8. ECONOMIC AND FINANCIAL EVALUATION

8 - 1 Economic Analysis

Economic evaluation of Master Plan was conducted to find the value in the economic internal rate of return (EIRR) by estimating the cost and benefits under the following conditions.

(1) Conditions

1) Economic project cost was estimated by deleting transfer elements of tax and duties.

2) Project benefit streams were enumerated for 30 years after the projects are completed.

3) Damages on railway substructures were grouped into three classes by scale: large (L), medium(M) and small(S). Their occurrence per year was determined as under. When rehabilitation projects are completed by stage 1 through 3, damage occurrence are thought to decrease progressively.

Table 8-1-1 Damage Occurrence and Improvements

Scale	without improvement	Stage 1 2005 -		Stage 2 2010 -		Stage 3 2020 -		Left over
	Damage/yr	Damage/yr	Improved/y	Damage/yr	Improved/y	Damage/yr	Improved/y	
L	0.95	0.95	0.38	0.57	0.14	0.43	0.39	0.04
M	2.45	2.45	0.97	1.48	0.36	1.12	1.01	0.11
S	3.40	3.40	1.35	2.05	0.50	1.55	1.40	0.15
Total	6.80	6.80	2.70	4.10	1.00	3.10	2.80	0.30

Notes: Damages on railways are assumed to decrease when improvements are completed by stage.

(2) Project Cost of the Master Plan

Table 8-1-2 Project Cost

($us in million of 1996 prices)

Stage	Economic cost	Financial cost
1	10.93	12.4
2	2.93	3.29
3	9.12	10.54
Total	22.98	26.23

(3) Economic Benefits

1) Savings in Damage Repair Costs

Mongolian Railway has repaired the damage suffered from natural disaster in the past years. The repair work was in urgent necessity of re-opening of the operation and provisional in nature, which would be subject of repetitive damages. The proposed projects in Master Plan will rehabilitate damageable points which realize the savings in cost of repetitive repair works assumed to occur every year.

Provisional repair costs in the economic evaluation were estimated for each scale by stage, while the averaged cost over the entire master plan was used in the assessment of Master Plan (Table 8-1-3).

Table 8-1-3 Provisional Damage Repair Cost

Urgent Repair Work	Econ Cost Annual Aver. Rep. Cost	E Cost St1 1st stage	E Cost St2 2nd stage	E Cost St3 3rd stage
Class L	1,256,800	1,738,272	434,501	1,082,858
Class M	123,100	123,100	123,100	123,100
Class S	82,080	82,080	82,080	82,080

Annual cost of provisional damage repair was estimated by the multiplication of damage occurrence and averaged cost by scale, which would be saved if the master plan projects are executed.

2) Savings in Passenger Time Cost

Waste time of passengers encountering the train stopping are estimated and their economic cost is measured by unit time value and the averaged wait hours of trains, in which the time value was tabulated from GDP per capita. The followings are time values and the averaged train wait hours by scale.

	Time value in 1996
Mongolian Passengers	$ 0.15 / hour
Foreign Passengers	$ 0.50 / hour
Averaged person	$ 0.266 / hour

Averaged Train Wait Hours

Damage L	13.5	hour
Damage M	10.5	hour
Damage S	5.3	hour

3) Savings in Road Vehicle Transport Cost

There would be losses in the Mongolian economy if damages occur and trains are forced to stop unexpectedly every year. Quantification of those losses in money terms is difficult and often they are termed qualitative impact. To represent the losses partly, the road transport cost was enumerated for passengers and cargoes involved in the train stopping. The economic vehicle operation cost (including depreciation cost, interest charges, costs of fuel, tires, parts, wages, maintenance, etc.) was studied in a way used often in other countries. Under the assumption of paved and unpaved road 50% respectively, the unit VOC per km by vehicle type is shown below, and they were used in the cost estimate.

Wagon bus	$ 181.71 per 1,000 km
Bus	$ 234.65 per 1,000 km
Truck	$ 241.63 per 1,000 km

Those encountered at the scale S were not included, assuming they would remain on trains not divert to the road transport.

4) Economic Internal Rate of Return

The economic internal rate of return (EIRR) was calculated for the entire master plan which resulted in the value of 12.09 % (Table 8-1-4 , the base case and sensitivity tests). The sensitivity test shows the lower values in EIRR in cases of reduced benefits than the cases of increased costs. However the difference is marginal and it is confirmed the lowest value shown in case VI remains close to the range of viability.

Considering the value and other elements such that the projects are only rehabilitation of rail infrastructure, the economy is not in a stable development stage yet, and EIRR of other developing countries, it is concluded the master plan is economically feasible.

Table 8-1-4 Master Plan: EIRR and Sensitivity Test

Case	EIRR	Case	EIRR
Base Case	12.09		
Case I	11.09	Case II	10.24
Case III	10.99	Case IV	9.86
Case V	10.07	Case VI	8.31

Case I	Increased cost by 10%
Case II	Increased Cost by 20%
Case III	Reduced Improvements by 10%
Case IV	Reduced Improvements by 20%
Case V	Combined I and II
Case VI	Combined II and IV

8 - 2 Financial Analysis

(1) Objectives and Methods of Analysis

As an index for financial analysis, the financial internal rate of return (FIRR) is used.

(2) Prerequisites

1) The earning capacity of this project is checked by analyzing the amount of investment and raising of funds for that purpose, the loss of transportation revenue and expenditure by disasters, and the savings of rehabilitation cost resulting from the damage reduced.

2) The period of project is assumed to be 30 years from the completion of the first stage work.

3) Market prices are used in financial analysis. (refer to Table 8-1-2).

4) The straight line method is used for depreciation. Earth structures will have a useful life of 100 years, uniformly depreciated in accordance with the regulations of MR.

5) For the foreign currency needed for the purchase of imported equipment of the investment amount, loans furnished by international organizations or government agencies in overseas countries will be used. Domestic currency funds are assumed to be obtained from MR's own funds.

(3) Number of Shutdowns that can be Prevented

The same numbers as for the economic analysis are used here. It is assumed that the effectiveness of the shutdown prevention program is proportional to the amount of construction investment during each stage of rehabilitation.

(4) Revenues and Expenses

It is assumed that the transportation revenue and expense to be lost due to shutdowns of railway service unless rehabilitation work is performed, are attributed to this project. Estimated reduction in annual time of interruptions to railway service is obtained from the number of occurrences of damage that can be prevented by the rehabilitation project, multiplied by the average time loss for each case by the scale of damage.

Passenger and freight fare rates at the time of investigation are obtained from the revenue and volume of MR transportation in 1995 by adding 37.8% of consumer price index increase. Other transportation revenue is assumed equal to 5% of total passenger and freight revenue based on the past records.

Transportation revenue is calculated from transportation volume for the section subjected to the rehabilitation project and fare rates. Estimated loss of transportation revenue, in case railway service is interrupted, obtained from transportation revenue multiplied by the rate of reduction of interruption by disaster prevention work, is shown in Table 8-2-1 together with administrative operating costs.

Table 8-2-1 Estimated Loss of Transportation Revenue and Operating Cost

(Unit: Million Tugrik)

Year	2005	2010	2020
Transportation Revenue	76	123	241
Administrative Operating Cost	41	70	159
Operating Profit	35	53	82

(5) Estimated Savings of Rehabilitation Cost

The savings of rehabilitation cost are estimated from the number of interruption occurrences that can be prevented by the upgrading project, multiplied by the rehabilitation cost for each damage (Table 8-2-2). Rehabilitation cost per each disaster is the same as in the economic analysis, but market prices are used in financial analysis.

Table 8-2-2 Estimated Savings of Rehabilitation Cost (Unit: Million Tugrik)

Year	2005	2010	2015	2020	2025
L	300	421	662	873	1,019
M	75	106	167	220	257
S	70	98	154	204	238
Total Saving	445	625	983	1,297	1,513

(6) Results of Analyses

Financial internal rates of return (FIRR) for each case are shown in Table 7-2-3.

Table 8-2-3 Comparison of FIRR

Case	FIRR	Case	FIRR
Fundamental Case	8.348%		
Sensitivity Analysis Case Ⅰ	7.594%	Sensitivity Analysis Case Ⅱ	6.953%
Sensitivity Analysis Case Ⅲ	7.518%	Sensitivity Analysis Case Ⅳ	6.666%
Sensitivity Analysis Case Ⅴ	6.823%	Sensitivity Analysis Case Ⅵ	5.493%

Case Ⅰ Construction cost increased by 10%.

Case Ⅱ Construction cost increased by 20%.

Case Ⅲ Number of occurrence of interruptions that can be prevented reduced by 10%.,

Case Ⅳ Number of occurrence of interruptions that can be prevented reduced by 20%.

Case Ⅴ Combination of cases Ⅰ and Ⅲ above.

Case Ⅵ Combination of cases Ⅱ and Ⅳ above.

The FIRR indicates the rate of return on the total invested capital. If foreign currency portion of the construction funds required for this rehabilitation project can be raised at a rate of 2.3% and the remaining can be raised from own funds, it is possible to carry out this project in view of profitability. From the aspect of cash flow, the amount of MR funds reaches only 500 to 700 million tugrik (from 2002 to 2003), and the accumulated balance at the peak will not exceed 1,300 million tugrik (in 2004).

In sensitivity analyses, the FIRR becomes lower in case of the number of interruptions decrease than in case of the construction costs increase, but the difference is not so significant. Even in the worst case (sensitivity analysis case Ⅵ), the situation is not so serious as to obstruct the implementation of the project.

9. EVALUATION OF MASTER PLAN

9 - 1 Outline of the Project

Master Plan of the directly necessary rehabilitation of railway structures has been drawn up, mainly for the Sukhe-baatar・Bayan section of about 450 km where natural disasters frequently occur. In this case, in order to ensure safe and reliable transport throughout the year, care has been taken to establish disaster-resistant structures or to enable restoration in a short time in case of disasters.

According to the Master Plan, the rehabilitation will be carried out in three stages. The target years of the 1st, 2nd, and 3rd stages are 2005, 2010,and 2020, respectively.

The total amount of the necessary investment is about US$ 26.2 million(1st:US$12.4million, 2nd:US$3.3million, and 3rd:US$10.5 million) at the price as of August 1996.

Table 9-1 shows an outline of the rehabilitation plan which covers 184 places.

Table 9-1 Outline of the Master Plan of the Rehabilitation

Item	Countermeasure	No. of places	Remarks
River bank Protection	Bank protect Groyne	11	31pk2-4 : Track transfer 208-209km: River route transfer
Slope Stability	Clear slope	22	
Track Lifting	Lifting	1	
Bridge Rehabilitation	Beam replace Repair	12	Beam replace : 8 Repair : 4
Drain Improvement	Adding drain New drain	138	Adding :116 New : 22
Total		184	

9 - 2 Evaluation

(1) Technical Aspect

1) Railway structures

In order to ensure stable transport by effectively coping with frequent natural disasters, a

Master Plan of the directly necessary rehabilitation of railway structures has been drawn up. In this case, consideration has been given to the present situation of the railway structures of the Mongolian Railway, situation of disasters, natural conditions, environment, and size of investment. As shown in Table 9-1, the main disaster countermeasures planned with high priority this time are measures against embankment erosion by large rivers, securing of cross-sectional drainage capacity, measures against falling rocks from cuttings and slopes, bridge rehabilitation, etc.

As for the implementation of the drawn-up rehabilitation plan in which the measures for earth structures(cutting, embankment) account for the most part, detailed investigations by river experts will be necessary for some portions such as the flow route alteration of rivers. However, the implementation of the rehabilitation plan is considered to be sufficiently feasible as a whole, in view of the design and construction technologies of the Mongolian Railway.

2) Track, station, and electric facilities

As for the track, station and electric facilities, although there are problems related to the superannuation of facilities, almost all of these problems can be solved by implementing plans of renewal and replacement which are now in progress or under planning.

3) Transport and rolling stock

The train operation plan has been drawn up on the basis of the existing train diagram by placing emphasis on ensuring stable transport and on meeting the increase in demand. Therefore, the number of train can be generally satisfied by utilizing the existing track capacity.

As for the rolling stock, it will become necessary to increase the number of rolling stock and reinforce the inspection and repair facilities in manners harmonized with the demand and the train operation plan. Since the project of this time is for the disaster countermeasures and rehabilitation of railway structures, increase in demand has not been directly considered in the project. Therefore, it is necessary to separately study the number of rolling stock to be additionally introduced by type of car, by confirming the changes in demand and also by considering the repair of rolling stock.

(2) Environmental Aspect

In Mongolia, several laws related to environmental preservation have been in force since 1995. They include laws on Special Protection Areas, Environmental Protection, Air, Water, Forest, and Plants. Since this project mainly concerns the rehabilitation planning of the existing line, the separation of villages and removal of residents are not entailed. The project also does not conflict with regulations on development related to relics, cultural assets, protection areas, etc.. It is necessary to pay special care concerning the vibration, noise, influence on plants and animals, river pollution, etc. caused by the construction as well as the disposal of spoil earth and sand.

However, in view of the object places and contents of the rehabilitation work, unfavorable environmental effects by this project will be small on the whole.

(3) Economic Aspect

The economic internal rate of return (EIRR) of this project is 12.09 %. This value is considered to be adequate in view of the standards used by the World Bank and other financial institutions in selecting projects of developing countries. Furthermore, this project is estimated to be very significant from the national economic standpoint, considering the indirect socio-economic benefits such as the vitalization of industrial activities entailed by the project implementation.

(4) Financial Aspect

The financial internal rate of return (FIRR) of this project is 8.34 %. It is possible to carry out this project in view of profitability.

(5) Comprehensive Evaluation

This project aiming at the rehabilitation of the railway structures is technically feasible and will not have large unfavorable effects on environment.

The EIRR of this project from the national economic standpoint is 12.09%. When other indirect benefits are also considered, this project is estimated to be feasible. The FIRR from the managerial standpoint of the Mongolian Railway is 8.34 %. However, in view of the funds necessary for other projects of the Mongolian Railway, efforts should be made, in implementing this project, to procure funds taking the financial standings of the Mongolian Railway into consideration.

This project concerns the rehabilitation planning for the railway structures where natural disasters in the rainy season compel the railway to cancel train operation, and emphasis is placed on ensuring stable transport. From the comprehensive standpoint, this project is evaluated to be adequate and also feasible from technical, environmental, economic and financial aspect.

Furthermore, the implementation of this project, coupled with the guarding systems(such as the checkup by patrol) in use in the Mongolian Railway against disasters will enable stable transport on trunk line of the railway and will also contribute to the development of the sound social and economic activities in Mongolia.

Volume 2 Feasibility Study

10. SHORT-TERM URGENT PROJECTS

10 – 1 Outline Procedure for Planning Urgent Projects

Since object section to be the subject of (72 places) short-term urgent improvement projects are many similar countermeasure in nature, the Rehabilitation Improvement will be established in accordance with outline of the procedure in Figure 10-1.

At first, all object sections with similar countermeasure items are grouped and standard sections are selected from that group. A standard design, construction plan, and rough cost estimate is prepared for the standard section. The results of analyses and study of the standard section is applied to all other locations with similar countermeasure items to establish the Rehabilitation Improvement plan to accomplish the short-term urgent projects. Where analytical data of a standard section is applied to a similar site, if special features are found at the similar site, the planning of the similar site will be studied with incorporating those features.

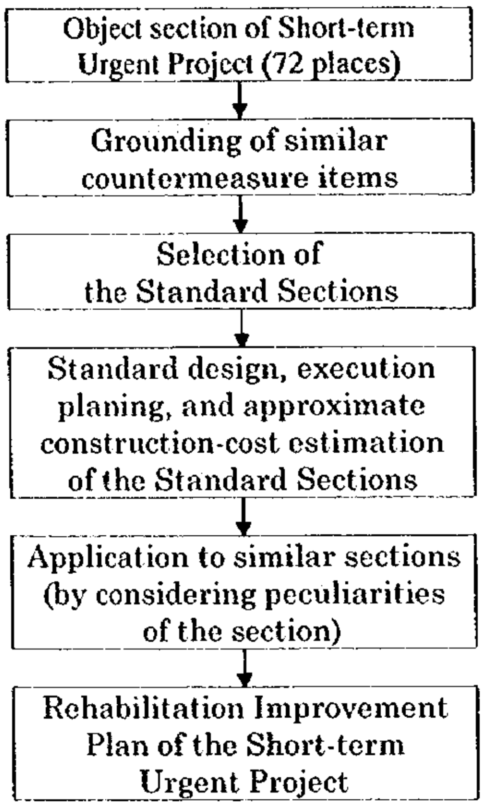


Fig. 10-1 Procedure for the Planning

10 - 2 Object Spots of the Short -Term Urgent Project

The sites to be subjected to short-term urgent project were selected from the general improvement plan, the base of the master plan, depending on the criticality and the importance, the base of field investigation reports, and in discussion with the government of Mongolia. There are a total of 72 such sites, as shown in Table 10-1. It was decided to execute a feasibility study for this work, on schedule to be completed in 2005.

