CHAPTER 8

CIVIL ENGINEERING WORKS PLAN

Chapter 8
Civil Engineering Works Plan

8 - 1 Existing Conditions and Problems

General Description of Existing Facilities

The construction works of existing routes of the Mongolian Railway (MR) was started from 1939 in the northeast, the line from the Mongolian-Russian border to Bayan-tumen, and continued the line between Naushki (Russia) and Ulaan-baatar, completed in 1949. Following them the line between Ulaan-baatar and Erehhot (China) was constructed during the period from 1952 to 1956.

These railways were constructed as a part of the Russian railway network, and were based on a design live load of N-8 (H-8) (enactment in 1931, refer to Figure 8-1-1) and specified as class 4 in the Russian Standards (Table 8-1-1).

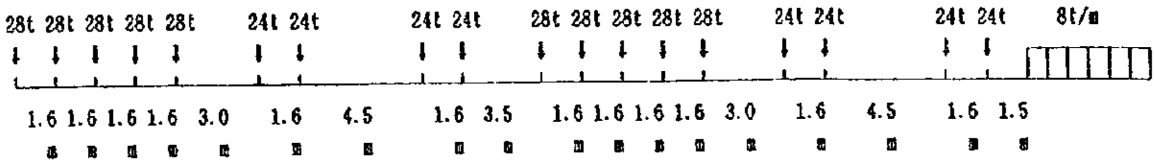


Fig.8-1-1 Scheme of N-8 (H-8) Load

The line from Naushki (Russia) via Ulaan-baatar to Bayan rises approximately 1,000 meters, from an elevation of 595 m above sea level at the Russian border to 1,560 m above sea level in the vicinity of Bayan (Figure 8-1-2). Despite the large difference in elevation, the topography is generally gentle because most of the railway is routed along large rivers, and there are few huge structures like crossing over the large rivers.

Most of the railway has grades of less than 9 ‰. Grades of over 9 ‰ occur from 379 km to 386 km, and grades of 9 to 10 ‰ are seen for short stretches in a few other places, for stretches of 200 m to 400 m, and a total length of 2 km. Between km 379 and km 386 there is a stretch 6.6 km long with a grade of 12 to 17‰.

Table 8-1-1 Russian Railway Grade Standard

Item	1class line	2 class line	3 class line	4 class line	MR line *
Rail	R65	R65 / R50	R50 / old R65	R43 / old R50	R50 / old R65
Sleeper	1class Timber Concrete	1class Timber Concrete	1class Timber Concrete	1class Timber Concrete	1,2class Timber Concrete
No. of Sleeper (/km) Straight or R>1200m R<1200m	 1840 2000	 1840 2000	 1600~1800 2000	 1600 1840	 1600~1840 1840~2000
Ballast Depth under the Ballast (cm) Crushed Stone Gravel	 30 --	 25 --	 20 35-40	 -- 25-30	 25-30
Radius of Curve (m) Train Speed 140~160km/h (Special) Train Speed <120km/h (Special)	 4000~2500 (800) 4000~1500 (600)	 4000~1200 (600)	 2000~1200 (400)	 2000~1000 (400~250)	 >280
Tangent Length (m) Train Speed 121~160km/h Train Speed <120km/h (Between Reverse Curve)	 150 100 (75)	 100 (75)	 100 (75)	 50 (50)	 50
Gradient (1/1000)	<15	<15	<20	<30	<17
Effective Siding Length (m) (Special Case)	1250~1050 (1050)	1050 (850)	1050 (850)	Design for each (850)	1200~1050 (850)

* Remark ; MR line means the situation of the Mongolian Railway main line between north border and Bayan.

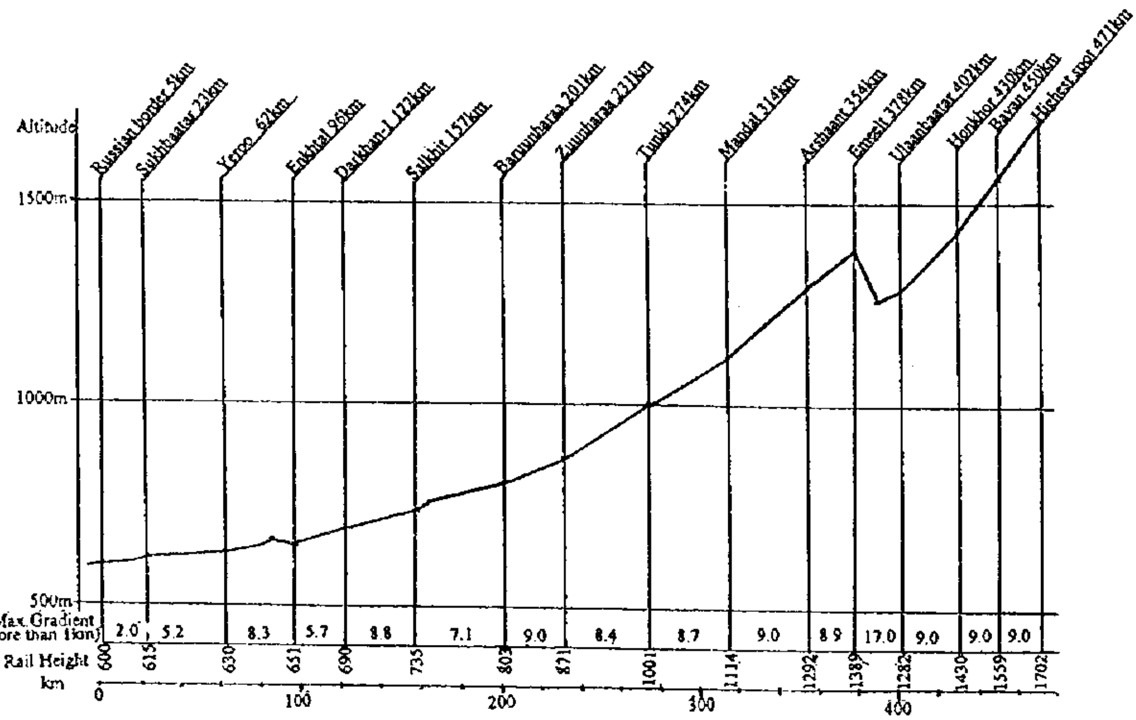


Fig. 8-1-2 Longitudinal Profile

The railways are laid out in selected sites with the intention reducing the volume of earthwork, so sections with curves of 500 m or less in radius, including some with radii slightly under 300 m, are seen in 110 or more places. As maximum limited speeds are 80 km/hr for curves with radii of 300 m, such curves are not currently considered a problem impacting the operating speed. The steep grades of the railway severely limit the speeds of freight trains, and the speed difference between the ascent and decline trains is becoming a hot topic, as is the maintenance of rails on steep grade curved sections.

In Mongolia the quantity of precipitation is small, with a maximum monthly rainfall of only 150 mm and maximum daily precipitation of 50 mm. Rivers and streams are not as large as expected. The average flow of the Haraa and the Yeroo rivers ranges from 25 to 50 m^3/sec, that of the Orkhon river from 100 to 200 m^3/sec, and that of the Selenge river slightly over 250 m^3/sec. Since forest and wood and puddle have little water retention capacity, water quickly flows out to the rivers after rains, and often damages river banks. There are no manmade structures in rivers, except for those existing in urban areas, and rivers are not controlled. Therefore, water channels are not stable and water flows freely, meandering or taking short cuts, often leaving oxbow lakes. For this reason, it was noted that the railway beds had been damaged in several locations by erosion caused by the meandering flow of rivers.

As railways are constructed parallel to contour lines, water flowing from the mountains is blocked by railway embankments, and can pond behind embankment in many places after heavy rains.

For slopes, natural slopes are generally gentle and cannot be easily damaged by landslide but it was noted that rocks had fallen down cut slopes due to weathering of rock surfaces.


Photo 8-1-1

On both sides of the railway, barbed wire fences one meter high are installed to prevent entry of livestock. (Photo 8-1-1) Grade crossings were rarely seen. Railway crossings are mainly made through the underside of river bridges. The number of two level cross roads is necessary to increase as the number of large vehicles and traffic demand is increasing, and to ensure the safe movement of animals.

Rail lines are constructed on embankments 2 to 3 meters high. The 5.5 m width of the existing rail bed is not sufficient for the rail gauge of 1,520 mm. Ballast is overlaid over the road bed during maintenance of track and the width of the road bed has been widened due to repeated increases in thickness of ballast. The road bed has been raised to the same level of the sloped surface of the slope surfaces of embankments and there is no clearance to provide spacing on the shoulder of embankment.

Since the ballast overlay is also provided for bridges, ballast thickness can increases excessively until it cannot be supported by the bridge structure. It was noted that bridge beams must be raised to accommodate the increased height of road bed and allow the normal thickness of ballast, which will prevent excessive dead load.

In Mongolia, temperature lowers to nearly minus 40° C in the winter, it was noted that tracks had heaved in many locations because of freezing of the ground. The amount of heave ranges from 10 mm to 35 mm, but this level is not a deathblow for train operation. Heave of the ground was seen at over 100 places including the embankment. The ground at a depth of 2 to 3 meters or more under the surface is permanently frozen, so the entire road bed becomes frozen in the winter.

Bridges are constructed mainly of reinforced concrete precast concrete beams. Span lengths of 2 m (beam length 2.5 m), 3 m (3.6 m), 4 m (4.7 m), 6 m (7.3 m), 8 m (9.3 m), and 10 m (11.5 m) are used as standard designs. Culverts with diameters of 1.0 m, 1.25 m, 1.5 m, 2.0 m, and 2.5 m are often used. The largest precast concrete box unit used is 2.5 m inner width, 2.0 m inner height, and 1 m length.

There are structures requiring repairs, 50 years after construction, due to deterioration from age or because of defective work at initial construction. Some of these are bridges that have been repaired by cement mortar but need to be repaired again because the cement mortar did not tightly bonded to the structural concrete. It was seen that river beds had been scoured down a few meters by floods caused by recent reductions of forest cover and by heavy rains.

Various facilities of the MR appeared to have not been adequately maintained due to economic confusion and the reduction of Russian support after the collapse of the Soviet Union. It was seen that damaged facilities had been left aside after emergency restoration, and others had not received timely repairs or replacement.

Note: In the MR, points along the railway line are expressed by ordinal numbers, using "pk" (picket). A given number indicates a point about 1 km beforehand where it is interpreted as a distance from the starting point.

In units of kilometers, the section between 36 km 000 to 100 m is expressed as 37pk1, that between 42 km 200 and 300 m as 43pk3, that between 56 km 900 m and 57 km 000 m as 57pk10.

8 - 2 Countermeasures

(1) Technical Criteria

The MR uses railway construction criteria established by Russia. Russian railway structure design criteria applied for each class are shown in Table 8-1-1. The existing railway of the MR was constructed based on Class 4 railway standards, but efforts are being made to improve facilities to meet the specifications of Class 3 standards when modifications are made.

In this project for facilities improvement where modifications or improvements are required, plans will be made based on the technical criteria shown in Table 8-2-1.

Table 8-2-1 Specification

Item	Current track specifications	Project specifications
Gauge	1,520mm(for R50 rail) 1,524mm(for R43 rail)	1520mm
Minimum curve radius	300m 296m (special case)	600m 300m (special case)
Maximum gradient	9/1000 18/1000 (special case)	9/1000
Rail size	GOST R50(51.67kg/m) 25m GOST R43(44.65kg/m) 25m	R50~R60
Sleeper	Wood 2,750mm*180mm*250mm Tie-plate 310mm*170mm Unti-creeper	same or PC sleeper Double elastic fastening
Sleeper space	543 mm (straight track) 500 mm (R<650m curve section)	same
Ballast depth (under the sleeper)	200~250mm(crushed stone) 250-300mm(sand / pebbles)	250mm(crushed stone or screened gravel)
Cant	12.5V*V/R (max.150mm)	same
Slack	max. 15mm	same
Turnout	1:9, 1:11	1:11 (main line)
Live load	1931, N-8 & 1962, S-14 load	1962, S-14 load
Formation width	5.5m	6.5m
Effective siding length	850m	same
Bank slope gradient	1:1.5 (h<6m) 1:1.75 (h>6m)	same
Cut slope gradient	1:1.5 (for earth) 1:1 (for soft rock, h<6m) 1:0.2 (for hard rock)	same

For construction gauge and train loading limitations, those currently used by the MR (Figure 8-2-1) will be applied.

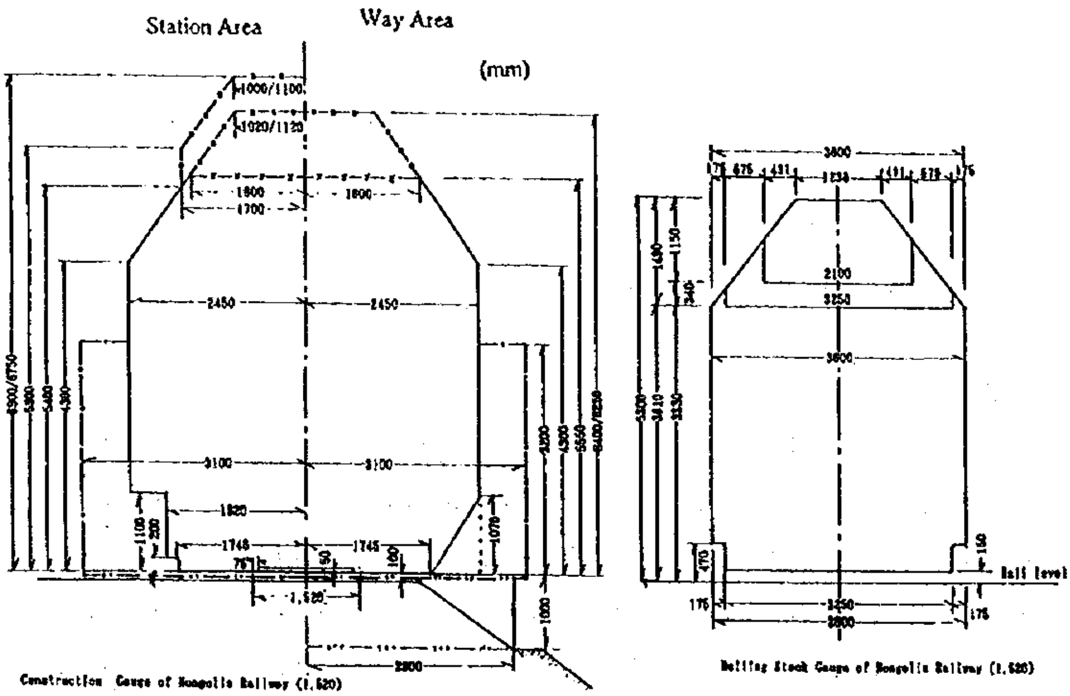


Fig.8-2-1 Construction Gauge and Rolling Stock Gauge

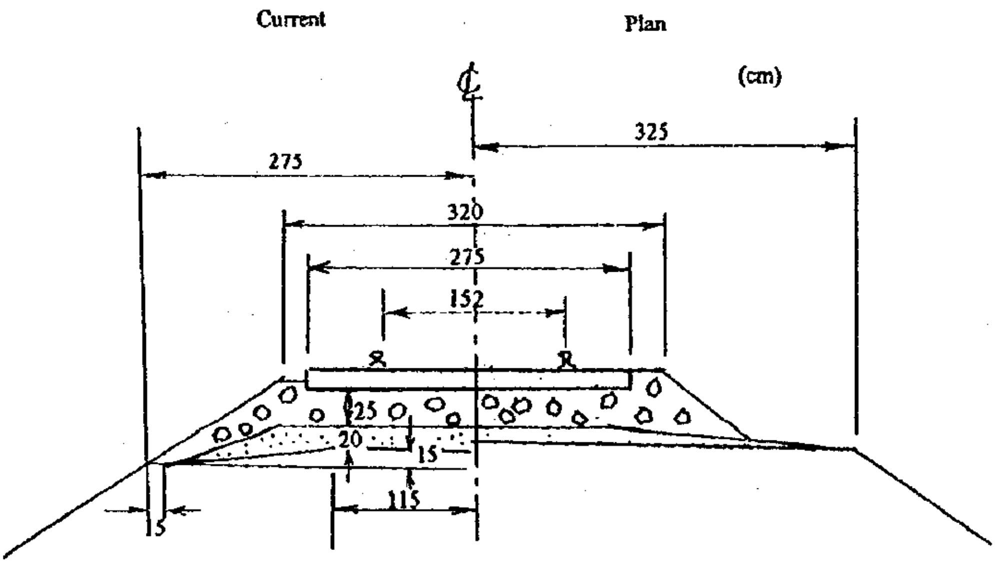


Fig.8-2-2 Track Profile

Rail gauge will be unified to 1,520 mm. taking this as a chance to replace the rails to 50 kg/m rails.

Curves will be designed with a curvature of at least 600 m in radius to meet the requirements of future speeds. Where this is not practicable due to topographic limitations, permissible curvature will be at least 300 m in radius.

Permissible rail gradient will be 9/1000, or less, including equivalent gradient (700/R), taking into consideration the curve running resistance.

Rails would be 50 kg/m and 25 meter lengths.

An effort will be made to introduce PC sleepers to an applicable section first in a sequence, adding to wooden sleepers currently used. The use of double flexible fasteners is desirable for improvement of train speeds.

It is desirable that the road bed ballast be replaced with crushed stone, and that materials be screened where gravel from rivers is used. Design thickness of ballast will be 25 cm under sleepers (Figure 8-2-2). Design live load for bridges will be load S-14, used by the MR since 1961. (Appendix 8-2-1) Since the current rail bed construction width of 5.5 m can raise maintenance problems, this will be changed to 6.5 m, starting with the sections to be improved (Figure 8-2-3). For curved sections, depending on the set cant, it is considered necessary to extend the width of bed, by 10 cm for curve radius of 1,200 m or less, 20 cm for 1,000 m or less, 30 cm for 800 m or less and 40 cm for 600 m or less.

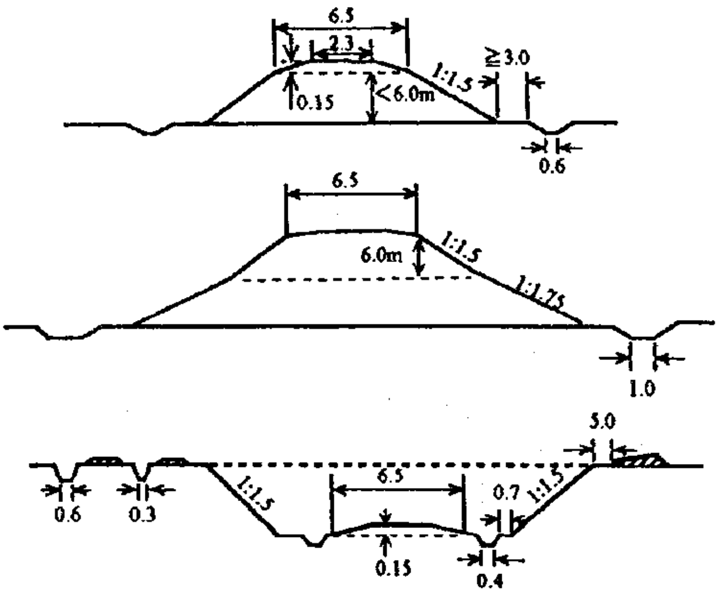


Fig.8-2-3 Standard Section of Earth Work

(2) Improvement Policy

This investigation will be carried with the intention to plan an improvement project to be completed in 2020, taking into consideration the following conditions.

