CHAPTER 11

REHABILITATION IMPLEMENTATION PLAN

Chapter 11
Rehabilitation Implementation Plan

11 – 1 Basis for Construction Cost Estimates

(1) Market prices, wages, and currency conversion rates are based on those as of August 1996. Conversion rates at that time were as shown below.

1 US$ = 550 Tugrik = 110 Japanese Yen

(2) Materials and equipment that were not expected to be available in Mongolia were assumed to be imported from overseas countries.

(3) Work involving new technologies that Mongolian engineers may not be familiar with were assumed to be carried out under the technical advice of foreign engineers.

(4) Construction cost estimates consist of the following cost items.

a. Direct costs (materials and labor), temporary work, and equipment depreciation.

b. Taxes and duties.

c. Indirect costs.

d. Contingencies (10% of a)).

e. General administration cost (10 to 16% for different trades) including supervision costs.

f. Engineering fee (construction management cost included 10% of a) and design cost included 5.6% of a))

(5) Setting of Unit Prices

Unit prices for labor cost and equipment depreciation were determined based on the results of a field investigation (see Appendix 11-1-1, Labor Cost and Equipment Cost). The unit prices for materials and equipment that are not available on the local market have been established in reference to market prices in Japan.

11 - 2 Implementation Plan

(1) Construction Policy

Construction will be carried out in three phases, depending on urgency and importance. The phase I project will be carried out from 1998 to 2004, phase II from 2005 to 2009, and phase III from 2010 to 2019.

1) River Bank Protection

As the clearance between the river and the railway can become dangerously narrow when the river erodes the bank, revetment improvement work for locations where train operations could be affected will be completed by 2004, together with the rail line rerouting in the vicinity of km 31. Revetment improvement work for areas where erosion does not threaten the railway, or is not so significant, will be carried out after 2005. Flood control work for controlling the meandering flow of rivers will be carried after 2005, based on detailed surveys of river conditions. Realignment of water channels of rivers with significant meanders will be carried out after 2010, following surveys of upstream and downstream areas of the water channel. These surveys will include surveys of environmental conditions.

2) Slope Stability

Cut slopes are progressing the weathering, and there is limited space between the toes of slopes and the railway. Removal of loose rocks in locations where rocks could fall onto the railway will be completed by 2004. Work schedule for all other areas will be determined based on continuous observations of slopes.

3) Track Lifting

Raising of the roadbed in areas subject to significant flooding will be provided where required, based on reports of flooding, and will be accomplished in conjunction with flood control work. This construction work will be performed after 2010.

4) Bridge Rehabilitation

Reconstruction and repairs to concrete bridges shown to be undersized, damaged, or with other significant defects, will be completed by 2004. Repair schedule for all other bridges will be determined based on the observation of defects.

5) Drain Improvement

Those locations damaged by past water flows (locations lacking drainage facilities and locations where existing drainage facilities are inadequate) will be improved as necessary, by 2004. All other locations will be taken care of after 2005, and will be provided with box culverts, taking into consideration the shortage of water conveyance capacity and the local flooding conditions.

6) Miscellaneous Work

For the provision of double-tracked rail lines, alteration of curves, and relocation of rail lines; data gathering and field surveys will be performed as necessary in response to changes in transportation volume. Methods, effects, and times of construction will be considered depending on when construction is to be performed. These are not incorporated in this plan as they are not expected to be completed by 2019.

(2) Construction Phases

Construction will be performed in phases, ranked by the type of work, based on the evaluation made on the following factors (see Appendixes 11-2-1, 11-2-2, and 11-2-3, Evaluation of Works).

1) River Bank Protection

a. Existing river conditions

b. Repairs to revetments made by MR in the past

c. Erosion occurring on river banks

d. Safety and reliability expected in the future

2) Bridge Rehabilitation

a. Existing condition of main girders

b. Existing condition of concrete slabs

c. Existing condition of substructures

d. Life expectancy

e. Existing serviceability

3) Drain Improvement

a. Water conveyance capacity based on data of USU ERDENE

b. Vertical clearance and width of existing structures

c. Existing field conditions determined by field inspections

11 - 3 Capital Requirements and Timing

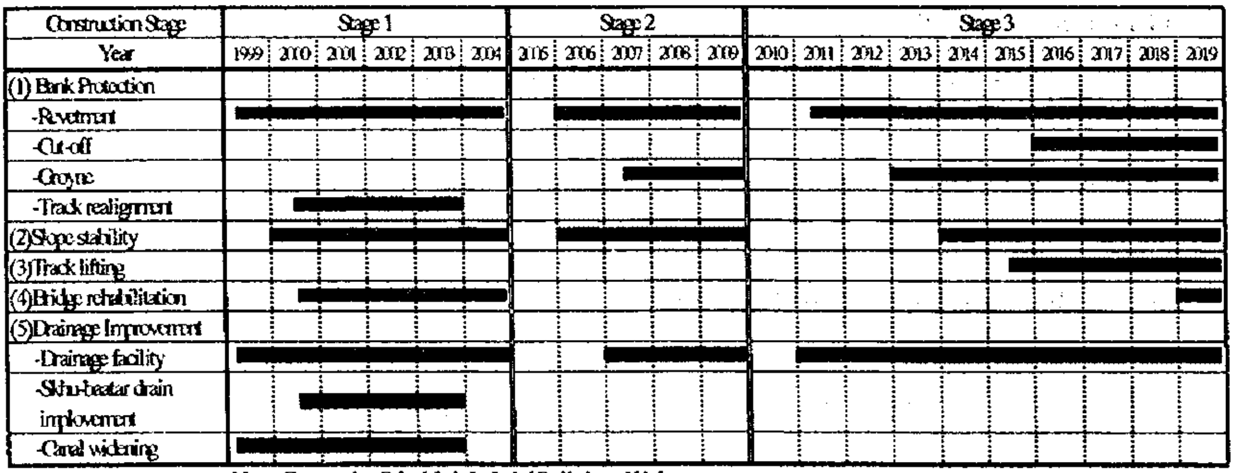
Required amount of investment is estimated to reach US$26,230,000. Investment will be made in three phases. In the 1st stage, the amount of investment is estimated as US$ 12,397 thousands and works will be finished by 2004. In the 2nd stage, it is estimated as US$ 3,293 thousands, by 2009. In the 3rd stage, it is estimated as US$ 10,540 thousands, by 2019. The amount of investment and investment time schedule are shown in Table 11-3-1 and Figure 11-3-1.

Construction workload and estimated construction costs for each section, based on the rehabilitation implementation plan, are as shown in Table 11-3-2.

Table 11-3-1 Investment Cost of Each Construction Stage

(Unit : 1,000US$)

Description \ Stage	Stage 1			Stage 2			Stage 3			Total Stage		
	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total	Local	Foreign	Total
Revetment	419	628	1,047	148	223	371	54	81	135	621	932	1,553
Cut-off	0	0	0	0	0	0	37	1,812	1,849	37	1,812	1,849
Groyne	0	0	0	365	548	913	274	411	685	639	959	1,598
Track realignment	263	2,661	2,924	0	0	0	0	0	0	263	2,661	2,924
Slope stability	30	340	370	11	126	137	2	28	30	43	494	537
Track lifting	0	0	0	0	0	0	154	1,765	1,919	154	1,765	1,919
Bridge rehabilitation	158	634	792	0	0	0	3	14	17	161	648	809
Drain improvement	578	1,073	1,651	217	403	620	785	1,459	2,244	1,580	2,935	4,515
Skhu-baatar drain improvement	82	245	327	0	0	0	0	0	0	82	245	327
Canal widening	17	97	114	0	0	0	0	0	0	17	97	114
Direct cost of civil work	1,547	5,676	7,225	741	1,300	2,041	1,309	5,570	6,879	3,597	12,548	16,145
Indirect cost	231	925	1,156	82	122	204	48	640	688	361	1,687	2,048
Physical contingency	168	670	838	90	134	224	53	704	757	311	1,508	1,819
Engineerin services	168	1,541	1,709	90	369	459	80	719	799	338	2,629	2,967
Total	567	3,136	3,703	262	625	887	181	2,063	2,244	1,010	5,824	6,834
Tax & Duties	1,469	0	1,469	365	0	365	1,417	0	1,417	3,251	0	3,251
Ground total	3,583	8,814	12,397	1,368	1,925	3,293	2,907	7,633	10,540	7,858	18,372	26,230



Note : Construction Schedule is Included Preliminary Works

Fig.11-3-1 Construction Schedule

Table 11-3-2 Approximate Quantity and Construction Cost Estimate (1)

Units : US$

No.	Description	Location	Prty	Unit	Qty	Stage 1	Stage 2	Stage 3	Remarks
1	Bank Protection								
		11 pk 1 - 4	1	m	250	168,962.73			Revetment
		11 pk 1 - 4	2	Location	1		228,099.68		Groyne
		16 pk 1 - 4	2	m	400		270,340.36		Revetment
		16 pk 1 - 4	3	Location	1			228,099.68	Groyne
		31 pk 2 - 4	1	m	300	220,755.27			Revetment
		31 pk 2 - 4		km	2	2,865,845.24			Track Transfer
	2.0m*2.0m / 1 Cell conc. culvert	31 pk 2 - 4		Each	2	57,984.77			Track Transfer
		51 pk 9 - 52 pk 1	1	m	250	168,962.73			Revetment
		51 pk 9 - 52 pk 1	2	Location	1		228,099.68		Groyne
		54 pk 4 - 5	1	m	150	101,377.64			Revetment
		54 pk 4 - 5	2	Location	1		228,099.68		Groyne
		55 pk 9	3	m	100			67,585.09	Revetment
		55 pk 9	4	Location	1			228,099.68	Groyne
		57 pk 9	1	m	150	101,377.64			Revetment
		65 pk 7	2	m	150		101,377.64		Revetment
		65 pk 7	3	Location	1			228,099.64	Groyne
		67 pk 4 - 6	1	m	300	202,755.27			Revetment
		88 pk 10	3	m	100			67,585.09	Revetment
		208 pk - 209 pk	1	m	150	101,377.64			Revetment
	Common excavation l=600m	208 pk - 209 pk	3	cu.m	180,000			1,848,600.00	Cut-off
		208 pk - 209 pk	2	Location	1		228,099.68		Groyne
	Total					3,989,398.93	1,284,116.72	2,668,069.18	

Units : US$

No.	Description	Location	Prty	Unit	Qty	Stage 1	Stage 2	Stage 3	Remarks
2	Slope Stability								
		8 pk 10	1	Lm	100	13,165.57			Rock Pool
		9 pk 5	2	Lm	70		13,165.57		Rock Pool
		10 pk 7	2	Lm	90		16,927.16		Rock Pool
		10 pk 8	2	Lm	90		16,927.16		Rock Pool
		12 pk 2	2	Lm	110		20,688.75		Rock Pool
		13 pk 4	1	Lm	80	28,211.93			Rock Pool
		14 pk 8	2	Lm	150		28,211.93		Rock Pool
		17 pk 6	1	Lm	70	13,165.57			Rock Pool
		18 pk 1	2	Lm	70		13,165.57		Rock Pool
		do	1			9,090.91			Foot Fixing
		18 pk 10	1	Lm	70	13,165.57			Rock Pool
		19 pk 1	1	Lm	80	15,046.36			Rock Pool
		19 pk 1	1	Lm	80	90,672.73			Concrete Lining
		51 pk 9	3	Lm	60			11,284.77	Rock Pool
		52 pk 3	2	Lm	90		16,927.16		Rock Pool
		52 pk 9	2	Lm	60		11,284.77		Rock Pool
		54 pk 2	1	Lm	100	18,807.95			Rock Pool
		57 pk 9	1	Lm	100	18,807.95			Rock Pool
		61 pk 9	1	Lm	200	37,615.91			Rock Pool
		88 pk 4	3	Lm	100			18,807.95	Rock Pool
		250 pk 7	1	Lm	120	22,569.55			Rock Pool
		251 pk 10	1	Lm	80	15,046.36			Rock Pool
		267 pk 4	1	Lm	150	28,211.93			Rock Pool
		do	1			18,181.82			Blasting
		282 pk - 283 pk	1	Lm	150	28,211.93			Rock Pool
	Total					369,972.04	137,298.07	30,092.72	

Table 11-3-2 Approximate Quantity and Construction Cost Estimate (2)

Units : US$

No.	Description	Location	Prty	Unit	Qty	Stage			Remarks
						Stage 1	Stage 2	Stage 3	
3	Track Lifting								
		92 pk - 96 pk	3	LS	1			1,919,395.18	w / PC ties
	Total					0.00	0.00	1,919,395.18	

Units : US$

No.	Description	Location	Prty	Unit	Qty	Stage			Remarks
						Stage 1	Stage 2	Stage 3	
4	Bridge Rehabilitation								
	Replace with a new beem L=9m	235 pk 3	1	BR	2	122,627.06			
	Crack injection	245 pk 5	1	BR	2	33,795.59			
	Replace with a new beem L=7m	255 pk 3	1	BR	2	87,916.90			
	Crack injection	255 pk 8	4	BR	1			16,897.80	
	Replace with a new beem L=9m	285 pk 1	1	BR	1	61,313.53			
	Replace with a new beem L=12m	289 pk 1	1	BR	1	80,847.12			
	Crack injection	326 pk 9	1	BR	1	16,897.80			
	Recasting Concrete	do	1	BR	1	17,042.46			
	Replace with a new beem L=12m	334 pk 3	1	BR	2	161,694.24			
	Replace with a new beem L=7m	338 pk 10	1	BR	1	43,958.45			
	Crack injection	342 pk 2	1	BR	1	16,897.80			
	Recasting Concrete	do	1	BR	1	17,042.46			
	Replace with a new beem L=7m	344 pk 1	1	BR	1	43,958.45			
	Replace with a new beem L=7m	356 pk 1	1	BR	2	87,916.90			
	Total					791,908.76	0.00	16,897.80	

Units : US$

No.	Description	Location	Prty	Unit	Qty	Stage			Remarks
						Stage 1	Stage 2	Stage 3	
5	Drain Improvement (1)								
	2.0m*2.0m / 1 Cell conc. culvert	11 pk 8	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	14 pk 1	3	Each	1			28,992.39	Drain Capacity
	2.5m*2.5m / 1 Cell conc. culvert	20 pk 2	2	Each	1		35,202.36		Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	21 pk 6	2	Each	1		28,992.39		Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	22 pk 8	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	22 pk 10	2	Each	1		28,992.39		Drain Capacity
	2.0m*2.0m conc. box CVT/Open Ditch	23 pk 2		m	100	315,757.09			Skhu-baatar drain improvement
	Groundsel / Gabion Mattress	23 pk 2		cu.m	100	11,264.18			Skhu-baatar discharge point
	2.0m*2.0m / 1 Cell conc. culvert	34 pk 3	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	37 pk 7	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	41 pk 2	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	50 pk 5	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	51 pk 3	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	54 pk 10	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	56 pk 1	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	56 pk 8	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	57 pk 10	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	59 pk 9	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	66 pk 4 - 5	1	Each	1	28,992.39			New Drain
	2.0m*2.0m / 1 Cell conc. culvert	82 pk 6	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	88 pk 6	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	88 pk 9	2	Each	1		28,992.39		Drain Capacity
	2.5m*2.5m / 1 Cell conc. culvert	89 pk 7	1	Each	1	35,202.36			Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	93 pk 1	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	93 km - 95 km	1	Each	1	28,992.39			New Drain
	Sub Total					420,208.41	122,179.53	463,878.24	

Table 11-3-2 Approximate Quantity and Construction Cost Estimate (3)

Units : US$

No.	Description	Location	Prty	Unit	Qty	Stage			Remarks
						Stage 1	Stage 2	Stage 3	
5	Drain Improvement (2)								
	2.0m*2.0m / 1 Cell conc. culvert	95 pk 2	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 2 Cell conc. culvert	97 pk 5	1	Each	1	41,901.98			Drain Capacity
	2.5m*2.5m / 1 Cell conc. culvert	100 pk 7	1	Each	1	35,202.36			Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	107 pk 6	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	111 pk 9	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	113 pk 4	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	116 pk 6	2	Each	1		28,992.39		Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	123 pk 1	4	Each	1			28,992.39	Drain Capacity
	10.0*1 span BR	125 pk 8	1	Each	1	61,313.53			Drain Capacity
	10.0*1 span BR	125 pk 8	1	Each	1	61,313.53			Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	128 pk 7	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	132 pk 6	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	135 pk 3	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	136 pk 8	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	138 pk 6	2	Each	1		28,992.39		Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	141 pk 6	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	143 km	1	Each	1	28,992.39			New Drain
	2.5m*2.5m / 2 Cell conc. culvert	145 pk 1	1	Each	1	46,752.71			Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	151 pk 3	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	155 pk 5	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	157 pk 5	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	158 pk 9	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	160 pk 9	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	166 pk 2	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	168 pk 4	1	Each	1	28,992.39			New Drain
	2.0m*2.0m / 1 Cell conc. culvert	170 pk 8	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	170 pk 1 - 3	1	Each	1	28,992.39			New Drain
	2.0m*2.0m / 1 Cell conc. culvert	171 pk 5	4	Each	1			28,992.39	Drain Capacity
	2.5m*2.5m / 1 Cell conc. culvert	172 pk 10	2	Each	1		35,202.36		Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	176 pk 6	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	177 pk 6	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	178 pk 7	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	182 pk 3	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	184 km	1	Each	1	28,992.39			New Drain
	2.0m*2.0m / 1 Cell conc. culvert	185 pk 6	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	189 pk 7	3	Each	1			28,992.39	Drain Capacity
	2m*2m / 1 Cell conc. culvert	190 km - 192 km	1	Each	1	28,992.39			New Drain
	2.0m*2.0m / 1 Cell conc. culvert	191 pk 5	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 2 Cell conc. culvert	197 pk 9	1	Each	1	41,901.98			Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	205 pk 7	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	207 pk 2	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	207 pk 8	4	Each	1			28,992.39	Drain Capacity
	2m*2m / conc. box	210 pk 6	1	Each	1	28,992.39			New Drain
	2.0m*2.0m / 1 Cell conc. culvert	211 pk 1	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	212 pk 8	3	Each	1			28,992.39	Drain Capacity
	2.5m*2.5m / 1 Cell conc. culvert	216 pk 6	2	Each	1		35,202.36		Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	217 pk 9	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	218 km	1	Each	1	28,992.39			New Drain
	2.0m*2.0m / 1 Cell conc. culvert	222 pk 10	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	223 pk 7	1	Each	1	28,992.39			New Drain
	2.0m*2.0m / 1 Cell conc. culvert	225 pk 8	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	228 pk 6	4	Each	1			28,992.39	Drain Capacity
	2.5m*2.5m / 2 Cell conc. culvert	230 pk 9	1	Each	1	46,752.71			Drain Capacity
	Sub Total					567,077.92	128,389.50	985,741.26	

Table 11-3-2 Approximate Quantity and Construction Cost Estimate (4)