Table 10-1 Object Spots of the Short-term Urgent Project

Item	No. of Spots	Object Location of F/S			
River bank Protection	7	10pk7-10	31pk2-4	51pk9-52pk1	54pk4-5
		57pk8-10	67pk6-7	208pk1-3	
Slope Stability	12	8pk10	13pk3	17pk5-6	18pk1
		18pk10-19pk1	54pk2-3	57pk9	61pk10
		250pk6-8	251pk2	267pk2-3	282pk9-282pk2
Bridge Rehabilitation	11	235pk3	245pk5	255pk3	285pk1
		289pk1	326pk9	334pk3	338pk10
		342pk2	344pk1	356pk1	
Drain Improvement	42	23pk2	66pk4	89pk7	94km
		97pk5	100pk7	125pk8	143pk7
		145pk1	168pk4	170pk3	184pk4
		190pk6	197pk2	210pk6	218pk5
		223pk7	230pk9	235pk3	242pk4
		252pk1	253pk3	255pk3	313pk10
		314pk10	329pk7	334pk3	340pk5
		345pk6	348pk7	352pk7	356pk1
		389pk1	391pk2	394pk4	399pk1
		417pk1	417pk10	420pk7	424pk7
		428pk4	438pk7		
Total	72				

10 – 3 Selection of Standard Section

(1) Concept for Selection of Standard Section

Standard section is selected from locations grouped with similar requirements, based on the concept described below.

①Select a highly critical site from sites which have more common factor of more geographic and geological than another one, and from those where train operations can be drastically curtailed during flood conditions. (Mainly revetment and slope stability)

②Select a site with a standard section that requires work that is also required by other structures similar in design cross section, and develop a design and construction method based on conditions described in ① above. (Mainly bridge and box culvert improvement work.)

③Select standard and applied section by the type of work from those selected by procedures ① and ② above upon close discussions with the government of Mongolia.

(2) Selection of Standard Section Type of Work and Application to Other Similar Sites

Standard section and similar sites selected as a result selection made in accordance with procedures described ①, ② and ③ above and based on field investigations are described below.

1) River Bank Protection (Revetment)

Standard section includes site of 54pk-45 as a revetment as shown in Table 10-2 and a single project for railway track transfer at 31pk2-4.

Table 10-2 River Bank Protection

Standard Section	Countermeasure	Applied Section	Remarks
31pk2-4	Track Transfer Box culvert 2m x 2m	31pk2-4	
54pk4-5	Revetment	10pk7-10	
		51pk9 – 52pk1	
		54pk4-5	
		57pk8-10	
		67pk6-7	
		208pk1-3	

2) Slope Stability

Standard section includes methods of slope surface improvement + rock pool and concrete lining + rock pool as shown in Table 10-3.

①In selection of rockfall prevention measures for cut slopes, standard sections selected for slope surface improvement (including rock pool), based on the results of investigations conducted on condition of slopes, cracks, degree of weathering, and loose rock, are classified into the following four typical types as shown in Fig. 10-2 : "Type I" for 13pk3, "Type II" for 61pk10, "Type III" for 282pk9 through 283pk2, and "Type IV" for 267pk2 to 267pk3.

② Site 18pk10 through 19pk1 is dealt as an individual site subject to slope surface improvement and concrete lining.

Since the railway at 251pk2 is not in danger of being affected by rockfall but the telephone poles at that location could be affected, it was decided to relocate the poles.

Table 10-3 Slope Stability

Standard Section	Countermeasure	Applied Section	Type of Slope	Remarks
13pk3	Removal of weathered rock (included installation of rock pool)	13pk3	I	
		18pk1	I	
61pk10	Removal of weathered rock (included installation of rock pool)	17pk5-6	II	
		57pk9	II	
		61pk10	II	
		250pk6-8	II	
282pk9 – 283pk2	Removal of weathered rock (included installation of rock pool)	54pk2-3	III	
		282pk9 – 283pk2	III	
18pk10 – 19pk1	Removal of weathered rock and concrete lining (included installation of rock pool)	18pk10 – 19pk1	I	
267pk2-3	Removal of weathered rock and Removal of overhang (included installation of rock pool)	8pk10	IV	
		267pk2-3	IV	
251pk2		251pk2	II	Telecommunication line Transfer

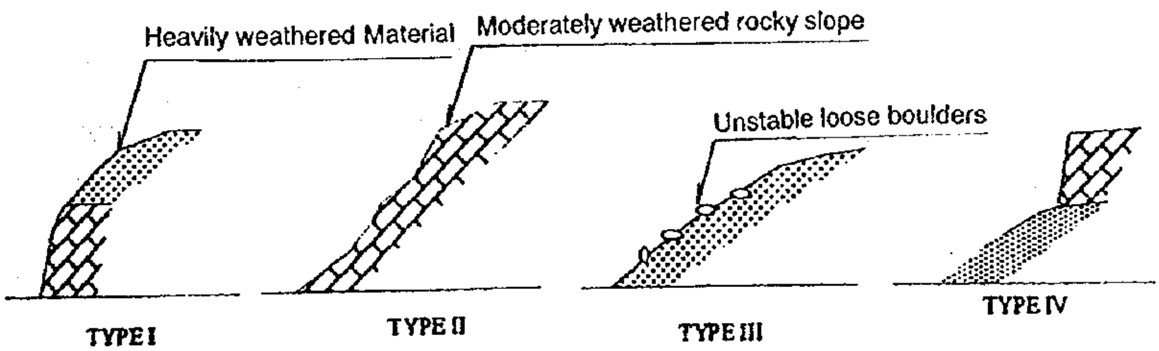


Fig. 10-2 Type of Slope

3) Bridge Rehabilitation

Bridges investigated under this project are over 50 years old and have been exposed to severe weather conditions. As standard section for improvements, the following two sites were selected to provide measures to improve damaged portions of beam bodies and their overhangs, and to improve damaged ballast stops (see Table 10-4).

① Point 334pk3 was selected as a typical site for replacement of beams (damaged beam body).

② Point 255pk3 was selected as a typical site for repair of local damage to overhang slabs and ballast stops).

Table 10-4 Bridge Rehabilitation

Standard Section	Countermeasure	Applied Section	Remarks
334pk3	Girder Replacement	285pk1	L=9.3m, 1 span
		289pk1	L=13.5m, 2 span
		334pk3	
		326pk9	L=13.5m, 3span
		338pk10	L=7.3m, 1 span
		344pk1	
		356pk1	L=7.3m, 2 span
255pk3	Repairing Waterproof Layer and Surface Treatment	235pk3	L=9.3m, 2 span
		255pk3	L=7.3m, 2 span
		245pk5	L=9.3m, 2 span
		342pk2	L=6.3m, 1 span

4) Drain Improvement

Standard section for improvement of drainage facilities include enlargement or new construction of box culverts, the addition of bridges, and widening of river channels.

① Since drainage structures crossing the railway are deficient in water carrying capacity at present, rainwater runoff can be blocked by embankments and can pond behind it, and slopes collapse repeatedly. Rainwater runoff often overtops the railway embankment.

Under such conditions, the following standard section were selected from two types classified by the structure and the five types classified by shape.

The selected standard section include the following:

- Box culvert, 2.0 m wide x 1.5 m high at 253pk3
- Box culvert, 2.5 m wide x 2.0 m high at 389pk1
- Box culvert, 2.5 m wide x 2.5 m high at 356pk1
- Bridge beam BR1, bridge length 11.5 m at 235pk3
- Bridge beam BR2, bridge length 13.5 m at 125pk8

② The site 23pk2, within the compound of the Sukhe-baatar station, was selected as an individual site for drainage facility improvements, and the site 399pk1 for river channel widening.

Table 10-5 Drain Improvement

Standard Section	Countermeasure	Applied Section	Remarks
23pk2	Drain Improvement of Sukhe-baatar station yard	23pk2	
253pk3	Box Culvert (CBC 1)	66pk4	W=2.0m, H=1.5m
		89pk7	
		94km	
		100pk7	
		143pk7	
		168pk4	
		170pk3	
		184pk4	
		190pk6	
		210pk6	
		218pk5	
		223pk7	
		230pk9	
		252pk1	
		253pk3	
		313pk10	
		329pk7	
		340pk5	
389pk1	Box Culvert (CBC 2)	97pk5	W=2.5m, H=2.0m
		145pk1	
		197pk2	
		242pk4	
		314pk10	
		345pk6	
		348pk7	
		389pk1	
		391pk2	
		394pk4	
		416pk10	
		417pk10	
		420pk8	
		424pk7	
		428pk4	
		438pk7	
356pk1	Box Culvert (CBC 3)	356pk1	W=2.5m, H=2.5m
235pk3	Bridge (BR 1)	235pk3	L=11.5m
		255pk3	
		334pk3	
125pk8	Bridge (BR 2)	125pk8	L=13.5m
		352pk7	
399pk1	Widening Channel	399pk1	Investigation of Soil

(1) Location of countermeasure work for each section between station

Location of countermeasure work is as shown in Fig. 10-3.

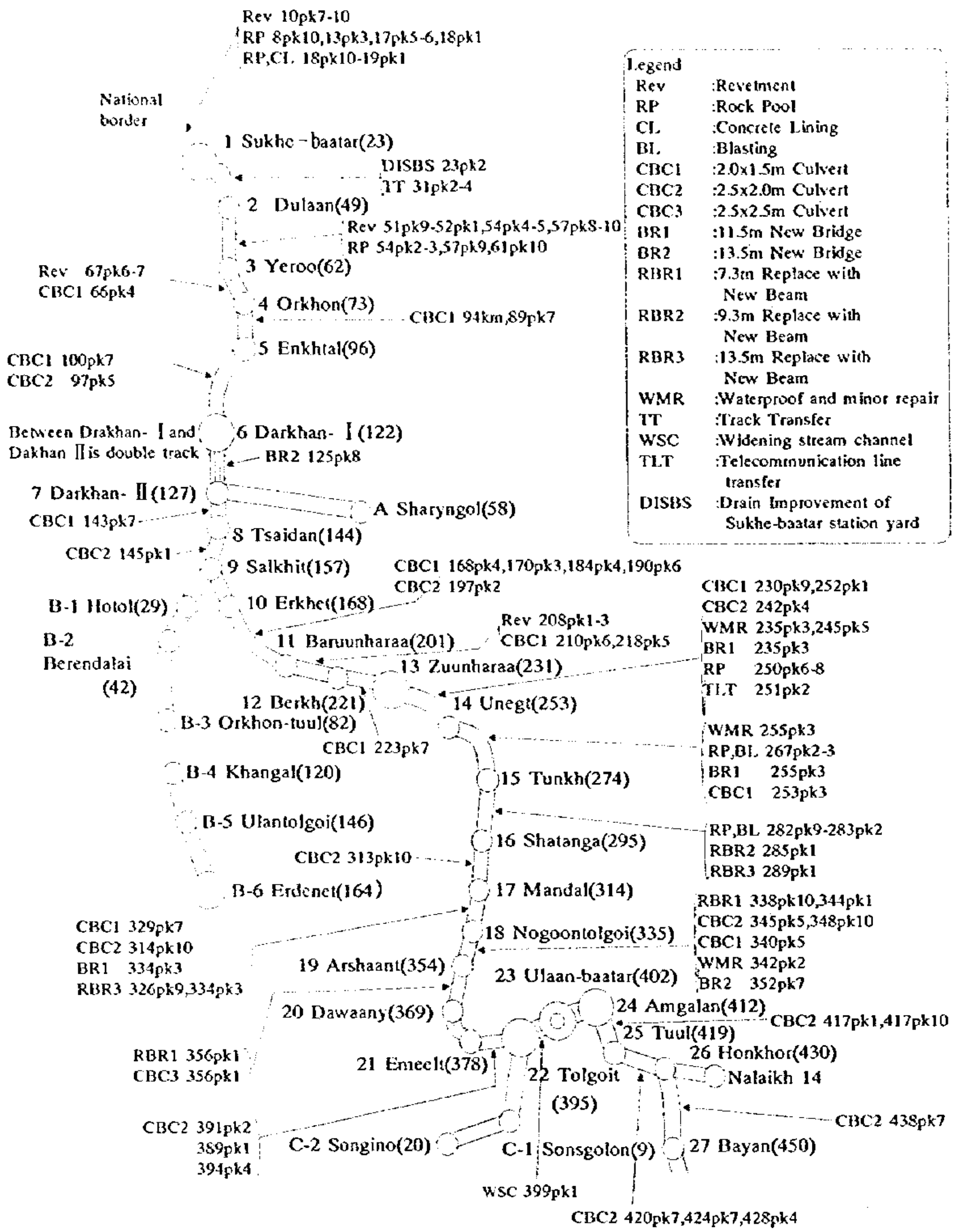


Fig. 10-3 Location of countermeasure work for each section between station

11. CIVIL ENGINEERING WORK PLAN

11-1 River Bank Protection

(1) Track Transfer (Standard Plan for Section 31 pk-2-4)

1) Preliminary Design

The section from 29 pk 1 to 31 pk 5 was determined to be transferred from the existing alignment with a total track transfer length of 2.5 km. The maximum distance to be shifted is approximately 170 m from the existing railway line at point 30 pk 2. The plan of this section is shown in Fig. 11.1.1. The planning for track transfer works were decided by the conditions below.

a. Design Criteria

The design criteria for the track transfer plan used the design standard are given in 4-1 of this summary.

b. Railway Formation Level

There is a difference in altitude of 6.0 m between start and finish points. The proposed design of the new railway formation level is 1.5 m higher than the existing level. In order to have a 1.5 m higher formation level than the existing, a gradient of 0.8 percent is proposed for both end sections.

c. Embankments and Cuttings

The slopes for embankments and cuttings are indicated in Table 11-1-1. The slope of 1:1.5 is used for the new alignment. However, a 1:1.75 slope is proposed at 20 pk 40 since the embankment height is more than 6 m.

Table 11-1-1 Slope for Embankment and Cutting

Embankment Slope	1.0 : 1.5 (h<6.0m) 1.0 : 1.75 (h>6.0m)
Cutting Slope	1.0 : 1.5 (for earth) 1.0 : 1.0 (for soft rock) 1.0 : 0.2 (for hard rock)

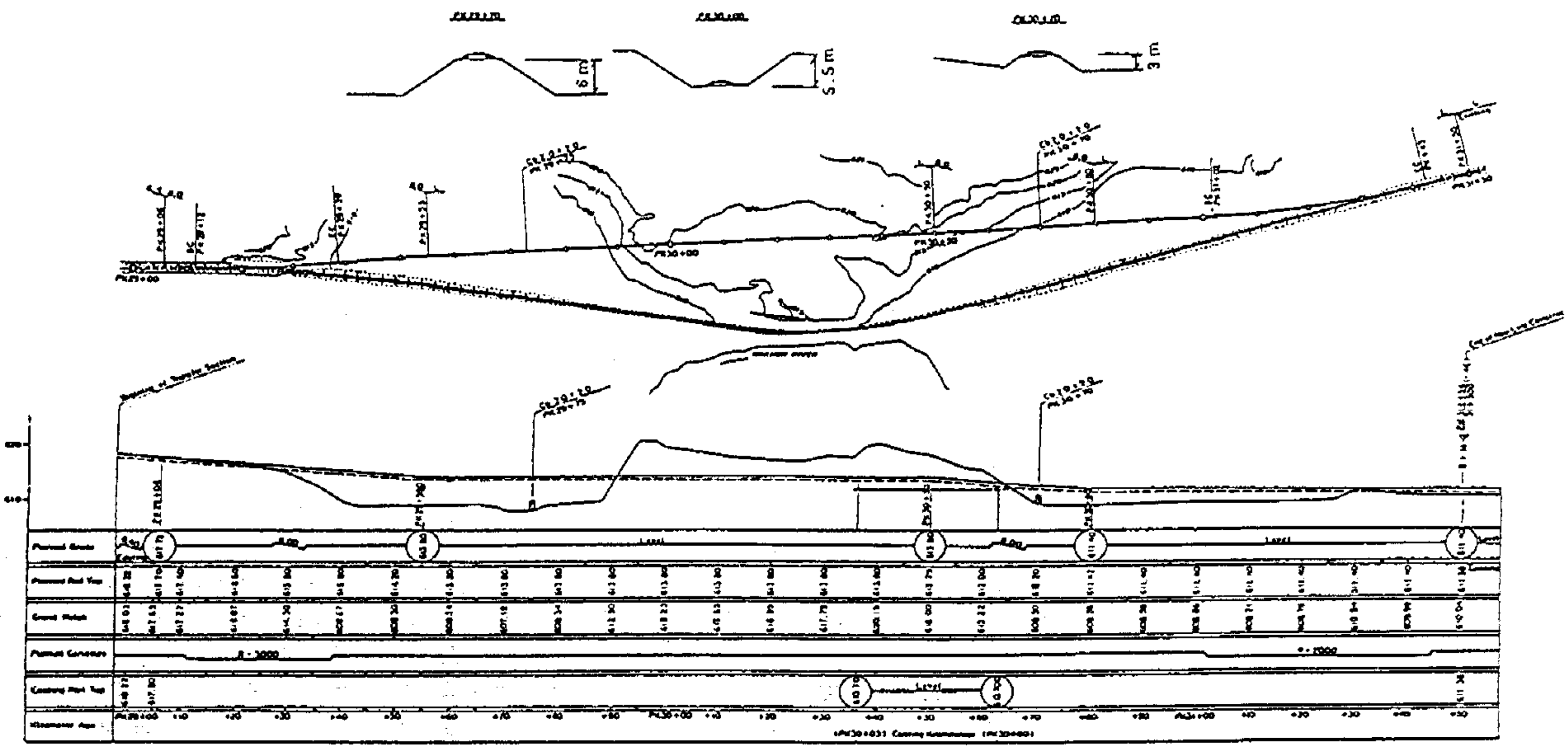


Fig.11-1-1 Railway Truck Transfer Plan

d. Protection against Frost Heave

The under ground water level is located approximately 1.5 m below the ground level. Gravel with high permeability should be used as the foundation material for the embankment to protect against frost heave.

e. Drainage

Box culverts (2.0 x 2.0) are to be installed at 29pk 75 and 30pk 70 to discharge water running down the hill slope which may be dammed by the newly constructed embankment.