- The master plan will focus the main line facilities between the Mongolian-Russian boundary and Bayan.
- Importance will be placed on the measures necessary for securing safe and uninterrupted operation. Each project for improving train speed and hauling capacity will be planned otherwise.
- Flood controls and other measures that cannot be solved only by the railway authority will be limited to the scope that can be handled by the railway.
- Construction plans will take into account the financial condition of the MR, as well as measures to extend the life of facilities and improve maintenance technology.
- Construction plans will be based on the priorities established for damaged facilities, taking into consideration the past records of damage, the assumed damage in the future, the increased level of benefits of improvements, and the estimated construction cost.

1) River Bank Protection

It is difficult to provide permanent measures for control of erosion damage to the railway embankment caused by the meandering flow of rivers until national flood control and water utilization plans have been established by the government. In order to secure safe operation of trains, it is considered necessary to immediately provide groyne in river beds to correct the meandering flow, with stone blocks cast in river banks to prevent washing of soil and erosion by floodwater. In order to withstand the traction force of the river flow and to prevent scouring, it may be important to increase the weight of the protection blocks.

For location where it is considered easier to relocate the railway for topographical reasons, study will be made for securing the safety of railways by relocating the railway to a hill side apart from a river bank.

These measures will be provided first for locations where train operations could be affected by erosion occurring in river banks, in precedence to others.

For locations where a river channel bends sharply and it is considered more effective to make the channel straight, measures of reducing erosion with a straightened channel may be provided. However, it is very costly to excavate river channels, and upstream and downstream areas can be greatly affected if the flow channel is changed. For these reasons, any construction of this sort must receive careful consideration.

River bank protection is closely related to flood controls. Where river channels are properly maintained, share of cost for the railway can be reduced. These measures are provided as a part of river improvement projects in Japan with investment of national funds. In Mongolia, it is difficult to expect for action by the government because they do not have systematic river improvement plan. Funds may have to be provided by the railway for necessary measures to secure safe operation of trains without delay.

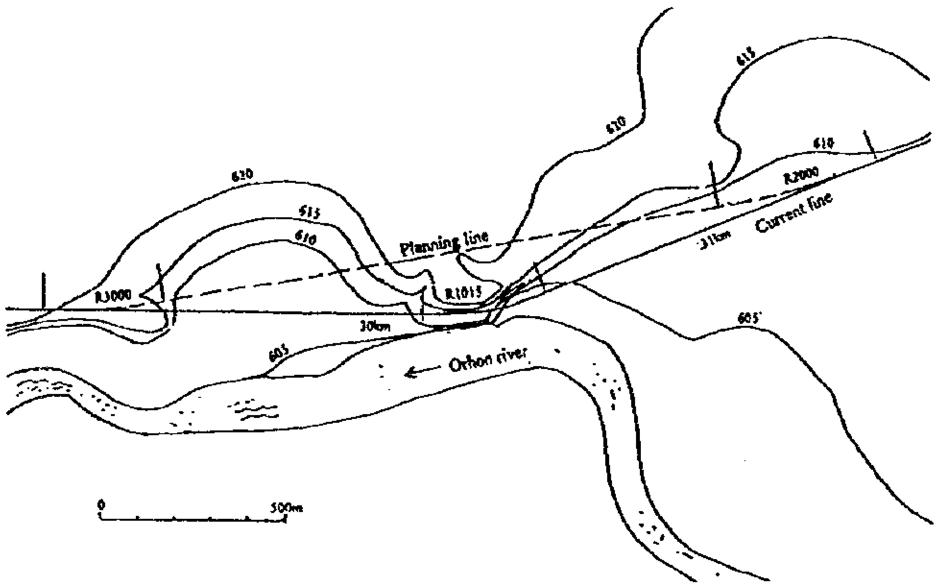


Fig.8-2-4 Plan of 31km Spot

2) Slope Stability

Rockfalls occur mainly on cut slopes that are not too high. In order to protect the rail line from weathered rocks washed down by rains, plans will be made to remove loose rock and to improve the slopes. With such measures, open areas can be obtained between slopes and the track to assure safety until the time surface rocks have become weathered again. Similar measures must be provided, as necessary, in response to the development of weathering in the future, keeping a close eye continuously on development of weathering. For locations where slopes are steep and weathering is rapid, studies will be made on construction of concrete paved protection. For locations where cracks are occurring in large rocks, studies will be made on the removal by blasting or reinforcement with concrete.

3) Track Lifting

To control over-topping of the railway by excessive floodwaters it is necessary to lift the railway above the level of pounding water. Since it can be presumed that flood conditions can vary widely, depending on the progress of flood control projects, plans for lifting of the railway will require a large investment and will be extended. Priorities will be placed on the improvement of drainage capacity of channels crossing under the railway.

4) Bridge Rehabilitation

Bridges are mainly constructed of concrete, with spans in several tens of meters long. Main beams of most bridges have sufficient resistance and strength. However, waterproofing of slabs has become damaged and water is infiltrating to the bodies of concrete structures. As it is feared that reinforcing bars will corrode and beams will lose their strength, it is necessary to repair or provide waterproofing and to prevent the rusting of reinforcing bars. Concrete cover on the undersides of beams has been damaged and repairs are necessary because horses, cattle and vehicles trespass the undersides of bridges. Cracks are occurring in the ends of beams or around the shoe of concrete beams due to deterioration or defective work. These cracks should be repaired. Damaged or cracked areas of concrete should be repaired with resin injection or resin mortar. If these repairs are provided, bridge beams can maintain their proper functions.

For bridges where main reinforcement is excessively rusted, with short spans, with beams having multiple defects, or with beams that must be provided with extended clearance under the beam, and for those that are considered more economical to replace rather than to repair, replacement projects will be recommended.

The track used for delivering coal to the Third Power Generation Plant in the city of Ulaan-baatar is now being supported by a temporary bridge consisting of steel beams on sleeper saddles on the ground, protected by steel sheets. This bridge should be replaced to permanent structure. It is not easy to collect the cost of a bridge improvement from the revenues of transportation of coal to the power generation plant, as freight fare is very cheap. Therefore, funds must be secured with some other means. (Appendix 8-2-2 UB Power Station Ⅲ bridge)

5) Drain Improvement

The compound of Sukhe-baatar Station was damaged by floodwater because the protective dike at the periphery of the city was not functioning properly. It can be presumed that such structures will fail to prevent damage from flash floods. It is considered necessary for local government to conduct field investigations and develop their own flood control plans to protect the entire area of the city, and to provide maintenance of structures at normal times. For preventing floodwaters from flowing into the compounds of railway stations, it will be necessary to determine the length of culverts for rail crossings and also to increase the drainage channels inside the station compound.

There are two hazardous places on railway bridges in the city of Ulaan-baatar that can affect the city area by flooding, because the river channels do not have enough capacity to flow water. Correction of this problem will not benefit the railway operation, but it is imperative to protect the city from floodwater. For this reason, it is necessary to widen river channels related to railway structures. (Appendix 8-2-3 Specification of Japanese River Bridge)

Outside of the city there are some bridges and underground drainage channels that can be overtopped during heavy rains, or places where water can pond in behind embankments because of insufficient water conveyance capacity of drainage channels. The water pounded behind embankments may not directly damage other properties in the suburbs, but embankments can be damaged as a result of fill soil being washed away by infiltrating water, or tracks can be overtopped, damaging or collapsing road beds and embankments. Where the embankment is not feared to over-top, slopes can be covered by concrete pavement. However, plans will be made to increase the number of culverts first in a sequence at a location where water can pond significantly because drainage capacity of traverse channels is definitely short. Upon planning the increase in the number of transverse drainage channels, plans will made to carry out construction work while train operations are shut down for 8 to 24 hours, with precast concrete boxes being delivered to the site. For areas where water conveyance capacity is estimated largely deficient, new concrete beam bridge construction is necessary. Temporary beams will be used to construct new abutment. In Mongolia except for the three summer months, where cast-in-place concrete is used it is necessary to provide heating devices, because temperatures can drop to under 0° C.

For bridges and culverts with insufficient water conveyance capacity, consideration should be given to provide concrete pavement to protect embankments from collapse due to increased water level behind the embankment and to increase the number of culverts, as necessary, taking into consideration the shortage of water conveyance capacity. For water conveyance capacity, plans will be developed based on calculations of water conveyance capacity data calculated by "USU ERDENE (hydraulic and soil investigation company)" provided by the MR. For practical application of such plans, it is necessary to develop an execution plan based on the understanding of discharge factors and underground streams, and actual flood conditions that can widely vary depending of vegetation, water utilization, and soil conditions.

6) Curve Improvement and Track Transfer

As the relocation of rails to a safer place to avoid hazards tends to increase the cost of construction, priority will be placed on individual countermeasures.

Since there are curves with radii of 300 m or less, as well as S-shaped curves and hairpin curves, improvement of such curves will not be incorporated into this project because direct economic effects cannot be expected for such a large construction cost. However, there are some allowances to discuss various subjects including reduction of wearing of rails at sharp curves, operational speeds in curved sections, and methods of setting cants and slacks, from the aspect of operations and maintenance.

Since maps have not been developed to allow discussion of changes in railway routes, maps should be developed urgently. Maps have not been developed or published for national security reasons and because of delicate relationships with adjacent countries, but the free use of detailed maps is now indispensable for facilitating national land development projects.

As to the curve improvement of vicinity of Honkhol Station also needs to prepare materials and study deeply. (Appendix 8-2-4)

7) Others

Concrete forms are required for the manufacture of concrete products in Mongolia. It is desirable that precast concrete culvert boxes be manufactured in the country. Concrete plants must be provided to carry out cross-railway drainage channel construction work.

In order to secure crushed ballast road beds in disaster prevention projects, it is necessary to furnish crushing, transporting, and handling equipment to produce the crushed ballast. In addition, construction plants and equipment are necessary for carrying out disaster prevention projects. If these are difficult to purchase in Mongolia, foreign currency should be prepared for them.

(3) Locations Subject to Discussing for Project

Locations and items to discuss are shown in Table 8-2-2.

Table 8-2-2 Spot List (1)

Item	Counter-measure	Location	Situation, Damage	Remark
River bank protection	Bank-protect,Groyne	11pk1-4	Protected,Groyne	River route
		16 1-4		
		31 2-4	Track washed	*Track transfer
		36 10	Stable	
		51 9-10		* River route
		52 1		
		54 4-5	Track washed	*
		55 9	Stable	
		57 9		*
		65 7		
		67 4-6	Hair pin route	* River route
		88 10		
		208-209		* River route
Slope Stability	Clear Slope	8pk10		*
		9 5		
		10 7		
		10 8		
		12 2		
		13 4		
		14 8		
		17 6		
		18 1	Large block	
		18 10		*
		19 1		*
		51 9		
		52 3		
		52 9		
		54 2		*
		57 9		*
		61 9		*
		88 4		
		250 7		*
		251 10		
		267 4	Jutting rock	
		282-283		*
Track Lifting	Lifting0.5~1.5m	92-96km		
Bridge Rehabilitation	Beam replace Resin injection	235pk3	2×8m	
		245 5	2×8m Slab crack	
		255 3	2×6m Beam end, slab	*
		255 8	Abutment crack	Minor damage
		285 1	8m Beam end	
		289 1	2×10m Beam end, flange	*
		326 9	3×10m saturate	
		334 3	2×10m Beam end, slab	*
		338 10	6m Re-bar erosion	*
		342 2	4m Abutment crack	
		344 1	6m Beam flange	
		356 1	2×6m end, flange	*

Remark * : required quick response

Table 8-2-2 Spot List (2)

Item	Counter-measure	Location	Situation, Damage	Remark
Drain Improve-ment	Adding new drain	11pk8		
		14 1		
		20 2		
		21 6		
		22 8		
		22 10		
		23 2	New	* Sukhe-baatar
		34 3		
		37 7		
		41 2		
		50 5		
		51 3		
		54 10	Over flow	
		56 1		
		56 8		
		57 10		
		59 9		
		66 4-5	1985 New	*
		82 6		
		88 6	Submerged ballast	
		88 9	Submerged ballast	
		89 7	1984, 96	*
		93 1		
		93-95	1994, 95 New	*
		95 2		
		97 5	1989, 90	*
		100 7		
		107 6		
		111 9		
		113 4		
		116 6		
		123 1		
		125 8		*Double track
		128 7		
		132 6		
		135 3		
		136 8		
		138 6		
		141 6		
		143	New	*
		145 1	1981, 91, 93	*
		151 3		
		155 5		
		157 5		
		158 9		
		160 9		
		166 2		
		168 4	1986 New	*

Remark * : required quick response

Table 8-2-2 Spot List (3)

Item	Counter-measure	Location	Situation, Damage	Remark
Drain Improve-ment	Adding new drain	170 1-3	1988 New	*
		170 8		
		171 5		
		172 10		
		176 6		
		177 6		
		178 7		
		182 3		
		184	New	*
		185 6		
		189 7		
		190-192	New	*
		191 5		
		197 9	1995	*
		205 7		
		207 2		
		207 8		
		210 6	Submerged ballast New	*
		211 1		
		212 8		
		216 6		
		217 9		
		218	New	*
		222 10		
		223 7	New	*
		225 8		
		228 6		
		230 9		*
		235 3		
		236 8		
		238 4		
		239 9		
		242 4		
		243 10		
		244 7		
		252 1		
		253 3		
		255 3		
		261 1		
		261 6		
		268 3		
		270 1		
		273 1		
		276 8		
		277 8		
		279 3		
		280 5		
		280 10		

Remark * : required quick response

Table 8-2-2 Spot List (4)

Item	Counter-measure	Location	Situation, Damage	Remark
Drain Improve-ment	Adding new drain	282 6		
		289 7		
		307 3		
		311 8		
		313 10	1984, 88, 94	
		314 10	1984, 88, 94	
		319 2		
		319 6		
		323 5		
		324 5		
		329	New	*
		331 7		
		332 4		
		333 5		
		334 3		
		334 4	New	*
		340 5	New	*
		342 2		
		345 5	New	*
		345 7		
		348 7		
		348 10	New	*
		349 10		
		352 7		
		356 1		
		357 7		
		365 3		
		367 5		
		370 9		
		378 3		
		381 4		
		386 8		
		389 1		
		391 4	1995	
		394 4	1996	*
		399 1	1996 Obstruct old bridge	*Widenning
		416 10	1993 New	*
		417	1993, 94 New	*
		420	1996 New	*
		424 3	1996 New	*
		428	1994, 96 New	*
		438	1993, 94, 96 New	*
Bridge Extent		Yeroo		Study after 2020
Concrete Factory		Hotol		Include drain construction
Quarry		Olonovoo Songino		Include other works
Curve Improve				Study otherwise
Track Transfer				Study otherwise

Remark * : required quick response

8 - 3 Determination of Detecting Defects and Improvement Plan

(1) Revetment and Groyne

1) Present Scouring Condition of Railway Embankment

Scour is defined as removal of stream bed/river bank materials by stream flow or the reduction of sediment loads. Scour/Erosion of river bank adjacent and along the railway track embankment toe or river banks due to stream flow is serious problem to Mongol Railway in some sections especially in northern part of the stretch summarized in Table. 8.3. 1, as shown in the table recurrent protection works have been carrying out by Mongol Railway. Stream properties are given in Table. 8-3-2, which are derived by determination of air photos, however the pictures are taken more than 20 years ago so present condition may be somewhat different from that in details.

Properties of the river in the project area between 11 km and 208-209 km section are classified as "Segment 2-2" which is characterized as the stream which has:

- Representative grain size of river bed material is between 1.0 cm to 0.3 mm, which is determined as sand, and gravel, and other silt or clayey mixture.
- Profile of river bed is approximately 1/400-1/5000.
  (Profile of the river between Sukhu-baatar and 98 km point is approximately 1/2400estimating from Topo maps.)
- Prominent meandering.
- Average depth of stream is 2.0-8.0 meter.
- Unstable stream alignment and bitumen, and other.

Table. 8-3-1 Present Condition of Embankment Erosion / Scour

LOCATION			Section Length L (m)	Present condition	Countermeasure
11	pk	1-4	250	• 3-4 meter/year width erosion of river bank. Erosion width increased very much in 1992-1993. • No erosion is observing so far after construction of rip rap bank protection.	• A total volume of about 8,000 cu. m of rip rap stones has been placed. • Bank might be eroded during high water flood.
16	pk	1-4	400	• 1-2 m width/year river bank erosion was observed before. • No damage in these 2-3 years.	• No countermeasure is adopted so far.
31	pk	2-4	300	• Continuing 5-6 meter width erosion/year of river bank from 1970.	• A total volume of 4,000 cu.m rip rap was placed between 1979 and 1996.
36	pk	10	120	• No serious damage to the track after cut-off.	• Cut-off of stream was carried out about 20 years ago.
51 - 52	pk pk	9 1	250	• 2-4 m width/year river bank erosion is continuing.	• A total volume of 500 cu.m rip rap was placed in 1987.
54	pk	4-5	150	• 1-3 m width/year river bank erosion.	• No countermeasure is adopted.
55	pk	9	100	• 3-5 m width/year river bank erosion from 1980. • No more erosion so far.	• Construction of rip rap bank protection between 1989 and 1991.
57	pk	9	150	• 1-3 m width/year river bank erosion.	• No countermeasure is constructed.
65	pk	7	150		
67	pk	4-6	300	• 3-5 m width/year erosion of river bank, which is accelerating recently.	• 500 cu.m volume of rip rap bank protection is under construction.
88	pk	10	100		• No bank protection is constructed.
208 km	-209 km		150	• Meandering Haraa river is souring river bank at 2-3 m width/year.	• 1000 cu. m volume of rip rap was placed.

