pier in the river	・Utilization of track crane ・No difficulty on construction ・Better constructability due to no pier in the river	・Utilization of track crane ・No difficulty on construction ・Better constructability due to no pier in the river
	Result: △	Result: ○	Result: ○	Result: ○
Procurement	・Concrete at local procurement ・PC steel material sand re-bar from Japan or third	・Concrete at local procurement ・PC steel material sand re-bar from Japan or third	・Concrete at local procurement ・PC steel material sand re-bar from Japan or third	・Concrete at local procurement ・PC steel material sand re-bar from Japan or third
	Result: △	Result: △	Result: △	Result: △
Environmental Impacts as Detour Roads	・An adjacent new bridge is utilized for a detour during construction ・Minimal natural destruction and no resettlement	・An adjacent new bridge is utilized for a detour during construction ・Minimal natural destruction and no resettlement	・An adjacent new bridge is utilized for a detour during construction ・Minimal natural destruction and no resettlement	・An adjacent new bridge is utilized for a detour during construction ・Minimal natural destruction and no resettlement
	Result: ○	Result: ○	Result: ○	Result: ○
Construction Duration	・Site work duration is longer due to construction of a pier	・Site work duration is medium	・Site work duration is shorter	・Site work duration is shorter
	Result: △	Result: △	Result: ○	Result: ○
Cost	・Economical (1.0)	・Economical (1.0)	・Costly (1.1)	・Costly (1.1)
	Result: ○	Result: ○	Result: ×	Result: ×
Maintenance Requirement	・Required maintenance is free due to concrete structure	・Required maintenance is free due to concrete structure	・Required maintenance is free due to concrete structure	・Applying on steel materials with weather proofing point
	Result: ○	Result: ○	Result: ○	Result: △
Total Evaluation	△	◎	△	△

Table 2.2.2-17 Comparison of foundation type for Keng-Burun bridge (Bridge No.14 Outbound)

	Scheme 1: Cast in place foundation	Scheme 2: Pile bent foundation	Scheme 3: Caisson type pile foundation
Cross Section			
Structural Characteristics	・Large bore hole excavation pile (diameter: more than 1m) ・Large vertical bearing capacity and horizontal resistance force ・Adapted to friction pile due to large skin friction resistence ・Quality of pile depends on working a bility by contractor	・Medium bore hole driving pile (diamoter: more than 0.8m) ・Medium vertical bearing capacity and horizontal resistence force ・Large resistence at tip of pile, adapted to bearing pile ・Suitable quality due to factory product	・Large bore hole excavation pile by man power (diameter: more than 1.5m) ・Large vertical hearing capacity and horizontal resistence force ・Fabrication of foundation at field (cast in place) ・Direct observation at bearing stratum
	Result: ○	Result: ○	Result: ○
Constructability	・Importance for construction supervision st excavation work ・Necessity for fabrication yard to temporary facilities and re-bar basket ・High safety during construction	・Importance for penetration control at pile driving ・Necessary for working yard of driving machine and space for pile keeping ・High safety during construction ・Necessity for large yard due to big construction equipment	・Importance for submerging work control at construction ・Necessity for working yard to temporary facilities and re-bar basket ・High safety during construction, unsuitable to ground spurting ground water
	Result: ○	Result: ○	Result: ○
Procurement	・Pile excavation machine and construction facilities are procured from Japan or third country ・Pile foundation fabricated by cast in place concrete ・Available local concrete ・Utilizing imported re-bar	・Pile excavation machine and construction facilities are procured from Japan or third country ・Pile bent is a factory procluct in Japan or third country ・Available local concrete ・Utilizing imported re-bar	・Construction facilities are procured from Japan or third country ・Cassion fabricated by cast in place concrete ・Available local concrete ・Utilizing imported re-bar
	Result: △	Result: △	Result: △
Environmental Impacts	・Low negative impacts due to a little noise and vabration at ・Required treatment against water pollution and industrial waste at excavation work (soluble)	・High negative impacts by large noise and vibration during construction ・Unnecessary treatment against industrial waste due to few soil excavation	・Low negative impacts due to a little noise and vabration during construction ・Required treatment against imdustrial waste due to large soil excavation
	Result: ○	Result: ×	Result: △
Construction Duration	・Working period is short due to small number of piles. Work is not affected by weather conditions	・Working period is short due to small number of piles. Work is affected by weather conditions	・Working period is longer due to inner excavation system and submerged method. Working is necessary done during winter season
	Result: ○	Result: ○	Result: ×
Cost	・Most economical (1.0)	・More costly than scheme 1 (1.0)	・Costly (1.0)
	Result: ○	Result: ×	Result: ×
Total Evaluation	◎	△	×

2.2.2.5.4 Approach roads and ancillary

(1) Approach roads design

The approach roads are adapted to the plan position and height of the new replaced bridge in order to set a plan curve and vertical curve in considering with the ensure of a smooth transition to the existing road and traffic safety. The carriageway width is 7.0m (3.5m/lane × 2 lanes). A plan curve radius is set on R = 1,000mbased on the Kyrgyz's standards. Total length of approach roads is set as minimum length. The total length of approach road (Biskek side) is 51.0m. And Tokmok side is 299.1m. Table 2.2.2-15 shows the coverage area of the approach roads.

(2) Pavement design

Pavement structures are decided based on the required pavement structure number (SN) which are calculated from the results of the traffic survey data. Conditions for the pavement design are the same as other 2 bridges. SN is calculated by the conditions. 2,850 is the result of the calculation and following pavement structures are adapted to SN = 2,850.