2) Construction Plan

Accessibility to the site is possible by using existing roads from the national road to the construction site, and construction equipment and materials can be transported by using those roads. Earthworks for cutting and embankment will maximize the use of mechanical equipment.

a. Construction Period

The Sukhe-baatar Meteorological Observatory located 6 km from this construction site has reported that the lowest temperature is minus 46 degrees C. and highest is 34 degrees C. April to October is considered the period suitable for construction works, and works should avoid the other months in cold season. Two years will be necessary for the track transfer work.

b. Civil Works

The hill area located from 29pk 90 to 30pk 60 will supply the necessary borrow material for embankment construction.

c. Track Works

The ballast is roller compacted until 5 cm below the sleeper bottom. PC sleepers are placed on the ballast. The general arrangement of the track elevation is indicated in Fig. 11-1-2.

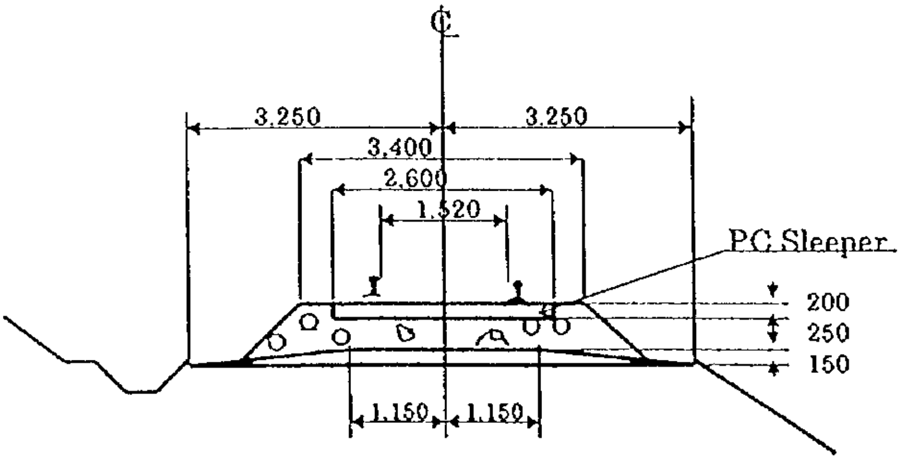


Fig. 11-1-2 Track Elevation

d. Rail Connection

When civil work, track work and relocation of the telecommunication cable have been completed, the new track is connected to the existing track at 29 pk 00 and 31 pk 50 during a suitable train operation interval.

3) Quantities and Cost

The quantities and the cost in total of the rail track transfer are shown in Table 11-1-2.

Table 11-1-2 Track Transfer: Total Quantities and Construction Cost

Unit: 1000 US$

ITEM	Qty.	Unit	Amount			Remark (Type,Class)
			Local Total	Foreign Total	Total	
1. Civil Work						
Embankment	cu.m	58,000	6	1,077	1,083	
Common excavation	cu.m	9,000	0	50	50	
Concrete box culvert	m	19	10	61	71	
Concrete box culvert	m	10	5	31	36	2.5m*2.0m/29+750
Wing wall	set	2	12	8	20	2.5m*2.0m/30+700
2. Track work						
Track work for rerouting	m	1,700	252	628	880	
Removal of existing rails	day	30	6	0	6	Second hand rails
3. Relocation of Telecom Cable			15	81	96	
Total			305	1,937	2,242	

(2) Revetment Works (54 pk 4~5)

1) Preliminary Design

River banks are destroyed by scour sometimes. In order to protect the bank from erosion, protection is proposed by the use of the following three approaches; bank slope protection, protection of slope toe: and the other foot protection against river scour.

The layout of the revetment at 54 pk 4-5 is indicated in Fig. 11-1-3 while the general drawing of structure is indicated in Fig. 11-1-4.

a. Slope Protection

- Blanket

The bank blanket such as geotextiles should be installed between the bank slope and the riprap protection to prevent encroachment by the river flow.

- Riprap on the slope

The thickness of riprap will require to be more than 1.2 m to protect against scour with boulders of 40 cm in diameter. A series of box gabion ribs are proposed on the slope: 0.5 m (height) x 0.5 m (width) installed at 5 m intervals. The slope gradient of riprap is planned at 1: 2.

b. Gabion Mattress

The gabion makes an elastic and flexible body of stone, and will provide strength against scour. Each gabion will be 0.5 m (height) x 1.0 m (length) x 1.5 m (width).

c. Drainage

In order to protect the railway formation, open drains should be provided along the railway line. The size of drains is 0.6 m (height) x 0.6 m (width), lined with concrete.

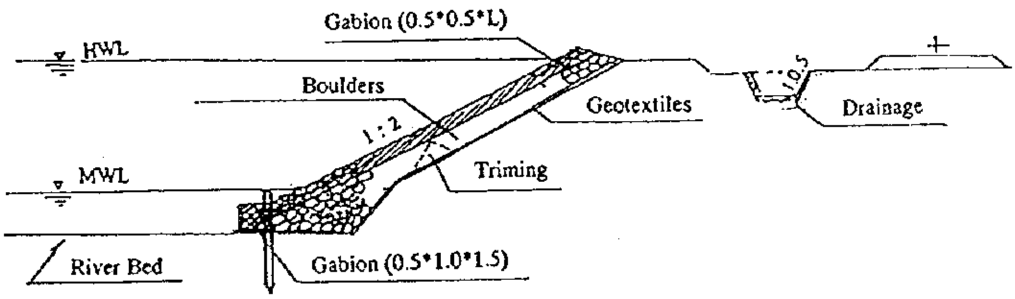


Fig. 11-1-3 Revetment Profile

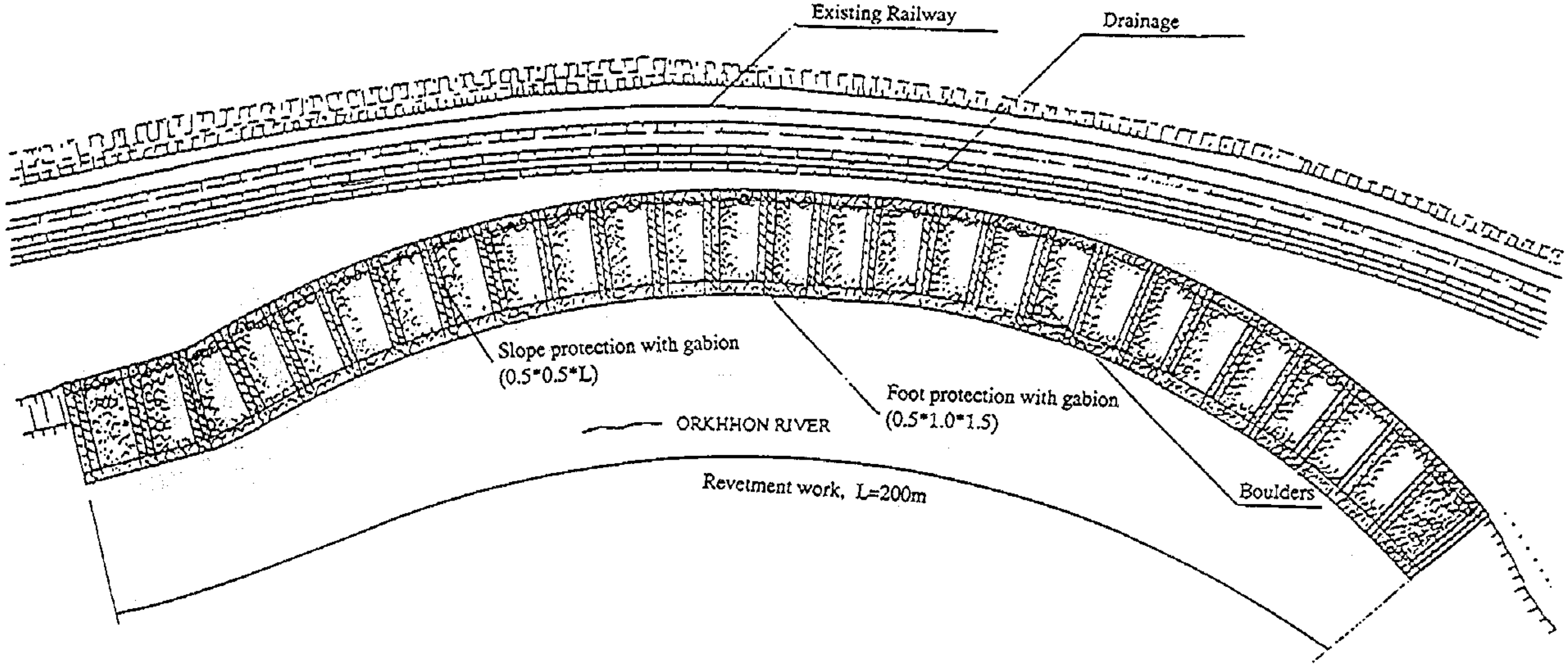


Fig. 11-1-4 Revetment Layout Plan

2) Construction Plan

The revetment works will be implemented during April to October. The works plan proposed is:

a. Trimming Slope

Back hoe will trim the slope where the river bank slope is irregular.

b. Installation of Blanket

The blanket is installed at the design position.

c. Mesh Box Gabion

The mesh box gabions to be assembled and installed at the designed position.

d. Riprap Foundation

The 1: 2 slope is trimmed using the riprap.

e. Installation of Ribs and Riprap Work

After trimming of riprap, the gabions are assembled near the river site, and installed at 5 m intervals at the design position by 10 ton crane, and filled with riprap

3) Quantities and Cost

The quantities and cost of the standard case are in Table 11-1-3.

Table 11-1-3 Revetment Works: Quantities and Cost (54pk 4-5)

Unit: 1,000 US$

ITEM	Unit	Qty.	Amount		Total
			Local Total	Foreign Total	
Common excavation	cu.m	16	0	0	0
Embankment	cu.m	68	0	1	1
Riprap	cu.m	1,992	22	3	25
Wire sylinder	cu.m	3,713	85	77	162
Blanket	sq.m	3,713	9	5	14
Concrete lined ditch	m	200.00	5	1	6
Total			121	87	208

(3) Applied Section

Table 11-1-4 shows requirements for applied sections.

Table 11-1-4 Requirements on Applied Section

Applied Location	Requirements
10 pk 7~10	Erosion of this point is caused by the revetment work which has been in progress at 11 pk. Erosion of river bank is rapidly proceeding, which should be studied further to find a plan of slope protection. But the water level come up to the railway formation level often during the rainy season. Drainage system should be studied on this section.
51 pk 9 ~52 pk 1	A 500 m^3 riprap was put in 1987, however the river bank is eroded by every year. Drainage is required because flood water covers railway formation level often. Further study is necessary to detained the scope of protection works.
57 pk 8~10	Riverbank protection works is not yet made, consequently, the bank is eroded by 1-2 m every year. Curved railway lines are located among hill slopes close to the river. Water level often comes up the formation level and MR restricts the train operation speed of 15~20 km/h in flood seasons. Drainage system should be considered in this section
67 pk 6~7	The Orkhon River meanders like a hairpin and the railway formation is eroded 2~3 m every year. MR has done urgently a 500 m^3 riprap work.
208 pk 1~3	The Hara River runs in parallel to the railway line in sharp spin styles, eroding the bank by 2~3 m per year. MR put in riprap works of 1,000 m^3 in the past. Road locate between the railway and river, which is also covered by water in occasional Railway embankment needs to be protect from the river scour floods.

(4) Total quantities and Cost

The total of quantities and cost of the revetment works are in Table 11-1-5

Table 11-1-5 Revetment: Total Quantities and Cost

Unit : 1,000US$

Locate	Length (m)	Amount		Total	Remarks
		Local Total	Foreign Total		
31pk 2-4	200	305	1,937	2,242	Standard Section
10pk 7-10	300	228	179	407	Applied Section
51pk 9-52pk1	300	185	142	327	Applied Section
54pk 4-5	200	121	87	208	Applied Section
57pk 8-10	300	183	137	320	Applied Section
67pk 6-7	250	172	130	302	Standard Section
208pk 1-3		140	107	247	Applied Section
Total		1,334	2,719	4,053	

11-2 Slope Stability

The protection plans against falling rocks were determined by considering in the slope configuration, available machines, work safety, maintenance capability and environment.

(1) Preliminary Design

Plans can be classified into several types. Locations, standard plan types and combination of methods against falling rock are in Table 11-2-1. A typical slope and protection methods are in Fig. 11-2-1.

Table 11-2-1 Improvement Programs for Standard Section

Standard program Section	Slopes Type	O.H	F.P	W.R	C.D.R	R.P	C.L	L.R
13pk3	I	○	○	○	○	○	—	—
61pk10	II	○	○	○	○	○		
282pk9 – 283pk2	III	—	—	—	—	—	—	○
18pk10 – 19pk1	I	○	○	○	○	○	○	—
267pk2 – 3	IV	○	○	○	○	○	—	—
251pk2	II	—	—	—	—	—	—	—

Programs : O.H, over hang; F.P, foot strengthening; W.P, removal of weathered rock; C.D.R, removal of sedimentary rocks; R.P, installation of rock pool; C.L, concrete lining; L.R, removal of loose boulders 251pk2 means the relocation of Telecom. Lines.

a. Removal of Overhang

This method will remove overhanging cleft rock, while the parent rock will be secured by foot fixing concreting.

b. Weathered Rock

The following numerical values will show the classified stable slopes on which weathered rocks are located.

hard rock 1:0.3 ～ 1:0.8

soft rock 1:0.5 ～ 1:1.2

Rock removal is required when the slope exceeds the above value.

c. Installation of Rock-pool (Rock Fall Zone)

Open area which can hold fallen rocks may provide protection against to the railway track. The width of the zone is determined by the rock rolling length from the slope toe to the railway line.

$L = h/\sin\theta$

Where L : rock rolling length (m) from the slope toe

h : height of locus from the point of the fallen rock

(ex. if the fall occurs at 10 m height, h = 1.3 m)

θ : angle of the slope

then; in case of angle slope is 45°, the result will be L = 1.8 m

Most of slope angles for surveyed areas are less than 45°. However, this project proposes a 2.0 m wide zone for rock falls with a depth of 1 m.

