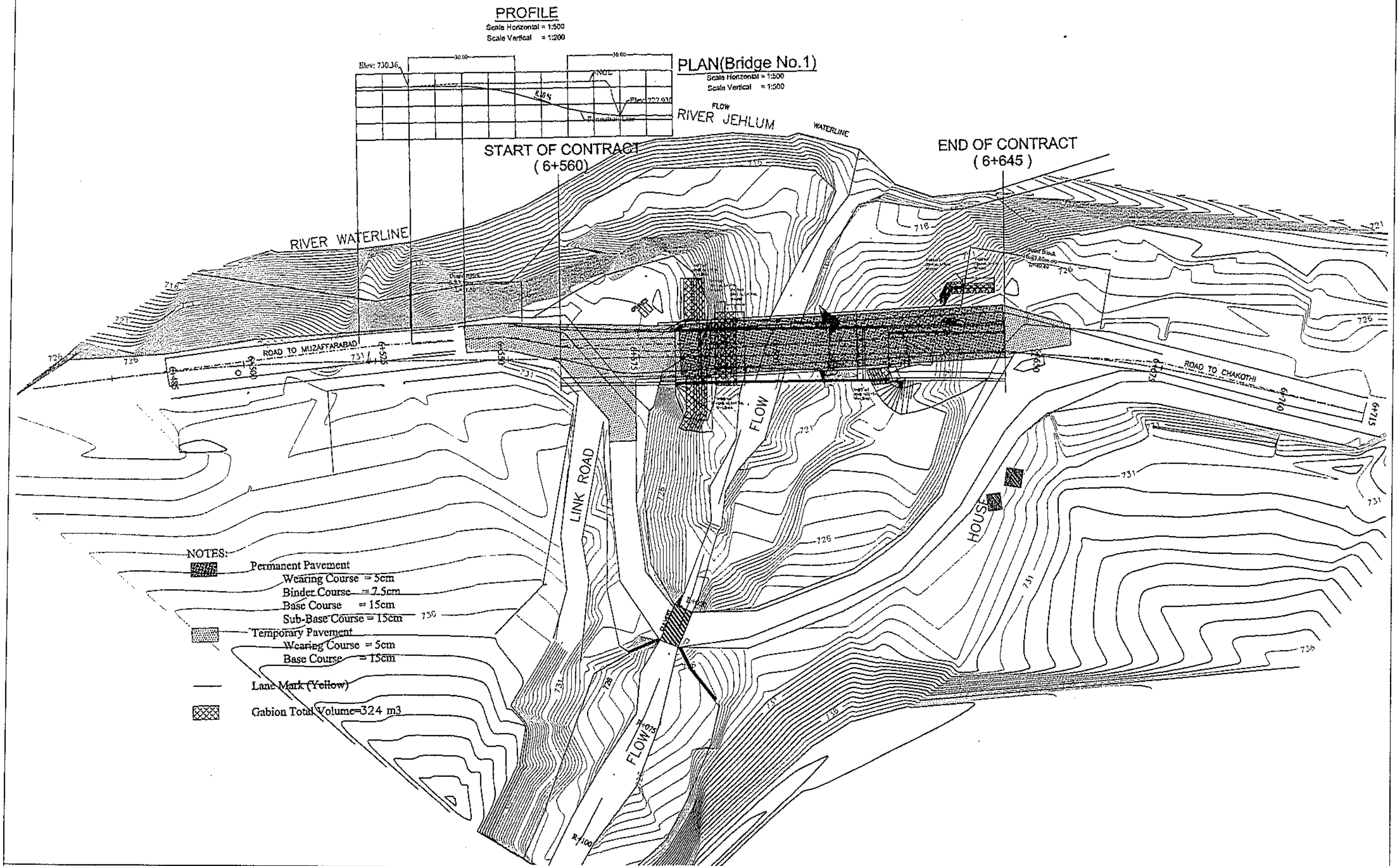
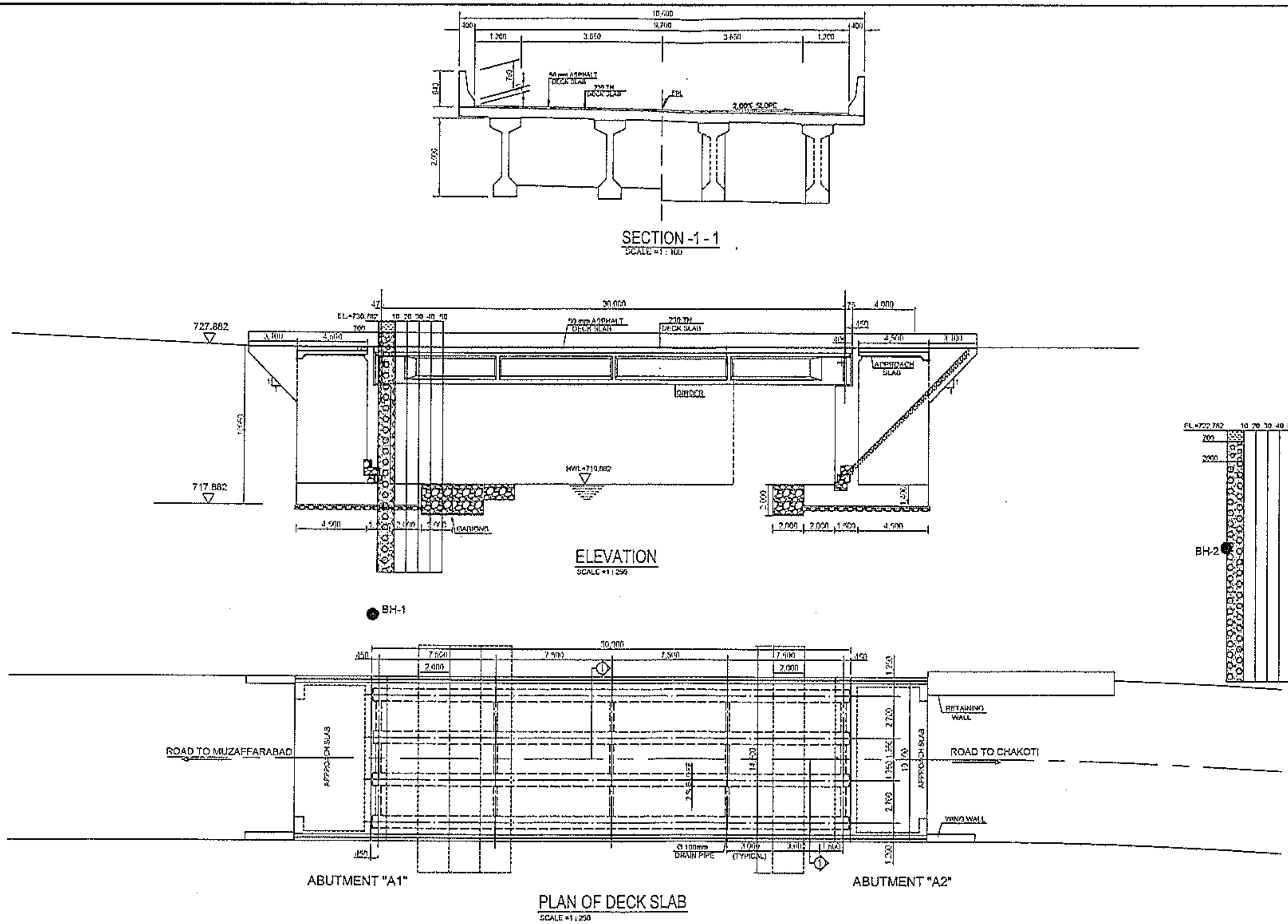
APPENDIX - B