Units : US$

No.	Description	Location	Prty	Unit	Qty	Stage 1	Stage 2	Stage 3	Remarks
5	Drain Improvement (3)								
	10.0m*1 span BR	235 pk 3	1	Each	1	61,313.53			Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	236 pk 8	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	238 pk 4	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	239 pk 9	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 2 Cell conc. culvert	242 pk 4	1	Each	1	41,901.98			Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	243 pk 10	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	244 pk 7	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	252 pk 1	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 2 Cell conc. culvert	253 pk 3	1	Each	1	41,901.98			Drain Capacity
	10.0m*1 span BR	255 pk 3	1	Each	1	59,772.18			Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	261 pk 1	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	261 pk 6	3	Each	1			28,992.39	Drain Capacity
	2.5m*2.5m / 1 Cell conc. culvert	268 pk 3	2	Each	1		35,202.36		Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	270 pk 1	3	Each	1			28,992.39	Drain Capacity
	2.5m*2.5m / 1 Cell conc. culvert	273 pk 1	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	276 pk 8	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	277 pk 8	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	279 pk 3	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	280 pk 5	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	280 pk 10	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	282 pk 6	2	Each	1		28,992.39		Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	289 pk 7	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	307 pk 3	3	Each	1			28,992.39	Drain Capacity
	2.5m*2.5m / 1 Cell conc. culvert	311 pk 8	3	Each	1			35,202.36	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	313 pk 10	1	Each	1	28,992.39			Drain Capacity
	2.0m*2.0m / 2 Cell conc. culvert	314 pk 10	1	Each	1	41,901.98			Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	319 pk 2	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	319 pk 6	2	Each	1		28,992.39		Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	323 pk 5	2	Each	1		28,992.39		Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	324 pk 5	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	329 km	1	Each	1	28,992.39			New Drain
	2.0m*2.0m / 1 Cell conc. culvert	331 pk 7	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	332 pk 4	2	Each	1		28,992.39		Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	333 pk 5	3	Each	1			28,992.39	Drain Capacity
	10.0m*1 span BR	334 pk 3	1	Each	1	71,322.53			New Drain
	10.0m*1 span BR	334 pk 4	1	Each	1	61,313.53			Drain Capacity
	2m*2m / 1 Cell conc. culvert	340 pk 5	1	Each	1	28,992.39			New Drain
	2.5m*2.5m / 1 Cell conc. culvert	342 pk 2	2	Each	1		35,202.36		Drain Capacity
	2.5m*2.5m / 1 Cell conc. culvert	345 pk 7	2	Each	1		35,202.36		Drain Capacity
	2m*2m / 1 Cell conc. culvert	345 pk 5	1	Each	1	28,992.39			New Drain
	2.5m*2.5m / 1 Cell conc. culvert	348 pk 7	2	Each	1		35,202.36		Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	348 pk 10	1	Each	1	28,992.39			New Drain
	2.0m*2.0m / 2 Cell conc. culvert	349 pk 10	2	Each	1		41,901.98		Drain Capacity
	12.0m*1 span BR	352 pk 7	1	Each	1	80,847.12			Drain Capacity
	10.0*1 span BR	356 pk 1	1	Each	1	61,313.53			Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	357 pk 7	2	Each	1		28,992.39		Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	365 pk 3	2	Each	1		28,992.39		Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	367 pk 5	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	370 pk 9	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	378 pk 3	3	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	381 pk 4	4	Each	1			28,992.39	Drain Capacity
	2.0m*2.0m / 1 Cell conc. culvert	386 pk 8	4	Each	1			28,992.39	Drain Capacity
	2.5m*2.5m / 2 Cell conc. culvert	389 pk 1	1	Each	1	46,752.71			Drain Capacity
	Sub Total					713,303.02	355,665.76	789,004.50	

Table 11-3-2 Approximate Quantity and Construction Cost Estimate (5)

Units : US$

No	Description	Location	Prty	Unit	Qty	Stage 1	Stage 2	Stage 3	Remarks
5	Drain Improvement (4)								
	2.0m*2.0m / 1 Cell conc. culvert	391 pk 4	1	Each	1	41,901.98			Drain Capacity
	10.0m*1 span BR	394 pk 4	1	Each	1	61,313.53			Drain Capacity
	Widening of Channel	399 pk 1	1	cu.m	1,400	14,380.57			Widening of channel
	Revetment / Conc. block	399 pk 1	1	sq.m	360	81,605.45			Widening of channel
	Demolition of superstructure	399 pk 1	1	Ls	1	11,970.97			Widening of channel
	Demolition of Existing Abut	399 pk 1	1	cu.m	90	5,502.44			Widening of channel
	2m*2m / 1 Cell conc. culvert	416 pk 10	1	Each	1	28,992.39			New Drain
	2m*2m / 1 Cell conc. culvert	417 km	1	Each	1	28,992.39			New Drain
	2m*2m / 1 Cell conc. culvert	420 km	1	Each	1	28,992.39			New Drain
	2m*2m / 1 Cell conc. culvert	424 pk 3	1	Each	1	28,992.39			New Drain
	2m*2m / 1 Cell conc. culvert	428 km	1	Each	1	28,992.39			New Drain
	2m*2m / 1 Cell conc. culvert	438 km	1	Each	1	28,992.39			New Drain
	Sub Total					390,629.28	0.00	0.00	
	Total					2,091,218.63	607,234.79	2,238,624.00	
									Total of Stage 1,2,3
	Grand Total					7,224,498.36	2,028,649.58	6,873,078.92	16,126,226.86

CHAPTER 12

OPERATING AND MANAGEMENT PLAN

Chapter 12
Operating and Management Plan

12 – 1 Organization and Personnel

The Mongolian Railway (MR) is organized as shown in Appendix 12-1. Comparison made between the changes in number of employees and the volume of transportation for the last six years is shown in Appendix 12-2.

For organizations, the headquarters personnel assigned to the railway transportation make up only two to three percent of the total number of employees. Six top personnel including the Chairman are responsible for management of all divisions. It can be appreciated that the headquarters is simply organized as a whole. In October last year, its organizations were reformed. Establishment, abolition and merger of divisions were made. The responsibility for some of the divisions were transferred from a top personnel to another. By these revisions and adjustments the more simple organizations were established and the share of the responsibility among the Chief Engineer and the Deputy Chairmen were made clearer.

MR is notable for its fairly wide range of business and services. The range of business and services other than railway transportation can be classified into those concerned with the railway (wood work, crushed stone production, manufacturing of wooden sleepers, etc.) and those not for the railway but rather for the welfare of the employees (education, housing construction, medical care, commodity distribution, cultural activities, etc.). The former should be commissioned to private sectors if commercial enterprises have become established. It is natural that the latter be handled by the government or by public corporations, although costs can be shared in the form of taxes and fees by enterprises or individual beneficiaries. For now, however, the present systems cannot be avoided in the current status of Mongolia, where the past system and organizations still survive. As a matter of fact, almost half of the MR employees are engaged in non-railway services. In the past, the products and the services of MR's non-railway divisions were almost for its own railway division and employees, but last year the section dealing commodity distribution to employees handled retail sales of provisions to outside customers for the first time and obtained some profit. Hotel operation was also started.

Facing rapid decline in transportation demands, MR has reduced approximately 2,000 persons or about 13% of its total employees for the period from 1991 to 1996. On such an occasion, it was a wise choice that reduction of non-railway service employees was preferred. Later, as the transportation volume began to recover from the bottom in 1994, the number of personnel turned into a slight increase in railway division. Meanwhile, the number of the non-railway service employees still continued to decrease exceeding expansion of the railway service personnel and thus, total number of employees has kept downward trend. This means that the MR Management has strong intention to refrain from increasing the number of employees.

It is considered important to set up a proper manpower plan based upon the suitable number of personnel needed in the railway transportation division in the future, taking into consideration the long-range tendency of transportation demands and the future prospects for introduction of new technologies enabling labor saving. As for non-railway divisions, fairly big cut of almost 30 percent has already been achieved. As rationalization and improvement of management seem to be coming to the limit, it is advisable for MR to appeal in accordance to development of the political reform for separation of social welfare matters for which the government should be responsible. In the future, MR should proceed in a direction placing more importance on railway transportation service which is its own proper business.

Other commercial business is just in trial stage. However, in case the big enterprise like MR enter into new line of business other than its own field under the present situation of Mongolia where the business society is still underdeveloped, it will not be blamed as smashing down the private sector, but rather be welcomed as giving impact on the nation's market economy. Therefore, MR should take up such kind of business positively after checking up the profitability carefully. In the reformation of organizations in October last year, Management and Planning Department was newly established under the direct control of the Chairman. It makes up MR's future plan covering all spheres of its business including non-railway divisions. Good results of its activities are highly expected.

12-2 Operating Management Expenditures

(1) Setting of Expense Items

Classify the operating management expenditures for this project into labor costs and material costs, and set the following eight expense items. Estimate necessary expenses based on the balance sheet of 1995, taking into consideration the price increases until the time investigations are conducted. Where any expense item shown in the financial statement of the MR does not fall in one of the following categories, refer to the financial statement of a similar railway company in Japan.

① General administrative expense: expenses required for operating management of general affairs and accounting departments, including welfare expenses for employees.

② Maintenance management expense: expenses required for the management of the maintenance of track, cars, and communication facilities, including expenses required for management of education and training of employees.

③ Transportation management expense: expenses required for handling of transportation service (railway stations) and expenses required for education and training of employees.

④ Railway maintenance expense: expenses required for maintenance of tracks, structures and other facilities related to maintenance of railways.

⑤ Communication maintenance expense: expenses required for maintenance of electric power, signaling and communication facilities.

⑥ Car maintenance expense: expenses required for inspections, repairs and maintenance of cars.

⑦ Transportation expense: expenses required for transportation of passengers and freight, including salaries and wages for station employees and conductors.

⑧ Operation expense: expenses required for operation of cars including power cost.

(2) Setting of Base Units

Set base units that are considered to be the most appropriate for each expense item. Apply the number of employees to labor cost and the following units to material cost.

① General administrative expense: number of employees

② Maintenance management expense: car travel distance in kilometers

③ Transportation management expense: transportation volume

④ Railway maintenance expense: car travel distance in kilometers

⑤ Communication maintenance expense: train travel distance in kilometers

⑥ Car maintenance expense: car travel distance in kilometers

⑦ Transportation expense: transportation volume

⑧ Operation expense: transportation volume

Set base units based on the actual record of operating management expenses, obtained from the 1995 financial statement of the MR. Where any expense item shown is not one of the above items, refer to the financial statement of a similar railway company in Japan and make adjustments. Taking into consideration the current economic situation in Mongolia, where inflation still persists, make adjustment to prices by adding 37.8% to current market prices, based on the consumer price index described in the Mongolian Economy and Society in the 1995 Statistical Yearbook and the Monthly Statistics. These prices were used as a base unit at the time of investigation (refer to Appendix 12-8).

(3) Estimation of Operating and Maintenance Expenses

Estimate operating and maintenance expenses for the years of 2005, 2010, and 2020, based on the increase from the year 1996 and the base units of the number of employees, the transportation volume, car kilometers, and train kilometers.

1) Number of Employees

Use the estimated increase in the number of employees shown in Table 6-12, Chapter 6. It can be presumed that the current number of railway maintenance personnel and signaling and communication personnel can respond to increased workload in the future. Do not take into account the rebound of the increase of transportation service personnel to the number of personnel of the administrative divisions of the headquarters.

2) Transportation Volume

Obtain person kilometers and tonnage kilometers for project sections (450 kilometers from 0th station to 27th station) from the OD table based on the prediction of demand.

3) Car Kilometers and Train Kilometers

Estimate passenger and freight cars travel distance and train distance in kilometers for the project sections, based on Tables 6-15 and 6-16, shown in Chapter 6.

Base units, number of personnel, transportation volume, car kilometers, and train kilometers based on the above prerequisite, and the operating and maintenance expenses estimated based on these data, are shown in Tables 12-1 through 12-3 below.

Table 12 - 1 Personnel, Transportation Volume, and Car and Train Travel Distance (km)

Item	Year	1996	2005	2010	2020
Number of Employees		3,590	3,912	4,131	4,279
(Persons)	Increment against 1996		322	541	689
Transportation Volume	Passenger	371	487	541	606
(Million Prs. km)	Increment against 1996		115	169	235
	Freight	994	1,443	1,700	1,937
(Million ton km)	Increment against 1996		449	706	943
	Total	1,365	1,930	2,240	2,543
(Million Prs.ton km)	Increment against 1996		565	875	1,178
Car km (1,000 km)	Passenger	14,576	14,676	15,940	18,240
	Freight	34,356	54,456	65,670	84,547
	Total	48,932	69,132	81,610	102,787
	Increment against 1996		20,201	32,679	53,855
Train km (1,000 km)	Passenger	1,364	1,364	1,471	1,532
	Freight	986	1,354	1,565	1,769
	Total	2,350	2,718	3,036	3,301
	Increment against 1996		368	687	951

Table 12 - 2 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)

Table 12 - 3 Operating and Maintenance Expense

(Unit : Million Tugrik)

Item \ Year	2005	2010	2020
Number of Employees (persons)	322	541	689
Transportation Volume (million passenger./ton-km)	565	875	1,178
Car Km (1,000 km)	20,201	32,679	53,855
Train Km (1,000 km)	368	687	951
Labor Cost	181	303	386
Material Cost			
General Administrative Expense	4	6	8
Maintenance Management Expense	5	9	14
Transportation Management Expense	4	6	8
Railway Maintenance Expense	310	501	826
Communication Maintenance Expense	24	45	63
Car Maintenance Expense	297	481	793
Transportation Expense	414	641	863
Operation Expense	1,072	1,734	2,858
Total Material Cost	2,130	3,424	5,432
Grand Total	2,130	3,727	5,819
US Dollar Equivalent (1,000 US$)	4,201	6,776	10,579

12 – 3 Education and Training

Recruiting, education and training of staffs are as briefly stated as below ;

a. Recruiting examination is applied for employing staffs by Mongolian Railway from those graduated personnel of railway academy or high-school.

b. After the education from 1 month – 1 year depend on the type of work, assignment is determined for further work position.

c. On the job training is conducted for 2 hours twice pre-condition to pass through examination held once a year for duty-performance.

CHAPTER 13

ECONOMIC AND FINANCIAL ANALYSIS

Chapter 13
Economic and Financial Analysis

The Master Plan is composed of rehabilitation work of the railway substructures at 184 locations. They are grouped into 3 stages for the phased implementation plan during 2000-2020, and the assessment is conducted here in economic and financial aspects.
After confirming the viability of the entire Plan, 72 projects are selected through engineering and environmental viewpoints to have necessity of urgent implementation. They are named the Short Term Urgent Projects and the similar economic and financial evaluations are conducted for this group in Chapter 20. In order to avoid the duplicated presentation, this chapter presents rather characteristic points in evaluation method for the entire master plan, while discussions in numerical data are edited rather in Chapter 20.

13-1 Economic Analysis

13-1-1 Objective and Methodology

The objective of economic analysis is to estimate the impact of the investment of the overall Master Plan in the economy. The impacts are shown numerically by Economic Internal Rate of Return (EIRR), together with qualitative description of other indirect benefits. These results are used in the overall assessment of the master plan proposed.

(1) Conditions

- Project Cost:

  The project is composed of rehabilitation and strengthening railway substructures at various points in the railway section from the Russian border to Bayan of 450 km. The rehabilitation cost of the project is estimated by the team together with engineers of MR and summarized in Chapter 11 in market prices of August 1996. The economic cost is tabulated at the cost of US$ 22.98 million without transfer elements of duties and taxes.

- Economic Benefits

  When the project is completed, it will strengthen the railway substructures and realize cost savings for the national economy in the following aspects.

  1) Repair cost of repetitive damages on railways by flood and others.

  2) Lost time cost of passengers by the interruption of train operation.

3) Additional cost of transportation assuming the diversion to road vehicle transport.

The benefit stream years in each stage are set at 30 years after the completion of the stage.

- Implementation Plan:

Implementation plan of the master plan is proposed in three stages:

Stage 1	:	2002 - 2004
Stage 2	:	2005 - 2009
Stage 3	:	2010 - 2019

(2) Evaluation

1) EIRR Calculation

EIRR is calculated in iteration method by the following model:

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

where i : the ith year as the 1st year is in 2002

n : the analysis period

Bi : benefits in the year i

Ci : project cost in the year i

2) Other Benefits

Other qualitative benefits which are not included in the EIRR calculation are described in 13-1-5 afterward which should be considered in the overall evaluation of the project.

13-1-2 Project Cost

The project costs are shown by stage in Ap. Table 13-1-1. The total economic cost is summarized with financial cost in the following Table 13-1-1.

Table 13 - 1 - 1 Project Cost

($us in million of 1996 prices)

Stage	Econ. Cost	Tax & Duty	Financial Cost
1	10.93	1.47	12.4
2	2.93	0.37	3.29
3	9.12	1.42	10.54
Total	22.98	3.25	26.23

Source: Table 11-3-1 & Ap Table 13-1-1

13-1-3 Economic Benefits

The project will reduce damages and loss inflicted repetitively on railway substructures caused by rains often concentrated in a limited spot, being categorized in the following three scales for quantification. Cost savings are identified as economic benefits in the sense that cost of damages can be reduced when the rehabilitation project is completed. The followings are the estimated cost savings to be realized by the project.

(1) Repair Cost of Damages

Damage Occurrence

Annual rainfall at Darkhan shows a modest volume of 472 - 196 mm in the past. It concentrates in June - August of the year often intensively in many small areas. Every year in the past floods caused by rainfalls associated with terrain conditions inflicted damages on railways. Data of damages on the whole railways in MR are shown in Table 7-1-2 in the chapter 7, from which those on the project sections for eight years during 1986 - 1995 are selected and developed into damages in ten years during which the number of damages are estimated at 68 without the project, being shown in Table 13-1-2. It means various magnitude of damages will occur 6.8 times per year. Since no other damage data are found in MR, it is assumed damages will happen at the same rate in average per year if there is no rehabilitation program. The damage scale is categorized in three classes of L, M, and S and occurrence is assumed to decrease if rehabilitation works are implemented by stage.

Damages have been repaired by MR urgently to restore railways and sub-structure conditions for safe train operations. Often those urgent repair works are conducted by mobilizing directly MR's staff and material. The repair cost used in the economic analysis differs from the costing of MR, instead, the economic cost should be estimated in the sense that the urgent work deprives resources to be used in other economic activities. Accordingly, it should be estimated at cost found in the market less transfer factors. Table 13-1-3 shows the cost, being copied from Ap Table 13-1-2. The cost covers direct work, overhead and physical contingency prevailed in the market. As shown in Ap Table 13-1-2, the cost of designing is neglected since the repair work is in urgent need having no time to conduct full D/D.

When projects are implemented in each stage, damage occurrence can be reduced and the costs of reparation, being tabulated by the averaged repair cost multiplied to the reducible damages in each stage, is saved. The urgent repair cost is considered to increase by 20 % in the second 10 years and by 40 % in the third 10 years of the benefit streams, since the costs may increase because facilities become obsolete with years and larger quantities of repair work may be required.