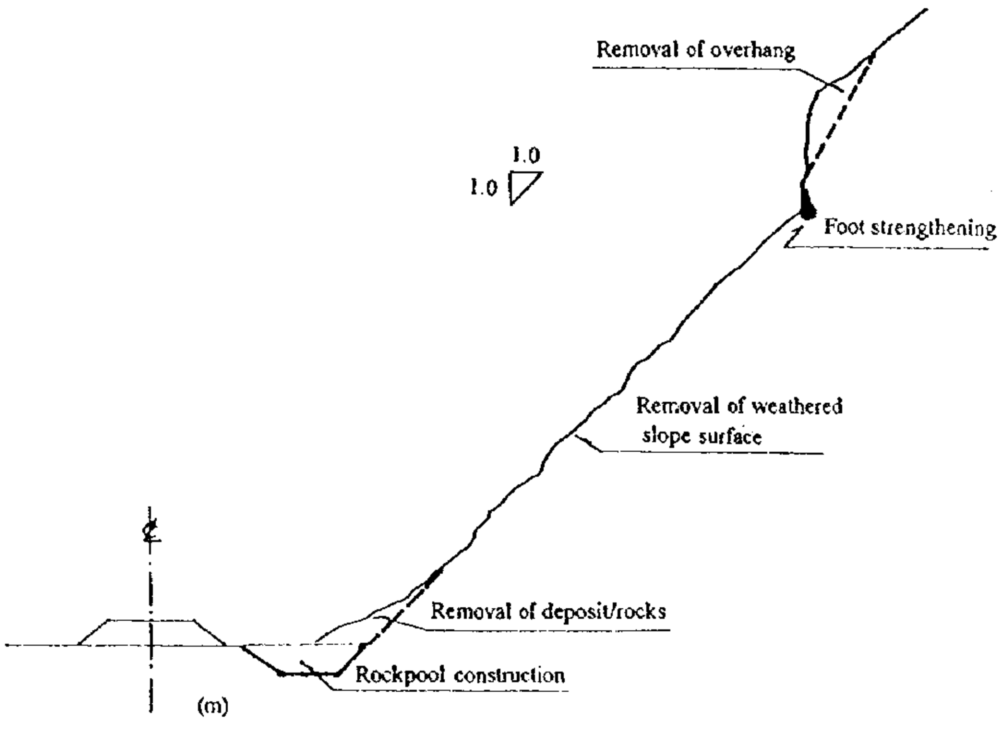


Fig. 11-2-1 Slope and Protection Plans

d. Removal of Loose Boulders and Foot Strengthening

The removal of loose rock should be carried out together with the removal of weathered rock. If large sized rocks need removal, this work may cause neighboring rocks to fall and/or worsen the slope conditions. This slope should be strengthened by concrete and foot fixing.

e. Concrete Lining

When clearance to form the zone is required between the railway and the toe of the slope, the toe must be excavated for widening. The concrete slope lining is used to protect the exposed rock's surface against weathering.

(2) Construction Plan

The protection method will be selected in consideration of the slope. The removal work is from top to bottom for safety reasons. April to October is planned for the working period.

a. Overhang Removal

The unstable large sized overhanging rocks can be removed by a controlled blasting method using a covering sheet to minimize blast damage on to railway track.. Small overhangs will be removed by breakers.

b. Weathered Rock Removal

This method depends on manual work instead of machinery. The section of excavation is determined by the slope condition.

c. Installation of the Rock-Pool

The open rock pool will be constructed at designated spots.

d. Removal of Loose Boulders and Work of Foot Strengthening

Removal of loose rocks follows the same method as for weathered rock. The foot strengthening work is employed to underpin the larger boulders and/or to provide stable conditions by the remove-clean-concrete method.

e. Concrete Lining Work

This method is used in the locations where space between slope toe and railway line is less than the tumble length of falling rocks. The pooling zone for rock fall is constructed by excavating part of slope toe using the concrete lining to protect the excavated face.

f. Relocation of Telecommunication Cable

It is likely rock fall will occur at 251 pk 2. This project proposes to relocate the telecommunication cable, while it is considered railway track is too far from the toe to be affected.

(3) Quantities and Cost

The quantities and cost of the standard section are in Table 11-2-2.

Table 11-2-2 Quantities and Construction Cast

(Unit : 1,000US$)

Location	ITEM	Unit	Qty.	Cost		Total
				Local Total	Foreign Total	
13pk3	Removal of loose deposit/rock	cu.m	304	0	3	3
	Slope toe excavation	cu.m	0	0	0	0
	Excavation for rock pool	cu.m	650	0	4	4
	Concrete lining	cu.m	0	0	0	0
	Removal of overhangs	cu.m	124	1	3	4
	Foot strengthening	cu.m	6	1	0	1
	Removal of weather slope	cu.m	747	3	9	12
	Removal of loose boulders	cu.m	0	0	0	0
	Total			5	19	24
61pk10	Removal of loose deposit/rock	cu.m	1,446	2	15	17
	Slope toe excavation	cu.m	0	0	0	0
	Excavation for rock pool	cu.m	570	0	3	3
	Concrete lining	cu.m	0	0	0	0
	Removal of overhangs	cu.m	94	0	2	2
	Foot strengthening	cu.m	5	0	0	0
	Removal of weather slope	cu.m	567	2	7	9
	Removal of loose boulders	cu.m	0	0	0	0
	Total			4	27	31
282pk9-283pk2	Removal of loose deposit/rock	cu.m	0	0	0	0
	Slope toe excavation	cu.m	0	0	0	0
	Excavation for rock pool	cu.m	0	0	0	0
	Concrete lining	cu.m	0	0	0	0
	Removal of overhangs	cu.m	0	0	0	0
	Foot strengthening	cu.m	0	0	0	0
	Removal of weather slope	cu.m	0	0	0	0
	Removal of loose boulders	cu.m	2,010	7	20	27
	Total			7	20	27
18pk10-19pk1	Removal of loose deposit/rock	cu.m	0	0	0	0
	Slope toe excavation	cu.m	252	0	4	4
	Excavation for rock pool	cu.m	242	0	1	1
	Concrete Lining	cu.m	225	40	43	83
	Removal of overhangs	cu.m	30	0	1	1
	Foot strengthening	cu.m	1	0	0	0
	Removal of weather slope	cu.m	177	1	2	3
	Removal of loose boulders	cu.m	0	0	0	0
	Total			41	51	92
267pk2-3	Removal of colluvial deposit/rock	cu.m	1,875	3	19	22
	Slope toe excavation	cu.m	0	0	0	0
	Excavation for rock pool	cu.m	525	0	3	3
	Concrete Lining	cu.m	0	0	0	0
	Removal of overhangs	cu.m	130	1	3	4
	Foot fixing	cu.m	7	1	0	1
	Removal of weather slope	cu.m	781	3	10	13
	Removal of loose boulders	cu.m	0	0	0	0
	Total			8	35	43
251pk2	Replacement of Telecom. Cable	L.S		0	5	5
	Total			0	5	5
	Grand Total			65	157	222

(4) Applied Section

Table 11-2-3 shows comments on applied sections.

Table 11-2-3 Requirement on Applied Sections

Type	Applied Section	Requirement
I	18 pk 1	Rock weathering is not severe when compared with other sections. However, many unstable rocks are found on the slope, and removal work requires caution not accentuate instability in adjacent slopes.
II	17 pk 5-6	Same as 18 pk 1
	57 pk 9	There are two types of slope, one is the collapsed slope which is stable now, other unstable slope which have the possibility of a rock slide coming close to the railway line. Removal work requires careful action and protection programs may include such as building stone walls to protect the railway formation and side ditches to prevent flooding of the railway.
	250 pk 6-8	Same as 57 pk 9
III	54 pk 2-3	The space along the railway is cleared since the forest road runs in parallel to the railway. However, the section 54 pk 2-3 has rock piles close to the railway, and their removal is recommended to have clear an open space.
IV	8 pk 10	There are much more rocks piles at toe of the slope more than those at 267 pk 2~3. Such piles need be removed and slope toe should be strengthened.

(5) Total Quantities and Costs

The totals of quantities and cost of slope stability are shown in Table 11-2-4.

Table 11-2-4 Slope stability : Total Quantities and Cost

(Unit : 1,000US$)

Location	Type	Length (m)	Amount		Total	Remarks
			Local Total	Foreign Total		
8 pk 10	IV	200	8	41	49	Applied Section
13 pk 3	I	200	4	19	23	Standard Section
17 pk 5-6	II	150	5	22	27	Applied Section
54 pk 2-3	III	100	3	5	8	Applied Section
57 pk 9	II	300	8	40	48	Applied Section
61 pk 10	II	200	5	27	32	Standard Section
250 pk 6-8	II	300	9	41	50	Applied Section
282 pk 9 – 283 pk 2	III	400	7	20	27	Standard Section
18 pk 1	I	90	4	17	21	Applied Section
18 pk 10 – 19 pk 1	I	150	41	52	93	Standard Section
267 pk 2-3	IV	150	8	35	43	Standard Section
251 pk 2	II	-	0	5	5	Standard Section
Total			102	324	426	

11-3 Bridge Rehabilitation

(1) Girder Replacement

Preliminary design for girder replacement is performed on 334pk3 bridge which is selected as a typical bridge for the design.

1) Preliminary Design

a) Materials and allowable stresses

Material	Type, Class	Allowable Stress
Concrete	σck=240 kg/sq.cm	90 kg/sq.cm
Reinforcing steel	SD35	2,000 kg/sq.cm

b) Loads

Load		Description	Remark
Live load		S-14	
Impact load		i=10/(20+L)	L:Clear span length (m)
Dead load	Reinforced concrete	γ =2.5 ton/cu.m	
	Ballast	γ =1.9 ton/cu.m	
	Track panel	γ =0.75 ton/m	

c) Results of Preliminary Design

The typical cross section and its details at the mid span of the bridge resulting from preliminary design are given in Table 11-3-1 and Fig. 11-3-1.

Table 11-3-1 Outline of Main Girder Dimensions at Mid Span of the Bridge

Location	Girder Len. (m)	Girder Depth(cm)	Girder Width (mm)	Bar Arrangement	Remark
334pk3	13.5	150	700	D32、 3 layers	T Girder

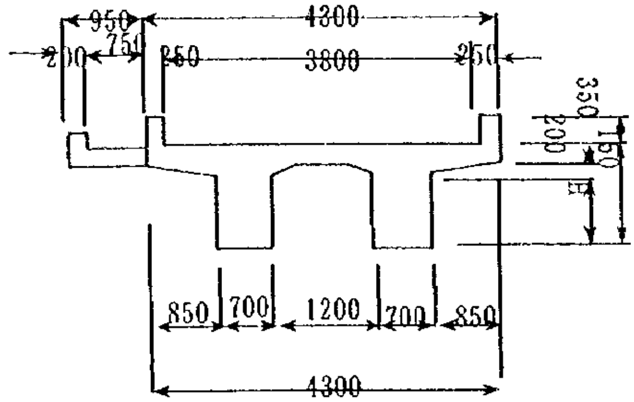


Fig. 11-3-1 Typical Cross Section of Bridge at 334 pk 3

2) Constiuction Plan

a. Construction Period

Fabrication of the concrete girders in a factory	15day/girder*2nos.=30 days
Transportation and erection of girders	= 8 days
Total	38 days／1 span

b. Construction Method

Removal of the existing girders and erection of new girders are to be executed by the 125 ton-crane which belongs to the Mongolian Railway. The concrete girders are fabricated in a concrete factory to be transported to the erection site which are erected after removal of the existing deteriorated girders.

The maximum working area , i.e. the maximum operation radius of the crane boom is estimated as 10 meters considering the expected maximum weight of the concrete girder is about 50 tons. Details shall be decided determining the actual rated lifting capacity curve of the crane.

3) Quantities and Costs

Quantities and costs of the standard bridge are shown in Table11-3-2.

Table 11-3-2 Approximate Quantities and Costs for Replacement of the Standard Bridge Girder

Unit; 1000 US$

Item	Qty	Unit	Amount			Remark
			Local	Foreign	Total	
Erection of new reinforced Concrete girders	2	Span	15.7	23.5	39.2	
Removal of existing concrete Girders	2	Span	2.3	3.3	5.6	
Riprap protection of embankment	136.2	Cu.m	4.9	2.6	7.5	
Miscellaneous	1	LS	1.2	6.0	7.2	
Total			24.1	35.4	59.5	

4) Total Quantities and Costs

The total quantities and costs of girder replacement are shown in Table 11-3-3.

Table 11-3-3 Total Quantities and Costs for Girder Replacement

Unit; 1000 US$

No.	Location	Bridge Length (m)	No. of Span	Concrete Volume (cu..m)	Rebars Weight (ton)	Amount			Remark
						Local	Foreign	Total	
1	285pk1	9.3	1	20.92	3.35	11	14	25	Applied Section
2	289pk1	13.5	2	87.62	14.89	25	35	60	Applied Section
3	326pk9	13.5	3	131.42	22.34	32	47	79	Applied Section
4	334pk3	13.5	2	87.62	14.89	24	35	59	Standard Section
5	338pk10	7.3	1	17.75	2.66	10	13	23	Applied Section
6	344pk1	7.3	1	17.75	2.66	10	13	23	Applied Section
7	356pk1	7.3	2	35.49	5.32	14	20	34	Applied Section
Total				398.56	66.13	126	177	303	Applied Section

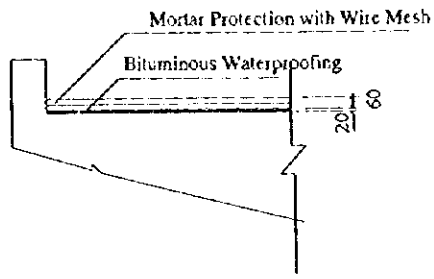
(2) Bridge Repair

Preliminary design of the bridge repair is carried out on 255pk 3 bridge selected as a typical bridge.

1) Preliminary Design and Construction Method

The method of bridge repair is as following;

a. Repairing Waterproof Layer



Bituminous waterproofing system shown in the right is recommended. Resurfacing of waterproofing layer with bituminous material with 10 mm thickness and protection mortar with 40 mm thickness are used to prevent water seepage into the concrete which may induce further progress of concrete deterioration due to freezing and thawing in the bridge components. All work shall be executed minimizing the effects on the train operation by supporting track panels on timber cribs, which will be installed on the slab immediately after removal of existing ballast and the deteriorated waterproof lager on the bridge slab.

b. Surface Treatment

Efflorescence and exudation of lime are observed in ballast walls and concrete slabs of some bridges. Spalling on concrete surface are found occasionally. Surface treatment with a three-layer treatment method with epoxy resin materials as shown in Table 11-3-4 is recommended to prevent further deterioration due to penetration of waters, freezing and thawing. The surface treatment system shall be tasted to confirm its applicability by exposure testing under such cold climate like Mongolia.

Tab. 11-3-4 Materials and Method of Surface Treatment

Description		Material	Coating (kg/sq.m)	Execution Method
Undercoating	Primer	Epoxy resin	0.1	Brush or roller
	Putty	Epoxy resin putty	0.3	Spatula or hawk
Second coating		Flexible epoxy resin	0.26	Brush or roller
Surface coating		Flexible polyurethane	0.12	Brush or roller

c. Recasting Concrete

Pattern cracking is observed in the abutment at 342pk2 bridge. The deteriorated portion will be removed to be repaired with recasting concrete method.

2) Total Quantities and Costs

Total quantities and costs of bridge repair are shown in Table 11-3-5.

Table 11-3-5 Total Quantities and Costs of Bridge Repair Work

Unit; 1000 US$

No.	Location	Girder Len. (m)	No. of Span	Water-proofing (sq.m)	Surface-Treatment (sq.m)	Concrete Repair (cu.m)	Amount			Remark
							Local	Foreign	Total	
1	235pk3	9.3	2	38.1	45.9		5	6	11	Applied Section
2	245pk5	9.3	2	38.1	45.9		5	6	11	Applied Section
3	255pk3	7.3	2	29.9	29.7		5	5	10	Standard Section
4	342pk2	6	1			5	1	1	2	Applied Section
Total				106.1	121.5	5	16	18	34	

11 - 4 Drain Improvement

Hydraulic analyses by the Mongolian Railway are used to determine the required discharge volume and dimensions of the drainage facilitates to improve the present conditions. Reinforced concrete culverts and/or bridges will be constructed to improve drain conditions at each location where necessary. Standard section for drain improvement are shown in Table 11-4-1. Reinforced concrete wing walls and aprons are to be constructed at the inlets and outlets of the culverts while riprap bank protection is planned behind the abutments to prevent erosion of the embankment during floods.