Table. 8-3-2 Stream Properties of River

Location km	Degree of sinuosity	Degree of braiding	Degree of anabranching	Variation of width	Development of bars
11~16	HMD	GB	LA to GA	RW	ILB
31	HMD	GB	LA to GA	RW	ILB
51~52	SN to MD	LB	LA	EW	WPB
54~57	SN to MD	LB	LA	EW	WPB
65~67	HMD	N.B	N.A.	EW	WPB
88	MD	LB	GA	EW	NPB
208	MD	LB	NA	WAB	WPB

Legend(Clarification of Segment 2-2 by Mr. Yamamoto)

Category	Rnak3	Rank2	Rank1
Degree of sinuosity	 Sinuous	 Meandering	 Highly meandering
Symbol	SN	MD	HMD
Degree of braiding	Not braided	 Locally braided	 Generally braided
Symbol	NB	LB	GB
Degree of anabranching	Not anabranched	 Locally anabranched	 Generally anabranched
Symbol	NA	LA	GA
Degree of variation of width	 Equiwidth	 Wide at bends	 Random variation
Symbol	EW	WAB	RV
Degree of development of bars	Narrow point bars	 Wide point bars	 Irregular lateral bars
Symbol	NPB	WPB	ILB

2) Improvement plan

Countermeasures against to scour are classified and provided important plan as:

a. Revetment

Typical revetment structure is shown in Fig. 8-3-1. Structure type and its dimensions should be determined considering hydraulic properties of the stream and slope gradient of embankment, and also soil properties of river bed and river bank materials.

b. Groyne

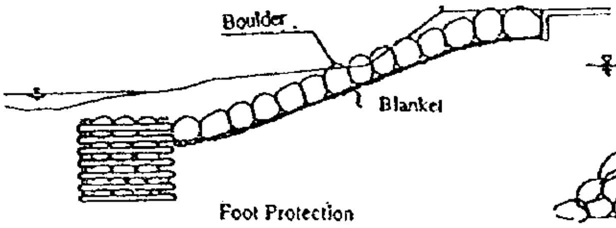
Groyne is constructed for the purpose to prevent scour which has function of;

- Decrease flow velocity by increase roughness
- Diversion of water flow direction

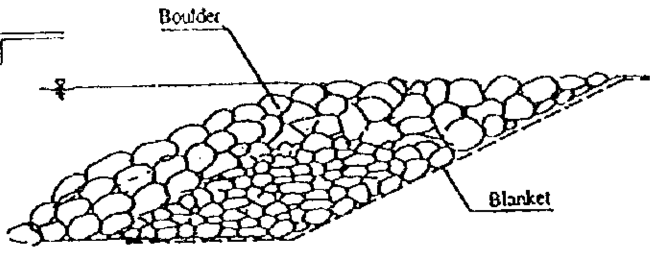
Typical cross section of groyne and recommended its length and spacing based on actual construction experience are shown in Fig. 8-3-2, which are block type and mattress with timber pile type.

c. Cut-off

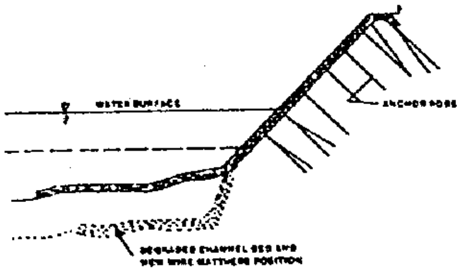
Sharply bended water flow will be cut-off to improve unsteady flow condition as shown in Fig. 8-3-3 schematically. The erosive force is a function of depth and velocity of the flowing water and also of the angle between the bank and the direction of flow of the current. Cut-off can be made successfully even on large stream should the bank above and below are reverted correctly. However, degradation possibly might be occurred in the upstream side due to increased water flow velocity while aggravation and water level raising might be appeared in down stream side after construction so that careful attention should be paid for this countermeasure adoption.



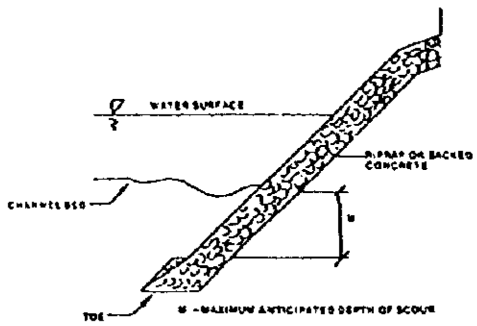
Dry Pitching



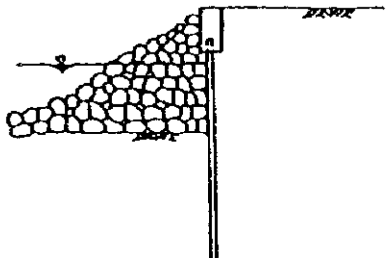
Dry Rip Rap



Gabion Mattress
(Rock and Wire Mattress)



Concrete Grouted Rip Rap



Dry Rip Rap with Sheet Pile

Fig. 8-3-1 Type of Revetment

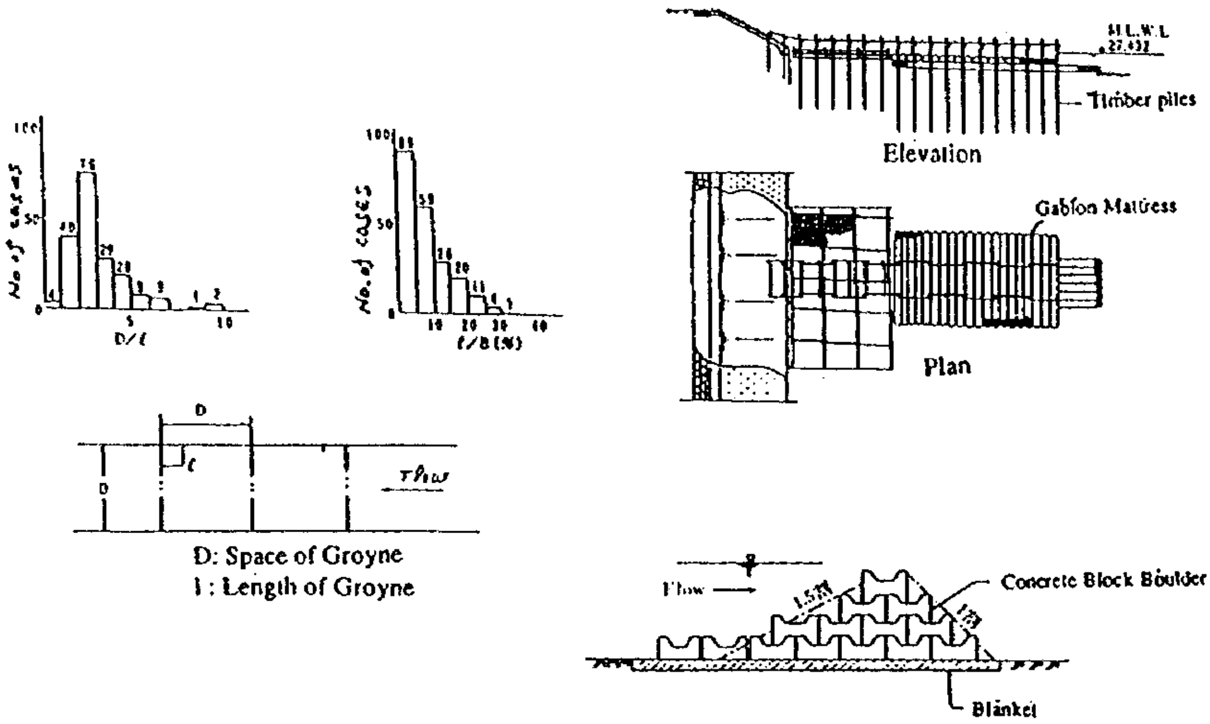


Fig. 8-3-2 Typical Cross Section and Dimensions of Groyne

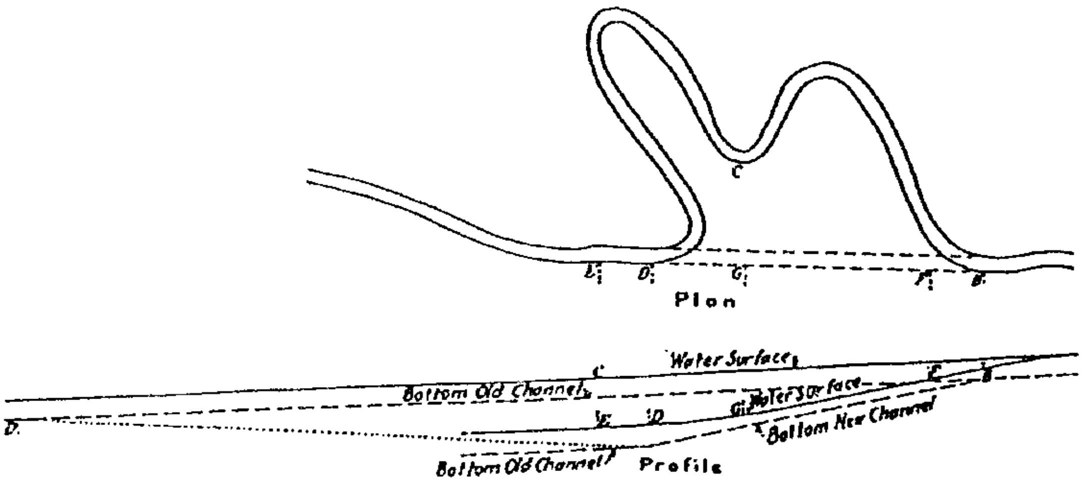


Fig. 8-3-3 Cut-Off of Stream

Necessity of revetment and groyne is determined by following river bank classification:

Rank 1:

River bank is unstable and continuous erosion has been occurring due to scour. Safety of river bank and railway track is considered to be seriously affected in near future by such expected scour.

Rank 2:

River bank erosion is continuing but it is not so serious/major comparing to "Rank 1." Serious damage on banks/railway track due to scour in near future might not be expected so far.

Rank 3

River bank which has little possibility of scour/erosion.

Improvement plans should be programmed to convert river condition from "Rank 1" to "Rank 2" for the stream classified as "Segment 2" by correcting stream alignment in principle, when it is not practical revetment construction should be considered as a countermeasure. For Rank 1 river banks in the project area, Groyne in addition to Gabion mattress revetment or boulder block revetment will be recommended as an emergency countermeasure for the time being. Considering unstable stream condition and no available detailed information/data for further study at the moment, Gabion mattress or boulder block revetment will be most suitable due to its easy and flexible implement ability, material availability at the site and low cost. Gabion mattress shall have dimensions shown in Fig. 8-3-4. with 360 gr./sq. m galvanizing wire.

To convert stream condition from Rank 1 to Rank 2 getting more stable flow, decreasing of flow velocity by Groyne is effective in some cases, where it is essential to determine and recognize causes of erosion and scour. Construction of groyne will be taken into account when decreasing of flow velocity is necessary and effective in addition to revetment bank protection, however realignment of stream is not required or impractical.

Reverted bank protection by boulder or concrete block revetment is recommended for Rank 2.

Determining its effects to study after construction of such countermeasures, additional/extensive construction and/or adoption of other type countermeasure such as cut-off should be taken into account based on more detailed data collected by periodical survey after construction.

3) Recommendation on Survey for Design Work

Countermeasures differ substantially from one site to another because each river system has different hydraulic environment; stream type, climate and geology. Careful analysis of the hydraulic and geomorphic factors of sinuosity/meandering, gradient, flood frequency, water level, flow velocity and other properties is important.

Data Collection ;

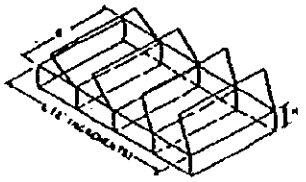
Field data collection should be made on a permanent fixed basis and old data should be re-checked for any changes, since the changes of stream character at one section will affect others, field surveys should be extended to the upstream and downstream section of the channel covering enough area for design work. To achieve the best scour countermeasures, it is suggested to collect extensive data at several different locations and different times, especially after flood. It should be emphasized that selected final alternative shall also be strictly based on social, environmental or legal considerations, not only engineering and economic view points. Following geomorphic, hydraulic, hydrologic and environmental information/data will be surveyed:

General properties of the stream,

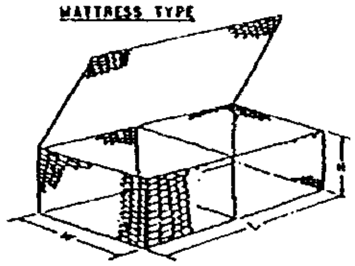
- Profile
- Cross section
- Alignment, meandering, and width and bars
- Soil material properties of river bed and river bank

To estimate external force for countermeasure design ,

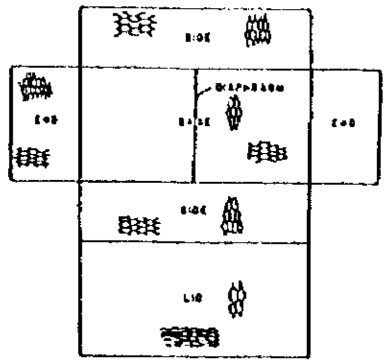
- Annual mean maximum discharge
- Flood water level
- Flow velocity
- Coefficient of roughness of river bed
- Change of river bed elevation
- Others



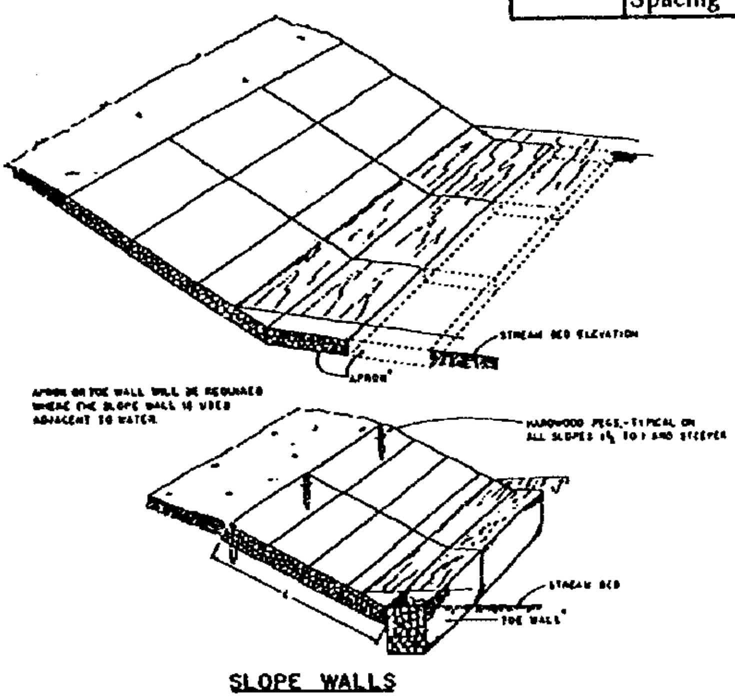
MATTRESS TYPE



WIRE MESH BASKETS



Thickens of basket		cm	30	50
Min. size of rock fill		cm	16	16
Wire mesh size		mm	65	65
Wire Dia.	Mesh	mm	4	5
	Skeleton	mm	4	6
	Diaphragm Spacing	m	less 1.5	less 1.5



SLOPE WALLS

Fig. 8-3-4 Details of Gabion Mattress

4) Proposed Implementation Method

Table 8-3-3 is indicated proposed implementation method of the bank protection.

Table. 8-3-3 Proposed Improvement Method of Bank Protection

Location	Counter measure
11 pk 1-4	Revetment and Groyne
16 pk 1-4	Revetment and Groyne
31 pk 2-4	Revetment and Track Realignment
51 - 52	Revetment and Groyne
54 pk 4-5	Revetment and Groyne
55 pk 9	Revetment and Groyne
57 pk 9	Revetment
65 pk 7	Revetment and Groyne
67 pk 4-6	Revetment
88 pk 10	Revetment
208pk - 209pk	Revetment and Groyne and Cut-off

(2) Slope Stability

1) Present Condition

Rock fall from weathered cutting slope is observed in some sections. Recurrent rock fall due to progress of weathering is expected which is induced by reduction of strength of joints or material it self. All of rock falls observed at the site is examined as that is caused due to surface weathering of cut rock slopes which have approximately 1:0.5 slope and 20 meter-25 meter high, while rock material itself which composing slope is still fresh except exposed slope surface.

2) Improvement Plan

Countermeasures are classified as;

a. Prevention countermeasure

- Removal of unstable rocks, weathered slope surface
- Foot protection of boulder supposed to be fallen down
- Shotcreting or Cast in place concrete protection
- Cast in place concrete crib
- Rock bolting/Anchoring
- Concrete lining
- Others

b. Protection countermeasure

- Concrete wall
- Wire net or fencing
- Others

Among above countermeasures, removal of boulders which possibly might fall down near future and of weathered rock slope surface are effective determining site condition and mother rock properties. Following two another types of countermeasure in addition to above are recommended as pilot construction work of countermeasure which will increase potential ability of maintenance works :

- Removal of boulder by blasting
- Protection method for Foot Fixing, Rock Pool and Retaining Wall type is indicated in Fig. 8-3-5.

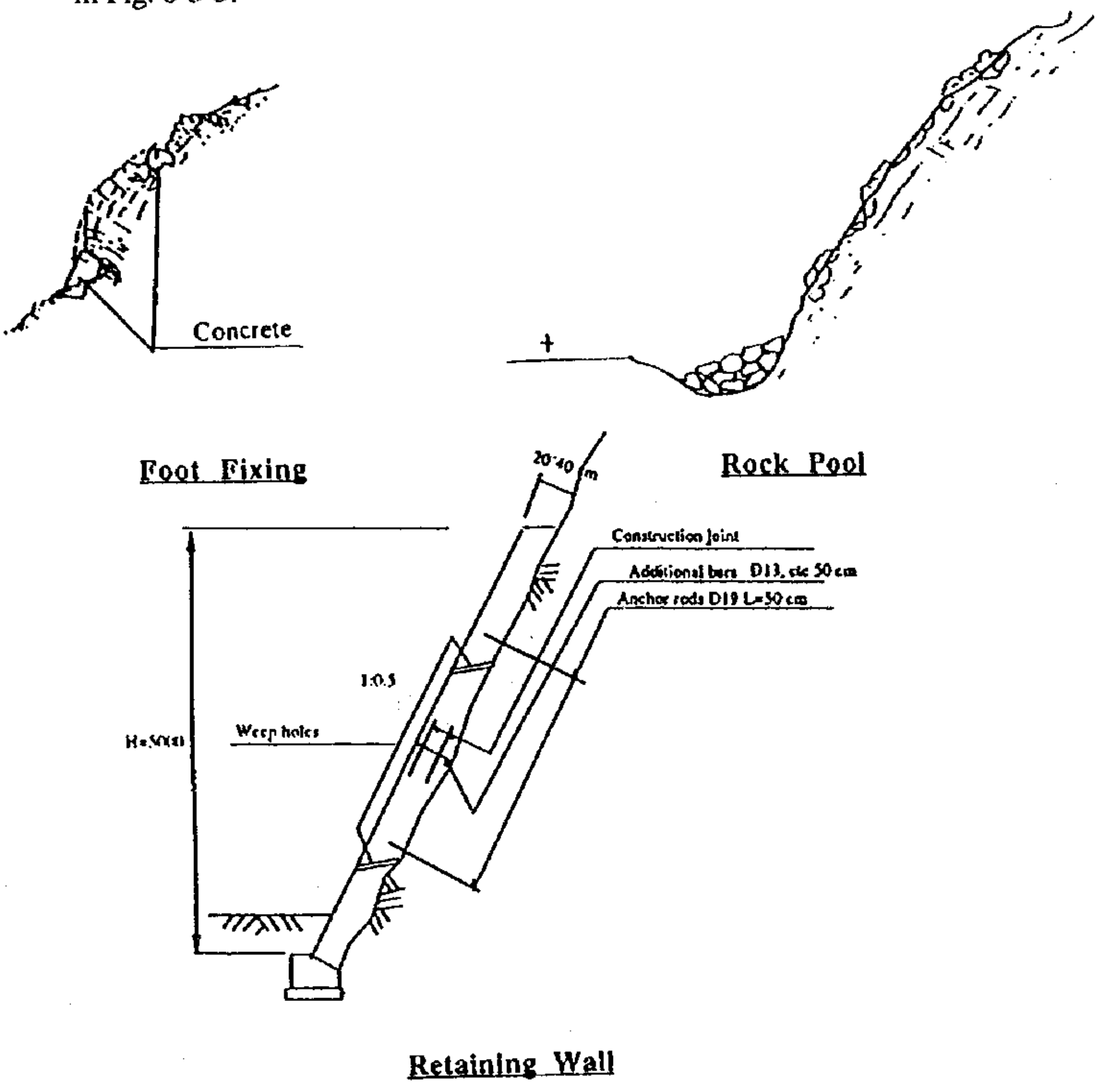


Fig. 8-3-5 Slope Protection Method

3) Proposed Implementation Method

Table 8-3-4 is indicates proposed implementation method of the protection.