Table 13-1-2 Damage Occurrence

Scale	Without improvement Damage/yr	Stage 1 2005 -		Stage 2 2010 -		Stage 3 2020 -		Left over
		Damage/y	Improved/y	Damage/y	Improved/y	Damage/y	Improved/y	
L	0.95	0.95	0.38	0.57	0.14	0.43	0.39	0.40
M	2.45	2.45	0.97	1.48	0.36	1.12	1.01	1.10
S	3.40	3.40	1.35	2.05	0.50	1.55	1.40	1.50
Total	6.80	6.80	2.70	4.10	1.00	3.10	2.80	3.00

Note : Damages on railways are assumed to decrease when improvements are completed by stage.
The followings are tabulation of damage reduction under the staged program.
The total number of rehabilitation work types is 204, an average of 68 in each stage, while the planned spot improvements are 84, 34,86 in each stage. A 5% is assumed for improvements to be repeated in each stage, the total of which is in "left over".
After stage 1 68*(84/204)*0.95=27 ...... remain 41
After stage 2 68*([84+34]/204)*0.95=37 ...... remain 31
After stage 3 68*([84+34+86]/204)*0.95=65 ...... remain 3
Total 27+10+28=65 remaining 3

Table 13-1-3 Averaged Repair Cost by Scale

Urgent 1) Repair Work	Econ Cost Annual Average Repair Cost	Econ Cost St 1 1st stage	Econ Cost St 2 2nd stage	E con Cost St 3 3rd stage
Class L 2)	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

Source : Ap Table 13-1-2
Notes : 1) Class L (Large) damage is represented by revetment rehabilitation work where the cost is the weighted average of L and 4.1M resulting in $ 1,256,800
Class M is represented by embankment rehabilitation of $ 123,100
Class S is represented by embankment rehabilitation at $ 82,080.
2) For benefit estimates of the entire master plan study, the unit cost of $ 1,256,800 is used, while other figures are adopted for study by stage.

When the average annual occurrence is multiplied by urgent repair cost, the amount means the repair cost of that year. Caused by repeated damages on the railways, the cost becomes a financial burden to MR management. The cost can be saved if rehabilitation works are conducted satisfactorily. The cost in each year is calculated and placed in one of the benefit streams.

(2) Time Cost of Waiting Passengers

Trains have carried not only Mongolian citizen but also many foreign nationalities.

Negative impact of waiting hours of those passengers will spread among various activities of the economy. From this viewpoint, the lost time is evaluated by hours of waiting and unit cost per hour. Ap Tables 20-1-1 and -1-2 shows the calculation and the following are the excerpt.

1) Time Value of Passengers

-1 Mongolian

GDP and population in 1995 are shown in the statistical data, from which GDP per capita 1996 is tabulated.

240,680 Tug/person (in 1996 prices)

GDP per person per hour is determined and converted to $ in 1996 prices at $1.00 = Tug 550.

240,680/(365 x 8) = 82.4 Tug = $0.150/H

where GDP is related to 8 hours work per day. Differentiation by trip purpose, age, sex, etc. is not taken into account. The cost will increase with traffic and GDP/person.

-2 Other Nationalities

Data in "World Social Indicators of Development, 1996" (World Bank, 1996) indicate GDP per capita at $2,460 for Russia and $530 for China in 1994. GDP per capita in 1996 is estimated by assuming changes for 2 years 1994 - 1996 in each country. Hourly rate per person is calculated respectively and the averaged value is estimated at $0.500/hr.

-3 Averaged Time Cost

Of all passengers, 2/3 are Mongolians and 1/3 are foreigners. Using this ratio the averaged time cost is tabulated at $0.266/hr per person in prices of 1996. They will increase at a rate same as the growth of GDP per capita of Mongolia, 2.3 % per annum.

(2/3 * 0.150 + 1/3 * 0.500 = $0.266 /hr per person)

2) Time Cost of Waiting Passengers

-1 Passengers

The passengers volume on the link of Tolgoit - Mandal (170-220) in 1995 was 1.1 million (mn) persons, which meant the average transport volume of 3200 per km on the project section. per day (8 trains and 3600 passengers). Growth of passengers are in Table 5-3-3 and the estimated volume is in Ap Table 5-8-23. Passengers per day is calculated at 4300, 4800, and 5400 respectively for 2005, 2010 and 2020.

-2 Damages and Waiting Hours

The cost of lost time is estimated by taking into account the average damage occurrence, average wait hours of passengers, traffic growth rates and rate of increase of GDP/person being in Ap Table 20-1-1, where a brief note is attached in calculating the averaged train wait hours. The cost in each year is tabulated and put in one of the benefit streams.

3) Time Value of Cargoes

No time value is vested in cargoes during the transportation.

(3) Transport Cost Assuming Diversion to Road Transport

An approach is conducted here to quantify the hypothetical transport cost of passengers and cargoes which would be carried by road vehicles because of the train disruption caused by damages. The road vehicle transport cost can be understood to represent a part of negative impacts of the railway damage inflicted on the economy. The cost can be saved if rehabilitation projects of this study are realized.

1) Conditions

a. Loading by Vehicles:

Bus	:	Average	30 persons/Veh.
Minibus	:	Average	10 persons/vehicle.
Truck	:	Average	8 tons/vehicle.

b. Vehicle Operation Cost

Depreciation, fuel, maintenance, tires, wages, and overhead cost are estimated at international prices at the border and tabulated into the unit vehicle operation cost. The vehicle market in Mongolia is mostly used ones with quite large variety of prices through which it is difficult to find representative vehicle types. Tax and duty need be excluded in economic evaluation. Under the circumstances, prices of new vehicles were confirmed at Customs Office. They are in Ap. Table 20-1-3 and the followings are VOC per 1000km.

Bus	:	$234.65/1,000 km
Minibus	:	$181.71/1,000 km
Truck	:	$241.63/1,000 km

c. Damage occurrence, etc. are in the same conditions described through (1) - (2) above. The diversion cost is tabulated for damage scale L and M, while trains encountering S are assumed waiting the re-opening and no shift to road vehicle transport.

2) Vehicle Transport Cost

Damage occurrence rate, volumes of transport, averaged haul distance and vehicle running cost on roads can tabulate the cost in prices of 1996. Growth rates of railway traffic summarized in Table 5-3-3 are taken into account for cost in future years. Ap. Table 20-1-4 presents the estimation of the cost of transport by vehicles for selected years in the future. The annual cost is tabulated and put in one of the benefit streams.

(4) Summary of Economic Benefits

Economic benefits are estimated (1) Repair Cost of Damages, (2) Time Cost of Waiting Passengers and (3) Road Transport Cost. They are summed up without discounting in Tabled 13-1-4, where the total is $108 million, and savings are composed by damage repair cost 60%, road transport cost 34%, and passenger time cost 6%.

Table 13-1-4 Economic Benefits

Project	Economic Benefits ($us mn in 1996 prices)			Total Savings
	Repair cost savings	Time cost Passengers	Rd transport cost	
Master plan (%)	64.9 (60)	6.8 (6)	36.3 (34)	108.1 (100)

13-1-4 Results and Sensitivity Analysis

(1) EIRR

EIRR of the entire Master Plan is calculated at 12.09%, using the estimated projects cost and benefits. They are summed up in the net benefit stream in Ap. Table 13-1-3 on which the result of sensitivity analysis is shown together..

(2) Sensitivity Analysis

Sensitivity analysis is conducted for the following cases of cost increases and/or reduced benefits and the result is in Table 13-1-5 together with the base case.

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

Table 13-1-5 EIRR and Sensitivity Analysis

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

Economic assessment of the base case, the overall master plan, shows the EIRR at 12.09%. The sensitivity test values lie in the range of 8.3 - 11.1% are only cases of cost increases and/or benefit reduction, while cases of reduced cost and/or increased benefits are not tested since they are considered in much larger range of viability not necessary to show in numerical values . The master plan with EIRR at 12.09 % is considered viable in economic justification.

13-1-5 Other Benefits

The followings are qualitative benefits difficult to show in numerical terms:

(1) Important Role of Railway Transport

International road network has not developed yet in better conditions, while customs clearance and common road traffic rules have not developed well to bring in free movement among the neighboring countries yet. Under the circumstances, railways contribute in all direct international movement of cargo and passengers.

In domestic service particularly, transport of coal to key cities and industries in order to support energy usage has been maintained in large volume. All those cargoes and their regular transport are fundamental to the economic activities. Punctual service of railways is indispensable for sustained development of those activities. Rehabilitation of railway substructure in this master plan will certainly contribute in realizing better stable transport service all through the year. Also the project will increase safety and regular operation and contribute in better management of MR.

(2) Support of Social and Industrial Activities

The project will realize stable service which can have better influences in economic production, increasing job opportunities, bringing about new industrial activities, enhancement of urban lives and cultural and education systems as well.

(3) Better Environmental Conditions

Reduced damages through this master plan project can protect the environment conditions of the region and prevent increases in air pollution, noise, etc. caused by diversion to the road vehicle transport.

13-1-6 Economic Analysis

EIRR is estimated at 12% approximately. The opportunity cost of investment in developing countries is generally at 10 - 12 %. Mongolia is one of those countries. Compared to this criteria the investment in this master plan project shows a sufficient return. In addition, non-quantified indirect benefits, which will serve enhancement of sustained activities of the economy, can be materialized together.

The entire projects in the master plan showed EIRR of 12.09%, which is considered feasible for Mongolian Railway and the national economy. With this return estimate in the background, it is recommended the staged implementation plan should be studied further in particular attention in the 1st stage.

13-2 Financial Analysis

(1) Objectives and Methods of Analysis

Financial analysis is made to check if the profit can be increased as a result of the upgrading project. As an index for this purpose, 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)

(2) Major Prerequisites

1) Subject of Analysis

The earning capacity of this project is checked by analyzing the amount of investment required for the project and raising of funds for that purpose, the loss of transportation revenue and expenditure in case train operations are interrupted by disasters, and the savings of rehabilitation cost resulting from the damage reduced by the project.

2) Analytical Period

The period of project is assumed to be 30 years from the completion of the first phase work. It is assumed that revenues and administrative operating costs will increase every year at constant rate through the years subjected to demand forecast (1995 to 2005, 2005 to 2010, and 2010 to 2020), and will remain on the same level after that until the end of the project.

3) Amount of Investment

Market prices are used in financial analysis. A value-added tax (10%) is imposed on equipment procured on the local market and custom duty (15%) and local tax totaling 26.5% (15% + 1.15 x 10%) are imposed on imported equipment. (refer to Table 13-1-1).

4) Depreciation

The straight line method is used for depreciation. Earth structures constructed under this rehabilitation project will have a useful life of 100 years, uniformly depreciated in accordance with the regulations of MR. Therefore, re-investment is not required during the project life. The remainder of investment amount, less the accrued depreciation, becomes the salvage value.

5) Raising of Funds

① Foreign Currency Funds

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. Financial parameters applicable to Mongolia are assumed to be as shown below.

Annual Interest Rate : 2.3%

Period of Loan : 30 years (grace of 10 years)

Method of Refundment : 20 years semi-annual equal installment

② Domestic Currency Funds

Current commercial interest rate in Mongolia is very high and it seems almost impossible to carry out projects with domestic currency obtained from bank loans. Since financial support from the government, such as grants-in-aid, also cannot be expected, it is inevitable to obtain necessary domestic currency funds from MR's own funds. Therefore, feasibility of this project will be studied assuming that all required funds will be obtained from MR's own funds, except for those from foreign currency loan.

(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 for the section between Sukhe-baatar and Bayan 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 in the government statistics. 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 based on the demand forecast 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 13-2-1 together with administrative operating costs.

Table 13-2-1 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
Revenue less Cost	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 13-2-2). Rehabilitation cost per each disaster is the same as in the economic analysis, but market prices are used in financial analysis. As it can be predicted that deterioration will be accelerated and expenditures will increase if affected facilities are left without improvement, estimated expenditures will be increased by 20% after2015 and by 40% after 2025.

Table 13-2-2 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) Sensitivity Analysis

Based upon the above conditions, the analysis for the fundamental case as well as sensitivity analyses for the following cases were conducted.

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.

(7) Results of Analyses

Financial internal rates of return (FIRR) for each case are shown in Table 13-2-3.

Table 13-2-3 Comparison of FIRR

Case	FIRR	Case	FIRR
Preliminary 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%

The FIRR indicates the rate of return on the total invested capital and it means that the relevant project is financially feasible if necessary funds can be raised at an interest rate below this level. 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, as described in the prerequisite, it is possible to carry out this project in view of profitability. From the aspect of cash flow, the amount of MR funds for complementing the shortage of foreign loans 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 FIRR is 5.493% and investment from MR's own funds reaches only 1,800 million tugrik at the peak. Complete solution of the fund shortage will be delayed to 2020, but it is not so serious as to obstruct the implementation of the project.

(8) Study on Scale of Investment

In recent years, MR has energetically executed important rehabilitation and improvement projects by introducing loans from overseas countries and international organizations. All necessary domestic currency funds were raised from its own funds under the financial situation of high interest rate that makes borrowing from banks almost impracticable. Grants-in-aid from the government also cannot be expected.

MR's own funds available (reserved profit + depreciation) in the last two years reached about 4,000 million tugrik per year. Although this figure can change widely under the situation where investment is being positively enforced under runaway inflation, the domestic currency funds required for the implementation of this project is bearable to MR as far as the above figure is considered to be the basis of estimate.

Table 13-2-4 Available Amount of Annual Investment

(Unit: Million Tugrik)

	Depreciation	Reserved Profit	Total
1994	3,896	431	4,326
1995	3,974	401	4,374

Although at present MR has no loan balance or interest to be paid immediately, refundment of the principal and payment of interest for loans agreed to in the past is scheduled to begin in 1998 and it will come to the peak in 2005. Naturally it has been ascertained by prestudies that the implementation of the projects will bring necessary funds for refundment of the principal and payment of interest through the increase in earnings. However, as the type and scale of MR's cash flow could change significantly in the near future, MR should carefully check the future prospects of its own profit and cash flow when introducing further new loans in the future.

CHAPTER 14

EVALUATION OF MASTER PLAN

Chapter 14
Evaluation of Master Plan

14-1 Outline of the Project

The trunk line between Sukhe-baatar and Zamyn-uud of the Mongolian Railway is an important transport route in Mongolia. 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 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$ 12.4 million, 2nd:US$ 3.3 million, and 3rd:US$ 10.5 million)at the price as of August 1996.

Table 14-1 shows an outline of the rehabilitation plan which covers 184 places.

Table 14-1 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	

14-2 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 railway structures of the Mongolian Railway, situation of disasters, natural conditions, environment, and size of investment. As shown in Table 14-1, 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 standing 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 aspects.

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 lines of the railway and will also contribute to the development of the sound social and economic activities in Mongolia.

VOLUME 2 FEASIBILITY STUDY

CHAPTER 15

SHORT-TERM URGENT PROJECT

Volume 2 Feasibility Study

Chapter 15
Short-term Urgent Projects

15 – 1 Outline Procedure for Planning Urgent Projects

Since object section to be the subject of (72 places) short-term urgent projects are many similar countermeasure in nature, the Rehabilitation Improvement plan will be established in accordance with outline of the procedure in Figure 15-1.

At first, all object sections with 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 improvement projects. Where analytical data of a standard section is applied to a similar site, if special features are found at the similar site, those features will be incorporated in the plan. Comparison table of M/P and F/S, refer to attached table 15-1.

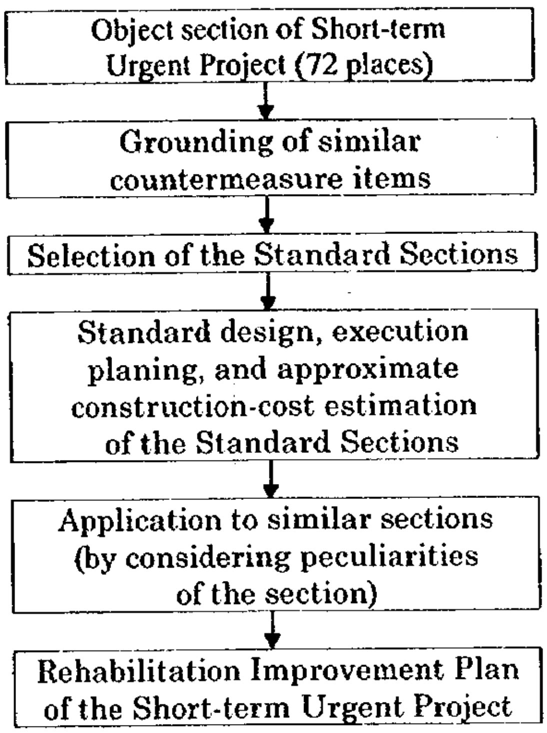


Fig. 15-1 Procedure for the Planning

15 - 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, on the master plan, depending on the criticality and the importance, based on field investigation reports, and in discussion with the government of Mongolia. There are a total of 72 such sites, as shown in Table 15-1. It was decided to execute a feasibility study for this work, on schedule to be completed in 2005.

Table 15-1 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				

15 – 3 Selection of Standard Section

(1) Concept for Selection of a 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 with similar geographic and geological conditions, 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 ¨ 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 and Applied Section by 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 revetment as shown in Table 15-2 and a single project for railway track transfer at 31pk2-4.

- 54pk4-5 is the place where (Orhon River) suddenly curved and the railway track is laid at very narrow point between hillock and river.

  Through the year, 1 – 3m of river bank are eroded, and at this point, train derailed because of flood swept away above the rail surface. At the time of site-investigation (normal current), it was measured 1.8m between the water-surface to river-bank and 7m from river-bank to the embankment slope face. Under such circumstance, it is presumed the urgency compared with other slope protection site. Therefore, should the countermeasure is established by designing at this site, it is judged that applicabilities to other similar site are possible as standard section of slope protection (refer to attached material 15-2 of site investigation result).

- As for the slope protection project at 31pk2-4, it is deemed necessary to conduct slope protection works in future, thus require more of the maintenance cost and also require curtailed train operation on all such occasion of flood, and as a consequence, it is thought necessary to take drastic measure and came to the conclusion to change the track-route.

Table 15-2 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 Project (Table 15-2)

①In selection of slope stability project, based on the result of site investigation of geology, crack weathered condition, boulder and loose rock of the face of slope, selected the standard section in classifying into 4-type (Fig. 15-2) at 13pk3, 61pk10, 282pk9 – 283pk2 and 267pk2 – 3 respectively judging basically from topographic features for Rock Pool (refer to Table 15-3 attached for the result of site-investigation).

a. Type I 13pk3 is selected as typical profile section.

13pk3, the slope is consist of the rock comparatively weathered on surface on lower part with moderate grade with gravel at upper position. At the time of heavy rainfall, this upper past will become loose and rock fall to the place near to the railway track, possibly harming the train. Also, since there are other similar places, would like to make this spot as standard section.

b. Type II 61pk10 is selected as standard section.

The slope of 61pk10 is consist of totally weathered joint. Therefore, these are loosing rock 50 – 60cm thick along the joint, some times fall down to the railway track which requiring to remove this rock which fears to harm the operation of train at any time. Other similar site, although there are rock fall but only within the size of 20cm pebbles and similar design and construction method can be applied, therefore determined as standard section.

c. Type III 282pk9 – 283pk9 is selected as standard section.