Table 11-4-1 Standard Section for Drain Improvement

Symbol	Location	Clear Space, Clear Height, Span Len.	Remark
Culvert			
CBC1	253pk3	2.0 m、1.5 m	Reinforced concrete box culvert
CBC2	389pk1	2.5 m、2.0 m	Reinforced concrete box culvert
CBC3	356pk1	2.5 m、2.5 m	Reinforced concrete box culvert
COC	23pk2	2.5 m、2.5 m	Reinforced concrete open culvert
Bridge			
BR1	235pk3	11.5 m	Reinforced concrete T-beam bridge
BR2	125pk8	13.5 m	Reinforced concrete T-beam bridge
	339pk1		Widening of the Channel

(1) Design Criteria

Conditions for preliminary design are in the following:

1) Materials and Allowable stresses

Material		Type, Class	Allowable stress
Concrete	Superstructure, Culvert	σ ck=240 kg/sq.cm	90 kg/sq.cm
	Substructure	σ ca=210 kg/sq.cm	80 kg/sq.cm
Reinforcing steel		SD35	2000 kg/sq.cm

2) Loads

Load		Description	Remark
Live load		S-14	
Impact load		i=10/(20+L)	L:Clear span length
Dead load	Reinforced concrete	γ =2.5 ton/cu.m	
	Ballast	γ =1.9 ton/cu.m	
	Track panel	γ =0.75 ton/m	
	Embankment	γ =1.8 ton/cu.m	

(2) Box Culvert

Preliminary design is carried out on the selected typical structures such as reinforced concrete box culverts located at 253pk3(CBC1), 389pk1(CBC2), and 356pk1(CBC3) and reinforced concrete open culvert at 23pk2(COC, Sukhe-baatar Station Yard).

1) Preliminary Design and Construction Plan

a. Preliminary Design

Dimensions of culverts are shown in Fig. 11-4-1 resulting from the preliminary design.

b. Construction Method

Pre-cast concrete barrel segments of the concrete culvert, approximately one meter long, are installed on a pre-cast concrete block foundation by the crane and connected each other by mechanical joints comprising bolts or steel ties to minimize working period at the site which will affect train operations. Clearing and widening/excavation of the channel in the upstream side and the downstream side of the culvert should be carried out.

c. Construction Period

Construction schedule of the standard pre-cast concrete culvert with approximately 7 meter long composed of seven blocks at the site is as following;

Track panel removal 1hour

Excavation, installation of concrete blocks foundation and pre-cast concrete barrels 5hours

Filling and restoration of track panels 4hours

Total 10hours

d. Drainage Improvement of Sukhe-baatar Station Yard

The drainage improvement scheme of the Sukhe-baatar station yard should be planned in accordance with the drainage plan covering the whole city area, however this is not established yet by the local government. The drainage system with a concrete open culvert (COC L=80m), a concrete box culvert (CBC3 L=50m), and a concrete lined open ditch (L=200m) is assumed tentatively for an estimate of construction costs. Groundsel is constructed at the outlet of the drainage to the Haraa river to prevent erosion. Detailed study shall be performed prior to the construction of the drainage system.

2) Quantities and Costs

Quantities and costs of each drainage structure are shown in Table 11-4-2. Dimensions are in Fig. 11-4-1.

Table 11-4-2 Quantities and Costs of Typical Culvert Construction

Unit; 1000 US$

Location	Symbol	Dimensions of Culvert			Amount (per meter)		
		No. of Cell	Clear Space (m)	Clear Height (m)	Local	Foreign	Total
253pk3	CBC 1	1	2.0	1.5	0.97	3.69	4.66
389pk1	CBC 2	1	2.5	2.0	1.11	3.82	4.93
356pk1	CBC 3	1	2.5	2.5	1.17	4.00	5.17
23pk2	CBC 3	1	2.5	2.5	1.17	1.44	2.61
23pk2	COC	1	2.5	2.5	0.50	0.45	0.95

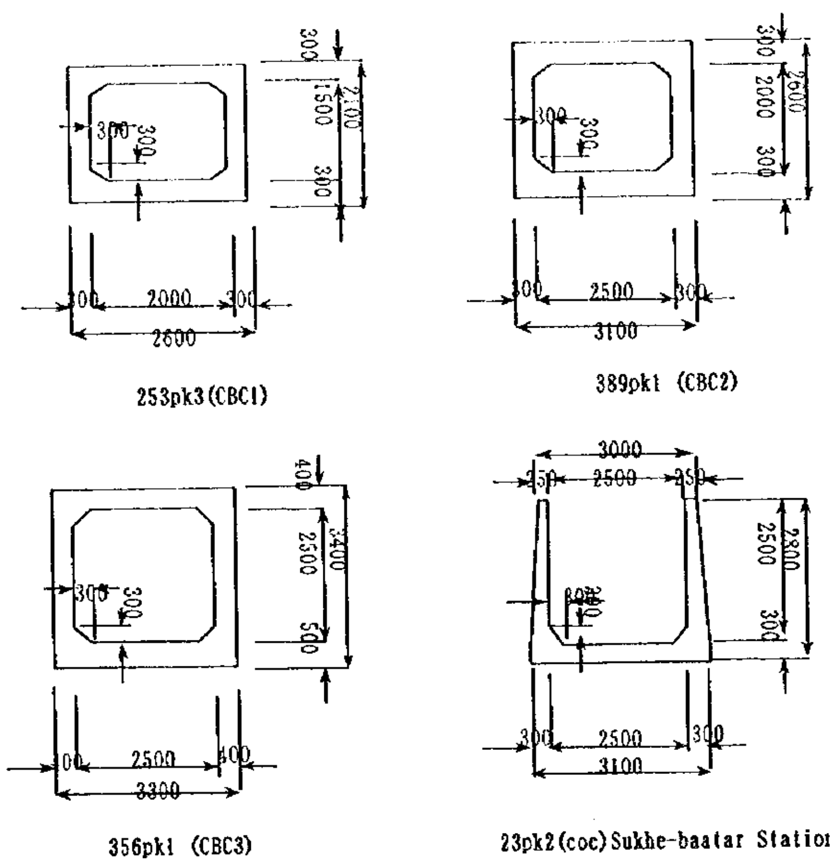


Fig.11-4-1 Dimensions of Culvert Section

3) Total Quantities and Costs

Quantities and costs of culvert construction are shown in Tab. 11-4-3.

Table 11-4-3 Total Quantities and Costs of Culvert Construction

Unit; 1000 US$

Symbol	Qty	Unit	Amount			Remarks
			Local	Foreign	Total	
CBC 1	199	(m)	194	734	928	66pk4、89pk7、94km、100pk7、143pk7、168pk4、170pk3、184pk4、190pk6、210pk6 、218pk5、223pk7、、230pk9、252pk1、253pk3、313pk10、329pk7、340pk5
CBC 2	158	(m)	176	604	780	97pk5、145pk1、197pk2、242pk4、314pk10、345pk6、348pk7、、389pk1、391pk2、394pk4、417pk1、417pk10、420pk7、424pk7、428pk4、438pk7、
CBC 3	58	(m)	68	104	172	356pk1, 23pk2
COC	80.0	(m)	40	36	76	23pk2
Apron, wing wall	1	LS	234	169	403	
Concrete lined ditch	200	(m)	3	5	8	Sukhe-baatar station yard
Groundsel	1	LS	1	16	17	outlet at Haraa river/ Sukhebaatar
Total			717	1,667	2,384	

(3) Bridge

1) Preliminary Design and Construction Plan

a. Preliminary Design

Preliminary design of bridge was carried out on 255pk3 and 125pk8. General drawings of the bridge structures are illustrated in Fig. 11-4-2 ~ Fig. 11-4-3.

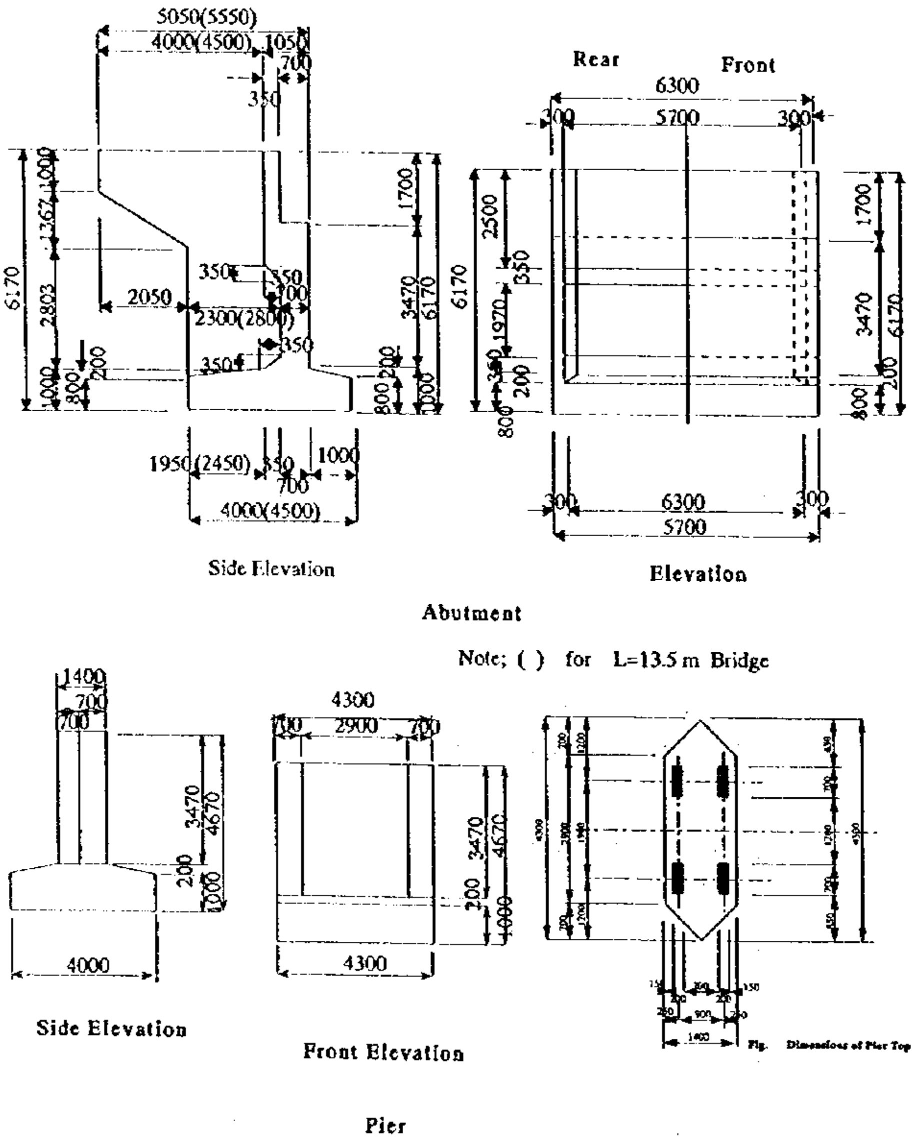
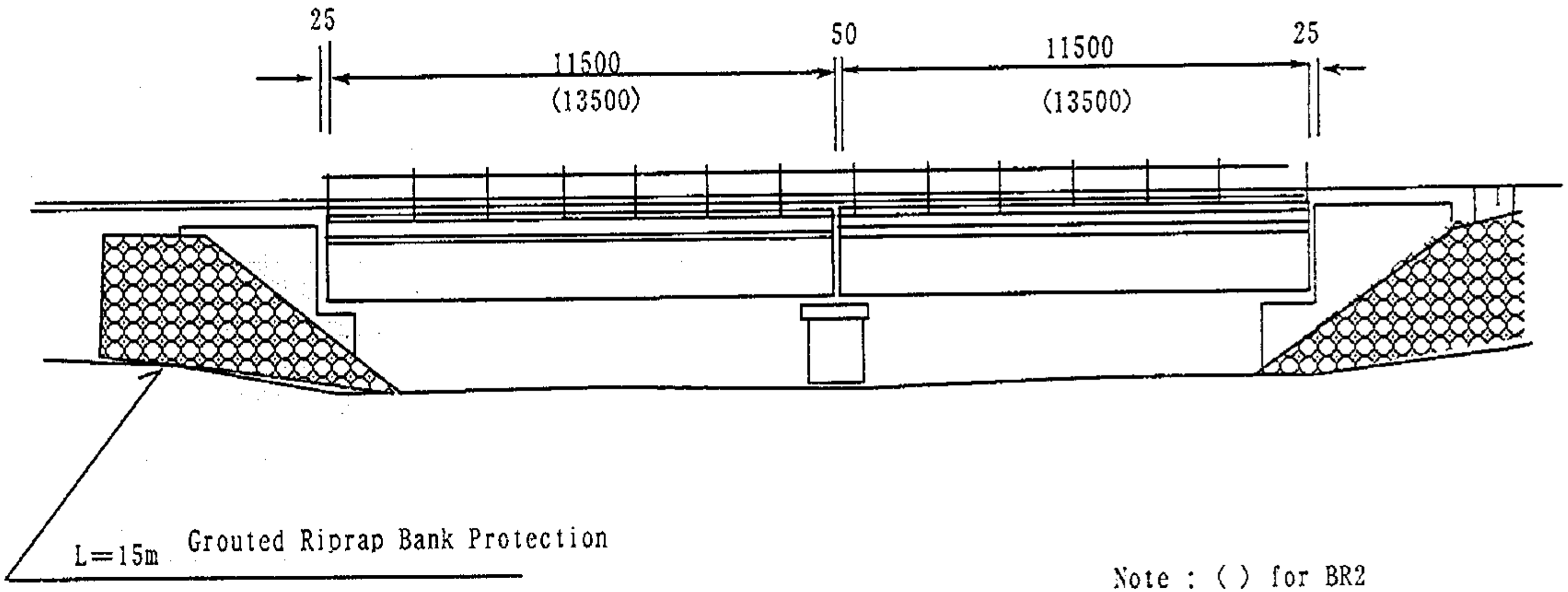


Fig.11-4-2 General View of Substructure



Note : ( ) for BR2

125pk3 BR1 L=11.5 m
235pk3 BR2 L=13.5 m

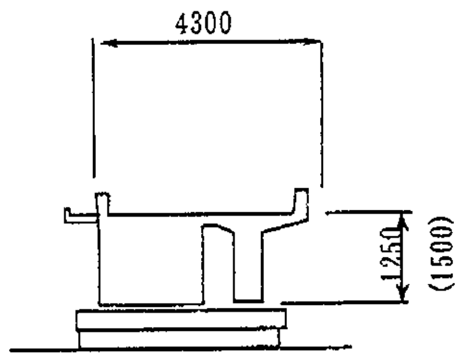


Fig 11-4-3 General View of Bridge at 125 pk 8

b. Construction Method

Newly fabricated girders are erected by the Mongolian Railway's crane. Substructure is designed as cast-in-place concrete structure type with a spread footing. Track panels are supported by cribbing and temporary girders during construction period of substructure not to disturb train operations.

The channel is widened and revetment is constructed at 399pk1 while the existing bridge structures are removed.

c. Construction Period

Schedule for construction of the bridge structure with two spans of 13.5 meter long T-girder superstructure, two abutments and a pier with spread footing type at the site is in the following;

Removal of track panel and excavation	6days
Installation of saddles	4days
Installation of temporary steel girders	2days
Construction of substructure	32days
Erection of superstructure	4days
Demobilization	1day
Total	49days

(per L= 13.5 m 2-span bridge with 2 abutments and 1 pier)

2) Quantities and Costs

Estimated quantities and costs of standard bridges are given in Table 11-4-4.

Table 11-4-4 Quantities and Costs

Unit; 1000 US$

Location	Symbol	Dimensions of Bridge		Amount Cost			Remark
		Girder Len (m)	No. of Span	Local	Foreign	Total	
235pk3	BR1	11.5	1	29	36	64	2 abutments
125pk8	BR2	13.5	2	51	67	118	2 abuts. 1 pier
399pk1				8	8	16	Widening of channel

(4) Total Quantities and Costs

The total quantities and costs of the bridge construction are given in Table 11-4-5.

Table 11-4-5 Total Quantities and Costs of Bridge Construction

Unit: 1,000US$

Location	Symbol	Dimensions of Bridge		Amount Cost			Remark
		Girder Len. (m)	No. of Span	Local	Foreign	Total	
125pk8	BR2	13.5	2	51	67	118	Standard Section
235pk3	BR1	11.5	1	28	36	64	Standard Section
255pk3	BR1	11.5	1	28	36	64	Applied Section
334pk3	BR1	11.5	1	28	36	64	Applied Section
352pk7	BR2	13.5	1	33	41	74	Applied Section
399pk1				8	8	16	Standard Section
Total				176	224	400	

11 - 5 Direct Construction Cost of Short Term Urgent Projects

Direct Construction Cost of Short Term Urgent Projects are summarized in Table 11-5-1.