Table.8-3-4 Remove weathered slope surface+Rock pool

Location	Counter measure
8 pk 10	Remove weathered slope surface+Rock pool
9 pk 5	Remove weathered slope surface+Rock pool
10 pk 7	Remove weathered slope surface+Rock pool
10 pk 8	Remove weathered slope surface+Rock pool
12 pk 2	Remove weathered slope surface+Rock pool
13 pk 4	Remove weathered slope surface+Rock pool
14 pk 8	Remove weathered slope surface+Rock pool
17 pk 6	Remove weathered slope surface+Rock pool
18 pk 1	Foot protection + Rock Pool
18 pk 10	Remove weathered slope surface+Rock Pool
19 pk 1	Remove weathered slope surface+Conc. Lining
51 pk 9	Remove weathered slope surface+Rock Pool
52 pk 3	Remove weathered slope surface+Rock Pool
52 pk 9	Remove weathered slope surface+Rock Pool
54 pk 2	Remove weathered slope surface+Rock Pool
57 pk 9	Remove weathered slope surface+Rock Pool
61 pk 9	Remove weathered slope surface+Rock Pool
88 pk 4	Remove weathered slope surface+Rock Pool
250 pk 7	Remove weathered slope surface+Rock Pool
251 pk 10	Remove weathered slope surface+Rock Pool
267 pk 4	Remove weathered slope surface+Rock Pool+Blasting
282 / 283	Remove weathered slope surface+Rock Pool

(3) Track Lifting

1) Present Condition

Track lifting of the section between 92 km and 96 km is necessary to improve present poor condition where railway track is sometimes washed out by flash floods which come from Orkhon River or Haraa River in spring and summer seasons overflowing existing formation level.

2) Improvement Plan

The existing 2.5 meter high embankment is recommended to be raised up by 1.0-1.5 meter with 1:1.5 embankment slope and 6.5 meter formation width in accordance with the Design Standards. Ensuring embankment width and reinforcing of in-let and out-let of drainage facility by grouted rip rap are also recommended. Two alternatives for Track lifting are shown in Fig. 8-3-6. and Alternative 1 is selected from the point of continuos train operation. Standard Penetration Test results show increasing no. of blows from 15 to 45 from the surface in accordance with the depth, which are composed of yellow sandy loam. Theses layers are expected to have enough allowable bearing capacity of 15-20 ton/sq.m for construction of railway embankment.

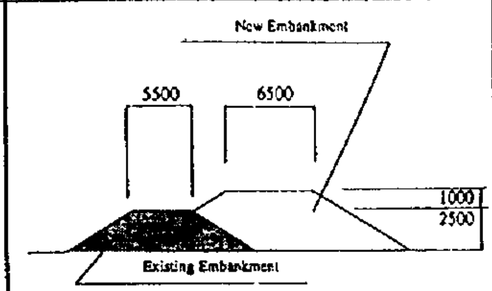
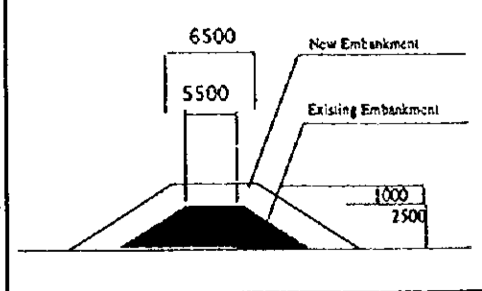
Alternative	Alternative 1	Alternative 2
Typical Cross Section		
Embankment Construction	-Track raising of 1.0 meter high. - New embankment is constructed on hill side slope of existing embankment as shown in above. - Stepping on the slope of existing embankment where new embankment is constructed.	-Track raising of 1.0 meter high.(soil material or ballast) - New embankment is constructed superimposing existing embankment. - Stepping on the both sides of existing embankment slope. -Construction costs and its schedule depend on opening window of train operations. -Staged construction method
Alignment	- A S-shape curve will be installed at the end point of the improving section, while realignment of existing curved section will be carried out at the beginning point to connect with the existing track alignment.	Horizontal alignment is same as existing one.

Fig. 8-3-6 Alternatives of Track Lifting

(4) Bridge Rehabilitation

1) Present Condition of Concrete Bridge

Observed present status of deteriorated concrete bridges are summarized in Table 8-3-5 based on visual site inspection results and its examination, paying attention to cracks, deficiencies, and textural defects;

a. Cracks

The significance of cracking in a particular component depends primarily on the location, origin, length and width of the crack, and whether the crack is active or not. The most important cracks, and those that require special treatments, are active cracks that are increasing in length, width or number, especially which has equal or more than 0.1-0.2 mm width. A monitoring program may be required to determine whether a crack is active or not. Among cracks observed in concrete bridges, following are considered to be structural cracks;

① Vertical wide cracks/break out of concrete at the end portion of girders on supports.

② Longitudinal wide cracks along soffit of main girders with exposed seriously corroded re-bars

③ less than 2mm crack under girders

These defects of concrete main girders may possibly be affected by recurrent freezing and thawing, which will induce structural critical conditions influencing public safety within some years so that which are determined as structural cracks.

b. Deterioration and Textural Defects

Following are description on such deterioration observed in bridge components at the site:

Concrete girder

- Honeycomb at soffit of a girder due to poor workmanship.
- Scratching of concrete at the bottom of girder by passing traffic.
- Pattern cracking with extrication and efflorescence.
- Exposed rebars and its non-structural corrosion.
- Substandard concrete cover of concrete girder .

Ballast stopper and Concrete Slab

- Longitudinal cracks along direction of bridge axis.
- Exudation and efflorescence from pattern cracking.

Bearing shoe

- Frozen steel plate type shoes due to dirt and corrosion.
- Frozen with overflowed concrete

Substructure

Cracks in breast walls of abutments are recommended to be monitored periodically to identify those are active or not.

Table 8-3-5 Present Condition of Deteriorated Concrete Bridge

			No.	1	2	3	4	5	6	7	8	9	10	11	12
			Location	235pk3	245pk5	255pk3	255pk8	285pk1	289pk1	326pk9	334pk3	338pk10	342pk2	344pk1	356pk2
			Span arrangement	2@9.3m	2@9.3m	2@7.3m	1@7.3m	1@9.3m	2@11.5m	3@11.5m	2@11.5m	1@7.3m	1@7.3m	1@7.3m	2@7.3m
Crack, Deficiencies Defects	Main Girder	1	Vertical cracks/breakage of conc. on supports	F	F	RPD	F	P	F	P	B	F	F	F	B
		2	Cracks in concrete girder	F	F	F	F	F	P	F	F	B	F	P	P
		3	Honeycomb/scratching at soffit of girders	F	F	F	F	P	F	F	F	B	F	P	P
		4	Exposed corroded rebars	F	F	F	F	P	F	F	F	F	F	B	P
	Slab	5	Cracks, w/ Efflorescence, Exudation	P	P	B	F	P	B	P	P	F	F	B	F
	Ballast wall	6	Cracks, w/ Efflorescence, Exudation	P	P	B	F	P	B	P	P	F	F	F	F
	Stress	7	Over loading of superset/due to track raising	G	P	G	G	G	G	G	G	P	G	F	F
	Shoe	8	Frozen bearings	P	P.	P	P	P	P	P	P	P	P	P	P
	Substructure	9	Cracks in substructure	G	G	G	P	G	G	G	G	G	P	G	G

Note:

RPD : Repaired by Mongol Railway by recasting concrete method.
G : Good
F : Fair
P : Poor
B : Bad

2) Improvement Plan

Wherever there is any danger to public safety, structural repairs become top priority. Structural repairs to bridges are required when the desirable level of traffic volume or load can no longer be carried safely, or when the maintenance costs become unacceptably high. Repairs for durability, although of a lower priority than structural repair, must also be considered to determining requirements for service life of components. Although these defects and deterioration are not structural, the confidence of the public using bridges is important and this must be weighed against the cost of maintenance and repair of the particular concrete component.

a) Rehabilitation Method

The repair strategy for a particular structure can be separated into the following phases:

- Determining condition of the structure.
- Reviewing the practical alternatives.
- Comparing the costs and consequence of selected alternatives.

Fig. 8-3-7 shows sequence of design and implementation of repair/rehabilitation work of a concrete bridge.

Repair materials could be classified as following in general:

- cementitious(concrete, mortar, grout or slurry);
- polymer impregnated concrete;
- polymer-modified cementitious;
- epoxy and polyester resins;
- joint sealant;
- surface sealers;
- reinforcement coatings;

Applicability or selection guide of these materials are given in Table 8-3-6.

Table 8-3-7 shows general guideline for selection of repair method. Recasting of resign mortar/concrete is recommended for repair of vertical cracks/break out of girder concrete on supports and resign injection is for repair of deteriorated concrete slabs. In addition to above mentioned bridge repair, abutment protection with semi-gravity type concrete wall is recommended.

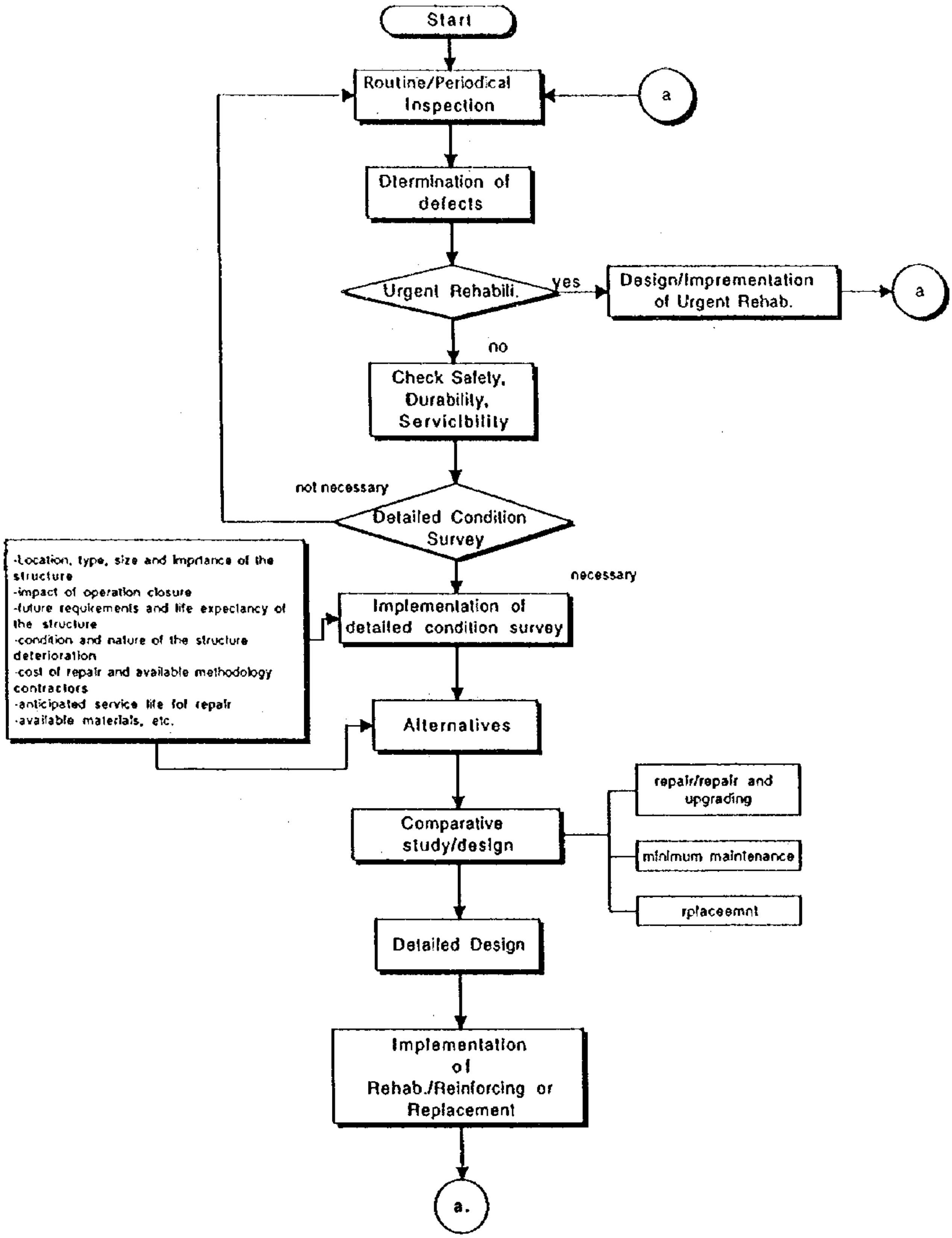


Fig.8-3-7 Flow Chart of Bridge Rehabilitation

Table 8-3-6 Concrete Bridge Repair Material

Type	Repair Material	Surface Treatment	Crack Injection	Crack Sealing	Remarks
Resign	Resign Mortar			AP	
	Epoxy resign		AP	AP	
	Elastic epoxy resign		AP	AP	
	Sealing material	AP		AP	
Cementitious Material	Polymer cement slurry		AP		
	Polymer cement past	AP			
	Polymer cement mortar			AP	
	Cement filler	AP			
	Cement grout		AP		

Note; AP: Applicable for the specified purpose.

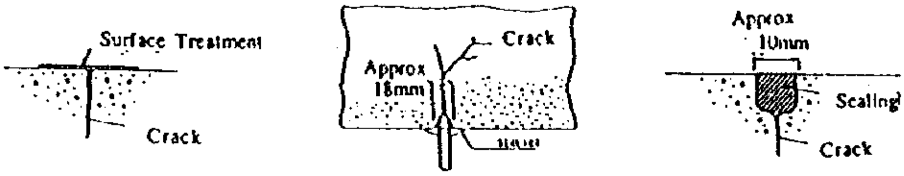


Table 8-3-7 Concrete Bridge Repair Method

Objective	Rebar Condition	Crack Condition	Crack Width	Surface treatment	Crack Injection	Crack Sealing	Recasting Conc./Mortar
For water proof Improvement	Not corroded	Active	wc<=0.2	●	•		
			0.2<wc<1	•	●	●	
		Not so acitve	wc<=0.2	•	•		
			0.2<wc<1	•	●	●	
For durability Improvement	Not corroded	Active	wc<=0.2	●	•	•	
			0.2<wc<1	•	●	●	
			wc>=1		•	●	
	Not corroded	Not so active	wc<=0.2	•	•	•	
			0.2<wc<1	•	●	●	
			wc>=1		•	●	●
	Corroded					●	●

Note:

● Most appreciable method

• Appreciable depending on conditions

3) Replacement of Beam

Seriously deteriorated concrete bridges having structural defects and/or in case repair may cost higher than renewal shall be replaced with new concrete bridges by the construction method shown in Fig. 8-3-8 during open window of train operations to minimize train operation disturbance considering restricted availability of big capacity cranes for bridge erection. This method will be adopted for replacement of rather heavy weight bridges whose span range is 7 meter or longer. The existing deteriorated concrete bridge set on rollers by jacking is pulled by chain blocks toward side direction horizontally to be replaced with a new concrete bridge by same procedure. Short span bridges with the span range of 5 meter or shorter could be replaced by conventional method using MR's crane.

4) Proposed Improvement Method

Recommendation on rehabilitation methodology, i.e. repair or replacement, is shown in Table 8-3-8, which are results of determination of structural safety, durability and serviceability of the structure .

In selecting replace or repair the bridge, following criteria are applied:

* Replacement with new bridge is recommended in such cases;
    a. There is structural defects which possibly may affect train operation safety near future.
    b. There are wide spread defects, which are not structural but repair cost become high.
* Repair of bridge components will be recommended in other case.

In addition to the above, clear height/space is one of the criterion in evaluation considering water flow and passing traffic.

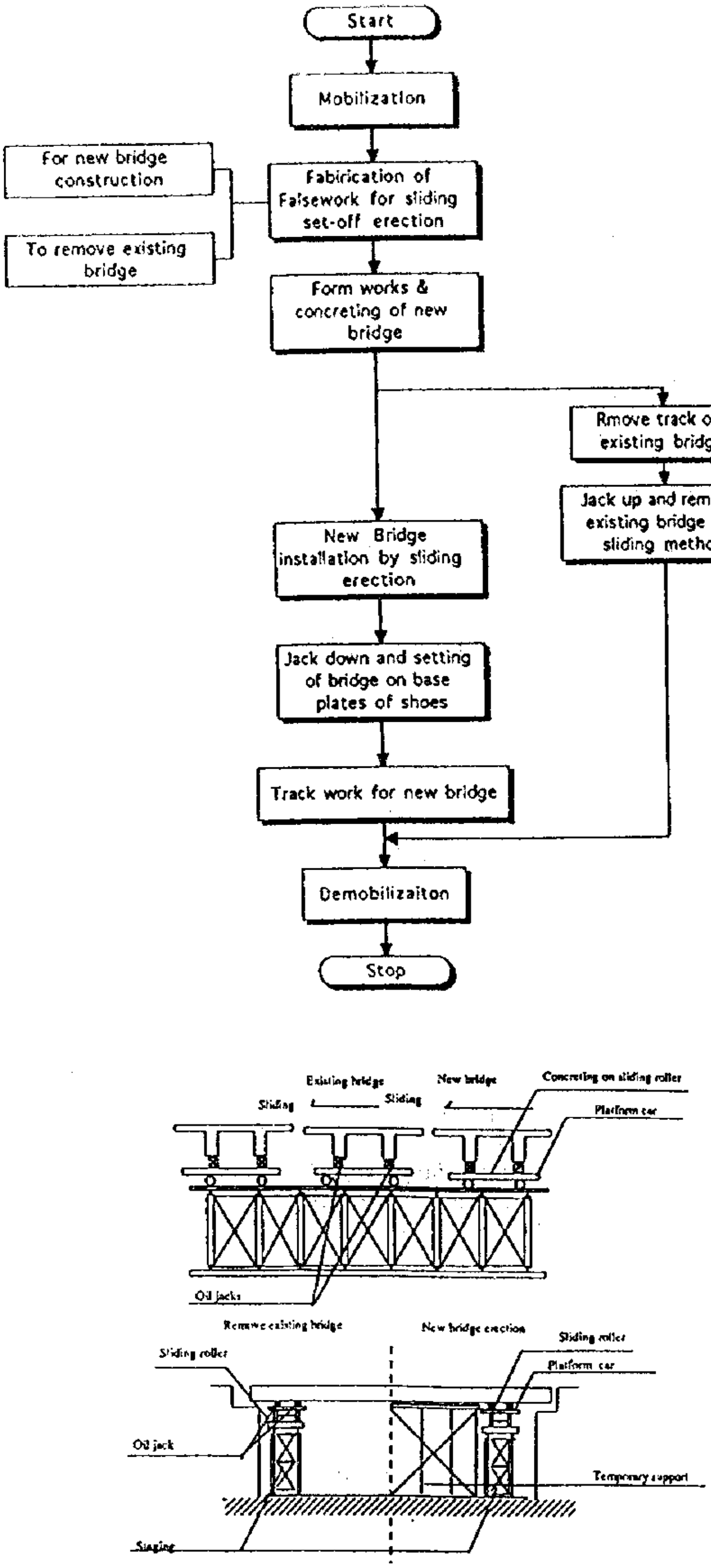


Fig.8-3-8 Concrete Beam Replacement

Table 8-3-8 Proposed Improvement Method of Bridge Rehabilitation

Location		Counter measure
235 pk	3	Replace with a new Beam L=9m
245 pk	5	Crack injection
255 pk	3	Replace with a new Beam L=7m
255 pk	8	Crack injection
285 pk	1	Replace with a new Beam L=9m
289 pk	1	Replace with a new Beam L=12m
326 pk	9	Crack injection and Recasting Concrete
334 pk	3	Replace with a new Beam L=12m
338 pk	10	Replace with a new Beam L=7m
342 pk	2	Crack injection and Recasting Concrete
344 pk	1	Replace with a new Beam L=7m
356 pk	1	Replace with a new Beam L=7m

(5) Drain Improvement

1) Present Condition

Concrete box culverts with a clear space of 1.0 meter to 3.0 meter and short span concrete bridges with span length of less than 13 meter are most popular drainage facilities of the existing railway track in the study area. Shortage of drainage capacity of existing facilities are pointed out in some locations based on theoretical computation and actual damage records. Washing out of in-let and out-let of culverts and embankment just behind structures are frequently reported due to inadequate countermeasure.