Slope at 282pk9 – 283pk9 is consist of cliff type geology covered with very weathered earth & sands all over and there are loose rock of 1m – 2m diameter on slope. This loose rock possibly hamper the railway track at the time of heavy rain along the drop down of rocks. At other site (54pk2), there are loose rocks but they are flat shape rock on relatively flat area and therefore, it is judged the probability is low and 282pk9 – 283pk9 is selected as standard section.

d. Type IV 267pk2 – 3 is selected as standard section. (Jointly use Blasting.)

Slope of 276pk2 – 3 (use jointly with blasting), is consist of rock with well advanced joint although the upper part is comparatively not weathered. The slope is the shape of cliff and there are over-hung portions being found. The lower part is consist of weathered pebbles. Over-hunged mass rocks are in condition fall down at any moment and if happens, there are possibilities to bring disasters accident of train. Although there is another site (8pk10) with hung-over but, in smaller scale. Therefore, 267pk2 – 3 is selected as standard section.

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

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 15-3 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

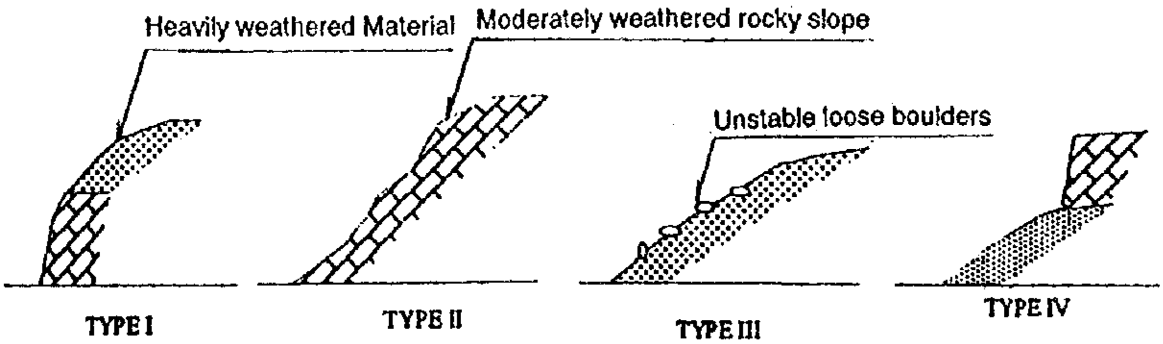


Fig. 15-2 Type of Slope

3) Bridge Rehabilitation

Bridges investigated under this project are over 50 years old and have been exposed to severe weather conditions. As selected sections 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 (Refer to attached Table 15-4, Result of site investigation).

① Replacement of beams (damage of main beam) Standard Section, 334pk3

There found a critical defect found on main beam (Winding crack, bottom part of beam is hollow, main steel bars are exposed and rusted and vertical crack on beam supporting portion), in future, possible structural destruction may occurred. This bridge is such detroriated than others, it is, therefore, being selected as standard section.

② Water-proofing and repair works for limited damaged portion (over-hung slabs ballast curb etc.). Standard section of 255pk3, the main beam is relatively in good condition, however, there are cracks found on slab and ballast cubs. Among those sections, 255pk3 is selected as standard section because crack and damages are remarkable.

Table 15-4 Bridge Rehabilitation

<table>
<tr><th>Standard Section</th><th>Countermeasure</th><th>Applied Section</th><th>Remarks</th></tr>
<tr><td rowspan="7">334pk3</td><td rowspan="7">Girder Replacement</td><td>285pk1</td><td>L=9.3m, 1 span</td></tr>
<tr><td>289pk1</td><td rowspan="2">L=13.5m, 2 span</td></tr>
<tr><td>334pk3</td></tr>
<tr><td>326pk9</td><td>L=13.5m, 3span</td></tr>
<tr><td>338pk10</td><td rowspan="2">L=7.3m, 1 span</td></tr>
<tr><td>344pk1</td></tr>
<tr><td>356pk1</td><td>L=7.3m, 2 span</td></tr>
<tr><td rowspan="4">255pk3</td><td rowspan="4">Repairing Waterproof Layer and Surface Treatment</td><td>235pk3</td><td>L=9.3m, 2 span</td></tr>
<tr><td>255pk3</td><td>L=7.3m, 2 span</td></tr>
<tr><td>245pk5</td><td>L=9.3m, 2 span</td></tr>
<tr><td>342pk2</td><td>L=6.3m, 1 span</td></tr>
</table>

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 sections were selected from two types classified by the structure and the five types classified by shape.

Flood water current volume (calculated from hydraulic data), specification of various structures, cross section of embankment at site and both side embankment configuration are used to divide into two (2) group (box culvert, bridge) and further box culvert is divide into three (3) types and bridge into two (2) types depending on shape and dimension.

From these classifications, the large volume of flood water current and frequent occurrence (embankment) site of water current over the railway track are chosen as standard section following each type as follow:

- 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

②The 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 15-5 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. 15-3.

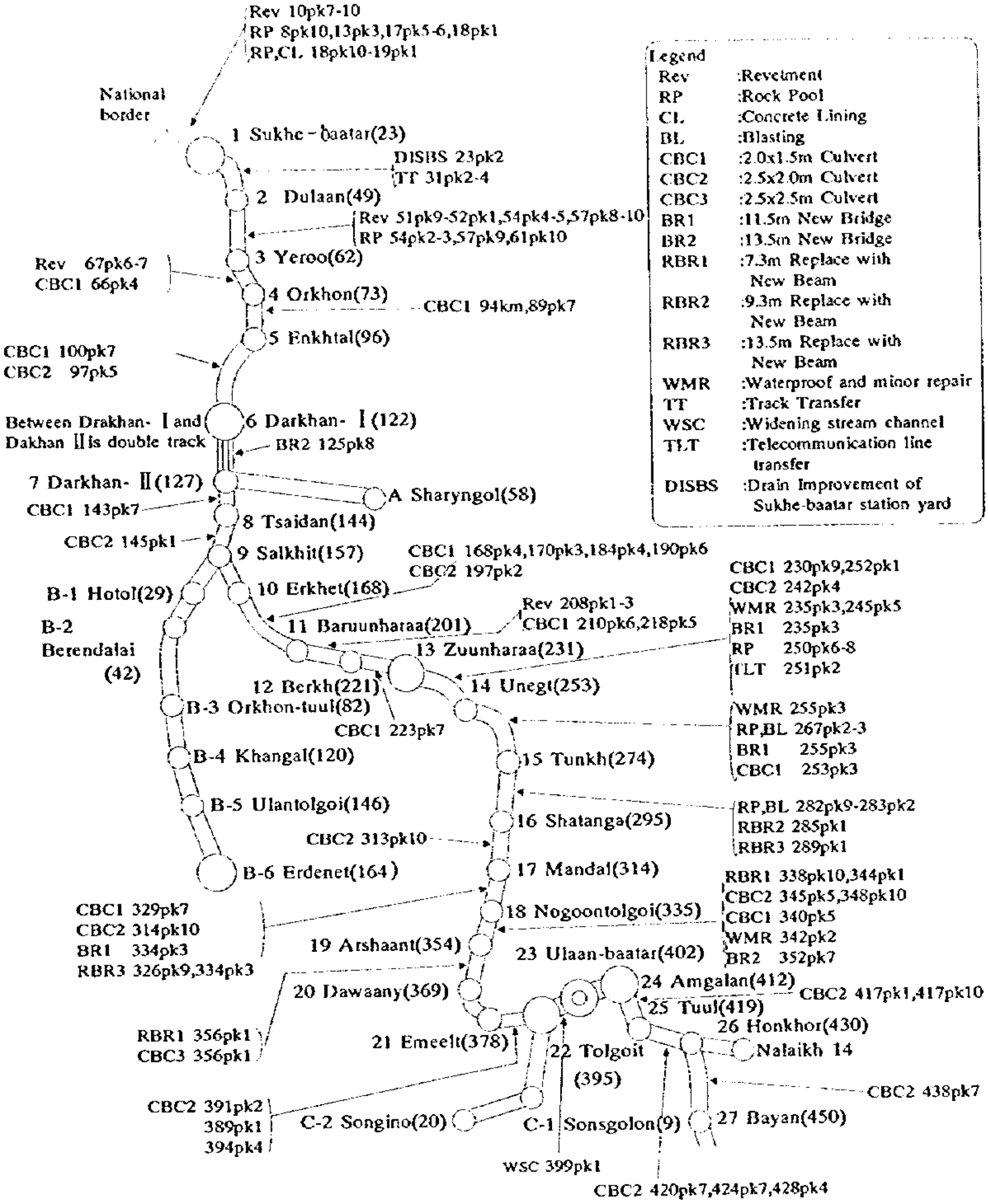


Fig. 15-3 Location of countermeasure work for each section between station

CHAPTER 16

RAILWAY STRUCTURE PLAN

Chapter 16
Railway Structure Plan

16 - 1 River Bank Protection

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

1) Preliminary Design

The section for track transfer was selected to avoid erosion damage by the Orkhon River. The start and finish points for construction were determined to be from 29 pk 1 and 31 pk 5, with a total track transfer length of 2.5 km. The maximum transfer distance is approximately 170 m from existing railway line at the point of 30 pk 2. The plane and profile of this section is shown in Fig. 16 -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 uses the design standard given in Chapter 8.

b. Railway Formation Level

The existing railway section near 30 pk 5 is submerged to bottom of sleeper in flood seasons. The proposed new railway formation level is to be higher than the existing rail-level. The difference of rail-level between start and finish points is approximately 6.0 m, while 0.8 percent of approach grade is introduced for both ends for covering difference height, to lifting up the rail level by 1.5 m.

c. Embankments and Cuttings

The slope gradient for embankments and cuttings is indicated in Table 16-1-1. The 1: 1.5 slope is used for the new alignment, however at 20 pk 40 the level is more than 6 m, 1: 1.75 slope is introduced.

The material for embankment is hauled from the cutting section. The soil comprises mostly silt with pebbles, and vegetation is to be provided for slope protection.

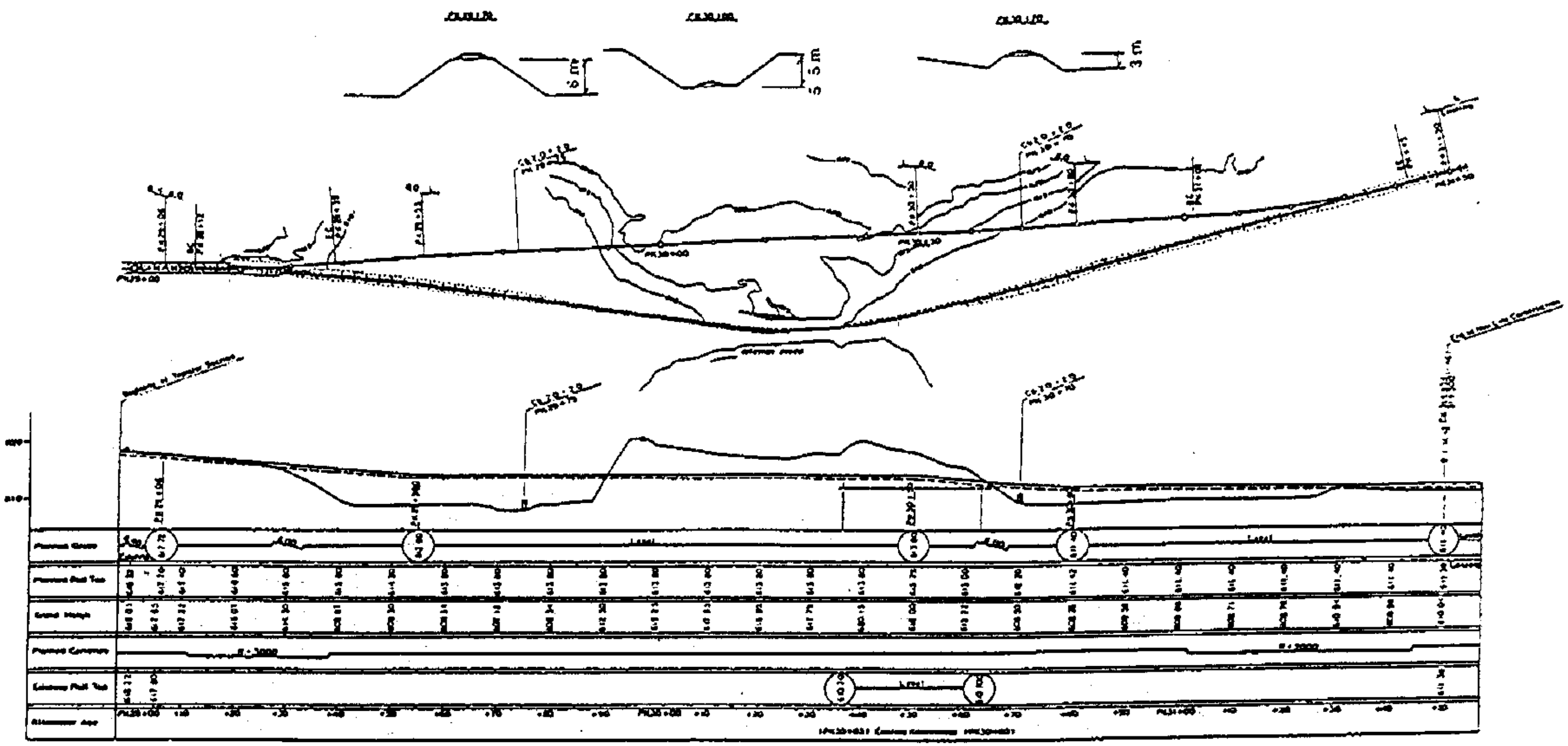


Fig. 16-1-1 Railway Track Transfer Plan

Table 16-1-1 Slope for Embankment and Cutting

Embankment Slope	1:1.5 ($h < 6m$) 1: 1.75 ($h > 6m$)
Cutting Slope	1:1.5 (for earth) 1:1.0 (for soft rock, $h < 6m$) 1:0.2 (for hard rock)

d. Protection from Frost Heave

The under ground water level is located approximately 1.5 m deep from the ground surface. Gravel with high permeability is used as the foundation material for embankments to protect against frost heave.

e. Drainage

Box culverts (2.5x2.0) are to be installed at 29 pk 75 and 30 pk 70, because hill slopes are located behind the planed track transfer line, and surface water will concentrate at these locations.

2) Construction Plan

Access to the site is possible to use existing temporary road from the national road to the construction site, and construction equipment and material can be transported by using this road.

a. Construction Period

The Sukhe-baatar Meteorological Observatory located 6 km from this construction site reports that the lowest temperature is minus 46 degrees C. and highest is 34 degrees C. April to October is the period for construction works, to avoid the severe cold season. Two years are required for the track transfer works.

b. Civil Works

Hill area located from 29 pk 90 to 30 pk 60 will provide the necessary material for embankment construction. The hauling distance is only 5~600 m, and as there are no steep slopes, then bulldozers, bucket loaders and trucks can be mobilized for this work.

Perforated drain pipe with 30 to 40 cm diameter will be installed for protection against sliding of the embankment on the existing hill slope. The drain works are also effective for protection against frost heave.

c. Track Works

The ballast will be procured from the Darkhan quarry site. The ballast is roller compacted until 5 cm below sleeper bottom. PC sleepers are placed on the ballast and 25 m long rails are installed with elastic fastenings. The finish work is implemented by adding ballast, and lifting rails and tamping by tie tamper. The general arrangement of the track profile is indicated in Fig. 16-1-2.

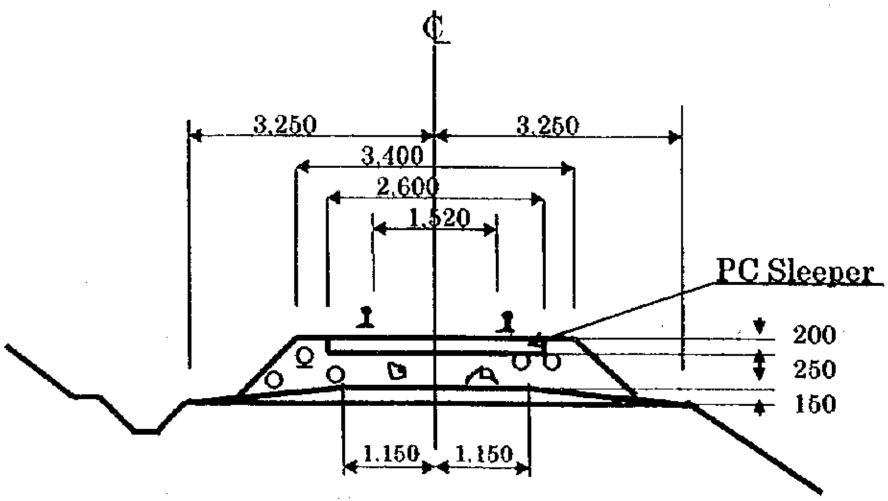


Fig. 16-1-2 Track Profile

d. Rail Connection

After the completion of civil works, viz. track work and relocating the telecommunication cable, new track and existing track at 29 pk 00 and 31 pk 50 are connected during a train interval.

3) Quantities / Construction Cost and Construction Schedule

Table 16-1-2 indicates the quantities / construction cost and Table 16-1-3 shows the construction schedule of the track transfer work.