Table 11-5-1 Direct Construction Cost of Short Term Urgent Projects

Unit : 1,000 US$

Project		Location	Amount Cost		Total
			Local	Foreign	
1	Bank Protection	7	1,334	2,719	4,053
2	Slope Protection	12	102	324	426
3	Bridge Rehabilitation	11	142	195	337
4	Drain Improvement	42	893	1,891	2,784
Total		72	2,471	5,129	7,600

12. ENVIRONMENTAL IMPACT ASSESSMENT (EIA)

12 - 1 Environmental Measures toward Construction Wastes

Construction wastes are produced in a track transfer (31pk2-4), widening stream channel (399pk1), drain improvements and so on. The construction wastes for this project consist of wasted sediment, soil, concrete and iron material. If the wasted soil and/or sediment has an offensive smell or a possibility of contamination, it is necessary to analyze it. The construction wastes should be reused as much as possible. Methods for disposal of construction wastes should be determined with a local government.

Site 399pk1, where a stream channel will be widen, is in an industrial zone and domestic wastewater flows in this channel. Heavy metals and bacteria in sediments and soils near the site 399pk1 were analyzed. Cyanides in the water sample were analyzed. Comparing the results for heavy metals with the Dutch guidelines, only cadmium concentration for every soil and sediment sample is between the reference (background) value and indicative value for further investigation. The other heavy metals' level was below the background value. Microbiological analysis show that fecal coliforms slightly contaminated the soil sample and slightly or moderately contaminated sediment samples. A pathogenic bacterium (*Clostridium perfringens*) was not detected in soil and sediment samples. Cyanides were not detected in the water sample. Local subcontractor's report (Report B) concluded that the sediment and soil can be transported and disposed at waste disposal place if proper permission will be given by the Ministry for Nature and Environment and the Sanitary Inspection body of the Ulaan-baatar city.

12 - 2 Environmental Measures toward Slope Stability

Slope stability will be done at sites 8pk10, 13pk3, 17pk5-6, 18pk1, 18pk10-19pk1, 54pk2-3, 57pk9, 61pk10, 250pk6-8, 267pk2-3, 282pk9-283pk2. The natural environment at these sites is relatively conserved. It was studied if there were nests of the rare bird species near the project sites. In the birds which were observed as shown in the local subcontractor's report (Report A, 1996) we check the following bird species:

Grey Heron (*Ardea cinerea*), Golden Eagle (*Aquila chrysaetos*), Black Kite (*Milvus migrans*), Northern Goshawk (*Accipiter gentilis*), Common Buzzard (*Buteo buteo*) and Eagle Owl (*Bubo bubo*). The majority of these bird species are internationally rare, but none of them are not protected by the Mongolian Law and appear in the Mongolian Red Data Book. Nests of these bird species were not found at the slope stability sites.

12 - 3 Environmental Measures toward River Bank Protection

The sites, where their river bank has been protected with rock blocks by now, are 11pk1-4 (250m)、31pk2-4 (300m)、51pk9-52pk1 (250m)、55pk9(100m)、67pk4-6 (300m)、208pk1-2. In this short term urgent project, river banks at the sites 10pk7-10、51pk9-52pk1、54pk4-5、57pk8-10、67pk6-7、208pk1-3 will be protected. After this project, the proportion of protected river bank between 10 km and 70km is less than 2 per cent.

Algae species are an ubiquitous group of photosynthetic organisms responsible for the majority of photosynthesis (the first stage of the food webs) in streams. Light attenuation by dissolved organic matter or suspended organic and inorganic particles can reduce light penetration in larger streams, particularly those that carry high suspended sediment loads. If the reduction of light penetration continues for a long period, aquatic ecosystem will be impacted. Therefore, it is necessary to choose the construction method with which suspended sediment occurs as little as possible. The spawning and hatching season for most fish species are from April to June. It is recommended that the construction will be carried out excluding this season if possible.

Impacts toward original aquatic biota with the river bank protection system may be small, because of the low proportion of river bank protected in the river side. And then the river bank protection system will produce a variety of habitats which have a different condition (flow velocity and surface property of the river bank) from original one. In general, species richness increases as a function of habitat complexity. Periodic, recurrent disturbances such as flash floods or droughts can cause local, short-term changes in community structure.

The severity of these disturbances can be ameliorated when the habitat is complex, because habitat complexity confers refuge.

Disturbed plants along river side during construction should be recovered as soon as possible, because bared soil induces the soil erosion.

12 - 4 Environmental Measures toward Track Transfer

The river bank at section 31pk 2-4 is eroded at a rate of 5 to 6 meters a year. Therefore, the track will be translocated to keep apart from the Orkhon river in the short-term urgent project. The zone impacted by the translocation of track is 2 km long and has a wood land which consists of Siberian Elm (*Ulmus pumila*). It is necessary to get a permission from the local government to clear trees. And this construction will impact the grassland, where rare plant species (Dichotomous Star (*Stellaria dichotoma*)、Chickweed (*Stellaria media*) and Seabuckthorn (*Hippophae rhamnoides*)) were found. The first two species are frequently found at the project sites along the Mongolian railway. It is necessary to communicate with the Local Government on these plants.

After the translocation of track the recovery of plant should be done as soon as possible in order to conserve the soil condition. Fences are generally made along the Mongolian railway in order to keep out cattle from tracks. Devastated vegetation should be protected with fences, and then the fences will be set to the normal position after the recovery of vegetation.

Rare vertebrate species which made nests at this project site were not found.

12 - 5 Environmental Measures towards New Bridge Construction and Replacement with Beam

New bridges will be constructed at the sites 125pk8, 235pk3, 255pk3, 334pk3 and 352pk7 and a beam will be replaced for some bridges at the sites 285pk1, 289pk1, 326pk9, 334pk3, 338pk10, 344pk1 and 356pk1. It is necessary to reduce the occurrence of suspended sediment during the construction as little as possible at the site where the river always has a water flow.

Since heavy machines will be used for this construction, the soil will be compacted with these machines near the construction site. In this respect, the disturbed area should be protected from grazing until the recovery of vegetation. It is recommended that heavy machines, equipment and materials should be transported by railway.

Construction wastes produced during construction, concrete and iron material, will be separated and should be appropriately treated including reusing them.

12 - 6 Environmental Measures toward Waterproof and Minor Methods

Bridges at the sites 235pk3, 245pk5, 255pk3, 342pk2 will be repaired with waterproof and minor methods. If chemicals will be used in repairing bridges, it is necessary to protect the environment from the contamination with chemicals. Used containers and residues of chemicals should be carried to Ulaan-baatar and properly treated.

12 - 7 Environmental Measures toward Drain Improvement

In the case of drain improvement for the Sukhe-baatar station, it is necessary to select the construction place, where a channel will lead flood water to the river, not to impact buildings. At other drain improvement sites, buildings and gers were not found. But it is necessary to check no impact against buildings and gers in introducing a new culvert.

There are disturbed grasslands near Sukhe-baatar, Darkhan, Baruunharaa, Zuunharaa and Ulaan-baatar (340 km to 395 km) due to over-grazing, intrusion of vehicles and urbanization. And the flood and the degradation of grassland form a vicious circle. This problem is not only for the Mongolian Railway but also for the Mongolian Government and Local Governments. From the long-term point of view, grasslands should be protected from over-grazing and stable soil system should be recovered, which will be effective measure against floods.

12 – 8 Conclusion

In the environmental aspect, this project will not cause especially large impacts. But it is necessary to take care of the impacts on fauna and flora and construction wastes. Mongolia has prepared environmental legislation, therefore, it is necessary that the project should be conducted in accordance with the guidance of the Mongolian Authorities concerned.

13. IMPLEMENTATION PLAN

13 - 1 Conditions

The Following are preliminary conditions to formulate the implementation plan:

(1) Timing

The short term urgent projects shall be completed by the end of 2004.

(2) Prices

The costs are estimated based on market prices as of August 1996 in the country. Materials and equipment which are not available in the country will be imported from other countries.

(3) Foreign Exchange

Foreign exchange rates between US$, Tugrik and Japanese Yen as of August 1996 is as following; components were considered for import of material, machines, personnel, etc.

$US 1.00 = 550 Tugrik = yen 110,-

(4) Unit Costs

Unit costs of various work items were determined and estimated based on market price inspection in the country and neighboring countries including Japan.

(5) The Investment Cost

The total investment costs are divided into direct and indirect costs as following;

a. Direct Construction Cost (Materials, personnel, machine and equipment, temporary work and mobilization / demobilization)

b. Overhead Cost (20 % of a.)

c. Contingency (10 % of a.)

d. Engineering (16 % of a.)

e. Taxes

13 - 2 Investment Cost

The total investment cost is $us 12.3 million in 1996 prices $us 6.5 million for the bank protection, $0.7 million for the slope stability, $0.5 million for the bridge rehabilitation, and $4.5 million for the drain improvements. They are given in Table 13-2-1.

Table 13-2-1 Investment Cost

Unit : 1,000U S $

Item	Bank protection			Slope protection			Bridge rehabilitation			Drain improvement			Total		
	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total
Direct Construction Cost	1,334	2,719	4,053	102	324	426	142	195	337	893	1,891	2,784	2,471	5,129	7,600
Overhead Cost	267	544	811	20	65	85	28	39	67	179	378	557	494	1,026	1,520
Contingency	134	271	405	11	32	43	15	19	34	89	189	278	247	513	760
Engineering Fee	133	514	647	10	61	71	14	37	51	89	358	447	247	969	1,216
Sub-Total	534	1,329	1,863	41	158	199	57	95	152	357	925	1,282	988	2,508	3,496
Total	1,868	4,048	5,916	143	482	625	199	290	489	1,250	2,816	4,066	3,459	7,637	11,096
Taxes	618		618	66		66	53		53	427		427	1,164		1,164
Grand-Total	2,486	4,048	6,534	209	482	691	252	290	542	1,677	2,816	4,493	4,623	7,637	12,260

13 - 3 Implementation Program

(1) Implantation Programs

The short term urgent project will be completed by the end of 2004, in which the years of 1998-2001 are for preparation. Execution of the 9 location out of 72 locations, where emergency countermeasures are required, will be carried out during 1999 – 2001 while the remaining majority will be constructed during 2002 – 2004.

Actions in preparatory years:

- Request and negotiation on funds with international and bilateral agencies
- Signature on the funding agreement.
- Preparation of detailed drawings and specifications for bidding
- Authorization of the contract
- Confirmation of the drawings

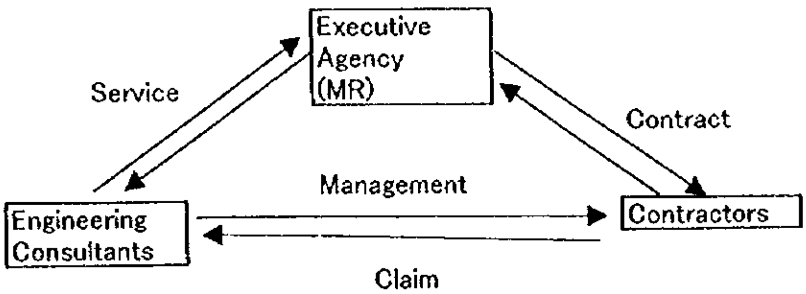
Actions in the execution years:

- Mobilization / Demobilization
- Execution
- Clearance of the sites

- Supervising and management of the project implementation

(2) Implementation system

The Mongolian Railway is the execution agency and Ministry of Infrastructure Development administers progress of the entire project. Actual management of the project execution is a tri-party system shown below:



Tri-party Organization

13 - 4 Annual Expenditure Plan

Expenditures are grouped into the years of preparation and those in work implementation

(1) Preparation

- Activities will include designing, fund negotiation, bidding procedures and others.

(2) Implementation

- Mobilization and demobilization

- Bank protection

  Rail track transfer at 31 pk 2-4, construction of revetment, shift of telecommunication lines, etc.

- Slope protection

  Works including removal of the over hanging rocks, weathered rocks and loose boulders. And construction of pooling zone for fallen rocks.

- Bridge rehabilitation

  Works comprise replacement of damaged girders and repairs at various bridges.

- Strengthen drainage system

  Drainage capacity is increased by constructing culverts and bridges at designated points. Drains in Sukhe-baatar station will be improved.

The following 9 locations are programmed to be executed in the beginning years, 1999 – 2001.

	Slope Protection	Drain Improvement	
1999	13pk3	399pk1	389pk1
2000	61pk10	391pk2	356pk1
2001	18pk1	340pk5	253pk3

Table 13-4-1 Annual Work Program by Major Clarification

	Total No.	1998	1999	2000	2001	2002	2003	2004
Preparation		■	■	■	■			
Construction								
Bank protection	7				■	■	■	■
Slope protection	12		■	■	■	■	■	■
Bridge rehabilitation	11					■	■	■
Strengthen drainage syst	42		■	■	■	■	■	■

Table 13-4-2 Annual Expenditure Plan

Unit : 1,000 U S $

	1999			2000			2001			2002			2003			2004			Grand-Total		
	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total
A Bank protection	0	0	0	0	0	0	0	0	0	554	1,276	1,830	479	1,217	1,696	301	226	527	1,334	2,719	4,053
B Slope protection	5	19	24	5	27	32	41	52	93	23	96	119	15	73	88	13	57	70	102	324	426
C Bridge rehabilitation	0	0	0	0	0	0	0	0	0	0	0	0	66	86	152	76	109	185	142	195	337
D drain improvement	45	91	136	26	70	96	29	72	101	183	433	616	180	348	528	430	877	1307	893	1,891	2,784
E Direct Construction Cos	50	110	160	31	97	128	70	124	194	760	1,805	2,565	740	1,724	2,464	820	1,269	2,089	2,471	5,129	7,600
F Overhead Cost	10	22	32	6	19	25	14	25	39	152	361	513	148	345	493	164	254	418	494	1,026	1,520
G Contingency	5	11	16	3	10	13	7	12	19	76	181	257	74	172	246	82	127	209	247	513	760
H Engineering	5	239	244	3	239	242	7	12	19	76	180	256	74	172	246	82	127	209	247	969	1,216
I Sub-Total	20	272	292	12	268	280	28	49	77	304	722	1,026	296	689	985	328	508	836	988	2,508	3,496
J Total (E + I)	70	382	452	43	365	408	98	173	271	1,064	2,527	3,591	1,036	2,413	3,449	1,148	1,777	2,925	3,459	7,637	11,096
K Taxes	24		24	19		19	30		30	391		391	377		377	324		324	1,164		1,164
L Grand-Total	94	382	476	62	365	427	128	173	301	1,455	2,527	3,982	1,413	2,413	3,826	1,472	1,777	3,249	4,623	7,637	12,260
(%)			3.9			3.5			2.5			32.5			31.2			26.5			100.0

14. OPERATING AND MANAGEMENT PLAN

14 - 1 Base Units

Base units for the short-term urgent project are estimated from the financial statement of MR for 1995 (adjusted for price increase of 37.8% up to the time of investigation).

Table 14-1 Base Unit

(Unit : Tugrik)

Expense Cost	Base Unit	
Labor cost	560,560/person	(number of employees)
Material Cost		
General Administrative Expense	11,457/person	(number of employees)
Maintenance Management Expense	0.27/km	(car km)
Transportation Management Expense	6.62/1,000prs.ton.km	(transportation volume)
Railway Maintenance Expense	15.33/km	(car km)
Communication Maintenance Expense	66.02/km	(train km)
Car Maintenance Expense	14.72/km	(car km)
Transportation Expense	732.50/1,000prs.ton.km	(transportation volume)
Operation Expense	53.07/km	(car km)

14 - 2 Calculation of Operating and Management Expenses

Operating and Management Expenses shown in Table 14-2 are calculated from number of employees, transportation volume, car kilometers, train kilometers and base units. Transportation volume, car kilometers and train kilometers are estimated for the project section from the OD table and train operation plan. As the results are about 44% of those for the whole MR lines, the number of the employees required for operating the project section is estimated as 44% of total staff of MR's railway divisions. Total staff of railway divisions are set as the actual number in 1996 plus the increase of the transportation personnel.