B-1: As Build Drawings (Summary)



GOVERNMENT OF PAKISTAN MINISTRY OF COMMUNICATIONS NATIONAL HIGHWAY AUTHORITY	JAPAN INTERNATIONAL COOPERATION AGENCY ASSIGNED TO: NIPPON KOEI CO., LTD. (JAPAN) CONSTRUCTED BY: SAMBU CONSTRUCTION CO.LTD. (KOREA)	AS BUILT DRAWING			Technical Assistance for Reconstruction Project of Bridges Damaged by October 8th Earthquake on The Jhelum Valley Road SITE NO.1 BRIDGE WORKS	General View of Site No. 1 Scale 1:1,000 DWG. NO. S1B-01-001
		Date:-	10 Nov 2007			
		Prepared By:	Q.S	Mr.Ehsun Munir		
		Checked By:	Sambu	Mr.E.J.Lee		
		Approved By:	Nippon Koi	Mr.Yamashita		



GOVERNMENT OF PAKISTAN
MINISTRY OF COMMUNICATIONS
NATIONAL HIGHWAY AUTHORITY

JAPAN INTERNATIONAL COOPERATION AGENCY
ASSIGNED TO:
NIPPON KOEI CO., LTD. (JAPAN)
CONSTRUCTED BY
SAMBU CONSTRUCTION CO. LTD. (KOREA)

As Built Drawing

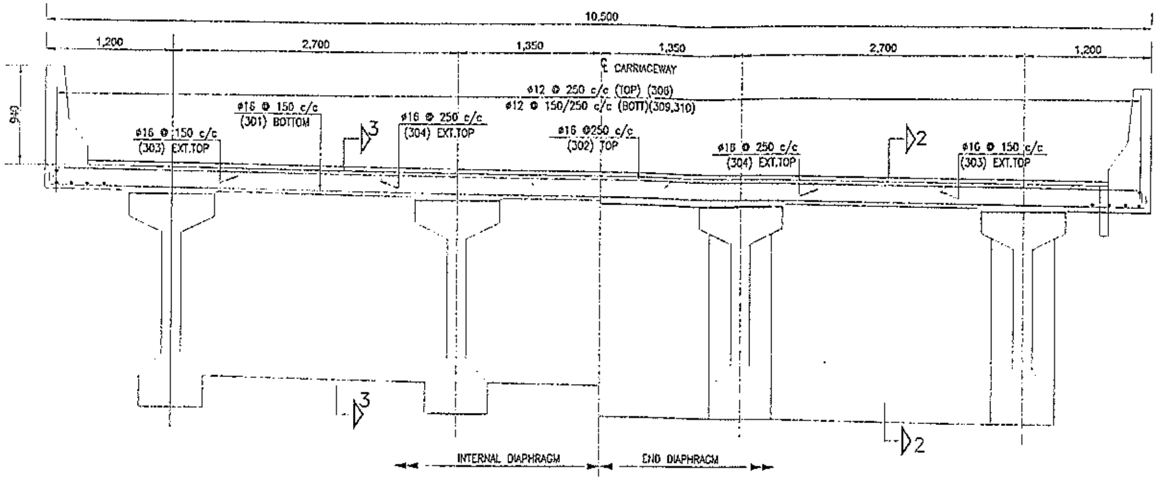
Date:-	10 Nov 2007	
Prepared By:	Q.S	Mr.Ehsan Munir
Checked By:	Sambu	Mr.E.J.Lee
Approved By:	Nippon Koi	Mr.Yamashita