Table 16-1-2 Quantities and Construction Cost

Unit: 1000 US$

ITEM	Unit	Qty.	Amount							Total
			Local			Foreign				
			Personnel	Material	Total	Personnel	Material	Equipment	Total	
1. Civil Work										
Embankment	cu.m	58,000	6	0	6	0	0	1,077	1,077	1,083
Common excavation	cu.m	9,000	0	0	0	0	0	50	50	50
Concrete box culvert	m	19.0	10	0	10	0	61	0	61	71
Concrete box culvert	m	10.0	5	0	5	0	31	0	31	36
Wing wall	set	2	1	10	11	0	2	7	9	20
Subtotal			22	10	32	0	94	1,134	1,228	1,260
2. Track work										
Track work for rerouting	m	1,700	252	0	252	0	0	628	628	880
Removal of existing rails	day	30	6	0	6	0	0	0	0	6
Subtotal			258	0	258	0	0	628	628	886
3. Relocation of Telecom Cabl	1		15	0	15	0	81	0	81	96
Total			295	10	305	0	175	1,763	1,937	2,242

Table 16-1-3 Work Schedule for Track Transfer

Work Item	1 st Year												2 nd Year											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
1 Mobilization	■	■	■																					
2 Relocation of Telecom Cable				■	■																			
2 Civil Works																								
1) Embankment					■	■	■	■																
2) Cutting				■	■	■	■																	
3) Drainage						■																		
3 Track Work																								
1) Ballasting								■	■	■														
2) Sleeper										■						■	■							
3) Rail																	■							
4 Sodding								■																
5 Finishing Work																		■	■					
6 Demobilization																			■	■				

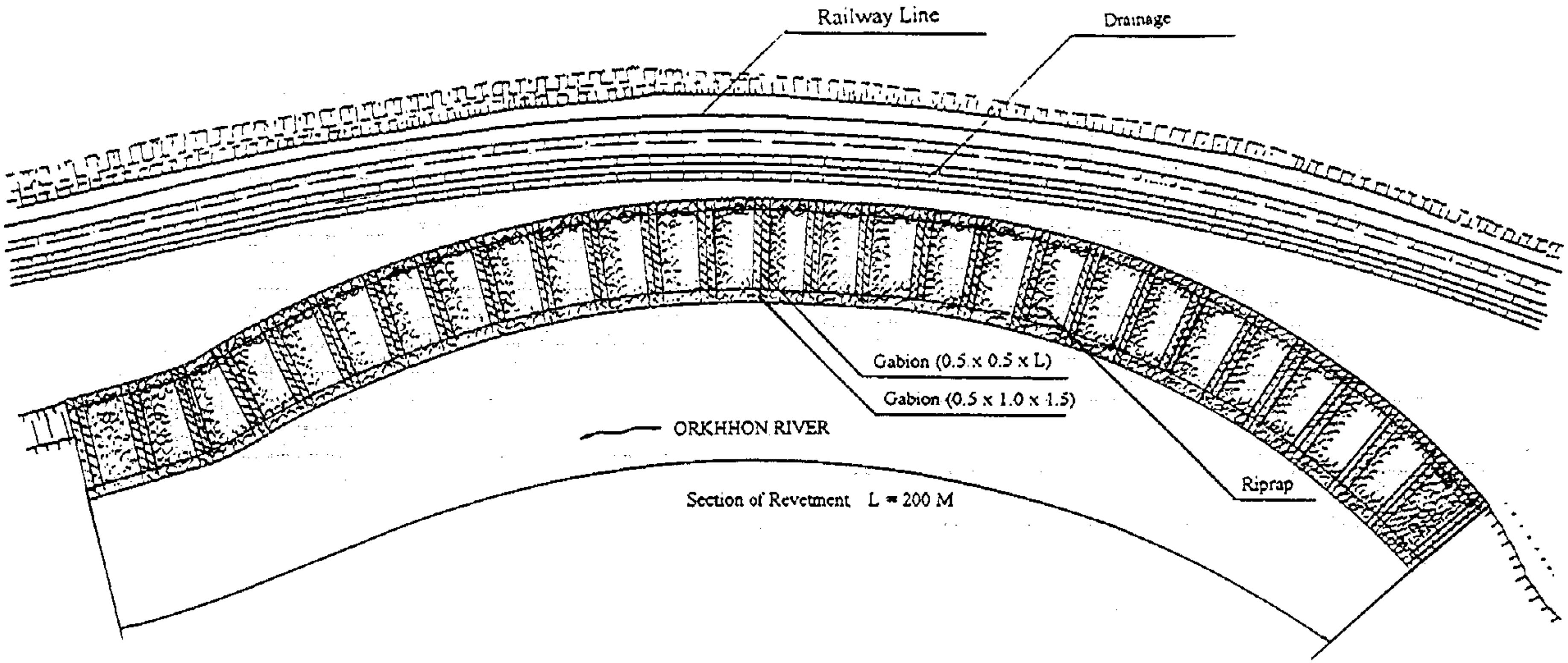


Fig. 16-1-3 Revetment Layout Plan

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

1) Method of Revetment Works

River banks are destroyed from foot by river scour sometimes. The river bank protection components comprise three structures; the bank slope protection, protection of slope toe and the other foot protection against river scour. The structure of slope toe protection consists of riprap and gabion protection.

The concrete lined ditch along the track will protect the railway track structure from flooding. The layout of revetment at 54 pk 4 -5 is indicated in Fig. 16-1-3 and the general drawing of structure is indicated in Fig 16-1-4.

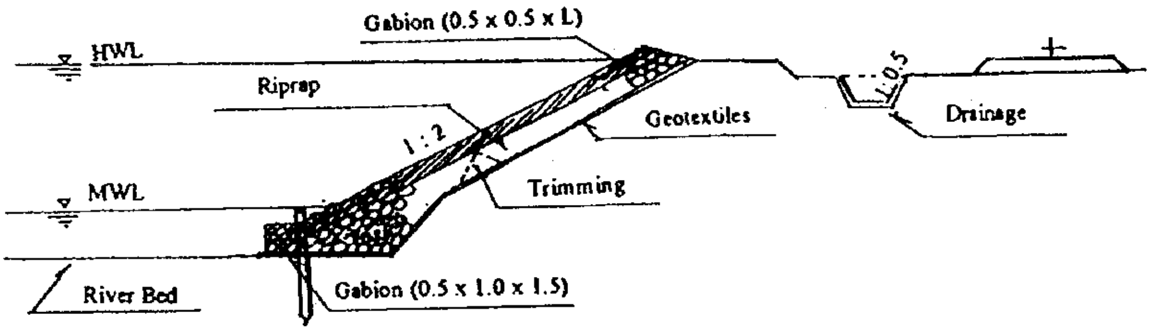


Fig. 16-1-4 General structure of Reverent Works

a. Slope Protection

- Protection Material for Blanket

The blanket protection material (geotextiles) is installed between the bank slope and riprap covering to protect against encroachment from the river flow.

- Riprap on the slope

The Orkhon River was classified as Segment 2-2 in the Master Plan. Based on the condition of river characteristics, the thickness of riprap is estimated to be more than 1.2 m and to protect against scour, boulders to be used are about 40 cm diameter. The calculation procedure for thickness is described in Appendix. The size of mesh boxes of the gabion mattress on the slope is 0.5 m (height) x 0.5 m (width) are installed 5 m intervals. The slope gradient of riprap is planned at 1: 2.

b. Riprap on foot

The gabion, which has flexible body and provides strength against scouring, is installed as foot protection. The size of each gabion is 0.5 m (height) x 1.0 m (length) x 1.5 m (width).

c. Drainage

It is reported the existing railway formation is inundated by river water in the flood seasons, drainage is provided along railway line to protect the railway formation. In order to protect the railway formation, a concrete lined ditch should be provided along the track. The size of ditch is 0.6 m (height) x 0.6 m (width) lined with concrete.

2) Construction Plan

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

a. Trimming Slope

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

b. Installation of Back-filling Material

The back-fill material is installed at the design position.

c. Mesh Box Gabion

The net box gabion is installed at the designed position.

d. Riprap Foundation

The slope of the riprap is 1 : 2.0.

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 16-1-4 and the implementation schedule is shown in Table 16-1-5.

Table 16-1-4 Revetment Works: Quantities and Cost (54 pk 4-5)

Unit: 1000 US$

Work Item	Unit	Qty.	Amount							Total
			Local			Foreign				
			Labor	Material	Total	Labor	Material	Equipment	Total	
Common Excavation	cu.m	16	0	0	0	0	0	0	0	0
Embankement	cu.m	68	0	0	0	0	0	1	1	1
Riprap	cu.m	1,992	1	21	22	0	0	3	3	25
Wire Sylinder	cu.m	3,713	22	63	85	0	65	12	77	162
Blanket	sq.m	3,713	9	0	9	0	5	1	5	14
Concrete Lined Dith	m	200.00	0	5	5	0	0	1	1	6
Total			32	89	121	0	70	17	87	208

Table 16-1-5 Work Schedule for Riverbank Protection

Work Item	1	2	3	4	5	6	7
1 Mobilization	■	■					
2 Cut & clearing		■	■				
3 Riprap Work and Formation		■	■	■	■		
4 Gabion Work			■	■	■		
5 Draining					■	■	
6 Final Work						■	
7 Demobilization						■	■

Note: Above figure is indicated the month

(3) Applied Section

Table 16-1-6 shows additional requirements for applied sections.

Table 16-1-6 Requirements on other Applied Sections

Applied Section	Requirements
10pk7~10	Erosion of this point is caused by the revetment 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.
51pk9~52pk1	A 500m^3 riprap was put in 1987, however river bank is eroded by every year. Drainage is required because flood water covers railway formation level often. Future study is necessary to detained the scope to protection works.
57pk8~10	Riverbank protection work is not yet made, consequently the bank is eroded by 1~2 m every year. Curved railway line are located among hill slopes close to the river. Water level often comes up the formation level and MR restricts the operating speed at 15~20 km/h in flood seasons. Drainage system should be considered in this section.
67pk6~7	The Orkhon River meander, like a hairpin, railway line is eroded 2~3m in every year. MR made urgently 500 m^3 temporally riprap works.
208pk1~3	The Haraa River runs 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 riprap works 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 score floods.

(4) Total Quantities and Cost

The total of quantities and cost of the revetment works are in Table 16-1-7.

Table 16-1-7 Revetment : Total Quantities and Cost

Unit: 1000US$

Location	Length (m)	Amount							Total	Remark
		Local			Foreign					
		Labor	Material	Total	Labor	Material	Equipment	Total		
31pk 2-4	200	294	11	306	0	174	1,763	1,937	2,242	Standard Section
10 pk 7-10	300	62	166	228	0	144	35	179	407	Applied Section
51 pk 9 - 52 pk	300	49	136	185	0	113	29	142	327	Applied Section
54 pk 4 -5	200	32	89	121	0	70	17	87	208	Applied Section
57 pk 8 -10	300	48	135	183	0	109	28	137	320	Applied Section
67 pk 6 -7	250	45	127	172	0	103	27	130	302	Standard Section
206 pk 1 - 3	*	37	103	140	0	85	22	107	247	Applied Section
Total		567	767	1,334	0	798	1,921	2,719	4,053	

*: Replacement of Telecommunication Cable

16－2 Slope Stability

The protection plans against falling rock were determined by considering the slope configuration, available equipment, work safety , maintenance capabilities and environment. Appendix 16-2-1~5 indicates the slope characteristics for each standard section.

(1) Preliminary Design

Plans can be classified into several types. Locations, standard plan type and combination of method against falling rock are in Table 16-2-1. Table 16-2~6 shows slope configuration and protection method for the standard section.

Table 1 6 - 2 - 1 Improvement Program for Standard Section

Standard Section	Slope Type	O.H	F.P	W.R	C.D.R	R.P	C.L	L.R
13pk3	I	O	O	O	O	O	-	-
61pk10	II	O	O	O	O	O		
282pk9~283pk2	III	-	-	-	-	-	-	O
18pk10~19pk1	I	O	O	O	O	O	O	-
267pk2-3	IV	O	O	O	O	O	-	-
251pk2	II	-	-	-	-	-	-	-

O.H :Overhang F. P :Food Strength W.R :Removal of Weathered Rock

C.D.R : Removal Sedimentary Rock R.P: Installation of Rock Pool.

C.L: Concrete Lining L.R: Removal of Loose boulders.

251 PK 2 is relocation of Telecom Cable

a. Removal of Overhang

This work intend to remove overhanging unstable portion of the slope and cleft rock, while the parent rock will be secured by foot protection 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 above value.

Table 16-2-2 Slope Characteristic and Protection Work (13 pk 3)

Type	Applied Section	Slope Characteristic
I	18pk1	The slope consists of two layers. Weathered rocks exposed on upper part of the slope surface and the lower part is composed of bed rock with well developed joints. Some shrubs covers both side of slopes.

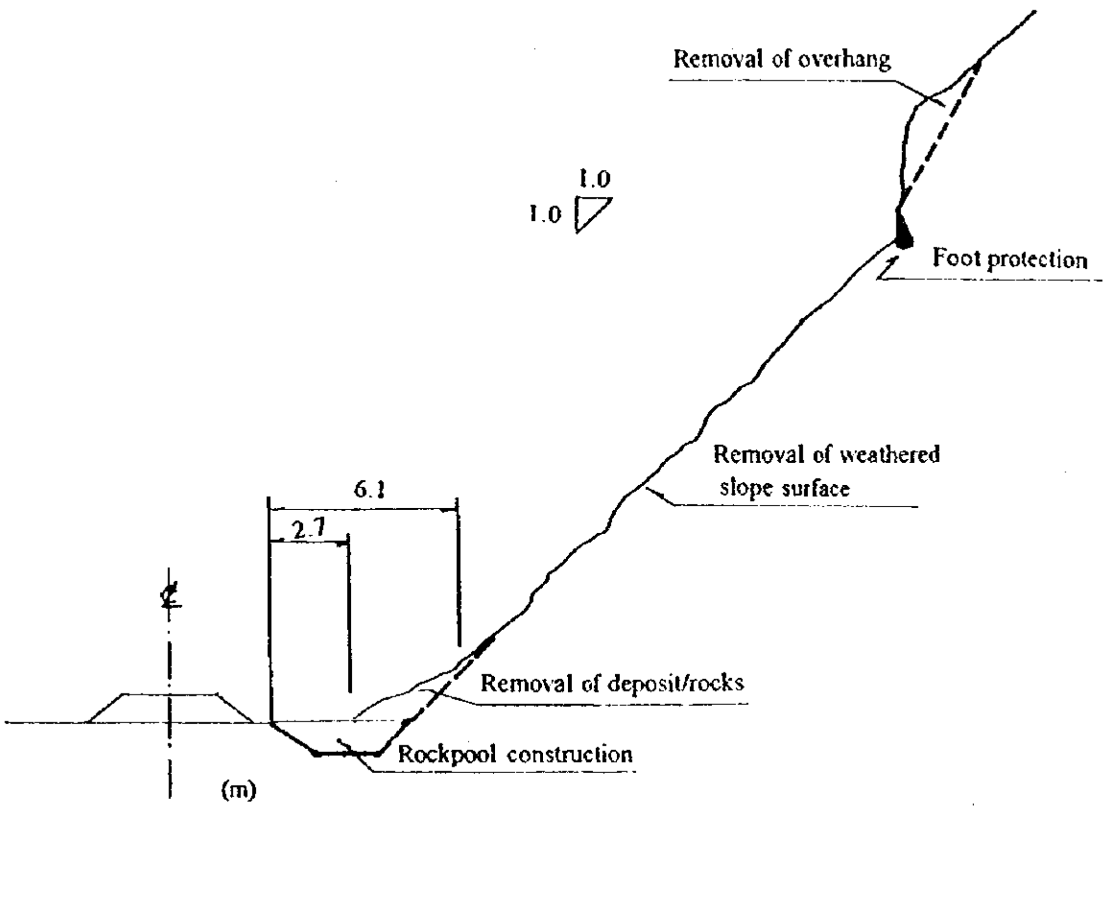


Table 16-2-3 Slope Characteristic and Protection Work (61 pk 10)

Type	Applied Section	Slope Characteristic
II	17pk5-6, 57pk9 250pk6-8	Weathering remarkably proceed onto slope and consists of two strata. Upper part makes cliff and lower part are piled by talus cones.

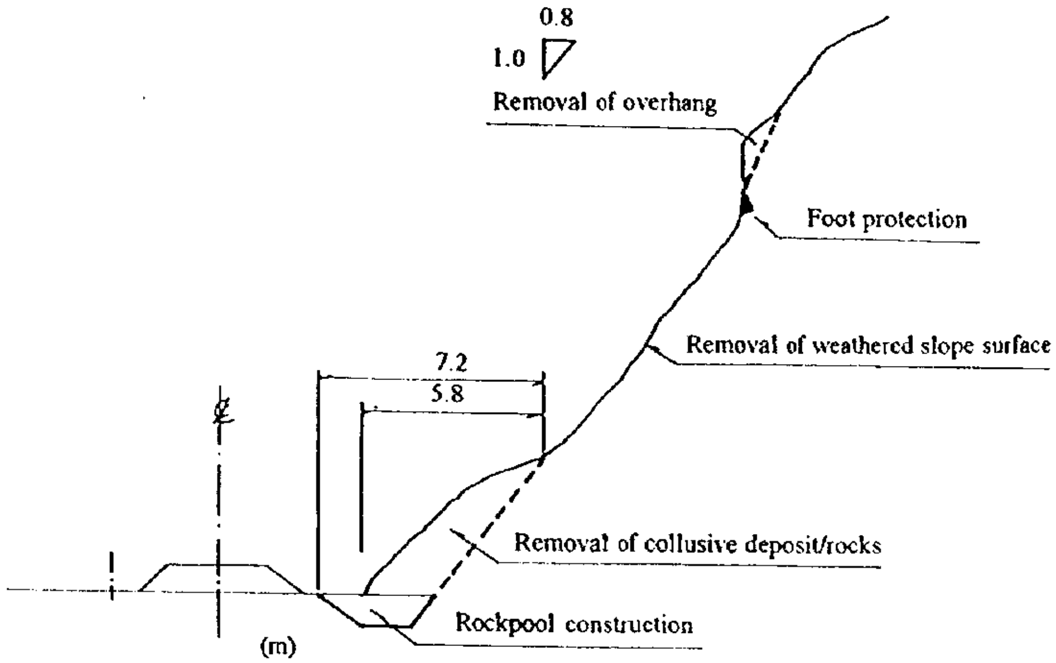


Table 16-2-4 Slope Characteristic and Protection Works (282 pk 9 ~ 283 pk 2)

Type	Applied Section	Slope Characteristic
III	54pk2-3	Weathering remarkably proceed onto steep slope and consists of two part. Upper part makes steep slope and lower part makes slope by talus cone. One meter size boulders locates which comes from upper part's exfoliation of soft layer.

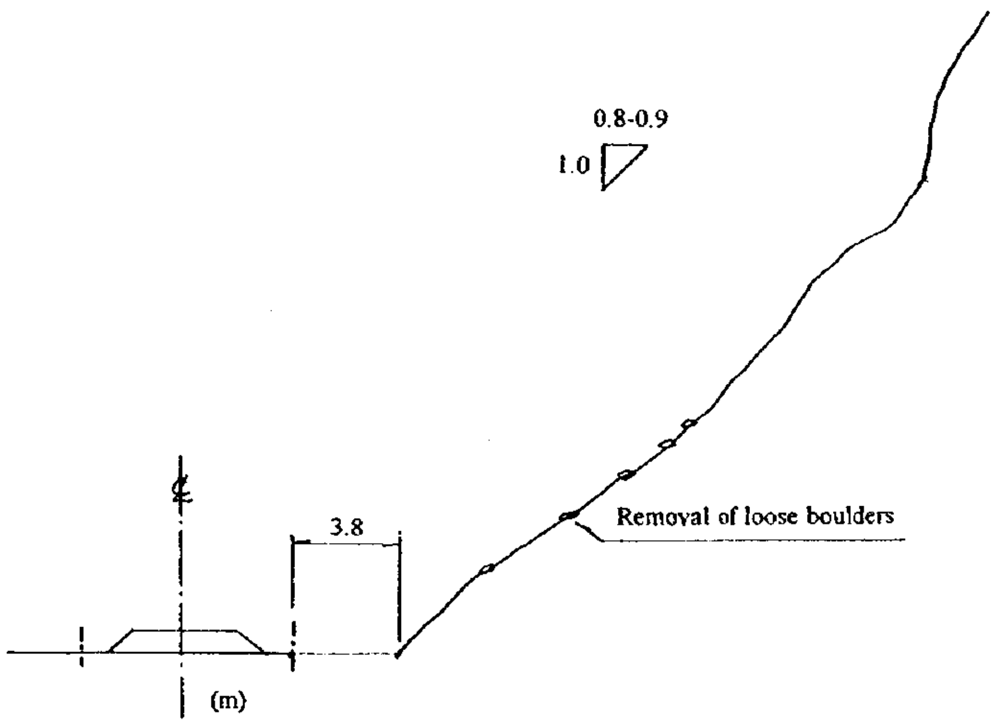


Table 16-2-5 Slope Characteristic and Protection Work (18 pk 10 - 19pk1)

Type	Applied Section	Slope Characteristic
1	Non	Slope characteristic is same as 13 pk . Slope toe is close to railway line.