Table 14-2 Operating and Management Expenses

(Unit: Million Tugrik)

Item / Year	2005	2010	2020
Number of Employees (persons)	3,094	3,196	3,261
Transportation Volume (million passenger./ton-km)	1,930	2,240	2,543
Car Km (1,000 km)	69,132	81,610	102,787
Train Km (1,000 km)	2,718	3,036	3,301
Labor Cost	1,734	1,792	1,828
Material Cost			
General Administrative Expense	35	37	37
Maintenance Management Expense	19	22	28
Transportation Management Expense	13	15	17
Railway Maintenance Expense	1,060	1,251	1,576
Communication Maintenance Expense	179	200	218
Car Maintenance Expense	1,018	1,201	1,513
Transportation Expense	1,414	1,641	1,863
Operation Expense	3,669	4,331	5,455
Total Material Cost	7,406	8,699	10,707
Grand Total	9,141	10,490	12,535
US Dollar Equivalent (1,000 US$)	16,620	19,073	22,790

15. ECONOMIC AND FINANCIAL ANALYSIS

15 – 1 Economic Analysis

Economic evaluation of the short term urgent projects was conducted to find the value in the economic internal rate of return (EIRR), an index used in economic assessment, by estimating the cost and benefits under the following conditions.

EIRR was calculated by the following formula

$$0=\sum_{i=1}^{n}(Bi-Ci)/(1+eirr)^{i-1}$$

Bi: Benefits in year i

Ci: Cost in year i

i : the year in number starting 1999 as 1

n: analysis period

(1) Conditions

1) Economic project cost was estimated by deleting transfer elements of tax and duty from the financial cost.

2) Project benefit streams were enumerated for 30 years beyond the year of completion of the projects.

3) Completion of those projects will reduce the damages caused by natural disaster. The expected reduction in damage occurrence is shown below (Table15-1-1):

Table 15-1-1 Changes in Damage Occurrence

(Annual average occurrence)

Damage Scale	Reduced Damages By Short Term Projects
L	0. 38
M	0. 97
S	1. 35
Total	2. 70

4) Economic benefits are composed of three factors.

-1 Savings in damage repair cost.

-2 Savings in passenger time cost

-3 Savings in road vehicle transport cost

(2) Project Cost of the Short Term Urgent Projects (Table 15-1-2)

Table 15-1-2 Project Costs: Economic and Financial

($us in 1, 000)

Year	Works	Economic Cost	Financial Cost
1999	Implementation	452	476
2000	Implementation	408	427
2001	Implementation	271	301
2002	Implementation	3, 591	3, 982
2003	Implementation	3, 449	3, 826
2004	Implementation	2, 925	3, 249
Total		11, 096	12, 260

(3) Economic Benefits

1) Savings in Damage Repair Costs

Mongolian Railway has repaired damages suffered from natural disaster in the past years by mobilizing all available resources. The repair work was in urgent necessity of re-opening of the operation, and often not strong enough physically which would have possibility of repetitive damages. The proposed projects will rehabilitate damageable points by strengthening railway substructure, which may include replacement of obsolete structures, thus will result in the savings in cost of repair works assumed to incur every year. (Table 15-1-3). The repair cost shown in average for the damage scale L,M and S respectively and the damage occurrence per year is quoted from Table 8-1-1.

Table 15-1-3 Repair Cost of the Urgent Short Term Projects

Damage		Repair Cost of the Damages in us$	
Scale	Occur.	Cost per project	Cost in'05
L	0.38	1,738,300	660,554
M	0.97	123,100	119,407
S	1.35	82,080	110,808
Total	2.70	1,943,480	890,769

Annual damage repair cost was estimated by the multiplication of damage occurrence and the averaged cost, which would be saved if the short term projects are executed. The annual repair cost is assumed to increase by 20% in 2015 and 2025 again caused by maintenance negligence.

2) Savings in Passenger Time Cost

Waste time of passengers during the train stopping were estimated and their economic cost was measured by unit time value and the averaged wait hours of trains, through which the time cost was tabulated. GDP per capita was used in the calculation and the estimate of it in future years was based on the same annual growth rate of 2.3% per annum used in the socio-economic framework. The followings are the averaged time values and train wait hours.

	Time value in 1996
Mongolian Passengers	$ 0.15 / hour
Foreign Passengers	$ 0.50 / hour
Averaged person	$ 0.266 / hour
	Averaged Train Wait Hours
Damage L	13.5 hour
Damage M	10.5 hour
Damage S	5.3 hour

3) Savings in Road Vehicle Transport Cost

There would be losses in the Mongolian economy if damages occur and trains are forced to stop unexpectedly every year. Quantification of those losses in money terms is difficult and often they are included in qualitative impacts. To represent part of the losses, the road transport cost was enumerated for passengers and cargoes involved in the train stopping. The economic vehicle operation cost (VOC, including depreciation cost, interest charges, costs of fuel, tires, parts, wages, maintenance, etc.) was studied under the assumption of paved and unpaved sections 50% respectively. The unit VOC per km by vehicle type was used with 450km of the road distance, being same to the project's railway distance (the Russian border to Bayan) to estimate the road transport cost. Numbers of required vehicles to be used on roads were calculated for the volumes involved in stopping and loading capacity per vehicle..

Wagon bus	$ 181.71 per 1,000 km
Bus	$ 234.65 per 1,000 km
Truck	$ 241.63 per 1,000 km

It is noted those trains encountering damages in scale S were not included in the road transport cost, assuming they would remain on trains not divert to the road transport.

4) Savings in Total

Savings of 30 years during 2005-34 are shown below together with percentage composition. The percentage composition of the saving benefits was 65% for damage repair, 29% for road transport and 6% for passenger time (Table 15-1-4).

Table 15-1-4 Summary of Benefits, 2005-34

($us'000 not discounted)

Years	Savings			
	Railway Repair	Pass Time C.	Road Veh. Transp	Total
2005-34	33,290	3,137	14,998	51,425
%	64.70%	6.10%	29.20%	100%

(4) Economic Internal Rate of Return

The economic internal rate of return (EIRR) for 'the short term urgent projects was calculated at 13.05% (Table 15-1-5). The sensitivity test showed EIRR was reduced to lower values when the benefits were assumed to decrease than the cost was increased. However, differences are marginal within this extent of variation.

Table15-1-5 Short Term Urgent Projects: EIRR and Sensitivity Tests

Case	EIRR	Case	EIRR
Base Case	13.05%		
Case I	11.92%	Case II	10.97%
Case III	11.81%	Case IV	10.54%
Case V	10.77%	Case VI	8.82%

Case I: increased cost by 10%
Case II: increased cost by 20%
Case III: reduced benefits by 10%
Case IV: reduced benefits by 20%
Case V: Combined cases of I and III
Case VI: Combined cases of II and IV

(5) Indirect Benefits

Main unquantified benefits are stated in the followings:

1) To ensure the Life line of the People

The land transport system of the country has a road network extending to the entire areas, but they cannot provide safe and constant travel service because of various factors. On the other side, the railway system has developed to be the life-line of the people since it connects main urban centers in the central corridor and maintains linkages to Russia and China. The followings are key services of the life-line.

Massive and constant transport of coal are indispensable in power generation and heating. The ensured transport service is necessary for the economy since there are difficulties in increasing stock capacity of coal at power plants. Import of petrol fuel and foodstuff also requires constant service of the railways.

Early implementation of the short term urgent projects will ensure the stable service for the life-line.

2) Support in social and industrial activities

The projects will support increases in employment in various economic sectors.

3) Improve environmental conditions

The country is famous for having uncontaminated nature of steppe, mountains, lakes, etc. The improvement on railways will help in securing better environment since it will not support unnecessary increases in vehicle transport which are easy in deteriorating environment.

(6) Conclusion

The value of EIRR in the base case was estimated at 13.05% which would be considered feasible in Mongolia. Considering other factors such that the security of rehabilitated railways is necessary to maintain the life-line of the people, the economic level is low and improved railways are prerequisite to the economic growth of the country, it is concluded 'the short term urgent projects' scheduled to be completed by 2004 should be implemented urgently.

15 – 2 Financial Analysis

As an index for financial evaluation, the financial internal rate of return (FIRR) is used.

$$0 = \sum_{t=1}^{n} \text{Cash Flow}_t \,/\, (1+\text{FIRR})^{t-1}$$

Where,

n	=	time period of analysis
Cash Flow_t	=	cash flow of every different year
Cash Flow	=	operating profit + depreciation - investment (salvage value to be added as a negative investment in the last year of project period)

(1) Conditions

1) The earning capacity of this project is checked by analyzing the amount of investment, the methods of raising funds, the loss of transportation revenue and expense in case train operations are interrupted by disasters and the savings of rehabilitation cost by the prevention of disasters.

2) The period of project is 30 years from the completion of the work.

3) In financial analysis market prices are used for the construction cost (refer to Table 15-1-2).

4) The straight line method is used for depreciation. Earth structures will have an equal useful life of 100 years according to the rule of MR.

5) All required domestic funds will be obtained from MR's own source.

(2) Number of Shutdowns that can be Prevented

The same numbers as for the economic analysis are used here. It is assumed that the effect of the shutdown prevention program is proportional to the amount of construction cost while the rehabilitation work is going on. (refer to Table 15-1-1)

(3) Revenue and Expense

It is assumed that the transportation revenue and expense to be lost due to shutdowns of railway service unless the rehabilitation work is performed, are attributed to this project. The amount is shown in Table 15-2-1.

Estimated reduction in annual time of interruptions of railway service is obtained from the number of occurrences of damage that can be prevented by the rehabilitation project, multiplied by the average time loss for each case by the scale of damage. Revenue and expense are lost by disasters of scale L and M only. In case of disasters of scale S, both passengers and cargo wait for resuming of operation and revenue and expense are not lost by shutdowns.

Fare rates at the time of investigation are obtained from the revenue and transportation volume of MR in 1995 by increasing 37.8% as price rise. Other transportation revenue is assumed equal to 5% of total passenger and freight revenue taking the past records into consideration.

Table 15-2-1 Estimated Loss of Transportation Revenue and Operating Cost

(Unit: Thousand US Dollar)

Year	2005	2010	2020
Transportation Revenue	81	93	106
Administrative Operating Cost	50	57	68
Operating Profit	31	36	38

(4) Estimated Savings of Rehabilitation Cost

The savings of rehabilitation cost are estimated from the number of occurrences of damage that can be prevented by the project, multiplied by the rehabilitation cost for each case by the scale of damage (Table 15-2-2).

Rehabilitation cost per each disaster is the same as in the economic analysis, but market prices are used here. Estimated expenditures will be increased by 20% after 2015 and by 40% after 2025.

Table 15-2-2 Estimated Savings of Rehabilitation Cost

(Unit: Thousand US Dollar)

Year	2005	2015	2025
L	718	861	1,005
M	131	157	183
S	121	145	169
Total Savings	970	1,164	1,358

(5) Results of Analyses

Financial internal rates of return (FIRR) for each case are shown in Table 15-2-3.

Table 15-2-3 FIRR and Sensitivity Analyses

Case	FIRR	Case	FIRR
Base Case	8.67%		
Case I	7.88%	Case II	7.21%
Case III	7.80%	Case IV	6.91%
Case V	7.08%	Case VI	5.70%

Case I Construction cost increased by 10%.
Case II Construction cost increased by 20%.
Case III Number of occurrence of interruptions that can be prevented reduced by 10%.,
Case IV Number of occurrence of interruptions that can be prevented reduced by 20%.
Case V Combination of cases I and III above.
Case VI Combination of cases II and IV above.

In sensitivity analyses, the FIRR becomes lower in case of the number of interruptions decrease than in case of the construction costs increase, but the difference is not so significant. Even in the worst case (sensitivity analysis case VI), the situation is not so serious as to obstruct the implementation of the project.

(6) Evaluation

FIRR in Base Case is 8.67%.

The FIRR indicates the rate of return on the total invested capital. If foreign currency portion of the construction cost required for this rehabilitation project can be raised at 2.3% and the remaining can be raised from own funds, it is possible to carry out this project in view of profitability. The amount of MR funds used for this project will reach its peak for about 2.6 million US Dollars (about 1,425 million Tugrik) in 2004. However, as from 1998 MR must start payment of interest and repayment of loans borrowed in the past and the annual payment will come to the maximum amount of over six million Dollars (about 3,300 million Tugrik) in 2005. Therefore, it is very important for MR to raise the funds with care taking loans for all prior projects into consideration.

16. CONCLUSION and RECOMMENDATION

16 – 1 Conclusion

(1) Outline of the Project

The trunk line between Sukhe-baatar and Zamyn-uud of the Mongolian Railway is an important transport route in Mogolia. Especially, the railway is playing a key role as the artery for freight distribution in terms of long-distance and international transport, partly because of the delay in road development. However, the bridges and earth structures of the railway are superannuated, and furthermore, natural disasters often occur every year in the rainy season from June through August. This compels the railway to cancel train operation, causing enormous unfavorable effects on the Mongolian economy due to the stoppage of freight distribution in the country. In view of the above circumstances, a Master Plan of the rehabilitation of railway structures has been drawn up and Short-term Urgent Projects have also been planned, mainly for the Sukhe-baatar · Bayan section of about 450 km where natural disasters frequently occur. In this case, in order to ensure safe and reliable transport throughout the year, care has been taken to establish disaster-resistant structures or to enable restoration in a short time in case of disasters.

Under the Master Plan (target year, 2020), 184 object places will be rehabilitated by stages and by making an investment totaling about US$ 26.2 million.

As the Short-term Urgent Projects (target year, 2005), 72 object places of high priority were selected from the Master Plan. The projects aim at river bank protection (7 places), slope stability (12 places) , bridge rehabilitation(11 places), and drain improvement(42 places).

The construction period of the Short-term Urgent Projects is 7 years from 1998 to 2004 including the preparatory stage. The total amount of the investment in the projects in about US$ 12.2 million at the price as of August 1996. It consists of about US$ 6.5 million for river bank protection, about US$ 0.7 million for slope stability, about US$ 0.5 million for bridge rehabilitation, and about US$ 4.5 million for drain improvement.

(2) Evaluation of the Short-term Urgent Projects

1) Technical aspect

Since there are many similar countermeasure items in the 72 object places of the Short-term Urgent Projects, the rehabilitation was planned by establishing 17 Standard Sections and 55 Sections for Application for each category of countermeasures, as shown in Table 16-1.

The rehabilitation plan was drawn up under the procedure shown in Fig.16-1, taking into consideration the experience in rehabilitation work execution and technical power of the Mongolian Railway.

The rehabilitation plan thus drawn up mainly concerns general civil works and there will be no special problem from the technical aspect of the Mongolian Railway regarding design and construction execution. Therefore, the Short-term Urgent Projects are estimated to be sufficiently feasible.

2) Environmental aspect

The Short-term Urgent Projects mainly concern the rehabilitation planning of the existing line, and will not have large unfavorable effects, including pollution, on social and natural environments. In executing the projects, however, it is necessary for the Mongolian Railway to get guidance from the governmental agencies concerned and pay special care regarding the vibration, noise, river pollution, waste disposal and so forth entailed by the construction.

3) Economic aspect

The economic internal rate of return (EIRR) of the Short-term Urgent Projects is 13.05 %. If indirect social and economic benefits entailed by the project execution are considered, the projects are estimated to be significant from the national economic standpoint.

4) Financial aspect

The financial internal rate of return (FIRR) of the Short-term Urgent Projects is 8.67 %. It is possible to carry out this project in view of profitability.

5) Comprehensive evaluation (Conclusion)

The Short-term Urgent Projects aiming at the rehabilitation of the existing line are technically feasible, and will not have large unfavorable effects on environmental conditions.

The EIRR is 13.05 %, and , if other indirect benefits are considered, the projects are estimated to be feasible from the national economic standpoint.

The FIRR is 8.67 %. However, in view of repayment of the existing loans and the funds necessary for future projects of the Mongolian Railway, it is very important for MR to raise the funds with care taking the very severe financial standings of the Mongolian Railway into consideration as this project aims at the stability of transportation.

The Short-term Urgent Projects concern the rehabilitation planning for the railway structures where natural disasters in the rainy season compel the Mongolian Railway to cancel train operation, and emphasis is placed on ensuring stable transport. From the comprehensive standpoint, the projects are evaluated to be adequate and also feasible from technical, environmental, economic, and financial aspects.

The implementation of the projects, coupled with the guarding against disasters including the checkup by patrol during rainfall , will enable the stable transport on the trunk line of the Mongolian Railway.

Furthermore, the Mongolian Railway is a life line providing freight transport services closely related to people's living, such as coal transport for power generation (accounting for 80 % of domestic freight traffic volume) and import of oil and consumer goods for Mongolian people. Therefore, the projects which mainly concern natural disaster countermeasures are important for stable railway transport and require early implementation.