Most of the shortage discharge volume are rather small, which are equal or less than 10 cum./sec as given in Fig. 8-3-9.

2) Improvement Plan

Precast reinforced concrete box culverts and reinforced concrete bridge of which dimensions are given in Fig.8-3-10 are recommended for drainage capacity improvement. Discharge capacity of each facilities is shown in Table 8-3-9, however depending on site conditions:

Table 8.3.9 Drainage Dimension and Discharge Capacity

Drainage Facility and Dimensions	Approx. Discharge Capacity
One-cell type Box Culvert	
Clear space*Clear Height	
2.0 m*2.0 m	10-15 cu.m/sec.
2.5 m*2.5 m	15-25 cu.m/sec.
Simple Span Bridge	
Clear span length L meter	
5.0 m	20-25 cu.m/sec.
7.0 m	30-40 cu.m/sec.
10.0 m	40-60 cu.m/sec.

a. Box Culvert

For the settlement of box culvert, the dimension of box culvert is not so large, we adopt to excavate required dimension with suspension of train operation during construction works.

b. Simple Span Bridge

The construction time for the simple span bridge is required more time than box culvert, it is because construction of abutment is required, we apply to introduce construction girder for construction of abutment as show Fig 8-3-11.

Abutment bank protection and in-let and out-let of culverts improvement by grouted rip rap or concrete wall are recommended.

As shown in the attached Soil Survey Report, Standard Penetration Test was carried out at 25 locations. Test results imply that careful attention should be paid for design of substructure and foundation of drainage facilities at 90 km, 145 km, 168 km, 170 km, 218 km, and 253 km due to observed soft layer which show less than 15 no. of brows.

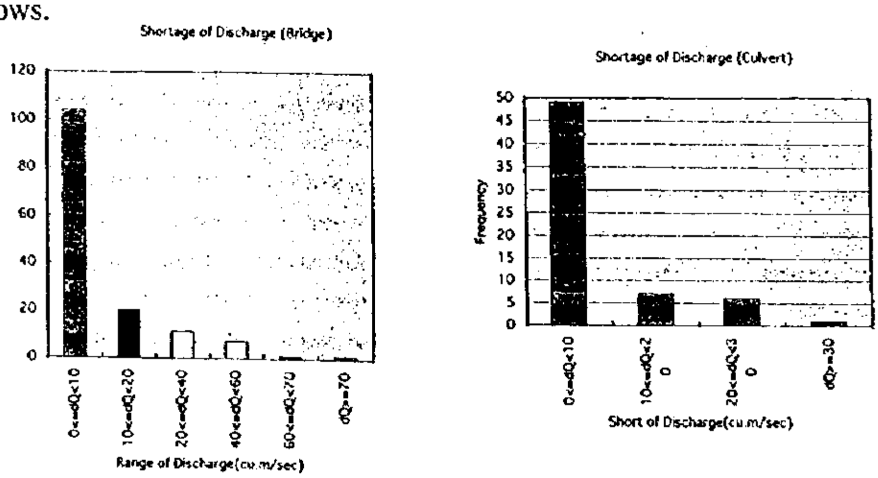


Fig.8-3-9 Shortage Volume of Existing Drainage Facility

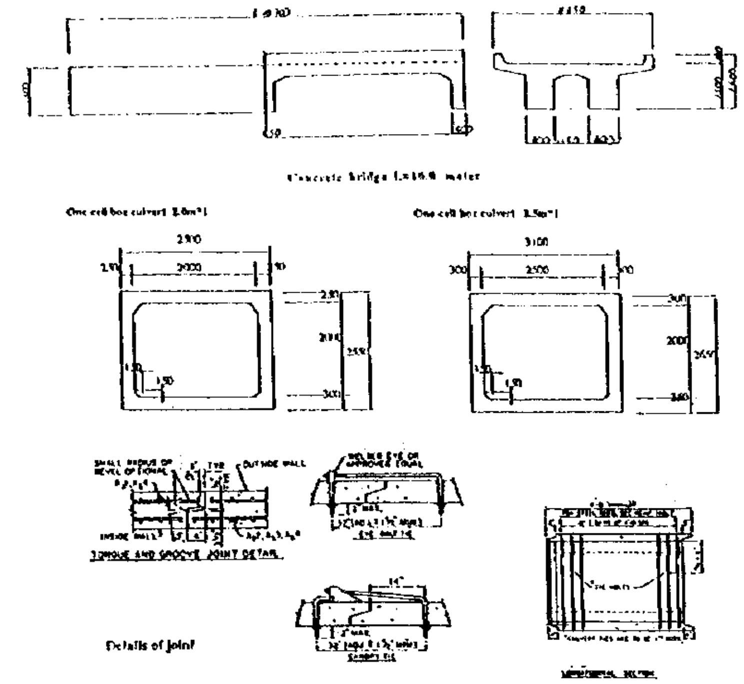


Fig.8-3-10 Dimension of Drainage Facility

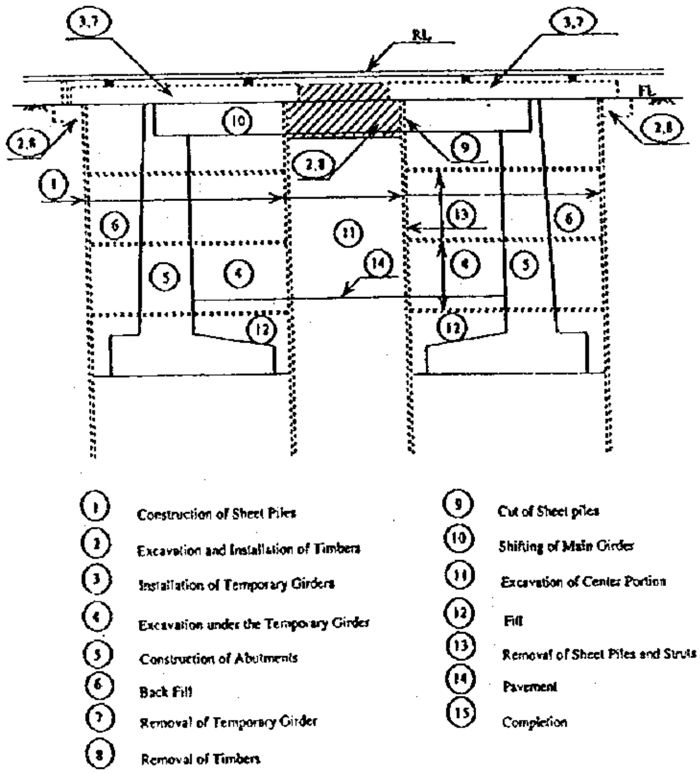


Fig.8-3-11 New Bridge Construction Method under Construction Girder

3) Proposed Implementation Method

Table 8-3-10 is indicated proposed implementation method of the drain improvement.

Table 8-3-10 Proposed Improvement Method of Drain Improvement

Location	Counter measure	Location	Counter measure	Location	Counter measure
11 pk 8	2.0m*2.0m/1Cell conc.culvert	166 pk 2	2.0m*2.0m/1Cell conc.culvert	280 pk 5	2.0m*2.0m/1Cell conc.culvert
14 pk 1	2.0m*2.0m/1Cell conc.culvert	168 pk 4	2.0m*2.0m/1Cell conc.culvert	280 pk 10	2.0m*2.0m/1Cell conc.culvert
20 pk 2	2.5m*2.5m/1Cell conc.culvert	170 pk 8	2.0m*2.0m/1Cell conc.culvert	282 pk 6	2.0m*2.0m/1Cell conc.culvert
21 pk 6	2.0m*2.0m/1Cell conc.culvert	170 pk 1-3	2.0m*2.0m/1Cell conc.culvert	289 pk 7	2.0m*2.0m/1Cell conc.culvert
22 pk 8	2.0m*2.0m/1Cell conc.culvert	171 pk 5	2.0m*2.0m/1Cell conc.culvert	307 pk 3	2.0m*2.0m/1Cell conc.culvert
22 pk 10	2.0m*2.0m/1Cell conc.culvert	172 pk 10	2.0m*2.0m/1Cell conc.culvert	311 pk 8	2.5m*2.5m/1Cell conc.culvert
23 pk 2	2.0m*2.0m conc.box CVT/Open Ditch	176 pk 6	2.0m*2.0m/1Cell conc.culvert	313 pk 10	2.0m*2.0m/1Cell conc.culvert
23 pk 2	Groundsel/Gabion Mattress	177 pk 6	2.0m*2.0m/1Cell conc.culvert	314 pk 10	2.0m*2.0m/2Cell conc.culvert
34 pk 3	2.0m*2.0m/1Cell conc.culvert	178 pk 7	2.0m*2.0m/1Cell conc.culvert	319 pk 2	2.0m*2.0m/1Cell conc.culvert
37 pk 7	2.0m*2.0m/1Cell conc.culvert	182 pk 3	2.0m*2.0m/1Cell conc.culvert	319 pk 6	2.0m*2.0m/1Cell conc.culvert
41 pk 2	2.0m*2.0m/1Cell conc.culvert	184 km	2.0m*2.0m/1Cell conc.culvert	323 pk 5	2.0m*2.0m/1Cell conc.culvert
50 pk 5	2.0m*2.0m/1Cell conc.culvert	185 pk 6	2.0m*2.0m/1Cell conc.culvert	324 pk 5	2.0m*2.0m/1Cell conc.culvert
51 pk 3	2.0m*2.0m/1Cell conc.culvert	189 pk 7	2.0m*2.0m/1Cell conc.culvert	329 km	2.0m*2.0m/1Cell conc.culvert
54 pk 10	2.0m*2.0m/1Cell conc.culvert	190-192km	2m*2m/1Cell conc.culvert	331 pk 7	2.0m*2.0m/1Cell conc.culvert
56 pk 1	2.0m*2.0m/1Cell conc.culvert	191 pk 5	2.0m*2.0m/1Cell conc.culvert	332 pk 4	2.0m*2.0m/1Cell conc.culvert
56 pk 8	2.0m*2.0m/1Cell conc.culvert	197 pk 9	2.0m*2.0m/2Cell conc.culvert	333 pk 5	2.0m*2.0m/1Cell conc.culvert
57 pk 10	2.0m*2.0m/1Cell conc.culvert	205 pk 7	2.0m*2.0m/1Cell conc.culvert	334 pk 3	10.0m*1 span BR
59 pk 9	2.0m*2.0m/1Cell conc.culvert	207 pk 2	2.0m*2.0m/1Cell conc.culvert	334 pk 4	10.0m*1 span BR
66 pk 4-5	2.0m*2.0m/1Cell conc.culvert	207 pk 8	2.0m*2.0m/1Cell conc.culvert	340 pk 5	2m*2m/1Cell conc.culvert
82 pk 6	2.0m*2.0m/1Cell conc.culvert	210 pk 6	2m*2m conc.box	342 pk 2	2.5m*2.5m/1Cell conc.culvert
88 pk 6	2.0m*2.0m/1Cell conc.culvert	211 pk 1	2.0m*2.0m/1Cell conc.culvert	345 pk 7	2.5m*2.5m/1Cell conc.culvert
88 pk 9	2.0m*2.0m/1Cell conc.culvert	212 pk 8	2.0m*2.0m/1Cell conc.culvert	345 pk 5	2m*2m/1Cell conc.culvert
89 pk 7	2.5*2.5m/1Cell conc.culvert	216 pk 6	2.0m*2.0m/1Cell conc.culvert	348 pk 7	2.5m*2.5m/1Cell conc.culvert
93 pk 1	2.0m*2.0m/1Cell conc.culvert	217 pk 9	2.0m*2.0m/1Cell conc.culvert	348 pk 10	2.0m*2.0m/1Cell conc.culvert
93 - 95 km	2.0m*2.0m/1Cell conc.culvert	218 km	2.0m*2.0m/1Cell conc.culvert	349 pk 10	2.0m*2.0m/2Cell conc.culvert
95 pk 2	2.0m*2.0m/1Cell conc.culvert	222 pk 10	2.0m*2.0m/1Cell conc.culvert	352 pk 7	12.0m*1 span BR
97 pk 5	2.0m*2.0m/1Cell conc.culvert	223 pk 7	2.0m*2.0m/1Cell conc.culvert	356 pk 1	10.0m*1 span BR
100 pk 7	2.0m*2.5m/1Cell conc.culvert	225 pk 8	2.0m*2.0m/1Cell conc.culvert	357 pk 7	2.0m*2.0m/1Cell conc.culvert
107 pk 6	2.0m*2.0m/1Cell conc.culvert	228 pk 6	2.0m*2.0m/1Cell conc.culvert	365 pk 3	2.0m*2.0m/1Cell conc.culvert
111 pk 9	2.0m*2.0m/1Cell conc.culvert	230 pk 9	2.0m*2.0m/2Cell conc.culvert	367 pk 5	2.0m*2.0m/1Cell conc.culvert
113 pk 4	2.0m*2.0m/1Cell conc.culvert	235 pk 3	10.0m* 1 span BR	370 pk 9	2.0m*2.0m/1Cell conc.culvert
116 pk 6	2.0m*2.0m/1Cell conc.culvert	236 pk 8	2.0m*2.0m/1Cell conc.culvert	378 pk 3	2.0m*2.0m/1Cell conc.culvert
123 pk 1	2.0m*2.0m/1Cell conc.culvert	238 pk 4	2.0m*2.0m/1Cell conc.culvert	381 pk 4	2.0m*2.0m/1Cell conc.culvert
125 pk 8	10.0*1 span BR	239 pk 9	2.0m*2.0m/1Cell conc.culvert	386 pk 8	2.0m*2.0m/1Cell conc.culvert
125 pk 8	10.0*2 span BR	242 pk 4	2.0m*2.0m/2Cell conc.culvert	389 pk 1	2.5m*2.5m/2Cell conc.culvert
128 pk 7	2.0m*2.0m/1Cell conc.culvert	243 pk 10	2.0m*2.0m/1Cell conc.culvert	391 pk 4	2.0m*2.0m/2Cell conc.culvert
132 pk 6	2.0m*2.0m/1Cell conc.culvert	244 pk 7	2.0m*2.0m/1Cell conc.culvert	394 pk 4	10.0m*1 span BR
135 pk 3	2.0m*2.0m/1Cell conc.culvert	252 pk 1	2.0m*2.0m/1Cell conc.culvert	399 pk 1	Widening of channel
136 pk 8	2.0m*2.0m/1Cell conc.culvert	253 pk 3	2.0m*2.0m/2Cell conc.culvert	399 pk 1	Revetment/Conc.block
138 pk 6	2.0m*2.0m/1Cell conc.culvert	255 pk 3	10.0m* 1 span BR	399 pk 1	Demolition of superstructure
141 pk 6	2.0m*2.0m/1Cell conc.culvert	261 pk 1	2.0m*2.0m/1Cell conc.culvert	399 pk 1	Demolition of Existing Abut
143 km	2.0m*2.0m/1Cell conc.culvert	261 pk 6	2.0m*2.0m/1Cell conc.culvert	416 pk 10	2m*2m/1Cell conc.culvert
145 pk 1	2.0m*2.5m/2Cell conc.culvert	268 pk 3	2.5m*2.5m/1Cell conc.culvert	417 km	2m*2m/1Cell conc.culvert
151 pk 3	2.0m*2.0m/1Cell conc.culvert	270 pk 1	2.0m*2.0m/1Cell conc.culvert	420 km	2.0m*2.0m/1Cell conc.culvert
155 pk 5	2.0m*2.0m/1Cell conc.culvert	273 pk 1	2.5m*2.5m/1Cell conc.culvert	424 pk 3	2.0m*2.0m/1Cell conc.culvert
157 pk 5	2.0m*2.0m/1Cell conc.culvert	276 pk 8	2.0m*2.0m/1Cell conc.culvert	428 km	2.0m*2.0m/1Cell conc.culvert
158 pk 9	2.0m*2.0m/1Cell conc.culvert	277 pk 8	2.0m*2.0m/1Cell conc.culvert	438 km	2.0m*2.0m/1Cell conc.culvert
160 pk 9	2.0m*2.0m/1Cell conc.culvert	279 pk 3	2.0m*2.0m/1Cell conc.culvert		

8 - 4 Prevention of Train Accidents Caused by Natural Phenomena and Earth Structures

(1) Prevention of Train Accidents

Railway structures are generally constructed to withstand natural phenomena caused by changes in weather conditions. However, natural conditions can be understood only as a probability and it will cost too much to construct earth structures that can withstand rarely occurring disastrous phenomena. For such reasons, investment in earth structures should be limited to an appropriate extent, taking into account the probability and the difficulty of repair of predicated damage. It should be considered that earth structures can be damaged under unexpected natural conditions. In order to prevent direct damage to trains, it is more economical to measure with daily management.

It is necessary to establish a daily structure inspection system to prevent deterioration from aging and wearing of earth structures and to execute appropriate maintenance. Also, measures should be provided to observe usual natural conditions, and to stop operations or reduce speeds before trains are damaged by such phenomena.