Technical Assistance for Reconstruction Project
of Bridges Damaged by October 8th Earthquake
on The Jhelum Valley Road
SITE NO.1 BRIDGE WORKS

General View of Bridge No. 1

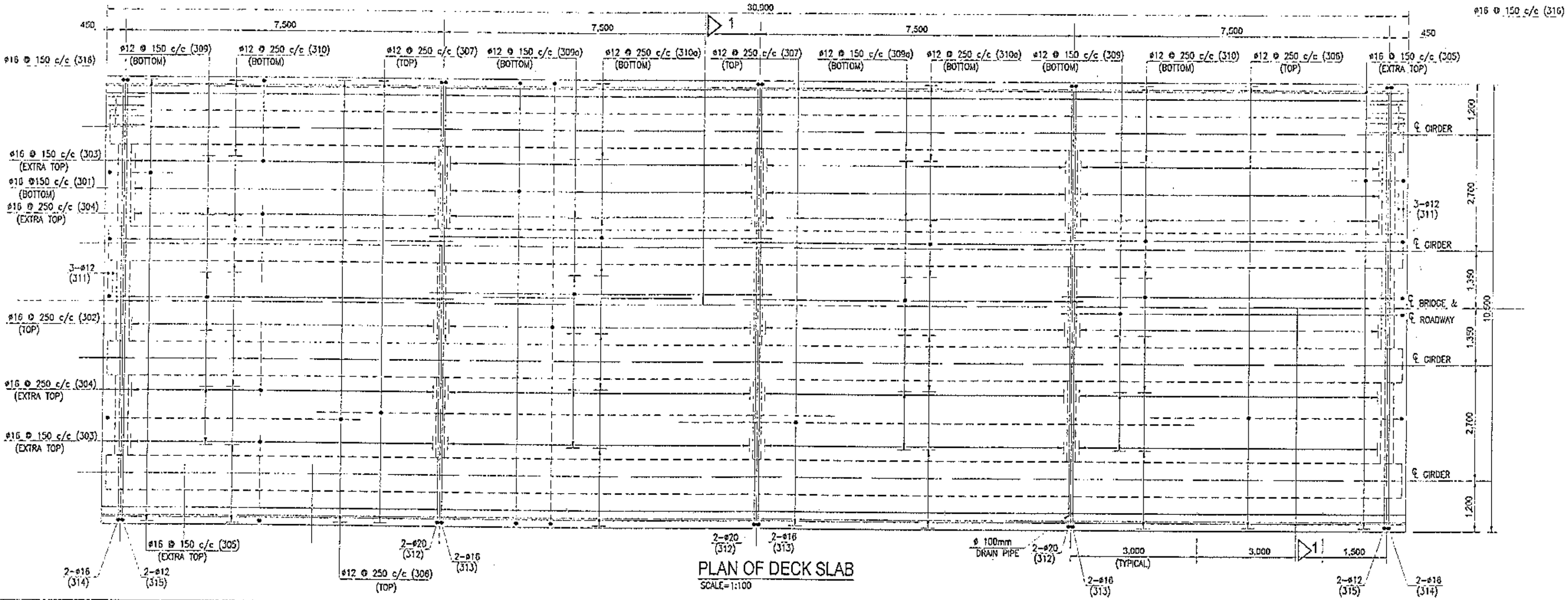
Scale
As Shown

DWG. NO. S1B-01-002



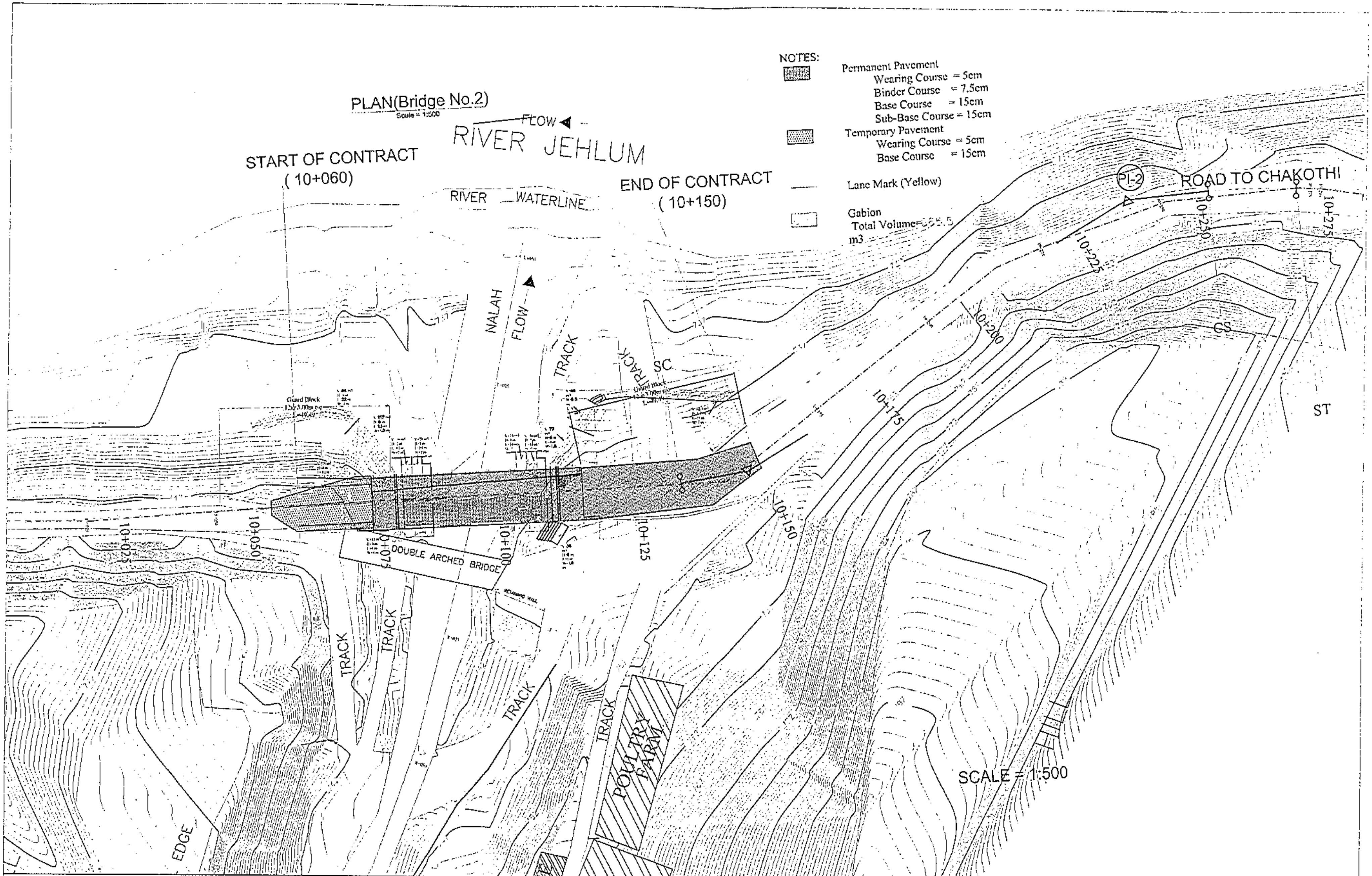
SECTION 1 - 1
SCALE 1:50

NOTES:

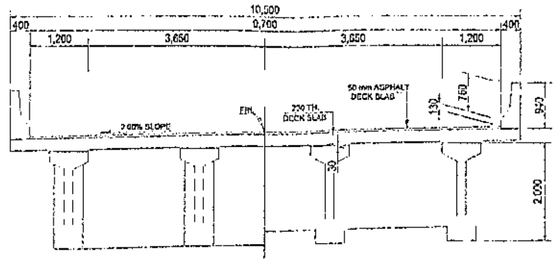


PLAN OF DECK SLAB
SCALE=1:100

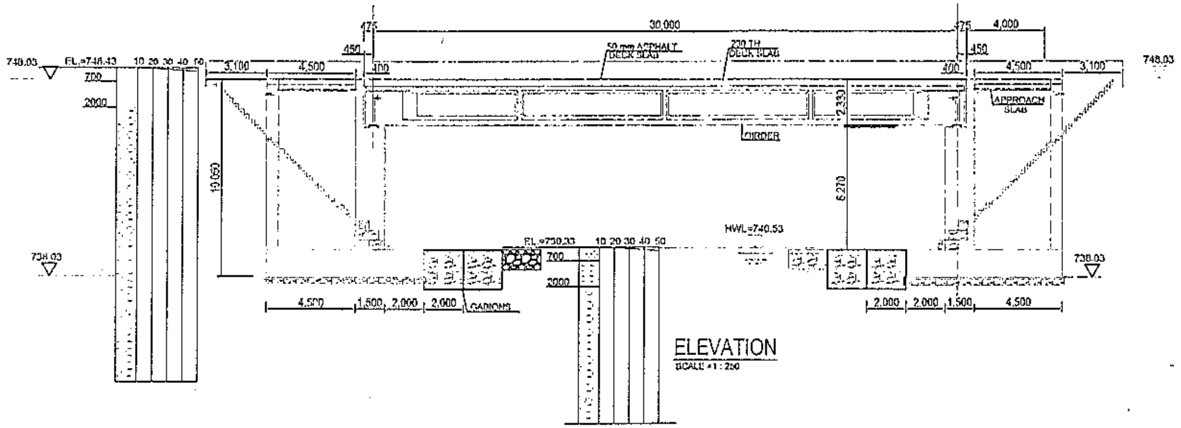
GOVERNMENT OF PAKISTAN MINISTRY OF COMMUNICATIONS NATIONAL HIGHWAY AUTHORITY	JAPAN INTERNATIONAL COOPERATION AGENCY ASSIGNED TO: NIPPON KOEI CO., LTD. (JAPAN) CONSTRUCTED BY SAMBU CONSTRUCTION CO; LTD. (KOREA)	As Built Drawing Date:- 10 Nov 2007 Prepared By: Q.S Mr.Ehsun Munir Checked By: Sambu Mr.E.J.Lee Approved By: Nippon Koi Mr.Yamashita	Technical Assistance for Reconstruction Project of Bridges Damaged by October 8th Earthquake on The Jhelum Valley Road SITE NO.1 BRIDGE WORKS	Reinforcement of Deck Slab DWG. NO. S1B-02-009	Scale As Shown