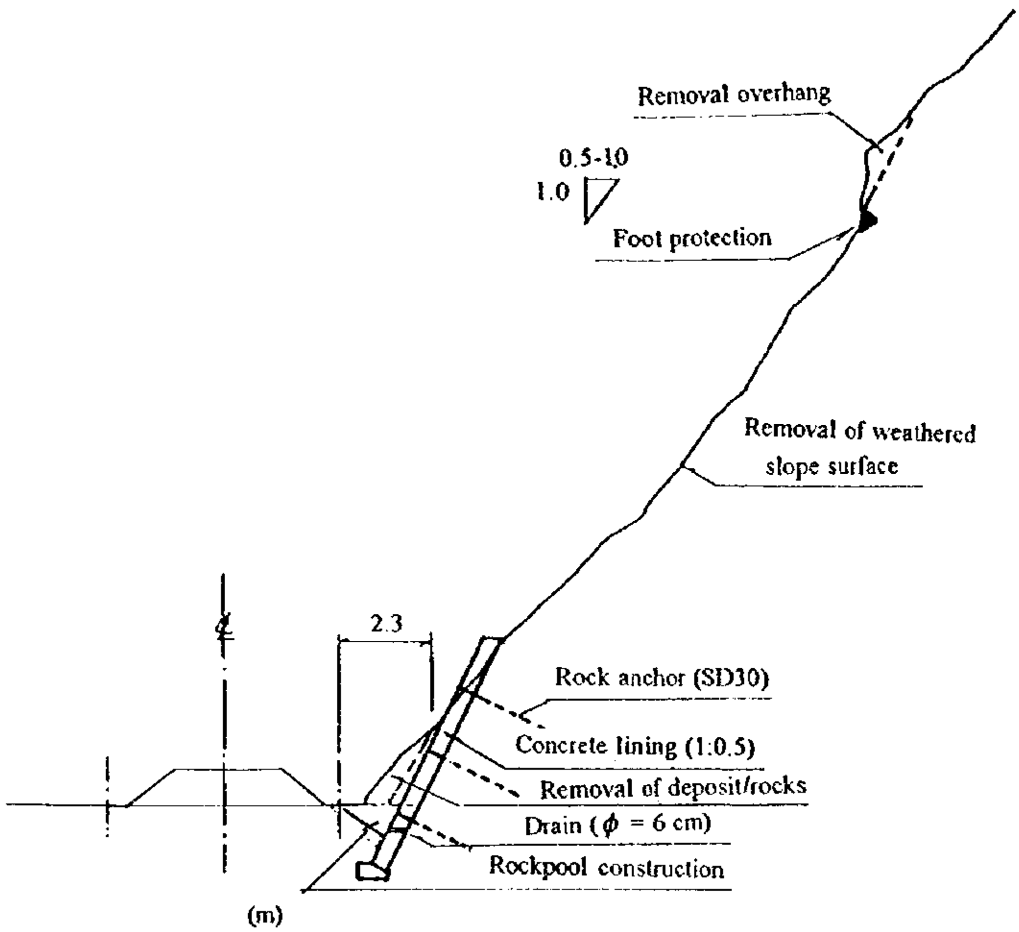
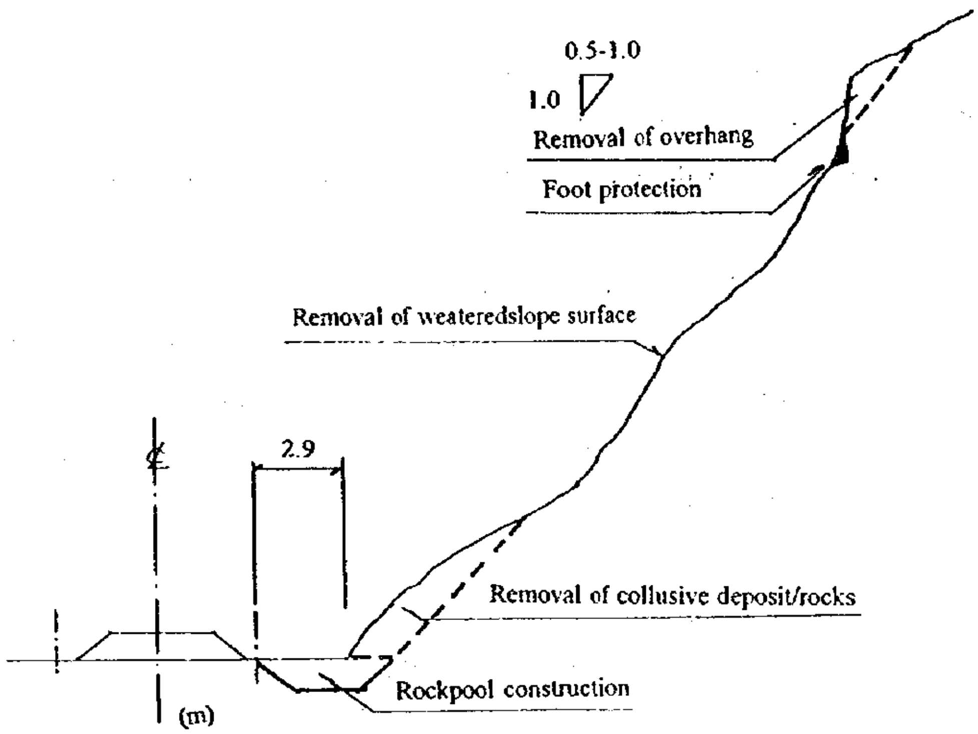


Table 16-2-6 Slope Characteristic and Protection Work (267 pk 2 ~ 3)

Type	Applied Section	Slope Characteristic
IV	8pk10	Weathering remarkably proceed onto slope and consists of two stratums. Upper part formed by rock cliff and lower part covers by talus cones.



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 rock-pool is determined by the rolling length from slope toe to railway line.

$$L = h/\sin\theta$$

here;

L : rolling length (m)

h : height of locus derived from location of fall

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

θ : angle of slope

then;

in case of angel slope is 45°, thence L = 1.8 m

Most of slope angle for surveyed areas are less than 45°. However this project will be introduced 2.0 m wide zone for falls, which includes a 1 m allowance for the depth of pile of rocks.

d. Removal of Loose Boulder and Foot Strengthening

The removal of loose rock will be carried out together with the removal of weathered rock. If larger size rocks need for removal this work may cause neighboring rocks to be fallen and/or worsen the slope stability conditions. This slope should be strengthen with foot fixing concreting.

e. Concrete Lining

At section 18 pk 10-19 pk, it is proposed to use the lining method. When clearance is required between the railway and the toe of the slope, the toe must be excavated for widening and the slope of the lining should have values at 1:05. Then the concrete lining is used to protect the exposed rock's surface against weathering with reinforcement and anchors as necessary.

Drain pipes with 6 cm diameter will cast into the base of the lining.

(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. Temporary protection arrangements are required for safety train operations during the works.

a. Overhang Removal Work

The unstable large sized overhanging rocks are removed by a controlled blasting method using a covering sheet to minimize the blast influence on railway operations. Small sized overhangs will be removed by breakers. Scaffolds will be provided for safety at work. There is also static blasting method by use of chemical expansion, but this depend on availability of material procurement.

b. Weathered Rock Removal

This project uses manual methods instead of machinery. The area of excavation is determined by the slope conditions.

c. Installation of the Rock-Pool

The open rock pool will be constructed at design spots.

d. Loose Boulders Removal and Foot Strength Works

Removal of loose rocks follow the same method as that of the weathered rocks. The foot strength work is recommended to underpin the larger boulder to a provide stable condition where removal is not suitable.

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 rock fall zone is made by excavating part of slope toe, with the concrete lining providing protection for the excavated face.

f. Relocation of Telecommunication Cable

It is forecast to occur the rock falling at the 251 pk 2. This project propose the relocation of telecommunication cable, while it is considered railway track is too far from the toe to be affected.

(3) Construction Cost and Implementation Schedule

Table 16-2-7~8 are indicated the construction cost and implementation schedule for the standard section.

Table 16-2-7 Quantities and Cost

Unit: 1000US$

Location	Item	Unit	Qty.	Amount							Total
				Local			Foreign				
				Personnel	Material	Subtotal	Personnel	Material	Equipment	Subtotal	
13pk3	Removal of Deposit Rock	cu.m	304	0	0	0	0	0	3	3	3
	Excavation for Rock Pool	cu.m	650	0	0	0	0	0	4	4	4
	Concrete Lining	cu.m	0	0	0	0	0	0	0	0	0
	Removal of Overhanging	cu.m	124	1	0	1	0	0	3	3	4
	Foot Strengthening	cu.m	6	0	1	1	0	0	0	0	1
	Removal of Weathered Boulders	cu.m	747	3	0	3	0	0	9	9	12
	Total			4	1	5	0	0	19	19	24
61pk10	Removal of Deposit Rock	cu.m	1,446	2	0	2	0	0	15	15	17
	Excavation for Rock Pool	cu.m	570	0	0	0	0	0	3	3	3
	Removal of Overhanging	cu.m	94	0	0	0	0	0	2	2	2
	Foot Strengthening	cu.m	5	0	0	0	0	0	0	0	0
	Removal of Weathered Boulders	cu.m	567	2	0	2	0	0	7	7	9
	Total			4	0	4	0	0	27	27	31
282pk9-283pk2	Removal of Loose Boulders	cu.m	2,010	7	0	7	0	0	20	20	27
	Total			7	0	7	0	0	20	20	27
18pk10-19pk1	Slope Toe Excavation	cu.m	252	0	0	0	0	0	4	4	4
	Excavation for Rock Pool	cu.m	242	0	0	0	0	0	1	1	1
	Concrete Lining	cu.m	225	12	28	40	0	36	7	43	83
	Removal of Overhanging	cu.m	30	0	0	0	0	0	1	1	1
	Foot Strengthening	cu.m	1	0	0	0	0	0	0	0	0
	Removal of Weathered Boulders	cu.m	177	1	0	1	0	0	2	2	3
	Total			13	28	41	0	36	15	51	92
267pk2-3	Removal of Deposit Rock	cu.m	1,875	3	0	3	0	0	19	19	22
	Slope Toe Excavation	cu.m	0	0	0	0	0	0	0	0	0
	Excavation for Rock Pool	cu.m	525	0	0	0	0	0	3	3	3
	Concrete Lining	cu.m	0	0	0	0	0	0	0	0	0
	Removal of Overhanging	cu.m	130	1	0	1	0	0	3	3	4
	Foot Strengthening	cu.m	7	1	0	1	0	0	0	0	1
	Removal of Weathered Boulders	cu.m	781	3	0	3	0	0	10	10	13
	Removal of Loose Boulders	cu.m	0	0	0	0	0	0	0	0	0
	Total			8	0	8	0	0	35	35	43
251pk2	Replacement of Telecom. Cable	LS		0	0	0	0	5	0	5	5
	Total			0	0	0	0	5	0	5	5
Grand Total				36	29	65	0	41	116	157	222

Table 16-2-8 Construction Schedule for Slope Stability

Location	1				2				3				4				5				6				Remarks
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	
13pk3(Type1)																									
1 Mobilization	■	■	■	■																					8 hours/day
2 Removal of overhang					■	■	■	■																	6 days/week
3 Removal of weathering Slope							■	■	■	■	■	■	■	■											
4 Foot protection											■	■	■	■											
5 Removal of collusive deposit													■	■	■	■									
6 Excavation of rock pool															■	■	■	■	■						
8 Demobilization																			■	■	■	■			
61pk10 (Type II)																									
1 Mobilization	■	■	■	■																					ditto
2 Removal of overhang					■	■	■	■																	
3 Removal of weathering slope							■	■	■	■	■	■	■	■											
4 Foot protection											■	■	■	■											
5 Removal of collusive deposit													■	■	■	■									
6 Rock excavation at slope toe															■	■	■	■							
7 Excavation of rock pool																	■	■	■	■					
8 Demobilization																					■	■	■	■	
282pk9-283pk2																									
1 Mobilization	■	■	■	■																					ditto
2 Removal of loose Boulder					■	■	■	■	■	■	■	■													
3 Demobilization													■	■	■	■									
18pk10-18pk1																									
1 Mobilization	■	■	■	■																					ditto
2 Removal of overhang					■	■	■	■																	
3 Removal of weathering slope							■	■	■	■	■	■	■	■											
4 Foot protection											■	■	■	■											
7 Rock excavation at slope toe													■	■	■	■									
8 Excavation of rock pool															■	■	■	■							
9 Concrete Lining																	■	■	■	■					
8 Demobilization																					■	■	■	■	
267pk2-3																									
1 Mobilization	■	■	■	■																					ditto
2 Removal of overhang					■	■	■	■																	
3 Removal of weathering slope							■	■	■	■	■	■	■	■											
4 Foot protection											■	■	■	■											
5 Removal of collusive deposit													■	■	■	■									
7 Excavation of rock pool																	■	■	■	■					
8 Demobilization																					■	■	■	■	

(4) Applied Section

Table 16-2-9 is indicated comments for the implementation works at the applied sections.

Table 11-2-9 Requirements on Applied Section

Type	Applied Section	Requirements
I	18pk 1	Rock weathering is not as severe compared with 13pk1. However many unsuitability rocks are on the slope and removal work is required with careful caution not accentuate instability in adjacent slope.
II	17pk5-6	same as 18pk1
	57pk9	There are two types of slope, one is the collapsed slope which have the possibility of rock slide coming close to railway line . Removal works 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 railway.
II	250pk6-8	same as 57pk9
III	54pk2-3	The space along the railway is cleared since the forest road runs at 282pk9~283pk2 in parallel to the railway. However this section has rock piles close to railway, and their removal is recommend to have clear an open space.
IV	8pk 10	There are much more rocks piles at toe of the slope more than at 267 pk 2~3. Such piles need be removed and slope toe should be strengthened.

(5) Total Quantities and Cost

Table 16-2-10 is indicated the project quantities and construction cost for slope stability.

Table 16-2-10 Total Quantities and Construction Cost

Unit : 1,000US$

Location	Type	Length (m)	Amount							Total	Note
			Local			Foreign					
			Personnel	Material	Subtotal	Personnel	Material	Equipment	Subtotal		
8 pk 10	IV	200	9	0	9	0	1	41	42	51	Applied Section
13 pk 3	I	200	5	0	5	0	1	18	19	24	Standard Section
17 pk 5 ~ 6	II	150	5	0	5	0	0	22	22	27	Applied Section
64 pk 2 ~ 3	III	100	1	1	2	0	0	5	5	7	Applied Section
57 pk 9	II	300	7	0	7	0	1	39	40	47	Applied Section
61 pk 10	II	200	4	0	4	0	0	27	27	31	Standard Section
250 pk 6 ~ 8	II	300	8	1	9	0	1	40	41	50	Applied Section
282 pk 9 ~ 283 pk 2	III	400	7	0	7	0	0	20	20	27	Standard Section
18 pk 1	I	90	5	0	5	0	0	17	17	22	Applied Section
18 pk 10 ~ 19pk 1	I	150	13	28	41	0	35	16	51	92	Standard Section
267 pk 2 ~ 3	IV	150	7	1	8	0	1	34	35	43	Standard Section
251 pk 2	II	-	0	0	0	0	5	0	5	5	Standard Section
Total			71	31	102	0	45	279	324	426	

Note: Location of 251pk 2 is relocation of telecom cable work

16 – 3 Bridge Rehabilitation

(1) Girder Replacement

Preliminary design for girder replacement is performed on 334 pk 3 bridge which is selected as a typical bridge for the design.

1) Preliminary Design

Properties and allowable stresses of the materials and loads used in the preliminary design are given in the following;

a) Materials and Allowable Stresses

Material	Type, Class	Allowable Stress
Concrete	σ ck=240 kg/sq.cm	90 kg/sq.cm
Reinforcing Steel	SD35	2000 kg/sq.cm

b) Loads

Load		Description	Remarks
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	

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 Tab. 16-3-1 and Fig. 16-3-1.

Table 6-3-1 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

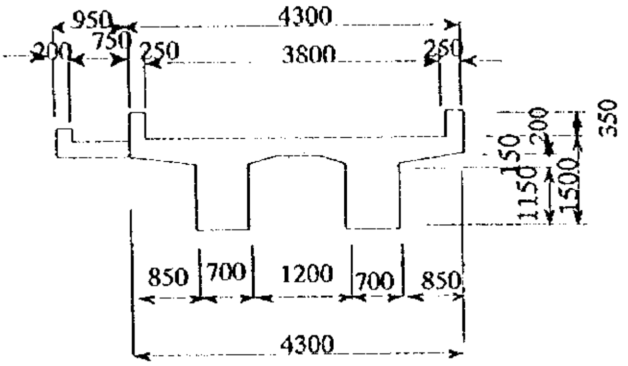


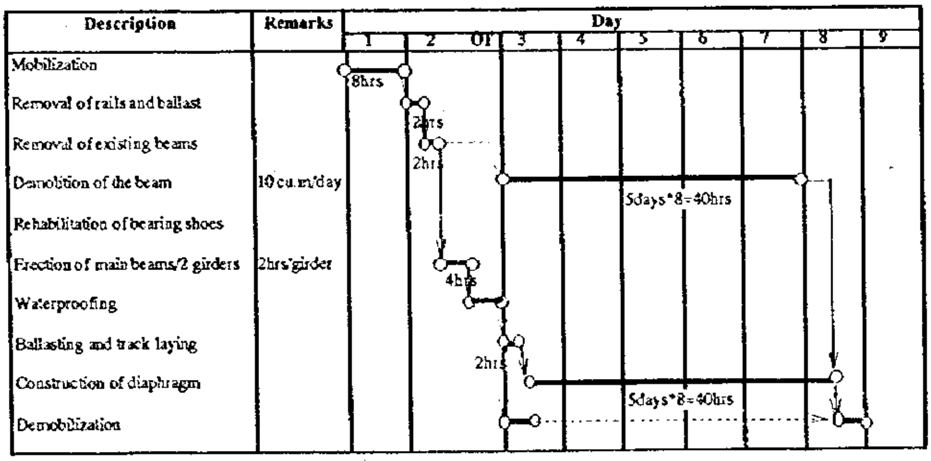
Fig.16-3-1 Typical Cross Section at the Mid Span of 334 pk 3 Bridge

Dimensions at mid span of other bridges with such span length of L=11.5 m, L=9.5 m and L=7.3 m are given in Appendix 16-1.

2) Construction Plan

a. Construction Period

Construction period of girder replacement per span of the bridge is illustrated in Fig. 16-3-2.



NOTE:

8-hour working hour per day
MR's 125 ton crane is used for removal/erection of beams.
15 days for fabrication of a T-beam at the concrete factory aside from above schedule at the site.
OT / Overtime

Fig. 16-3-2 Construction Period

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 estimated weight of the concrete girder is about 50 tons. Details shall be determined and be designed in accordance with the actual rated lifting capacity curve of the crane.

3) Quantities and Costs

Quantities and costs for construction of the standard bridge are shown in Tab. 16-3-2.