(2) Inspections of Structures

It is necessary to establish appropriate times for repair or replacement of structures, including bridges and culverts, based on the follow-up investigations on cracks or any other irregularities found by patrol men. For this purpose, it is necessary to designate personnel responsible for the inspection of structures and to provide education and training. Structural inspectors are required to issue directives, to monitor irregularities, to control data, and to perform periodic checks and examinations to evaluate the conformity of structures.

a) Visual Inspection by Patrolmen

Patrol men are required to conduct visual inspections of earth structures, slopes, and river banks during daily patrols to find irregularities and their development, and to observe environmental changes.

b) Management and Inspection by Civil Engineers

Each facility management department is required to educate and train civil engineers to conduct inspections on structures where irregularities were found, to file data, to evaluate conformity, and to determine appropriate times for repairs.

(3) Disaster Prevention Security System

Where damage from rain can be predicted, facilities are currently watched by patrol men. In addition, it is necessary to establish a security system for prevention of possible disasters, using available data and weather forecast information for protection of trains from damage with appropriate rules of operation.

To observe the rainfall amount of the river territory may assume increasing water level at large river side. Using such information, patrol men shall be dispatched to watch the flooding situation. If the water level comes to dangerous level, trains shall be controlled their operation to avoid to meet disasters.

But, in small rivers, local rainfall may increase their water level rapidly, so beforehand precaution with applying weather forecast is necessary.

The slope disasters due to not only the continuos rainfall amount, but also one hour rainfall amount (density of rainfall). To prevent the train accident caused to the slope disaster, the information of one hour rainfall amount is necessary. It needs to give some attention that there are some cases in rock falling, disaster attacks long after the heavy rain.

Samples of operating regulations adopted in Japan for times of unusual weather and earthquakes are shown in Appendix 8-4-1.

CHAPTER 9

TRACK AND STATION

Chapter 9
Track and Station

9-1 Existing Track Condition

(1) Rail

At the beginning stage of construction, R43(43kg/m) type of rail was adopted, however, after weight (axle load) of train becoming heavier, rails have been replaced by R50 (50kg/m) from 1976, completing 1,115km of track line replaced with the heavier rail while 14km of length partially between 725 - 870 km is still remained as with R43 type rails and replacement of rail for this section is being progressively advancing.

The points replaced and their volume is as shown in Table 9-1 and Figure 9-1 as below.

Table 9-1 Table shows the replacement of rail

Year	Length replacement (km)	Place of replacement (km)
1976	1.1	0-7
1977	7.0	7-14
1978	34.0	15-25, 50-72
1979	45.3	73-97, 144-155, 245-255
1980	45.2	256-300
1981	45.5	300-307, 361-395, 411-417
1982	49.4	417-468, 510-512
1983	55.7	155-158, 165-180, 469-510
1984	77.4	25-49, 158-165, 180-220
1985	98.7	98-144, 120-137, 225-245, 307-314,318-320
1986	128.2	106-120, 150-163, 315-317, 320-360,512-570
1987	110.7	87-106, 137-150, 395-412, 570-632
1988	119.5	74-87, 212-237,871-952
1989	92.5	202-212, 953-1,034
1990	68.7	163-172, 1,035-1,095
1991	59.4	191-202, 631-659,1,095-1,115
1992	5.0	172-177
1993	0.0	
1994	31.7	659-691
1995	25.0	691-716
1996	10.0	724-734

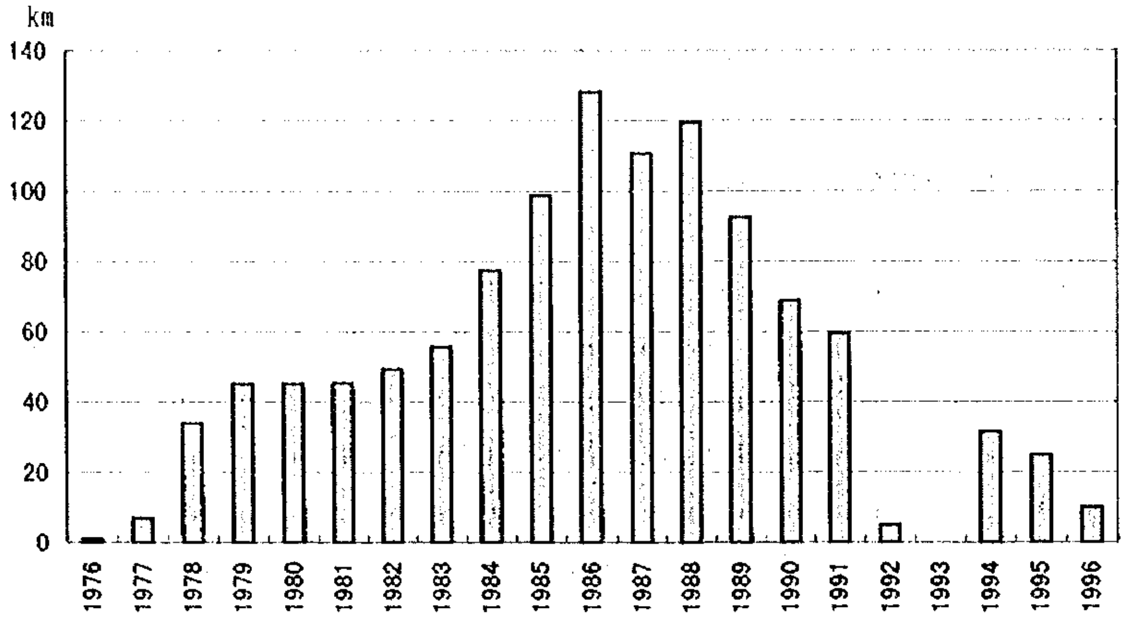


Figure 9-1 Particulars of Rail Replaced in Volume (1976-1996)
(R43→R50)

Also, as for the secular change and wearing conditions of existing rail is as shown in Table 9-2. At present, with the grant assistance by World Bank (W/B) and Loan from OECF, Austrian made heat-treated rail replacement is now undergone. Table 9-3 shows the heat-treated laying conditions and its further plan. Beside this, wheel burn and shelling caused from heavy axle are seen quite often.

Table 9-2 Rail by kind, years and wearing condition

Place		Kind by Rail	Produced Year	Progress Years	Wearing Condition	
km	Km				Head (mm)	Side (mm)
7	23	R65	1995 , 1996		0	2 - 3
23	725	R50	1978 - 1996		1 - 8	2 - 3
725	871	R50	1954	42	3 - 5	3 - 4
871	1,115	R43	1989 - 1991	5 - 7	0	0
1	166	R50	1974	22	0 - 2	1 - 2
1	94	R50	1976	20	0 - 2	1 - 2
1	60	R50	1986	10	0 - 2	4 - 5
1	50	R50	1985	11	0	0

Table 9-3 State of Rail laying by W/B Assistance and OECF Loan

Name of Maintenance Depot	Volume Distribution		Volume Replaced				Volume Replaced Total	
			1995		1996			
	(No.)	(m)	(No.)	(m)	(No.)	(m)	(No.)	(m)
No. 1	3,675	91,875	1,308	32,700	439	10,975	1,747	43,675
No. 2	4,011	100,275	2,929	73,225	258	6,450	3,187	79,675
No. 3	334	8,350	449	11,225	327	8,175	776	19,400
No. 4	231	5,775	191	4,775	0	0	191	4,775
No. 6	756	18,900	521	13,025	186	4,650	707	17,675
Reserve	987	24,675	---	---	---	---	---	---
Total	9,994	249,850	5,398	134,950	1,210	30,250	6,608	165,200

(2) Sleeper

At present, all sleepers are of wooden ones, however, with the technical - introduction from China, plant is now being built to produce pre-stressed concrete-sleeper and preparation is advancing to replace with concrete sleeper instead of wooden ones.

Laying standard of sleeper is as follows;

		R50 rail
Radius Curve	R≦650m	2,000 / km
Radius Curve	R> 650m	1,840 / km
Straight Line		1,840 / km

For experimental use, concrete sleepers introduced from China are laid with 10,000 sleepers (2,000 / km) between the section 31 km - 35 km.

Plant to produce pre-stressed concrete sleeper with the capacity of annual production of 180,000 sleepers is now being built to be completed within 1996. General drawing of sleeper production is shown Fig. 9 - 2.

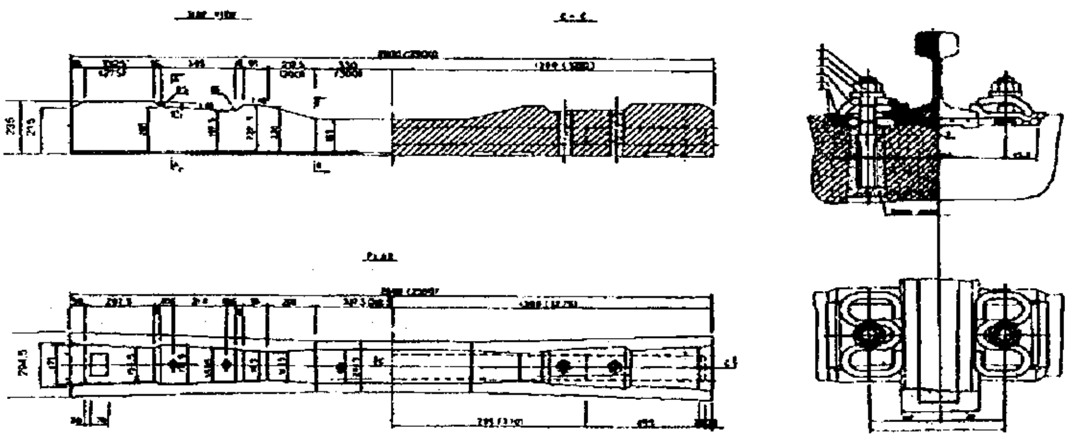
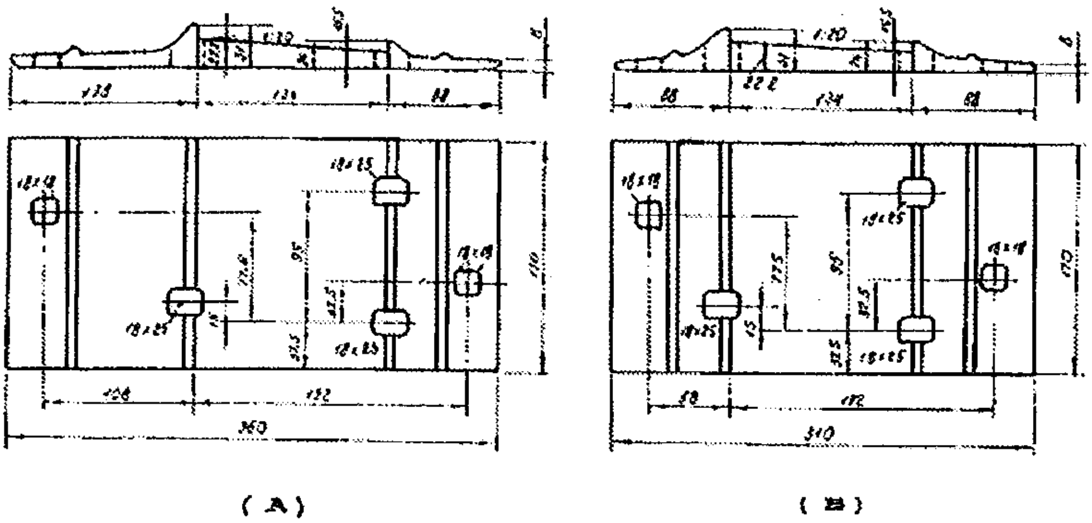


Fig. 9 - 2 General Concept of Pre-stressed Concrete Sleeper

(3) Fastening

To fasten the rail, dog spike is used on sleeper by inserting tie-plate as shown in Fig. 9 - 3.



	TYPE	OUTER RAIL	INNER RAIL
A	DH-50	LESS THAN RADIUS 900	LESS THAN RADIUS 900
B	D-50	RADIUS 900 AND MORE	RADIUS 900 AND MORE

[illegible]	
[illegible]	[illegible]
[illegible]	[illegible]

Fig. 9 - 3 Rail fastening

(4) Rail bed

Rail bed was, firstly, constructed mainly with un-screened gravel but, nowadays, crushed stones are introduced. Laying state of rail bed is shown in Table 9 - 4 and 9 - 5 shows the crushed ballast in the year 1995. But, mostly un-screened gravel is applied for area studied at this survey.

Table 9 - 4 State of Rail Bed Construction

Section	From (km)	Until (km)	Kind of Rail bed	Remarks
Main Line	1	22	Crushed stone	built in 1995-96
Ditto	22	570	Un-screened Gravel	
Ditto	570	1,115	Crushed stone	
Salkhit – Erdenet	0	166	Un-screened Gravel	
Bagakhangay – Baganuur	0	94	Un-screened Gravel	
Airag – Borondor	0	60	Un-screened Gravel	
Sainshand – Zuunbayan	0	50	Un-screened Gravel	

Table 9 - 5 State of crushed stone, un-screened gravel (1995)

Section	From (km)	Until (km)	Kind of Rail bed	Volume used	Reasons
Main Line	7	12	Crushed stone	6,300	track improvement
Main Line	691	716	Crushed stone	30,240	track improvement
Main & Branch Line	Entire Line		Un-screened Gravel	33,961	Normal track maintenance
Main & Branch Line	Entire Line		Crushed stone	4,520	Normal track maintenance
Main Line	Bridge improvement		Un-screened Gravel	8,300	
Main Line	Disaster restoration		Un-screened Gravel	2,240	
Main Line	Zamynuud yard		Crushed stone	4,500	new track laid
Total			Crushed stone	45,560	
			Un-screened Gravel	44,501	
Ground Total				90,061	

Roadway diagram stipulates to secure rail bed with 50cm to the road shoulder, however, at the present condition, there are many places found not properly secured such rule. Therefore, there are many cases of ballast washed down to the slope and there are many places the edge of sleepers are shown up. For the effective functioning of ballast, it is sought necessary to take measures to enlarge the rail bed, etc.

(5) Turnout Placement Condition

Turnout used in MR is as shown in Table 9 - 6.

Table 9 - 6 Table of turnout used

Kind	Structure & Numbers						Total	Remarks
	Kind of Rail			Type of Crossing				
	R43	R50	R60	Assemble	Fixed	Moveable		
1 / 9 (9#) simple	408	791	---	53	1,146	---	1,199	for side track
1 / 11(11#) simple	42	252	---	---	294	---	294	for main track
Total	450	1,043	---	53	1,140	---	1,493	

Note : In MR, maximum permissible passing speed at turnout is defined as 50 km/h at straight track side and 25 km/h at branched side respectively.

On main line, No. 11 simple turnout is used and fixed crossing is adopted. Maximum passing speed on straight - track is regulated to 50 km/h causing difficulties on train - operation plan, but beginning the year of 1997, improvement is now made to 70km/h-except some of the stations.

9 - 2 Track Maintenance Structure

(1) Organization and Personnel

Track Facilities Department (TFD)

TFD is taking charge of normal maintenance of entire track and control related facilities (track, embankment, bridge and culvert). In TFD, there are 5 normal track maintenance depot and 1 track construction / improvement depot. Other than these, there is a sleeper - production site and ballast production plant, totaling 8 field organization. Fig. 9 - 4 shows the entire organization and Fig. 9 - 5 shows the organization of track - maintenance and its personnel strength.

As for the track - maintenance, No.1, 2, 3, 4, 6 depot are taking charge of normal track maintenance. Implementation works are made by the appropriation provided by the MR's revenue. The budget which can be used for track maintenance work is limited within the frame work of deducted depreciating against the Railway Track Principal Asset for the total investment fund and implement under the planned scheme approved by the MR's executives.

On the other hand, Ballast Plant is regarded as production field for MR and self - supporting accounting system rule is adopted.

Further, personnel arrangement Facility Department and track maintenance covering length is shown in Table 9 - 7 and chain of command of Facility Department is shown in Fig. 9 -- 4, 5.

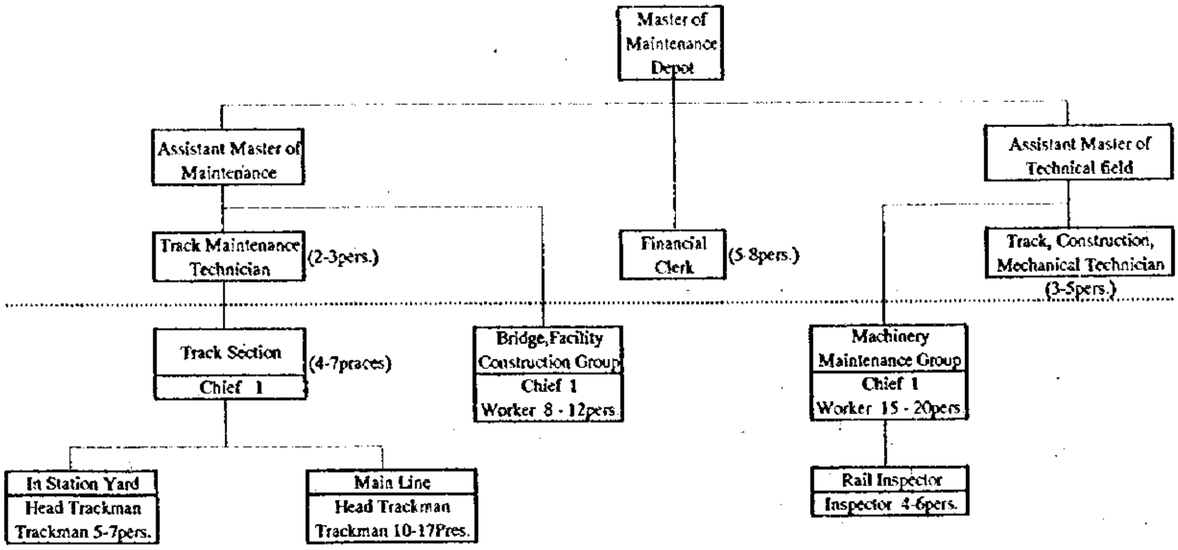


Fig. 9 - 4 Track Maintenance Organization / Personnel

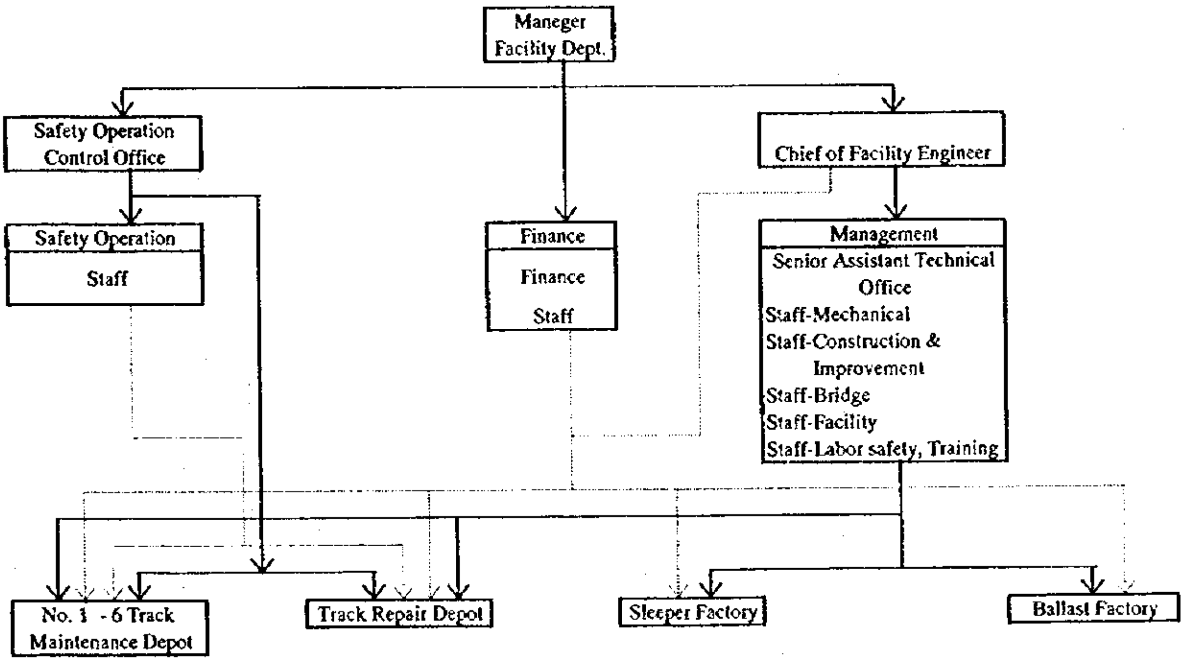


Fig. 9 - 5 Chain of Command on Facility related Organization

Table 9 - 7 Table of Number of Facility Oriented Personnel, Total Length of Maintenance of Rail and Number of Maintenance Depot