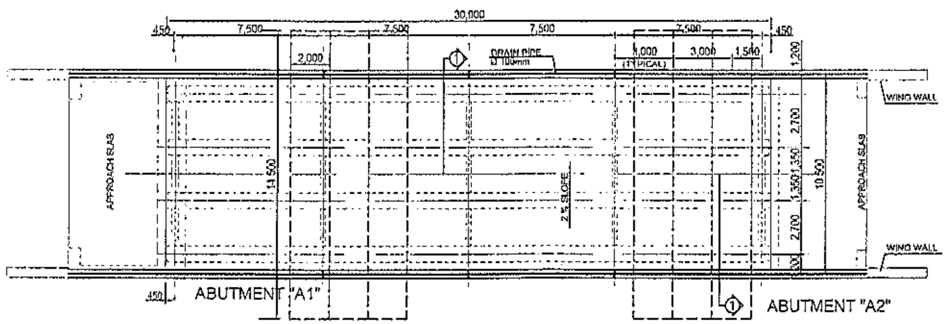
GOVERNMENT OF PAKISTAN MINISTRY OF COMMUNICATIONS NATIONAL HIGHWAY AUTHORITY	JAPAN INTERNATIONAL COOPERATION AGENCY ASSIGNED TO: JICA NIPPON KOEI CO., LTD. (JAPAN) CONSTRUCTED BY: SAMBU CONSTRUCTION CO.LTD. (KOREA)	AS BUILT DRAWING Date:- 10 Nov 2007 Prepared By: Q.S Mr.Ehsun Munir Checked By: Sambu Mr.E.J.Lee Approved By: Nippon Koi Mr.Yamashita	Technical Assistance for Reconstruction Project of Bridges Damaged by October 8th Earthquake on The Jhelum Valley Road SITE NO.2 BRIDGE WORKS	General View of Site No. 2 DATE March, 2006 DWG. NO. S2B-01-001	Scale 1:1,000



SECTION -1 - 1
SCALE =1 : 100

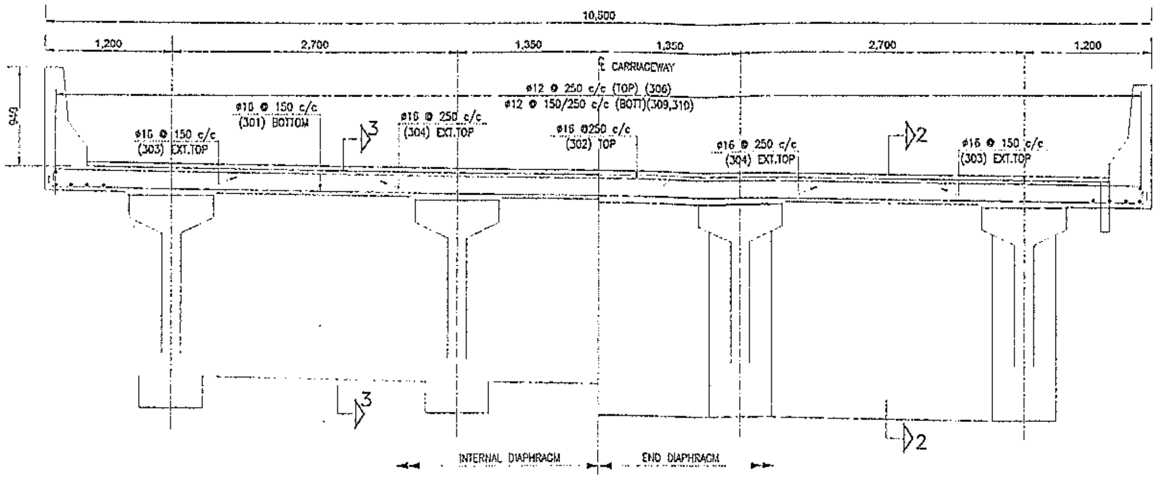


ELEVATION
SCALE =1 : 250



PLAN OF DECK SLAB
SCALE =1 : 250

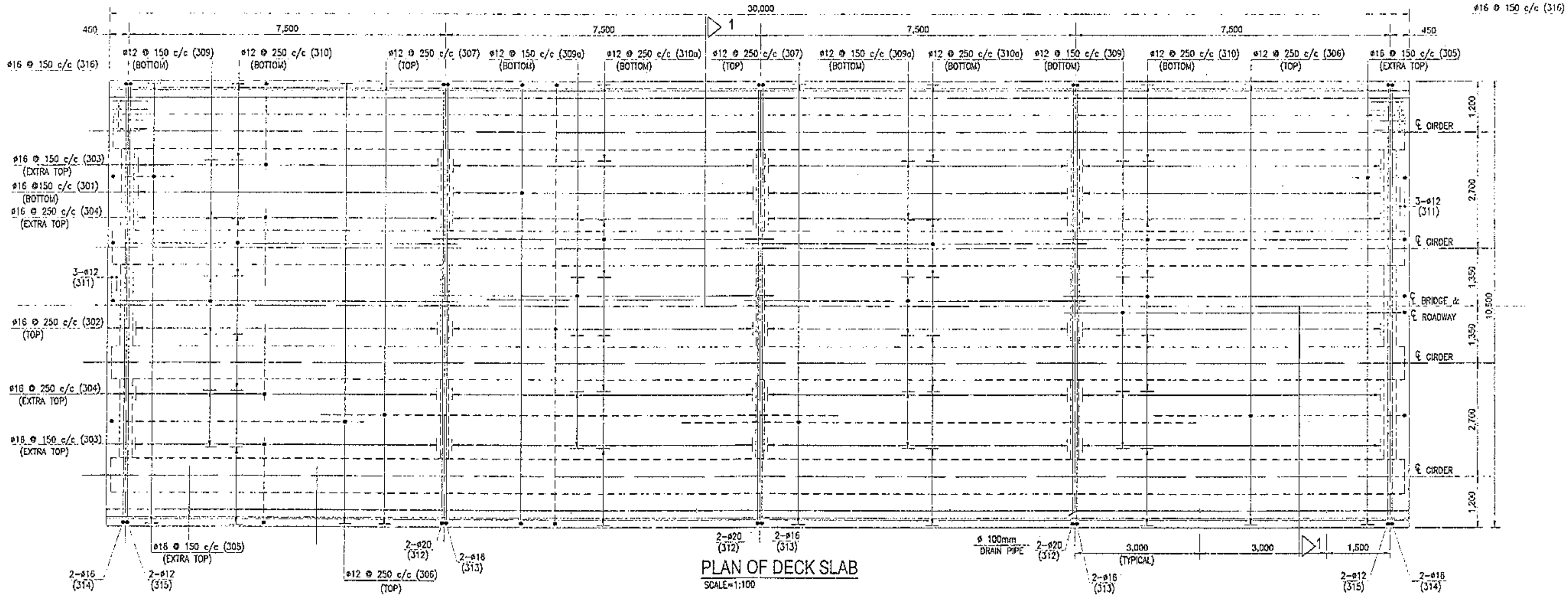
GOVERNMENT OF PAKISTAN MINISTRY OF COMMUNICATIONS NATIONAL HIGHWAY AUTHORITY	JAPAN INTERNATIONAL COOPERATION AGENCY ASSIGNED TO: NIPPON KOEI CO., LTD. (JAPAN) CONSTRUCTED BY SAMBU CONSTRUCTION CO: LTD. (KOREA)	As Built Drawing Date: 10 Nov 2007 Prepared By: Q.S — Mr.Ehsun Munir Checked By: Sambu — Mr.E.J.Lee Approved By: Nippon Koi — Mr.Yamashita	Technical Assistance for Reconstruction Project of Bridges Damaged by October 8th Earthquake on The Jhelum Valley Road SITE NO.2 BRIDGE WORKS	General View of Bridge No. 2 Scale: As Shown DWG. NO. S2B-01-002