Tab. 16-3-2 Quantities and Costs

Unit; US$ 1,000

Item	Unit	Qty.	Local			Foreign				Total
			Personnel	Others	Subtotal	Personnel	Material	Equipment	Subtotal	
Erection of New Girders	Span	2	7.4	8.3	15.7	0.0	17.0	6.5	23.5	39.2
Removal of Existing Girders	Span	2	2.3	0.0	2.3	0.0	0.0	3.3	3.3	5.6
Riprap Protection of Embankment	cu.m	136.2	0.3	4.6	4.9	0.0	1.3	1.3	2.6	7.5
Miscellaneous	LS	1	1.1	0.1	1.2	0.0	2.7	3.3	6.0	7.2
Total			11.1	13.0	24.1	0.0	21.0	14.4	35.4	59.5

4) Total Quantities and Costs of Girder Replacement Work

The total estimated quantities and costs of girder replacement work are shown in Tab. 16-3-3.

Tab. 16-3-3 Total Quantities and Costs for Girder Replacement

(Unit; US$ 1,000)

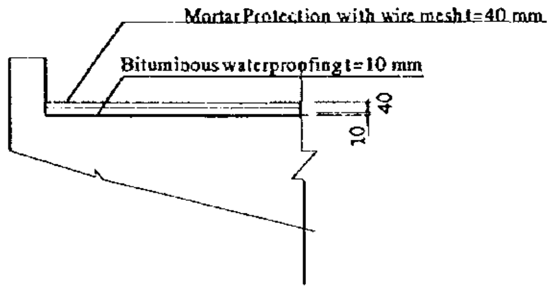
No	Location	Bridge Length (m)	No. of span	Concrete (cu.m)	Rebars (ton)	Local			Foreign				Total	Remarks
						Personnel	Other	Sub-total	Personnel	Material	Equipment	Sub-total		
1	258pk1	9.3	1	20.92	3.36	4.2	6.8	11.1	0.0	6.3	7.9	14.2	25.2	Applied Section
2	289pk1	13.5	2	87.62	14.89	11.4	13.0	24.3	0.0	21.0	14.4	35.4	59.7	Applied Section
3	326pk9	13.5	3	131.42	22.34	15.1	17.1	32.2	0.0	30.9	16.0	46.9	79.1	Applied Section
4	334pk3	13.5	2	87.62	14.89	11.2	13.0	24.1	0.0	21.0	14.4	35.4	59.5	Applied Section
5	338pk10	7.3	1	17.75	2.66	3.6	6.4	10.0	0.0	5.2	7.5	12.7	22.7	Applied Section
6	344pk1	7.3	1	17.75	2.66	3.6	6.4	10.0	0.0	5.2	7.5	12.7	22.7	Standard Section
7	356pk1	7.3	2	35.49	5.32	6.1	8.0	14.1	0.0	9.0	10.5	19.5	33.7	Applied Section
	Total					55.2	70.7	125.9	0.0	98.6	78.2	176.8	302.7	

(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

a. The method of bridge repair is as following;



Repairing waterproof layer with bituminous material 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.

Temporary supports shown in Fig. 16-3-3 is used to support track panels during construction not to disturb train operations, which will be installed on the slab immediately after removal of existing ballast and deteriorated waterproof layer on the bridge.

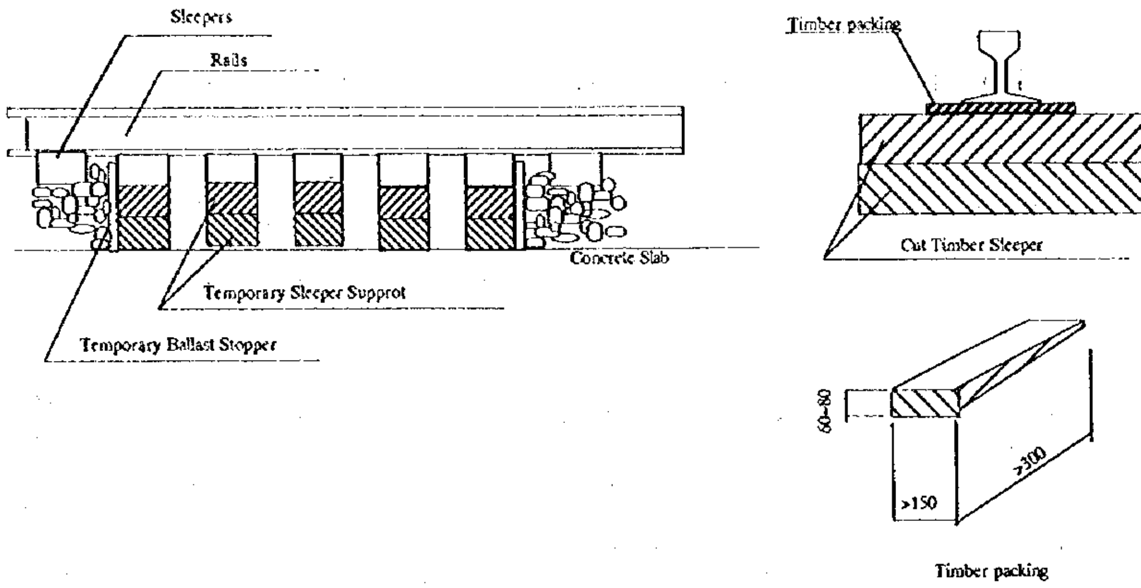


Fig. 16-3-3 Temporary Support of Track Panel

b. Surface Treatment

Efflorescence and exudation with lime are observed in ballast walls and concrete slabs of some bridges. Damage due to spalling is found on concrete surface occasionally. Surface treatment with a three-layer treatment method with epoxy resin materials as shown in Table 16-3-4 is recommended to prevent further deterioration due to penetration of waters, freezing and thawing.

Tab. 16-3-4 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

The surface treatment system shall be tested to confirm its applicability by exposure testing under such cold climate like Mongolia.

c. Recasting Concrete

Pattern cracking, which might be caused by freezing and thawing, however which is not structural defects is observed in the abutment at 342pk2 bridge. The deteriorated portion will be removed to be repaired with recasting concrete method.

d. Others

Installation of drips and improvement of drain pipes, of which details are given in Fig. 16-3-4 are required to discharge water to avert water seepage into the concrete slab and/or ballast stopper which may induce adversely affects due to freezing and thawing.

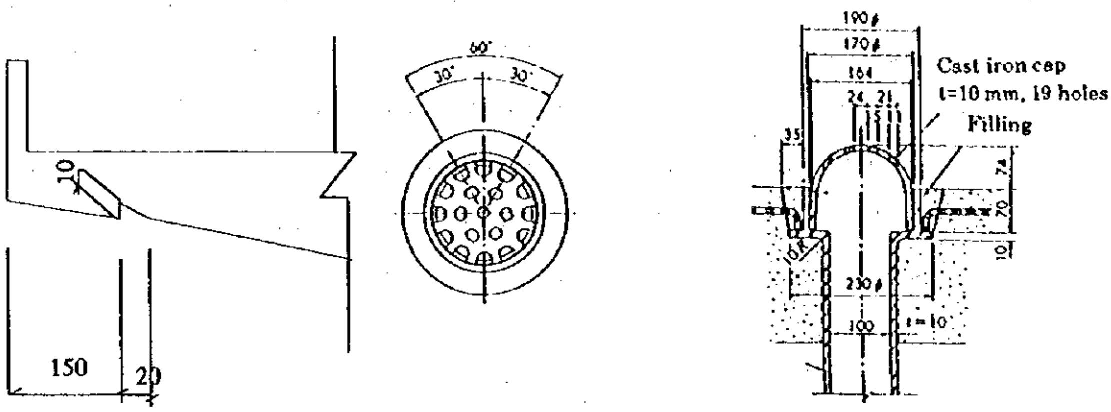
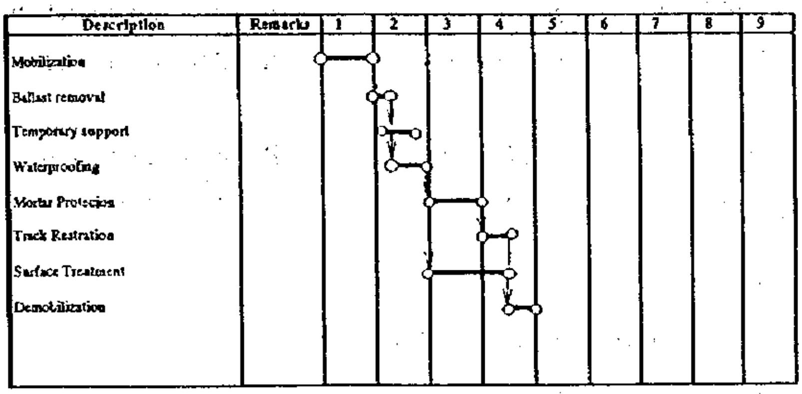


Fig. 16-3-4 Details of Drip and Drain Pipe

e. Work Period

Work period of waterproofing improvement is shown in Fig. 16-3-5.



NOTE:
8-hour working hour per day
All works shall be carried out without train operation suspension.

Fig. 16-3-5 Work Period of Waterproofing Improvement

2) Total Quantities and Costs of Typical Bridge Repair

Total quantities and costs of bridge repair work are shown in Tab. 16-3-5.

Table 16-3-5 Total Quantities and Costs of Bridge Repair Work

(Unit; US$ 1,000)

No	Location	Bridge Length (m)	Water-Proofing Sq.m	Surface Treat. Sq.m	Conc. Repair Cu.m	Local			Foreign				Total	Remarks
						Per-sonnel	Others	Sub-Total	Per-sonnel	Material	Equipment	Sub-Total		
1	235pk3	9.3	38.1	45.9	0.0	0.7	4.7	5.4	0.0	4.6	1.3	5.9	11.1	Applied Section
2	245pk5	9.3	38.1	45.9	0.0	0.7	4.7	5.4	0.0	3.5	1.3	4.9	10.2	Applied Section
3	255pk3	7.3	29.9	29.7	0.0	0.7	4.6	5.3	0.0	4.6	1.3	5.9	11.2	Standard Section
4	342pk2	6.0	0.0	0.0	5.0	0.3	0.0	0.3	0.0	1.4	0.0	1.4	1.7	Applied Section
Total			106.1	121.5	5.0	2.4	14.0	16.4	0.0	14.1	3.9	18.0	34.3	

16-4 Drain Improvement

Hydraulic analysis by the Mongolian Railway is 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. Dimensions of the culvert sections used in the design are shown in Tab. 16-4-1. 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.

Tab. 16-4-1 Dimensions of Typical Culvert and Bridge

Symbol	Location	Clear Space, Clear Height, Span Length	Remarks
Culvert			
CBC 1	253pk3	2.0 m、1.5 m	Reinforced concrete box culvert
CBC 2	389pk1	2.5 m、2.0 m	Reinforced concrete box culvert
CBC 3	356pk1	2.5 m、2.5 m	Reinforced concrete box culvert
COC	23pk2	2.5 m、2.5 m	Reinforced concrete box culvert
Bridge			
BR 1	235pk3	11.5 m	Reinforced concrete T-beam bridge
BR 2	125pk8	13.5 m	Reinforced concrete T-beam bridge

(1) Design Condition

Conditions for preliminary design are in the following:

1) Materials and Allowable stresses

Materials and allowable stresses used in the preliminary design are as following;

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

Loads applied in the preliminary design are as follows;

Load		Description	Remarks
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 the section of culverts and outline of bar arrangement are shown in Fig. 16-4-1 and Tab. 16-4-2.

Tab. 16-4-2 Outline of Bar Arrangement

	Bar Arrangement				Remarks
	Top Slab/ Corner	Side Wall Mid Span	Side Wall Corner	Bottom Slab Corner	
CBC 1	D16 ctc125	D13 ctc125	D16 ctc 125	D13 ctc125	
CBC 2	D19 ctc125	D13 ctc125	D19 ctc125	D16 ctc 125	
CBC 3	D19 ctc125	D16 ctc125	D19 ctc125	D16 ctc 125	
COC	-------	-------	D16 ctc125	D16 ctc 125	

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.

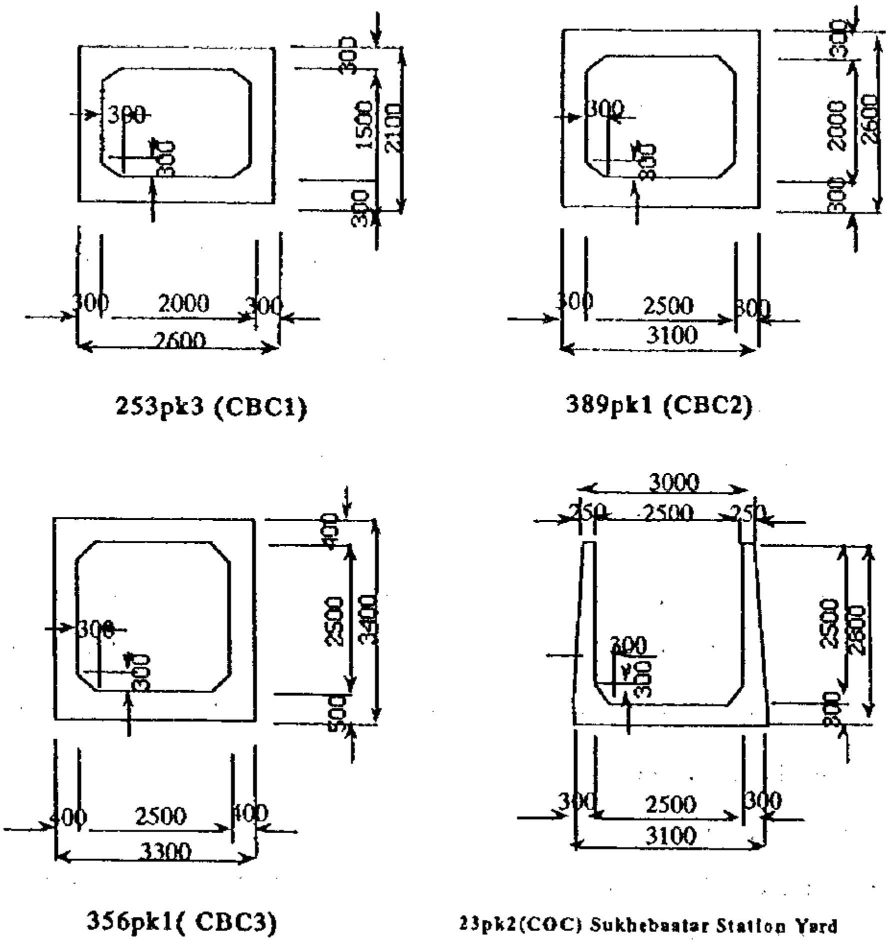


Fig. 16-4-1 Dimensions of Culvert Section

c. Construction Period

Construction period of the standard pre-cast concrete culvert with approximately 7 meter long composed of seven blocks is shown in Fig. 16-4-2.

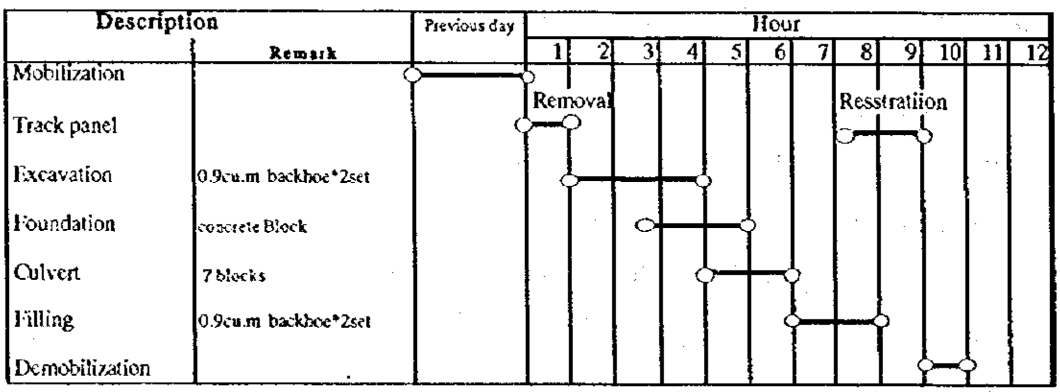


Fig. 16-4-2 Construction Schedule of Pre-cast Concrete Box culvert

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) illustrated in Fig. 16-4-3 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 of Typical Culvert Construction

Estimated quantities and costs of each drainage structure are shown in Tab. 16-4-3.

Tab. 16-4-3 Quantities and Costs

Unit; US$ 1,000

Location	Symbol	Dimensions of Cell			Amount (per meter)			Remark
		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	1/
389pk1	CBC 2	1	2.5	2.0	1.11	3.82	4.93	1/
356pk1	CBC 3	1	2.5	2.5	1.17	4.00	5.17	1/
23pk2	CBC 3	1	2.5	2.5	1.17	1.44	2.61	2/
23pk2	COC	1	2.5	2.5	0.50	0.45	0.95	2/, 3/

Note:

1/ Including costs for structure excavation for construction of the barrels and common excavation to widen the channel along upstream side and down stream side of the culverts.

2/ Structure excavation for construction of culverts only.

3/ Cast-in-place concrete open culvert.

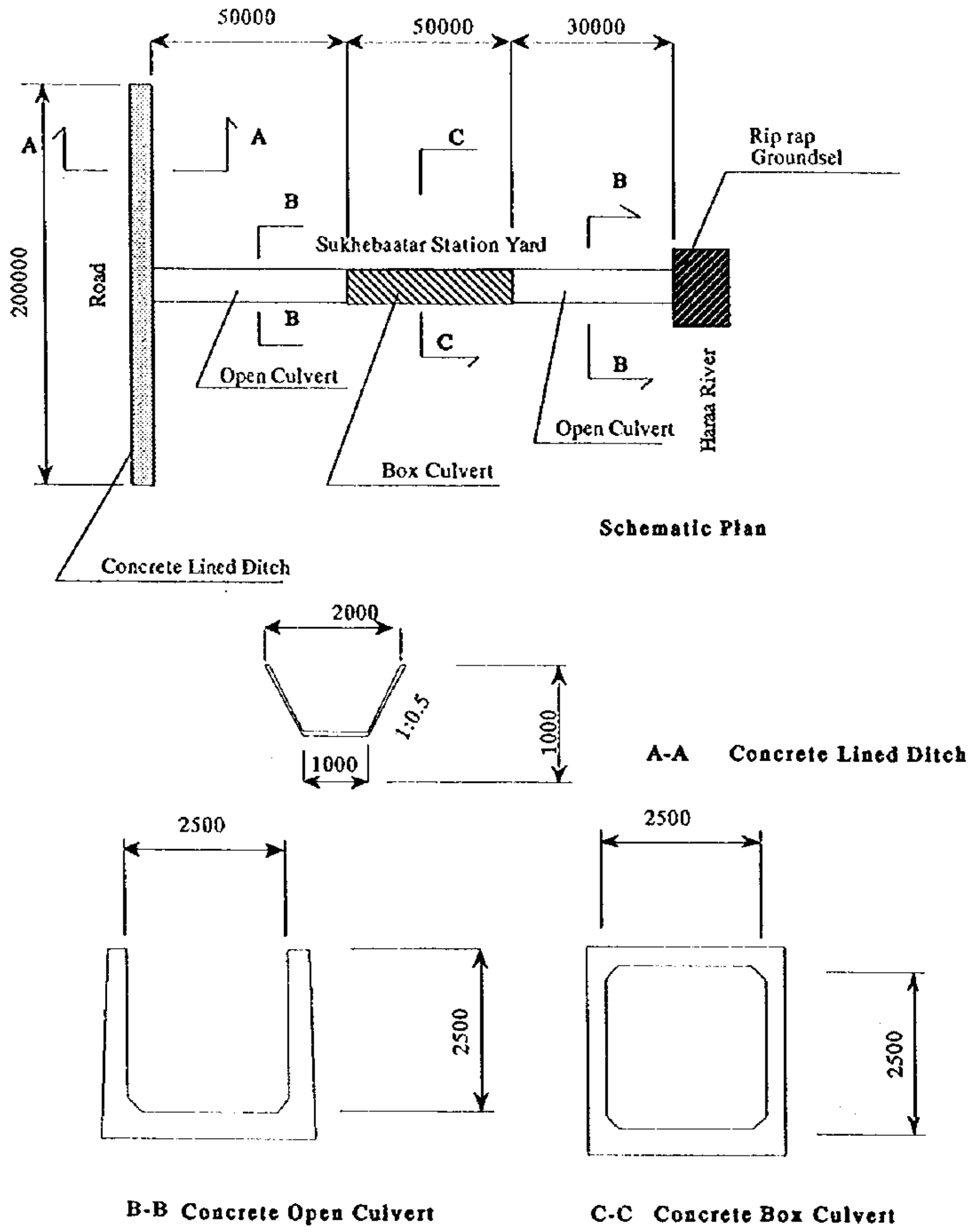


Fig. 16-4-3 Drain Improvement Plan for Sukhe-baatar Station Yard

3) Total Quantities and Costs of Culvert Construction

The total quantities and costs of culvert construction are shown in Tab. 164-4.