(As of 1 January 1996)

Name of Assignment	Grand Total (Pers.)	Number of Officers	General Staff: Maintenance / Improvement Grp.	Chief Maintenance /Improvement Grp.	Security Group	Inspection / Survey	Structure Repair Grp.	Maintenance Machine Gp.	General Affair	Sub Total	Maintenance Staff	Total Length of Track maitenance: Main Line Track L.	Side Line Track L.	Total Track Length	Number of Maintenance Group: No.of Track Mainte.Gp.	Trackman Total	Trackman (6km)	Trackman (12-25km)
Track Maintenance Department	11	11								11	0							
No. 1 Track Maintenance Depot (Darkhan-1)	607	21	254	63	85	6	10	15	12	466	141	336	120	456	15	25	11	14
No. 2 Track Maintenance Depot (Ulaan-bataar)	800	23	410	73	85	28	9	18	7	653	147	400	209	609	18	29	13	16
No. 3 Track Maintenance Depot (Choir)	339	16	165	41	34	4	3	9	8	280	59	338	69	407	13	13		13
No. 4 Track Maintenance depot (Sain-shand)	336	19	188	54	48	4	6	11	2	332	4	332	29	361	13	13		13
No. 6 Track Maintenance Depot (Salkhit)	337	15	110	23	41	2	7	8	7	213	124	166	34	200	8	9	1	8
Track Improvement Department (Ulaan-baatar)	317	16	130	14			13	45	22	240	77		14	14				
Total	2,747	121	1,257	268	293	44	48	106	58	2,195	552	1,572	475	2,047	67	89	25	64

Note : 1. Total Facility Oriented number of staff within this figure 195 staffs are for transport field, remaining 606 staffs are Facility Oriented number of staff.

2. Among related staff, 315staffs is for sleeper plant and 53 staffs is for for gravel plant.

3. Among Security group, 157 staffs are for keeping away domestic animal into rail, 53 are for crossing gate watcher and 103 turnout cleanner are included.

(2) Track Maintenance Security Structure

1) Security Handling Section

At each maintenance depot, operate 24 hours "Facility Dispatcher" is established and all data from various observation point with patrol performance condition, weather forecast information, track condition are informed by direct circuit. From outside organization, it is so arranged to receive state weather information by means of mail or telephone contact and that information is transmitted to Security Section enable to make provision against disasters.

Other than those railway crossing security station at 10 places, horse - ridden patrols are done to supervise the live-stocks to enter into tracks and immediate contact is made to the "Dispatcher" to transmit the same to trains in operation. Also, snow, rain flood information are transmitted.

2) Guard for Disaster

When raining season starts, water - levels of Rivers and Streams are measured and when the water go over the designated level, it is so arranged to secure the safety of train operation.

Table 9 - 8 Table of Water Level Observatory Point

No.	Water Level Observatory Point	Maintenance Depot	Dry Season W.L. (Standard height)	Wet Season W.L. (Standard height)
1	Main L. 11 - p km	No. 1	594.72 m	601.00 m
2	Main L. 64 - p km	No. 1	608.66 m	630.40 m
3	Main L. 72 - p km	No. 1	632.96 m	635.96 m
4	Main L. 301 - p km	No. 2	1,076.64 m	1,078.51 m
5	Main L. 415 - p km	No. 2	1,309.00 m	1,311.95 m
6	S. – E. 03 -p km	No. 6	735.00 m	737.50 m
7	S. – E. 91 -p km	No. 6	771.00 m	774.50 m

3) Provision against Disaster

* Obtaining Weather Information

Purchase Weather Forecast from National Weather Laboratory

a) Forecast of (every) monthly temperature, wind velocity, rainfall, snowfall, river - level and their compared material with long - term average.

b) Weekly weather forecast

c) If in case of sudden - change in weekly forecast, telephone contact will be accepted.

* Anticipating the occurrence of disaster, emergency contact - line structure is prepared, and in order to secure the proper number of staff before hand, mobilization structure is arranged at each maintenance depot.
* In providing the restoration - work from 15 June until 15 September, about 1,000 m^3 of gravel and about 650 m^3 of ballast are loaded into wagon - cars ready for works at the station Ulaan - baatar, Choir, Shainshand and Ulaan - uul. Beside, at each maintenance depot 400 - 800 sleepers are loaded on wagons ready for works.

4) Restoration Work

Main disaster is the wash - out of rail bed by flood. Depending on the size of wash - out, it usually take approximately 5 hours for restoration work. However, for last 2 or 3 years, there are 4 to 5 times of such which took 12 - 20 hours.

In the MR history, there are 2 cases of disaster which took 10 - 14 days for restoration works.

(3) Track Maintenance Standard

Track Maintenance Standard is as shown in figure itemized below and if it exceeds such standards, maintenance work is taken place and its finish limit is stipulated at ±2 mm.

* rail gauge	+ 6 mm, - 4 mm			
* level	+ 4 mm, - 4 mm			
* alignment	+ 15 mm, - 15 mm			
* longitudinal level	+ 10 mm, - 10 mm			
* standardized slack	R50 rail		R43 rail (724 - 820km)	
	R > 350	0 mm	R > 650	4 mm
	300<R≦350	10 mm	450<R≦650	10mm
	R≦300	15 mm	350<R≦450	15mm
			R≦350	20mm

* cant fixed max. 150 mm formula : $C = 12.5 \dfrac{V^2}{R} \leqq 150$ mm

(4) Track Maintenance and Maintenance Machines & Tools

Track maintenance work in MR is largely divided into two (2), one is the group to make renewal exclusively by large machine and the other group is to conduct normal maintenance work in their respected assigned sections. The group which handle large machine is placed near Ulaan-baatar and to conduct track renewal work with 20 - 25 years of cycle, however, because of the financial reasons, it is becoming difficult to keep this defined cycle.

On the other hand, for the group doing the every - day inspection / repair works, it seems that equipment / tools to handle larger size rail and ballast works are not adequately provided.

Main equipment and tools owned by each group is as follows,

1) Following are main track maintenance equipment / tool (for 1 maintenance group)

* Automobile {one (1)} to move maintenance workers, to transport equipment / tool, material
* Tie Tamper {one (1) - two (2)}
* Electrical Rail Cutting Machine, Electrical Drilling Machine, Rail Sharpening Machine, Electrical Spike Driver
* Hydraulic Track Jacking Machine (5 - 8 units), Hydraulic Rail Straightening Machine
* Hand tools Sleeper - packing tool, Spike Hammer, Bar, Rail bed tamping bar

2) Material Transport Car, Other large size equipment

* Trolley to be used for transport collected materials (2 - 3 units)
* Welding machine (1 - 2 units)
* Snow bracing machine (1 - 2 units)
* Freight automobile (3 - 4 units)
* Large sized excavation machine (Tractor 1 unit, Excavator 1 unit)

3) Machine for Track Renewal or new Track Laying

* Multiple Tie Tamper (1 set) (Photo 9 - 1)
* Ballast carrying Car (80 cars)
* Track Remover, Track Laying Car (30 ton)(Photo 9 - 2)
* Track Liner (1 set)

Photo 9 - 1

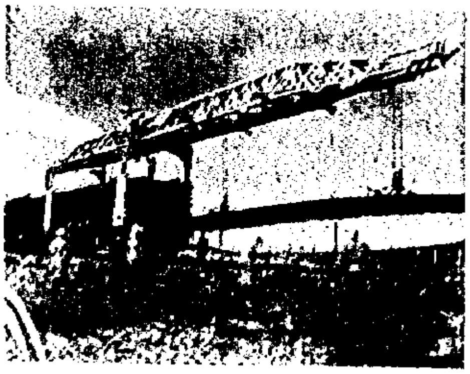


Photo 9 - 2

9 - 3 Point of Issue and Countermeasures

Point of issue which MR is facing in regard the Railway Civil Engineering Works, extend broadly on facilities, maintenance, and personnel and they are all connected to the shortage of fund.

(1) Points of Issue

a) Superannuated large - size maintenance machine.

All these large - size maintenance machines owned by (MR) are operated under scheduled renewal methods. But they are all made in between 1960 to 1970, used for 30 - 40 years. Because of the shortage of spare parts supply, low capability and low working efficiency becomed evident. Whether to keep continue to use large - size machine or to make changeover to use more quick wheeling small - size maintenance machine is difficult to decide because of the available time to make maintenance is very limited in this country.

b) Supply of Ballast and its Quality

At present, there is a quarry in Ulaan-baatar and a ballast plant in Olon-ovoo but because of the superannuated stone - crusher and screen, the working efficiency become lower.

c) Improvement of maintenance equipment / tools

Among those maintenance equipment / tools used by the group undertaking minor maintenance, some machine are not adequately functioning for gravel - ballast and not enough maintenance are provided to support aggravated weight.

d) Control on Track Condition

Track test car is measuring track conditions of all lines once for two (2) weeks but its data is not properly used. Numerical control is vital for establishing more effective maintenance method.

e) Curve speed restriction and rail wear

Against the curvature of approximately 300m, there are instructions of speed limitation. However, by observing the list of curve speed limit, there are many scattered variation. Theoretically, for the same radius curvature, the same speed limitation must be applied in general , although there may be some circumstances at site which can not absolutely defined.

For the speed to pass through the curvature, "Cant" must be provided.

There are many factors to determine the permissible curvature, such as actual "Cant" volume, permissible cant deficiency and train - performance which pass through that curvature.

At any rate, it is hoped to establish the unified rule for each radius curvature.

This is one of the big cause for side - face - wear of rail and therefore, it is an important task to make synthetic study for the sake of future train operation plan, car - performance, rail structure and maintenance capability.

f) Decreased maintenance volume

For past few years, because of the flood disaster and its restoration work man-powers were forced to be used. Regular maintenance work therefore were not satisfactorily implemented.

g) Track maintenance work (in MR) is carried out with very limited manpower of average 0.35p/km. Since the Mongolian Railway (MR) is not yet established for entrust the entire track maintenance work to out - side, it is essential to keep maintain such manpower of today to ensure the safety train operation.

Further subject for MR is to firmly enforce the improvement and modernization of track maintenance scheme upon securing the necessary manpower as of at present.

(2) Improvement Countermeasures

a) Useful application of track inspection car

One for two (2) weeks in average track inspection car is collecting four (4) basic date. By making good use of these basic date, it is possible to prepare and implement the maintenance to formulate necessary personnel against disasters and others.

By sorting out these collected data, rail gauge track level, longitudinal level and alignment can be obtained and, by adopting statistical technique, collective maintenance work can be fulfilled focused on where many problems occur track sections.

Review must be made on the Maintenance Method which is now centering on large - size equipment repair method.

By charging into medium and small type maintenance method, it is possible to keep good track condition with smaller fund and personnel.

b) Small Radius Curvature and Rail Wear

At present, with the financial assistance offered by World Bank and OECF, replacing rails with heat - treated rails for places where wear and tear are remarkable and it is scheduled complete by the fiscal year 1996.

Curvature and rail wear is the phenomenon rivalry occurred with all conditions of track, running car and others conditions. However, it is extremely hard to determine exact measure unconditionally.

Main causes viewing from the track - side can be summarized as follows ;

* Is the "Super-elevation" against average passing speed adequate enough?
* Is the "Cant Deficiency Volume" appropriate enough for lateral force?
* Is the "Gauge Slack" properly set up?

Commonly, the speed restriction for curvature, permissible passing speed value is always the same when actual super-elevations maximum value with permissible cant deficiency is fixed. However, in MR, various speed limit are defined (See Annex 9 - 2).

From the viewpoint of operating train, the train crew may get confused. Urgent technical judgment is needed for review.

c) Quality Control of Rail Bed Ballast

Rail bed is the portion of the track structure composed of crushed stone used between the sleeper and road bed and main function is ;

* To support sleeper tightly and evenly
* To disperse the transmitted train - load from sleeper over to road bed extensively and evenly
* To function easy maintenance work like tamping
* To have certain elasticity on track structure
* To make track better for drainage and prevent track from weeding

In order to satisfy such conditions, road bed ballast degree is so stipulated in Japan.

Table 9 - 9 Ballast Degree of Road Bed

Mesh dimension (mm)	Weight to go trough standard screen				
	63.5	50.8	38.1	25.4	19.1
Crushed stone and Screened Sand	100%	80% | 100%	35% | 75%	0% | 40%	0% | 5%

Also in MR, it is recommended to keep quality control on road bed ballast at gravel plant to prevent the mixture of non - even size stones or gravel to provide well cared gravel to be supplied. Furthermore, it is recommended to apply screen at river gravel quarry in order to get screened gravel without sand.

9 - 4 Concept of Tracking Plan of Improving Section of Track Structure

1) Sections where to be repaired or improved, track renewal work shall be done.
2) Rail shall be reused from existing ones and sections where rails are extremely worn, MR's stocked rail shall be used.
3) Sleepers ; Use sleepers produced by the completed concrete sleeper plant.
4) Ballast is laid to keep the depth of 250mm under the sleeper and if track formation is less than what stipulated, widening work should be secured with 500mm of width between the end of ballast to the sloop end.

9 - 5 Present State of Railway Station

Rail station of Mongolian Railway seems to be excessively facilitated, each stations main track and sub main track, effective length is designed as 850m which is way longer than the length of existing trains operated. Side tracks are also secured sufficiently. For the prospected increasing transport volume, sufficient facilities are provided.

Partially, there are places where stations forced to be built at the curved section, however, there are less facilities around hindering clear sight passage. There are many industry side tracks laid for each enterprise but they are all facilitated branched from the station yard and there is no problem for future development.

CHAPTER 10

PLANNING OF ELECTRICAL SYSTEM

Chapter 10
Planning of Electrical System

10–1 Present Electrical System

(1) Signal System

1) Block System

A token-less block system is used, except for Zamyn-und station on the Mongolian-Chinese border. A single train is blocked between stations. Track circuits are laid out at each station in continuation and each track circuit of a station is connected by a communication circuit (bare wire carrier transmission line) with that of the next station. Existing station track circuits are either an alternating current (AC) track circuit or a direct current (DC) track circuit, depending on location.

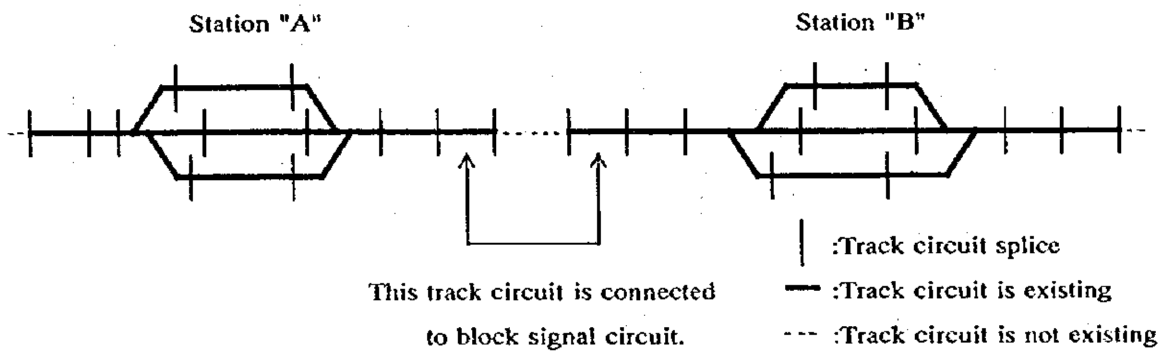


Fig. 10 - 1 Track circuit Construction Diagram

2) Signal System

Signal system used for all stations is the multiple color light signal system. Signal is indicated by the G–Y–R system as a rule, but the GG, YY, and Y flash systems are also used. The signal equipment used for train operations includes departure signals, entry signals, and repeating signals. Signal bulbs of 12 VAC x 8 W are used. Methods of signal indication are shown in the appendix 10–2. For shunting of car, shunting indicators and shunting train radio communication systems are used.

3) Interlocking System

Except for Zamyn-und station on the Mongolian-Chinese border, the class 1 relay interlock system is adopted for all stations on the main line. The relay interlock system being used was made in Russia.

4) Points

Power-operated points are used for the main line except at some branch lines. The power source for the points can be either from the AC or the DC source. Most of the points are made in Russia.

5) Railway Crossing Protection Devices

Railway crossings are automated and classified into three classes as shown in Table 10–1. Track circuits are laid out exclusively for railway crossings, as shown in figure 10–2. Where a train passes through a crossing from "A," going in a direction of "B," either a barrier or an alarm unit is activated to annunciate the approach of a train to automobiles and others, as soon as the train approaches track circuit 1. As soon as the train passes through track circuit 2, the barrier or the alarm unit is released from its action. Reverse operation takes place in the reverse order.

Table 10 - 1 Classification of Railway Crossing

Category	Description (Traffic volume of road crossing with railway)	Alarm Unit	Barrier	Watchman shed
Class 1	High dense traffic volume (trolley buses, buses, automobile, and pedestrians)	○	○	○
Class 2	Intermediate traffic volume (buses, automobile, and pedestrians)	○	○	×
Class 3	Low dense traffic volume	○	×	×

*1: Class 1 watchman shed is on 24-hour duty system.
*2: Only difference between Class 1 and Class 2 is the presence of watchman shed.
There is no difference in system and equipment.