SECTION 1 - 1

SCALE 1:50

NOTES:



PLAN OF DECK SLAB

SCALE=1:100

GOVERNMENT OF PAKISTAN MINISTRY OF COMMUNICATIONS NATIONAL HIGHWAY AUTHORITY	JAPAN INTERNATIONAL COOPERATION AGENCY ASSIGNED TO: NIPPON KOEI CO., LTD. (JAPAN) CONSTRUCTED BY SAMBU CONSTRUCTION CO; LTD. (KOREA)

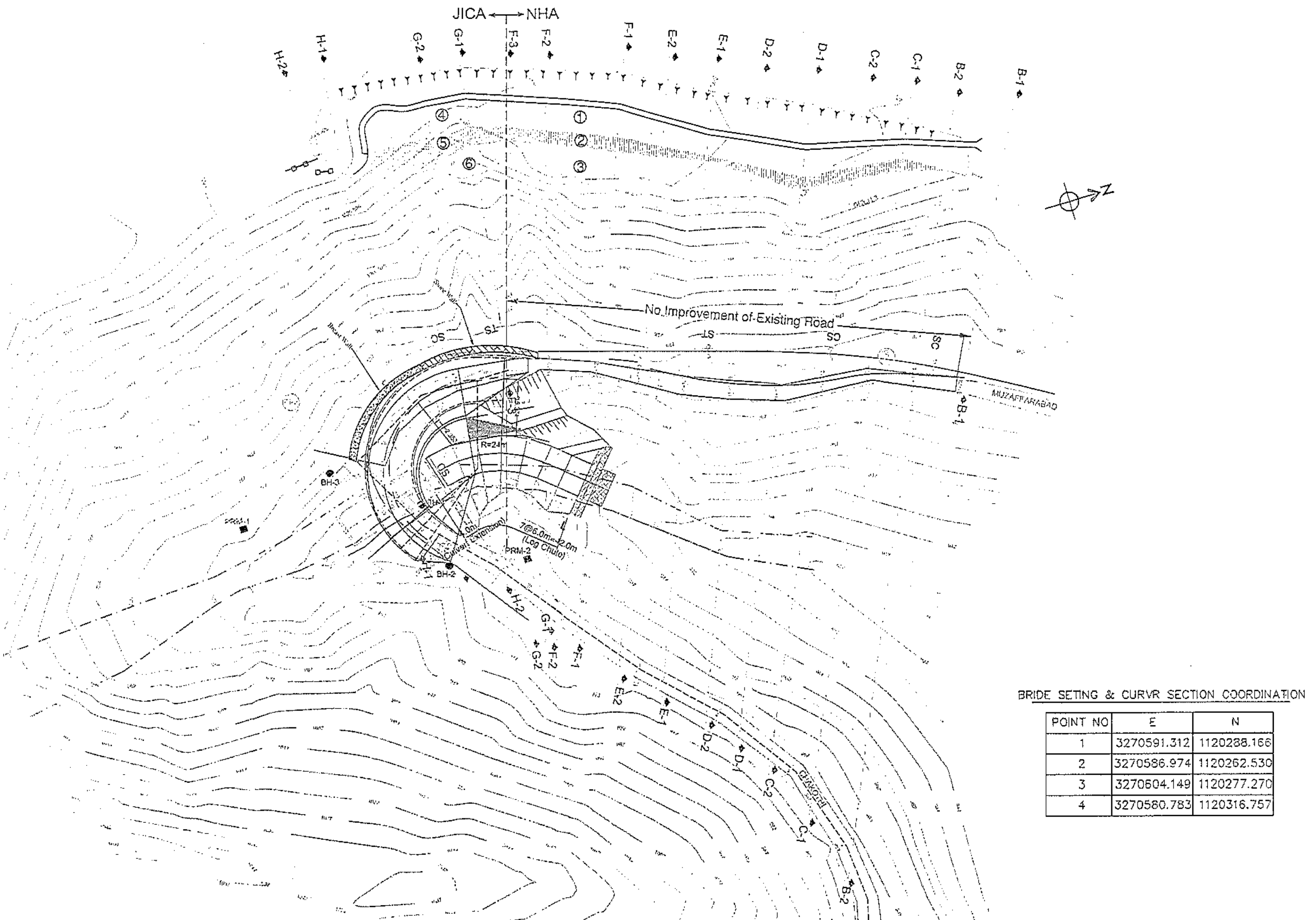
As Built Drawing			
Date:-	10 Nov 2007		
Prepared By:	Q.S	Mr.Ehsun Munir	
Checked By:	Sambu	Mr.E.J.Lee	
Approved By:	Nippon Koi	Mr.Yamashita	