Table16-1 Outline of the Short-term Urgent Projects

Item	Countermeasure	Standard Section	No.of Sections for Application
River Bank Protection (7places)	Track transformation	31pk2～4	0
	Revetment	54pk4～5	5
Slope Stability (12 places)	Slope surface improvement (I)	13pk3	1
	Slope surface improvement (II)	61pk10	3
	Slope surface improvement (III)	282pk9～283pk2	1
	Slope surface improvement (IV)	267pk2～3	1
	Concrete lining	18pk10～19pk1	0
	Telecommunication line removal	251pk2	0
Bridge Rehabilitation (11 places)	Beam replacement	334pk3	6
	Repair	255pk3	3
Drain Improvement (42 places)	Drain in Sukhe-baatar St.	23pk2	0
	Box culvert (2 x1.5m)	253pk3	17
	Box culvert (2.5 x 2m)	389pk1	15
	Box culvert (2.5 x 2.5m)	356pk1	0
	Bridge (11.5 m)	235pk3	2
	Bridge (13.5m)	125pk8	1
	River width expansion	399pk1	0
Object sections (72 places in total)		17 places	55 places

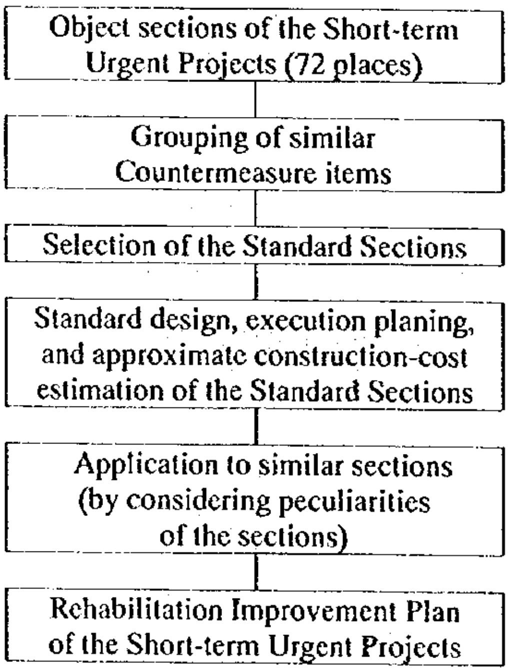


Fig.16- 1 Procedure for the Planning

16 - 2 Recommendation

The following issues are recommended to the Mongolian Railway, for executing the projects and also for improving natural disaster countermeasures, maintenance and operation , and business administration of the railway.

(1) Natural Disaster Countermeasures

1) Strengthening of software sectors

Concerning the disaster countermeasures, together with the reinforcement of hardware sectors by the project execution, it is important to further strengthen software sectors, such as disaster guarding systems and train operation control during rainfall.

2) Application of the standard countermeasures to all lines.

Concerning the countermeasures against natural disasters and superannuation of facilities on trunk and branch lines of the Mongolian Railway other than the section between Sukhe-baatar and Bayan, it is essential to positively promote necessary studies by utilizing the countermeasures planned this time for the standard sections by kind of countermeasures, so as to ensure stable transport in the Mongolian Railway.

3) Drainage countermeasures in Sukhe-baatar station yard

As for the drainage countermeasures in Sukhe-baatar station yard, drainage facilities in the station yard have been planned, in this Study, as an urgent measure. However, since the major cause of the problem is the inflow of water from Sukhe-baatar city areas, it is necessary to establish countermeasures against flood in Sukhe-baatar City, through consultations with the municipal government, and to utilize these countermeasures for strengthening drainage countermeasures in Sukhe-baatar station yard.

(2) Smooth Construction Promotion and Environmental Consideration

1) Establishment of construction execution systems

In the projects, various kinds of countermeasures are taken and object places are also located dispersedly. Therefore, in actually implementing the projects, it is necessary to study systems for the construction execution and work process administration which pay sufficient consideration to the prevention of train accidents and injuries, after drawing up detailed work schedules and also grasping the entire construction work.

2) Technical Cooperation

For the systematic and smooth implementation of this project, it is effective to promote disaster countermeasures from both hardware and software aspects by obtaining technical cooperation of countries with advanced railways through accepting experts from such countries.

3) Waste disposal

The waste from the construction should be carried to adequate places and be disposed in order to prevent the occurrence of social problems after the disposal. Especially, the spoil earth from the river expansion at the 399 pk1 point should be disposed under the guidance of the agencies concerned.

4) Protection of ecological environment

When there is no well-developed road to a construction site, ruts will be made on the grassland due to the passage of automobiles, exerting unfavorable influence on weak ecological environment. Therefore, the construction materials and equipment as well as the construction workers should be carried by the railway as much as possible.

(3) Curtailment of Investment

1) Fund procurement for the projects

For ensuring sound finance of the Mongolian Railway, it is essential to procure funds taking the severe financial standindings of the Mongolian Railway into consideration in order to realize the projects, in view of the repayment of the existing loans and the funds necessary for other projects (for example, procurement of rolling stock).

2) Investment in other projects

From the managerial aspect of the Mongolian Railway, efforts should be made to introduce funds at the lowest interest possible, in making investment in other projects and newly obtaining loans in the future.

Since the projects concern disaster countermeasures and rehabilitation of railway structures, there will be no increase in demand by the projects. Therefore, the rolling stock cost and the like have not been earmarked in the project cost.

Especially, in additionally procuring rolling stock, it is separately necessary to curtail investment to the extent possible, taking into consideration such factors as the trend in demand, and inspection and repair of rolling stock.

(4) Maintenance, Administration and Operation, and Management Improvement

1) Modernization of transport administration, etc.

① Review and improvement of train diagram and traffic control work

Train diagrams are achievements of railways, and it is necessary to conduct train operation administration (including command judgement and operational adjustment) in accordance with basic diagrams and daily "execution plan diagrams" as well. The execution plan diagram is used as a basis for operational adjustment and the like because all plans for the day (such as trains operated and maintenance work) are described in it beforehand.

Therefore, it is advisable to introduce train diagrams which cover the entire day from 0:00 to 24:00.

② Scheduling of regular freight trains

Just like passenger trains, the minimum number of regular freight trains should be scheduled and irregular trains should be separately scheduled to cope with traffic fluctuations. This will become a basis of freight transport modernization and lead to the increase in demand.

③ Operational safety system and management improvement (Future task)

In the Mongolian Railway, operational safety systems such as block, signaling, and interlocking systems are sophisticated, enabling smooth introduction of Centralized Traffic Control(CTC) system and the like in the future. However, since facilities of these operational safety systems are superannuated, their replacement and improvement will become necessary with the increase in transport demand in future. In the replacement and improvement, it is advisable to study such matters as the introduction of CTC and promote management improvement based on the study. Furthermore, the introduction of optical cables which is now under planning will become further effective.

For further effective utilization of the optical cables, it is necessary to study the introduction of cable transmission or small-capacity light carrier devices, for communication between main stations (optical transmission terminals) and other stations, etc. In addition, together with the introduction of optical fiber cables and the promotion of the replacement of superannuated facilities and the utilization of CTC in the future, it will become essential to strengthen power-source facilities for these main facilities.

2) Replacement and further introduction of rolling stock

In the future, it will become necessary to replace superannuated passenger cars, freight cars, and locomotives and also introduce further rolling stock.

Especially, it is essential to study the performance of locomotives to be newly introduced, taking into consideration such factors as transport capacity reinforcement and speedup.

3) Track-related improvement

① Improvement of basic record books of railway structure maintenance

Structures will gradually deteriorate due mainly to : the superannuation by the lapse of time ; function reduction by external natural forces such as rainfall, water flow, frozen soil, and earthquake; and obsolescence entailed by transport modernization such as the speedup of trains and increase in load.

For ensuring safe train operation and transport capacity and also for reducing direct and indirect damage from disasters. it is important to conduct adequate maintenance of heavily-worn structures, Furthermore, it is advisable from the economic standpoint to prevent the deterioration of facilities and prolong their life by taking appropriate measures, such as repair and reinforcement, before their becoming fatally worn and depending upon the degree of deterioration. In this regard, in the Mongolian Railway which has many railway structures, adequate maintenance and administration are important for the structures themselves and also from the managerial aspect.

For conducting adequate maintenance and administration of the structures, it is advisable to accurately and promptly grasp the situation of entire structures and also to preserve the record of the situation as basic record books of railway structure maintenance. Furthermore, it is also advisable to inspect all structures at least once in a few years, record the situation of the structure deformation in the basic record books, and systematically take adequate measures based on the results of inspection.

② Establishment of permissible cant deficiency and maximum train speed

The maximum cant restricts the inward inclination of trains, and the permissible cant deficiency restricts the outward inclination of trains. The two are closely related each other. In the Mongolian Railway, although there is a specified rule on the maximum cant, no consideration has been made so far concerning the permissible cant deficiency. Just like the maximum cant, it is important to establish the permissible cant deficiency.

In the case of the Mongolian Railway, the maximum cant deficiency (Cd) is estimated to be 115 mm from the theoretical limit of the outward inclination. This estimated value is the same as the value in use in Russian railways. Therefore, it is advisable to establish the maximum train speed at passing curves, by utilizing this value of cant deficiency. The formula for calculating the maximum train speed (Vmax) is follows.

$V_{max} = \sqrt{R(C+Cd)/12.5}$ when Vmax: Maximum train speed(km/h)

C : Established cant (Actual cant) (mm)

Cd: Permissible cant deficiency (mm)

R : Curve radius (m)

③ Promotion of crushed stone utilization for ballast

In the Mongolian Railway, the main component of ballast is unscreened gravel. However, unscreened gravel is liable to have unfavorable influence on track structure, because it is short of elasticity, susceptible to deformation, and poor in the performance of absorbing impacts of trains. Therefore, from the standpoint of track maintenance, it is advisable to promote the utilization of crushed stones for ballast, in order to sustain good track conditions for a long time. Since the utilization of crushed stones for all lines takes large amounts of time and cost, it is advisable, as the second best measure, to promote the utilization of screened gravel by eliminating the fine grain portion of less than 20 mm out of the ballast gravel.

④ Utilization of crushed stones for ballast at turnout portions, and speedup of trains

Turnouts are complicated in terms of track structure, and also have many weak points. Enormous labor will be needed to sustain favorable track conditions when unscreened gravel is used for ballast. Therefore, it is advisable to urgently promote the utilization of crushed stones, as stated in the above item ③.

Furthermore, although it is not long since the permissible train speed at passing the straight-line side of a turnout was increased to 70km/h, the realization of 90km/h just like on ordinary sections is desirable. This will become possible by using crushed stones for ballast at turnout portions on main tracks. In realizing the 90 km/h operation, safety should be sufficiently confirmed beforehand by conducting vibration tests and other necessary examinations of turnouts concerning gaps in crossing, guardrails, points, and rail joints.

4) Management improvement

① Efficient operation of personnel

The introduction of CTC will enable the reduction of station personnel in charge of train operation handling, and will also enable unmanned operation of signal stations (train interchange facilities) which may be newly constructed due to the shortage of track capacity in the future. Furthermore, personnel in charge of customer services can be concentrated to key stations. This will lead to the efficient operation of personnel and will contribute to the management improvement of the Mongolian Railway.

② Promotion of related enterprises

Most revenues of the non-railway sectors in the Mongolian Railway are form the railway sectors of the organization and the employees of the railway sectors. The rationalization by drastic personnel reduction is also approaching its limit. The Mongolian Railway has recently started the development of related enterprises targeted at general external customers by newly establishing the Corporate Planning Department. In the future, therefore, it is necessary to study the further expansion of such related enterprises, in order to promote the management improvement of the

Mongolian Railways.

(5) Others

1) Improvement of curves near Honkhor

It is considered necessary to improve the sections near Honkhor where curves with a small radius exist in succession. However, since such improvement requires a large amount of investment, the improvement should be materialized after conducting sufficient studies on related factors including the effects of the investment.

2) Damaged bridges on the Third Power Station Line

As for the damaged bridges on the Third Power Station Line which have been in use after the temporary repair, it is necessary to urgently study full-scale rehabilitation works, in order to ensure smooth transport of coal.

3) Internationalization of Standards (Example of Soil investigation)

A soil investigation has been conducted this time as a study entrusted to a local company. The Mongolian local soil investigation company has made evaluations by conducting Russian-style tests using appliances produced on the basis of Russian standards. In the future, cooperation of other countries will become necessary in addition to that from Russia. Therefore it is essential, from the technological standpoint, to evaluate the test results using universal standards, such as ASTM (American Society for Testing and Materials) and BS (British Standards) not only for soil investigation but also other investigation.

Concerned Member List

Concerned Member List

(1) Japanese Members

1) Advisory Committee

Name	Work Assignment	Current Position
Akira YONEZAWA	Chairman	Engineering Planning Division Railway Bureau, Ministry of Transport Deputy Director
Norio ITO	Railway Facilities Planning	Facilities Division Railway Bureau, Ministry of Transport Chief of the Section
Jyunya MATSUMOTO	Transportation Planning	Personal Division Administration Department Kyushu Railway Company Chief

2) JICA

Name	Work Assignment	Current Position
Shouichi TSUGANE	Study Supervision	First Development Study Division Social Development Study Department Japan International Cooperation Agency

3) Study Team

Name	Work Assignment
Naofumi TAKASHIGE	Team Leader
Yoshio SHIBUYA	Deputy Leader/Route Planning
Isamu YOSHITAKE	Transportation and Rolling Stock Planning
Tsuneo HASHIMOTO (1996. 7～1997. 3) Kiyoshi EDO (1997.4～)	Structure and Disaster Prevention Planning
Naonori YAMADA	Track and Station Planning
Masami NAKAJIMA	Electrical Facilities Planning
Taro IWATA	Financial Analysis and Administration Operation
Teruhiko HORIE	Demands Forecast and Economic Analysis
Yoshinori KOTANI	Structural Design and Construction (Bridges)
Kenji MAEDA	Structural Design and Construction (Earth Structures)
Teruo OTSUKI	Track & Station Design and Construction
Shinya NAKAMURA	Natural Conditions
Kazuhiko IKEDA	Environmental Impact Assessment

(2) Mongolian Members

1) Steering Committee

NAME	MINISTRY/OFFICE	POSITION
N.BATMUNKH (1996.7 ~ 1997.2) G.BATKHUU (1997.3 ~)	Mongolian Railway Ministry of Infrastructure Development	Chairman
J.NYAMAA	Mongolian Railway	Member
N.BATMUNKH (1997.3 ~)	Mongolian Railway	Member
R.GANKHUYAG	Ministry of External Relations	Member
D.RENTSENDORJ	Ministry of Finance	Member
S.JAMTS	Ministry of Infrastructure Development	Member
B.JAMTS (1996.7 ~ 1997.2) B.TUMURBAATAR (1997.3 ~)	Ministry of Nature and the Environment Ministry of Nature and the Environment	Member

2) Mongolian Railway Counterpart Team

NAME	POSITION/DEPARTMENT	PROFESSION
J.NYAMAA	Chief Engineer of the Mongolian Railway	Locomotive Engineer
D.DASHZEVEG	Head Engineer in charge of Management and Planning Department	Locomotive Engineer
V.OTGONDEMBEREL	Head of Management and Planning Department	Railway transportation Management Engineer
L.PUREVBAATAR (1997.3 ~)	Senior Engineer of Management and Planning Department	Railway Telecommunication Engineer
G.VANDANDAGVA (1996.7 ~ 1997.2) N.BATMUNKH (1997.3 ~)	Head of Track Facilities Department Head of Track Facilities Department (Deputy Chairman of the Mongolian Railway)	Track Engineer Track Engineer
Z.ZORIG	Chief Engineer of Track Facilities Department	Track Engineer
Z.UURDMANDAKH	Deputy Head of Track Facilities Department	Track Engineer
Ch.ERDENEDALAI	Senior Engineer in charge of artificial structures at Track Facilities Department	Bridgework Engineer
Ch.LKHAGVASUREN	Chief Engineer of Freight Transportation Department	Railway Transportation Management Engineer
T.DASHDEMBEREL	Head of Technical Section of Freight Transportation Department	Rolling Stock Engineer
D.BATBOLD	Chief Engineer of Passenger Transportation Department	Rolling Stock Engineer
L.GANBAATAR	Chief Engineer of Locomotive Facilites Department	Locomotive Engineer
SEREENENDORJ	Senior Engineer of Signalling & Communication Department	Railway Automatics Engineer
B.ARIUNAA	Deputy Head of Financial Department	Economist
L.TUDEV (1996.7 ~ 1997.2) T.BATBOLD (1997.3 ~)	Head of Statistic and information Center Head of Statistic and information Center	Railway Economist Railway Transportation Management Engineer

JICA