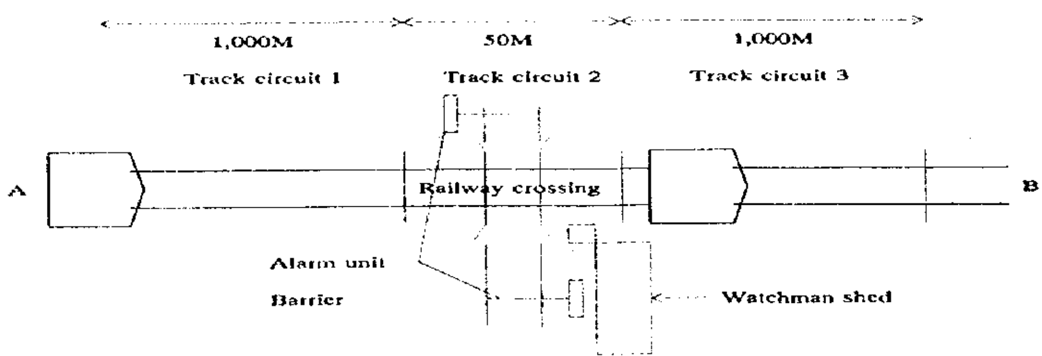


Fig. 10 - 2 Railway Crossing Construction

(2) Telecommunication System

1) Wire Telecommunication System

The wire telecommunication system uses 8 pairs of bare wires, 4 or 5 mm in diameter. Telecommunication poles are installed at a spacing of 50 meters. The telecommunication poles are made of a combination of a wooden pole and rail or concrete supports, securely tied together. The combination pole is constructed with a wooden pole placed between rails or concrete supports on each side, tied securely with iron wire in five or six turns at the tops and bottoms of the supports. It was noted that a number of poles were out of the upright position. Typical construction of existing telecommunication poles is shown in figure 10-3.

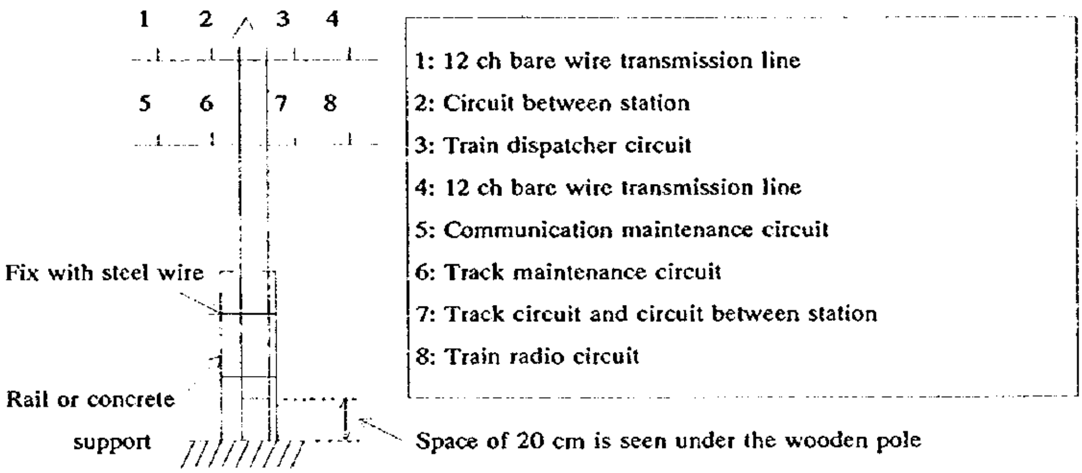


Fig. 10 - 3 Electric Pole Construction

Typical use of bare wires is to have two pairs of bare copper clad steel wire for bare wire carrier transmission, and 6 pairs of copper wire for train dispatch circuits, block signal circuits, communication circuits between railway stations, and maintenance circuits. Each circuit is numbered sequentially going north and the south from Ulaan-baatar. The circuits north of Ulaan-baatar are given odd numbers and those south are given even numbers. (As an example, the Train dispatcher circuit is numbered '800' on the north and '801' on the south.)

For the bare wire carrier transmission, two different frequency division multiplex transmission systems, one with 3 channels and one with from 3 to 12 channels are used. The characteristics of each type are shown in the following table.

Table 10 - 2 Type of Carrier Transmission Unit

Number of Channels	Using Frequency	Model
3 channels	33 kHz or less	Model B-3-3
3 to 12 channels	33 to 150 kHz	Model B-12-3

Most carrier transmitters being used are either Russian model STA or RTA-80, but German model E-2000K is used in some locations.

2) Radio Communication System

A radio communication system has been adopted for trains. Two different radio systems are used; one for locomotives for train operation and the other for shunting locomotives. The former system uses the Russian model 42-PTM (for locomotives) and model 43-PTC (for stations), using frequencies of 2130 and 2150 kHz, and the latter system uses the U. S. model GP-300 (Motorola), using a 150 MHz frequency band. Radio units for shunting were upgraded two years ago.

3) Telephone Exchange System

Telephone exchange units are installed at 16 stations of the whole Mongolian Railway. Russian analog units (crossbar system) are used at 11 stations. At the remaining 5 stations, German digital units (Siemens) are used. Subscribers to the same exchange unit can initiate telephone communication by direct dialing, but subscribers wanting to contact different exchange units must call the exchange station first to connect with the others. Railway stations equipped with telephone exchange units are shown in Table 10–3.

Table 10 - 3 List of Telephone Exchange Unit Location

Analog Exchange Unit		Digital Exchange Unit
Sukhe-baatar[200](1)	Airag[100](39)	Darkhan-1[1000](6)
Salkhit[300](9)	Ulaan-uul[128](43)	Zuunharaa[500](13)
Mandal[50](17)	Zamyn-uud[200](45)	Ulaan-baatar[3000](23)
Tolgoit[50](22)	Erdenet[128](B-6)	Choir[500](35)
Amagalan[200](24)	Baganuur[100](E-3)	Sain-shand[500](41)
Bagakhangai[100](31)		

*1: Numbers encircled by [ ] indicate the capacity of telephone exchange unit
*2: Numbers encircled by ( ) indicate the route number of the Mongolian Railway

4) Miscellaneous Devices

Within each station and depot, a talk-back system is installed for the use in maintenance of equipment and shunting of trains.

At the Ulaan-baatar Communication Center, telegraphs are installed in all directions to convey various items of information.

At the Ulaan-baatar Communication Center, two centralized telephone units (model GLT-2-61) are also installed to issue operation commands. Areas covered by these telephone units are divided into the north and south of the Ulaan-baatar station. The centralized telephone operation table is also installed at the operation command room of Ulaan-baatar station so that all stations under control can be called by pushbutton.

(3) Power Supply Equipment

1) Power Sources for Signal and Communication Systems

In order to provide a power source for signal and communication systems, transformers (for AC Power), rectifiers (for DC Power), and storage batteries are installed. Gasoline engine-driven generators (24 kW or less) are installed for use at times of power failures. This equipment is under control of the signal and communications section.

Engine-driven generators are installed at most stations by the signal and communication section and by the power and water supply section, described later, to be ready for power failures. Most of the generators are made in Russia.

2) Power and Water Supply System

Electric power is distributed to each station through overhead distribution lines (3 phase 6,000 volts or 10,000 volts) on poles installed along the railway track at a spacing of 50 to 70 meters (see figure 10–4) to provide power for train operation and for use in station buildings and for station employees. The power wires are identified as line "A," line "B," and line "C," and are color coded at the service entry to prevent misconnection.

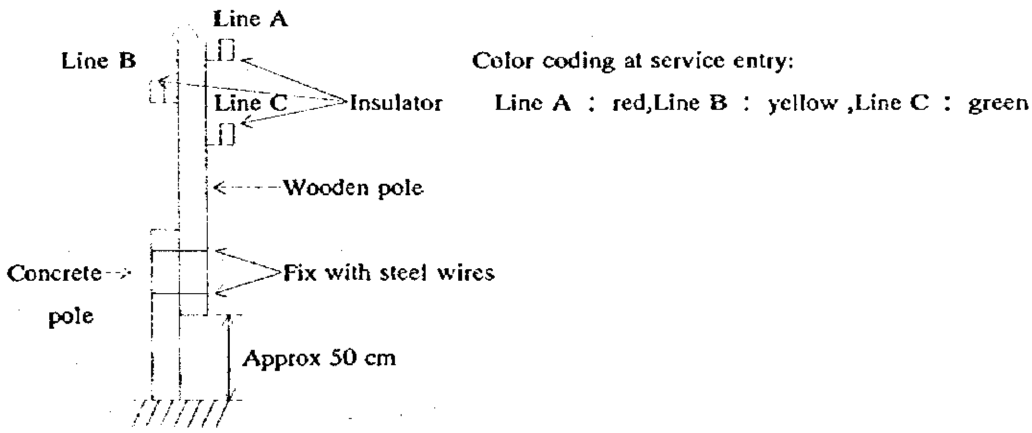


Fig. 10 - 4 Electric Pole Construction

At all stations, diesel engine-driven generators (24 kW or 48 kW) are installed. The electrical characteristics of power generated by these units is 3 phase, 200 volts or 380 volts. Although the stations of Sain-shand and Zamyn-und are not included in the S/W, two sets of 630 kW diesel engine-driven generators are installed at these stations to be ready for supplying power to all stations in the south at times of power failures.

At the power and water supply district in Ulaan-baatar, power distribution facilities are existing in areas adjacent to the power generation plant to provide power for use in railway service. All these power distribution facilities are made in Russia.

The power department is also responsible for providing water supply. Monitoring and supervision of water wells, pumps and potable water pipelines at all stations are under control of the power department. All these water supply facilities use equipment made in Russia.

A water supply command unit is installed at the power and water supply department to supervise both the areas north and south of Ulaan-baatar.

10-2 Maintenance System

(1) Maintenance

1) Signal and Communication Department

The Signal and Communications Department is an organization of 600 employees. Nine employees (including four commanders) are assigned under the Manager at the Headquarters. This department is responsible for maintenance of the main line of the Mongolian Railway covered by three signal and communication stations, in addition to the signal and communication district set up for the east line (Bayan-tumen).

A signal and communication district is set up for each of the three districts of Darkhan, Ulaan-baatar and Sain-shand. The maintenance area of each district covers a section of track of approximately 300 km. Approximately 200 employees are assigned to each communication district. A maintenance area is divided into 100 km sections maintained by three signal engineers. Each 100 km section is further divided into 50 km sections to be maintained by two team leaders. One maintenance team is composed of 10 to 15 employees. Maintenance services are performed for communication facilities, broken down into the categories of maintenance of transmission poles, maintenance of communication buildings, and maintenance of telephones and telegraphs (only for Ulaan-baatar). Each team is organized of 10 to 15 employees.

Under the chief engineer, technicians are assigned to provide inspection and repair services for maintenance of signal, communication, and radio facilities. In addition to these groups, another group is assigned to the shop/car depot and are responsible for operating the concrete pole support fabrication shop, automobile shop and generator shop. Approximately 10 to 15 employees are assigned to these groups.

There is a signal analysis laboratory where foreign-trained engineers are assigned to inspect and repair signal and communications devices that are difficult to repair on site.

Working schedule of employees is shown in Table 10–4. For the signal communication organization, refer to the appendix 10–3.

Table 10 - 4 Work Shift and Work Hour

Work Shift	Work Hours	Remark
Headquarters Mon thru Fri and Sat	8:00~17:00 8:00~14:00	
Signal Man	8:00~17:00	Work on call in night time
Train Radio Man	8:00~20:00 20:00~ 8:00	24-hour duty system (4 shift)
Telephone Exchange Operator Transmission Dispatcher	8:00~14:00 14:00~20:00 20:00~ 8:00	24-hour duty system (4 shift)

2) Power and Water Supply Department

The Power and Water Supply Department is an organization of 309 employees. At the headquarters, a manager and nine office staff (including four commanders) are assigned. The main line is divided into two power and water supply departments. No. 1 Power and Water Supply Section (Ulaan-baatar) is staffed by 165 employees and No. 2 Power and Water Supply Section (Sain-shand) by 135 employees.

No. 1 Power and Water Supply Section controls the area between Sukhe-baatar and Maanyt. This area is divided into seven branches for maintenance purposes. The power and water supply department has a repair shop in Ulan-baatar for power and water supply facilities, and an inspection and repair depot for repair of cars. These shop and depot provide inspection and repair services for all power and water supply facilities of the Mongolian Railway.

No. 2 Power and Water Supply Section controls the area between Maanyt and Zamyn-und. This area is divided into five branches for maintenance purposes. These branches include the branches that maintain generators at Sain-shaud and Zamyn-und. At Sain-shaud a repair team is assigned for repair of power and water supply facilities and an inspection and repair shed for repair of cars. Water tank cars are maintained for water supply service provided for the southern area. The working time table of employees is shown in Table 10–5.

For the organization of the Power and Water Supply Department, refer to the appendix 10–4.

Table 10 - 5 Work Shift and Work Hours

Work Shift	Work Hours	Remark
Head Office Mon - Fri and Sat	8:00~17:00 8:00~14:00	
Electrician 1 *1	8:00~17:00	Work on call in night time
Electrician 2 *2 Water supply Dispatcher	8:00~20:00 20:00~ 8:00	24-hour duty system (4 shift)

*1 : Power maintenance personnel assigned to the following stations
(where diesel engine-driven generators of 24 kW or 48 kW are installed)
Darkhan-1 (6), Salkhit (9), Zuunharaa (13), Bagakhangai (31), Airag (39), Olon-ovoo (38), Erdenet (B-6), and Baga-nuur (E-3).

*2 : Power maintenance personnel and water supply maintenance personnel assigned to the following stations
Power maintenance personnel:
Ulaan-baatar (23), Choir (35), Sain-shand (41), and Zamyn-uud (45)
Water supply maintenance personnel:
Zuuunharaa (13), Ulaan-baatar (23), choir (35), Sain-shand (41), and Zamyn-uud (45)

The numbers in parentheses indicate the station number shown on the route map of the Mongolian Railway.

3) Inspection and Maintenance Services

Both the signal communication and the power and water supply departments carry out inspection and maintenance services according to the schedule shown in the following Table 10-6. Inspection and maintenance services are carried in a manner of preventive maintenance as a rule, based on the rule of life-cycle maintenance or critical value maintenance for each individual equipment. Life-cycle maintenance of equipment is carried out by the use of interlocking relays or watt-hour meters. Critical value maintenance of equipment is carried out by the use of carrier transmission devices.

Table 10 - 6 Inspection Frequency and Inspector

Time interval	Place of inspection	Inspector
Daily	Depot	Foreman
Weekly	Depot	Section Chief
Monthly	Depot	Engineer
Quarterly	Department	Engineer
Semi-annual	Headquarters	Inspection Committee (headed by the Deputy Chairman and Chief Engineer)
Annual	Headquarters	Inspection Committee (headed by the Chairman)

* Inspection committee is organized at times with inspection are conducted.

(2) Education and Training Courses

Training for the electrical field is largely divided into three (3) categories for its implementation.

The first one for signal and communication and power / water supply is given by its own engineer at a rate of once in a week. In addition, group training is arranged for all employees gathered at place.

Secondly, for matters relating to signal communication, the engineer assigned to the analysis laboratory at Ulaan-baatar conducts visiting OJT in case of failure occurs at a site. And,

Thirdly, for the education of engineers, proper education course is also provided at Staff Training College.

10-3 Problems, and Subjects Needing Improvement

(1) Signal Equipment

The most serious problem is the unavailability of necessary parts, as most signal equipment was made in Russia. Existing equipment is rapidly deteriorating and it is presumed that upgrading is urgently required for all such equipment. For upgrading these equipments, Centralized Traffic Control system must be taken into consideration for successful upgrading. This system of CTC will bring up the reliability of train operation and, at the same time, it will also greatly contribute to improve the management of Mongolian Railway.

It is also considered necessary to provide technical training to young employees, and to establish repair and restoration systems, as signal equipment performance is closely related to the operation of trains.

(2) Telecommunication System

Since bare wires are used in the telecommunication system, the number of circuits is limited and noise generation cannot be prevented. Wiring is installed overhead on composite poles and the wooden parts are rapidly deteriorating. For the telephone exchange system, analog and digital exchange units are being used currently, telephone numbers are not united and it is difficult for subscribers of one unit to communicate with subscribers of other type units.

These problems can be solved if existing equipment is replaced. A project to improve the existing system by providing an optical fiber cable carrier transmission system, and a project to replace the digital exchange units are now being planned by the Mongolian Railway. If these projects are carried out, chronical shortage of telecommunication circuit in Mongolian Railway can be solved and also, at the same time, it is presumed the entire telecommunication situation of Mongolia other than railway field will drastically be improved.

However, optical fiber cable terminal is still expensive and therefore, it is hard to provide terminals in all stations. For transmission from these large stations installed with optical fiber cable, it is considered necessary to study to install smaller capacity optical fiber cable other than to use normal cable transmission.

(3) Power System

The most serious problem for the power system is the deteriorated equipment. Since power cables are installed overhead on combination poles together with the telecommunication wiring, deterioration of the wooden parts causes many problems.

In order to solve these problems, it is necessary to replace existing wooden poles with concrete poles and replace the deteriorated equipment. Along with the installation of aforementioned CTC system and optical fiber cable, it is necessary to strange then the power system, because, if these apparatus be practically utilized, it is feared that the fluctuation of power source will affect so large for the operation of trains.

10–4 Design Concept for Electrical Systems

As a result of the Study made on the existing electrical systems of the Mongolian Railway, it was determined from general conditions observed that existing systems are at an advanced level that can fully support the Mongolian Railway. Inspection of equipment is intensively performed at a fixed base. However, some equipment has been in use for over 40 years and problems are occurring because of the time required for maintenance and repair of such equipment.

This problem can be solved when replacement is carried out. In addition, a few projects are being planned by the Mongolian Railway to replace the existing carrier transmission system with an optical fiber cable system, to replace analog exchange units with digital exchange units, and to provide new or replace existing generators. These plans are outlined in the appendix 10–1. As some of these plans can be performed within two or three years, it is necessary to develop plan of electrical systems based on the full understanding of existing earth structures that will be investigated.

10–5 Improvement of Electrical Systems

Improvement of existing electrical systems will not be planned this time because no electrical systems are involved attached to the earth structures for basic improvement section and projects for providing optical fiber cables and replacing existing telephone exchange units with digital units are already under way.

It is also considered unnecessary to increase the number of employees until 2020, because existing signal communication and power and water supply systems can be fully maintained by the current manpower, even if some equipment is replaced. However, education and training of engineers will become necessary to keep abreast of new equipment introduced.

There are two (2) places in surveyed sections for electrical equipment required to be improved, first is the route-change of telecommunication circuit covering approximately 2 km at near by 31 pk and the second one is the prevention measure of rock-fall at 251pk2.

(1) At 31 pk, in order to minimize the influence on existing telecommunication, to changing the route, new telecommunication circuit is considered to be installed along new track route and change over at both end.

(2) At 251 pk 2, no influence of rock sliding to the railway track, but telecommunication poles are erected at mountain side which cause the wire breaking. At this place, it is planned to

move those existing poles for the length of 200 m to the track side 30 meter away from the place where feared the rock-slide.

As for construction cost, please refer to Civil Structure plan.