Technical Assistance for Reconstruction Project of Bridges Damaged by October 8th Earthquake on The Jhelum Valley Road
SITE NO.2 BRIDGE WORKS

Reinforcement of Deck Slab

Scale: As Shown

DWG. NO. S2B-02-009



BRIDE SETING & CURVR SECTION COORDINATION

POINT NO	E	N
1	3270591.312	1120288.166
2	3270586.974	1120262.530
3	3270604.149	1120277.270
4	3270580.783	1120316.757

GOVERNMENT OF PAKISTAN
MINISTRY OF COMMUNICATIONS
NATIONAL HIGHWAY AUTHORITY

JAPAN INTERNATIONAL COOPERATION AGENCY
ASSIGNED TO:
NIPPON KOEI CO., LTD. (NK)
ALMEC CORPORATION LTD. (ALMEC)

AS BUILT DRAWING

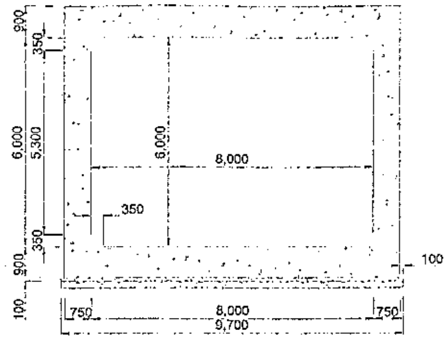
DATE	30 Jan 2008		
PREPARED BY	O.S	Mr.Ehsun Munir	
CHECKED BY	Sambu	Mr.E.J.Lee	
APPROVED BY	Nippon Koi	Mr.Yamashita	

Technical Assistance for Reconstruction Project of Bridge Damaged by October 8th Earthquake on The Jhelum Valley Road
Site No. 3

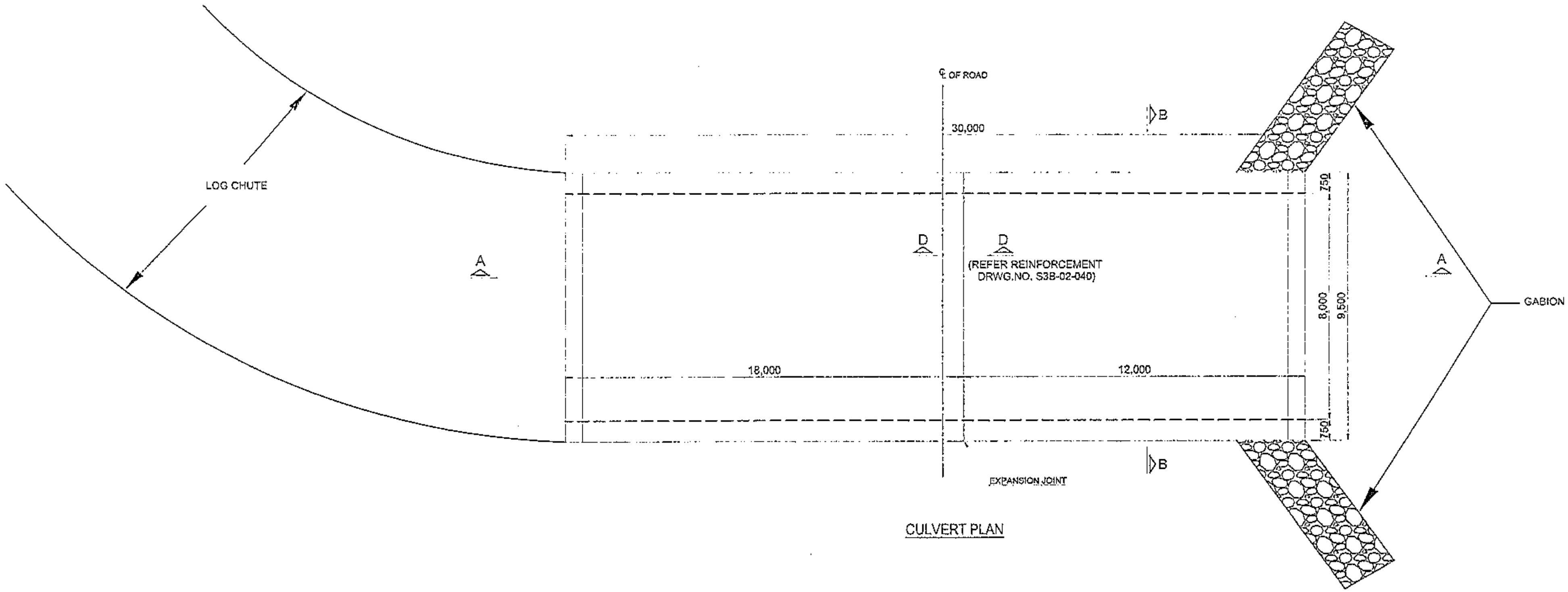
General View Plan

DWG. NO.