Table 16-4-4 Total Quantities and Costs for Culvert Construction

Unit; US$ 1,000

Symbol	Unit	Qty.	Amount: Local			Amount: Foreign			Sub Total	Total	Remarks
			Personnel	Others	Sub total	Personnel	Material	Equipment			
CBC 1	(m)	199	58.1	136.3	194.4	0.0	27.1	706.5	733.6	928.0	66pk4、89pk7、94km、143pk7、168pk4、170pk3、184pk4、190pk6、210pk6 、218pk5、223pk7、230pk9、252pk1、253pk3、313pk10、329pk7、340pk5、420pk7
CBC 2	(m)	158	49.6	126.3	175.9	0.0	26.1	577.9	604.0	780.9	97pk5、100pk7、145pk1、197pk2、242pk4、314pk10、345pk6、348pk7、389pk1、391pk2、394pk4、417pk1、417pk10、424pk7、428pk4、438pk7、
CBC 3	(m)	58	19.0	49.4	68.4	0.0	10.3	93.7	104.0	172.4	356pk1, 23pk2
COC	(m)	80.0	5.8	34.0	39.8	0.0	7.5	28.1	35.6	75.5	23pk2、
Wing Wall, Apron	LS	1	70.3	164.0	234.3	0.0	135.2	33.8	169.0	403.3	
Concrete Lined Ditch	(m)	200	0.4	2.8	3.2	0.0	0.6	3.7	4.3	7.4	Sukhe-baatar Station Yard
Groundsel	LS	1	0.1	1.0	1.1	0.0	0.0	16.2	16.2	17.3	Sukhe-baatar Station Yard Outlet
Total			203.3	514.8	717.1	0.0	206.8	1,459.9	1,666.7	2,384.8	

(3) Bridge

1) 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. 16-4-4 ~ Fig. 16-4-5.

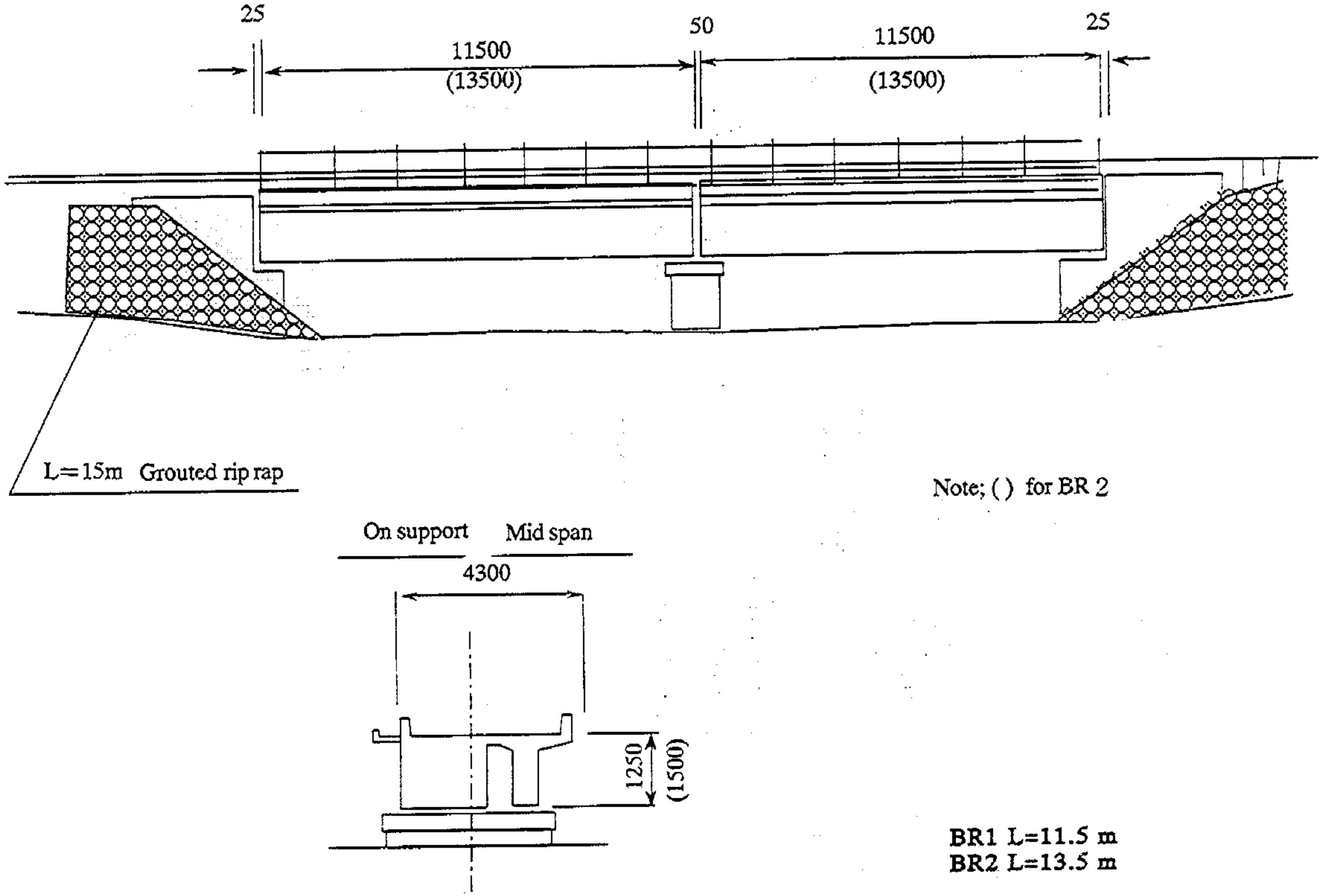


Fig. 16-4-4 T-Girder Bridge

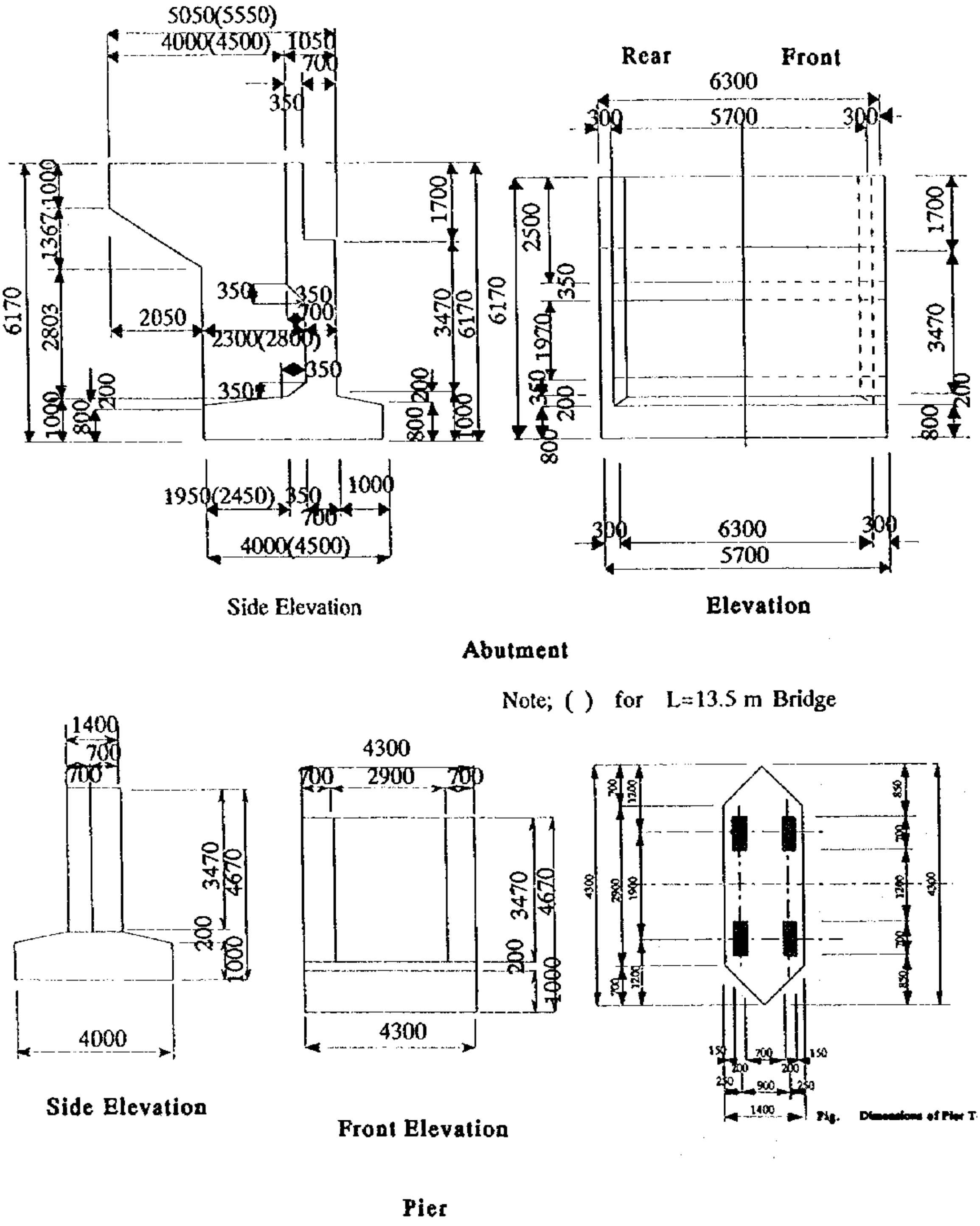


Fig. 16-4-5 General View of Substructure

b. Construction Plan

Newly fabricated girders are erected by the Mongolian Railway's crane. Substructure is designed as cast-in-place concrete structure type with spread footing foundation. Track panels are supported by timber saddles 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 to improve the present bottle-neck condition.

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 is given in Fig. 16-4-6.

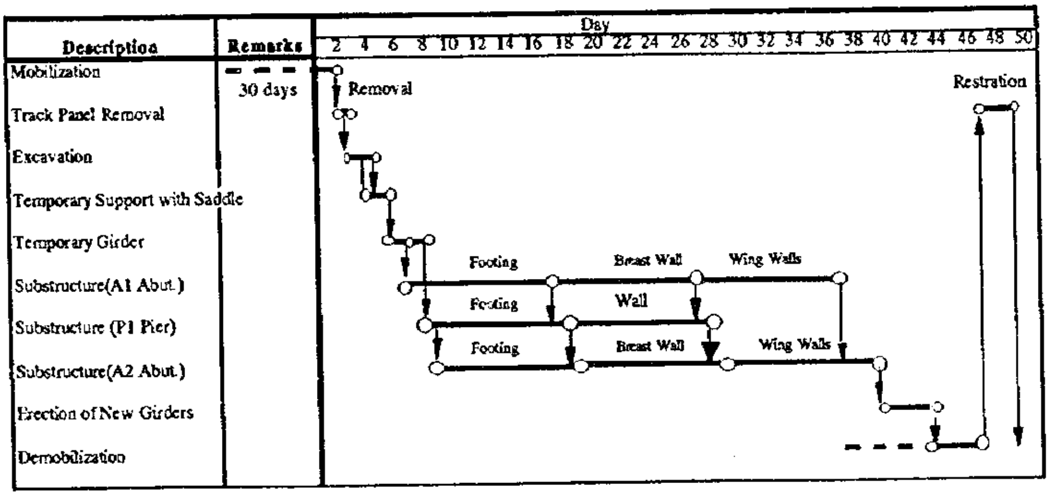
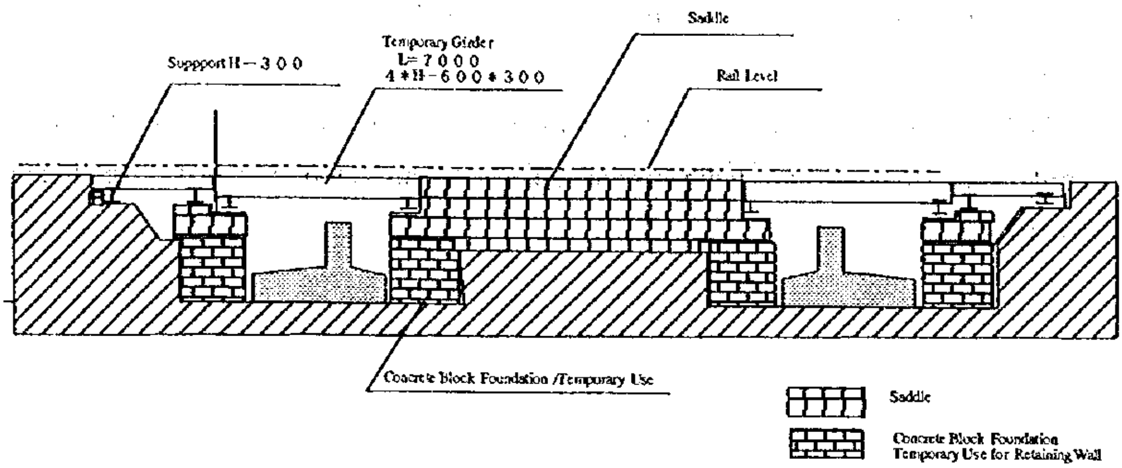


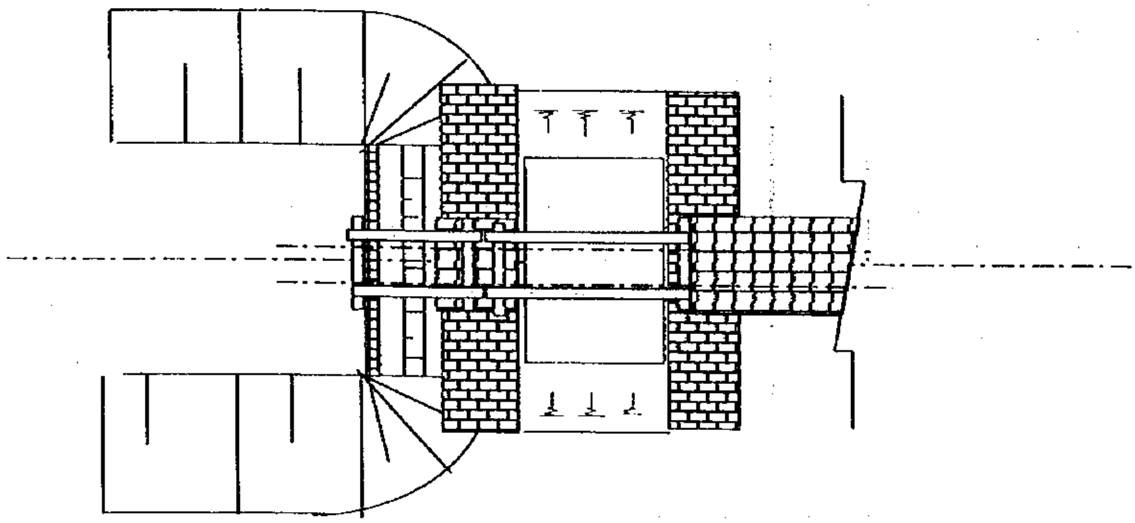
Fig. 16-4-6 Schedule for New Bridge Construction

d. Construction Method

Temporary girders and saddles to support track panels during construction of the bridge structure are shown in fig. 16-4-7.



Side Elevation



Plan

Fig. 16-4-7 Temporary Supports for Construction of Bridge Structure

2) Quantities and Costs

Quantities and costs of standard bridges are given in Table 11-4-5.

Table 11-4-5 Quantities and Costs

Unit; US$ 1,000

Location	Symbol	Dimensions		Amount							Total	Remarks
				Local			Foreign					
		Girder Len.(m)	No. of Span	Personnel	Others	Sub total	Personnel	Material	Equipment	Sub total		
235pk3	BR 1	11.5	1	12.6	15.9	28.5	0.0	18.8	17.0	35.8	64.3	2Abuts.
125pk8	BR 2	13.5	2	21.7	29.5	51.2	0.0	36.6	30.3	66.9	118.1	2Abuts.1Pier
399pk1	-----	-----	-----	4.3	3.8	8.1	0.0	0.0	7.8	7.8	15.9	Widening of channel

(4) Total Quantities and Costs of Bridge Construction Work

The total estimated quantities and costs of the bridge construction work are given in Table 11-4-6.

Tab. 16-4-6 Total Quantities and Costs of Bridge Construction

Unit : 1000 US$

Location	Symbol	Dimensions of Bridge		Amount							Total	Remarks
				Local			Foreign					
		Span Len.(m)	No. of Span	Personnel	Others	Sub total	Personnel	Material	Equipment	Sub total		
125pk8	BR 2	13.5	2	21.7	29.5	51.2	0.0	36.6	30.3	66.9	118.1	Standard Section
235pk3	BR 1	11.5	1	12.6	15.9	28.5	0.0	18.8	17.0	35.8	64.3	Standard Section
255pk3	BR 1	11.5	1	12.6	15.9	28.5	0.0	18.8	17.0	35.8	64.3	Applied Section
334pk3	BR 1	11.5	1	12.6	15.9	28.5	0.0	18.8	17.0	35.8	64.3	Applied Section
352pk7	BR 2	13.5	1	14.4	18.1	32.6	0.0	22.7	18.7	41.4	73.9	Applied Section
399pk1				4.3	3.8	8.1	0.0	0.0	7.8	7.8	15.9	Standard Section
Total				78.2	99.1	177.3	0.0	115.7	107.8	223.5	400.8	