SCALE
1:1000

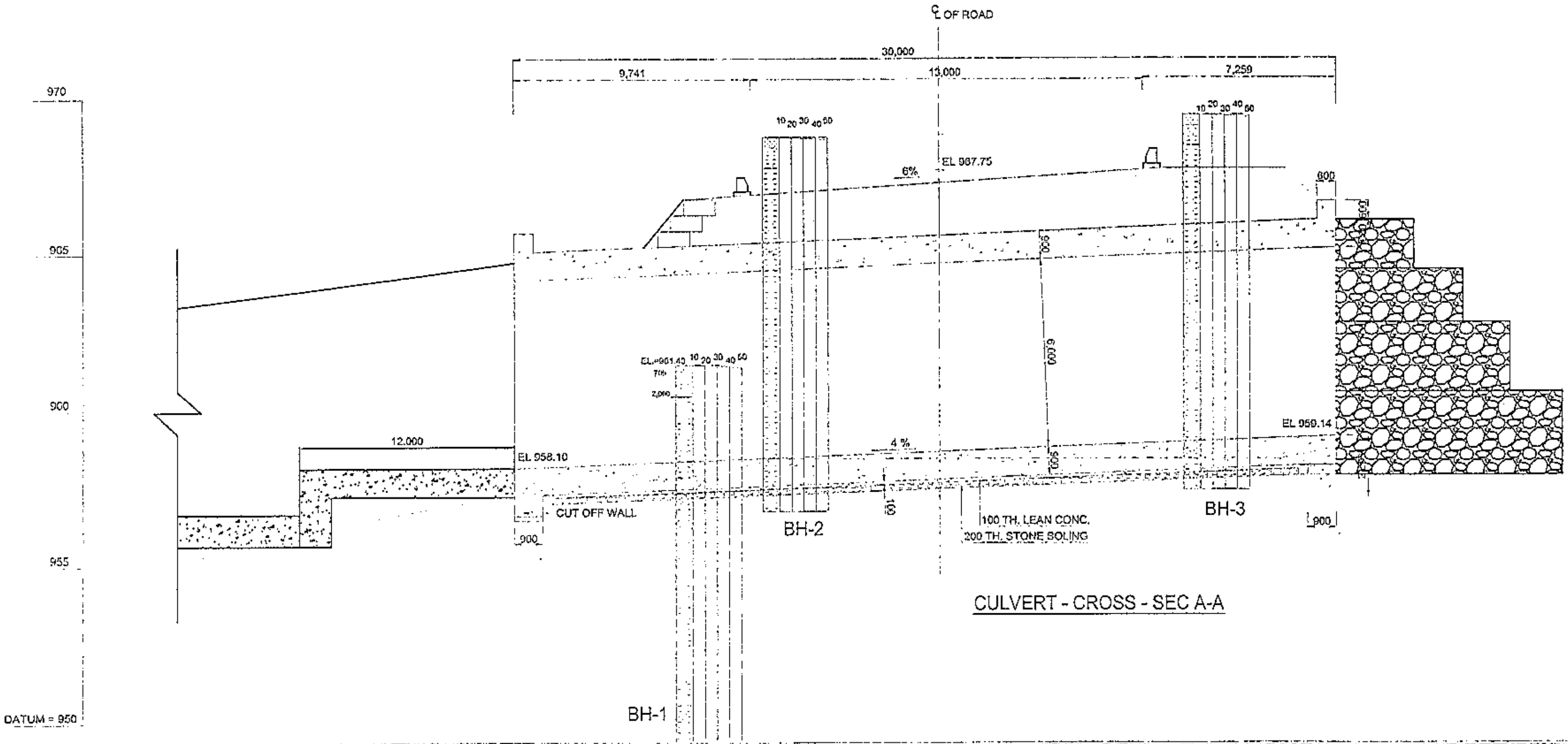


SEC-B-B BOX CULVERT



CULVERT PLAN

GOVERNMENT OF PAKISTAN MINISTRY OF COMMUNICATIONS NATIONAL HIGHWAY AUTHORITY	JAPAN INTERNATIONAL COOPERATION AGENCY JICA ASSIGNED TO: NIPPON KOEI CO., LTD. (NK) ALMEC CORPORATION LTD. (ALMEC)	AS BUILT DRAWING DATE: 30 Jan 2008 PREPARED BY: Q.S — Mr.Ehsun Munir CHECKED BY: Sambu — Mr.E.J.Lee APPROVED BY: Nippon Koi — Mr.Yamashita	Technical Assistance for Reconstruction Project of Bridges Damaged by October 8th Earthquake on The Jhelum Valley Road SITE NO.3 BRIDGE WORKS	General View of Structure No. 3 S=1:150 DWG. NO. S3B-02-003



CULVERT - CROSS - SEC A-A

NSL														
LEVEL	955.26	955.43	956.43	957.43	957.93	958.43	958.43	958.43	958.43	958.93	959.93	960.93	961.93
DISTANCE	-23.69	-22.00	-18.00	-12.50	-7.00	-5.00	0.00	2.25	11.00	13.50	17.00	22.00	25.00

GOVERNMENT OF PAKISTAN
MINISTRY OF COMMUNICATIONS
NATIONAL HIGHWAY AUTHORITY

JAPAN INTERNATIONAL COOPERATION AGENCY
JICA
ASSIGNED TO:
NIPPON KOEI CO., LTD. (NK)
ALMEC CORPORATION LTD. (ALMEC)

AS BUILT DRAWING			
DATE	30 Jan 2008		
PREPARED BY	Q.S	Mr.Ehsan Munir	
CHECKED BY	Sambu	Mr.E.J.Lee	
APPROVED BY	Nippon Koi	Mr.Yamoshita	

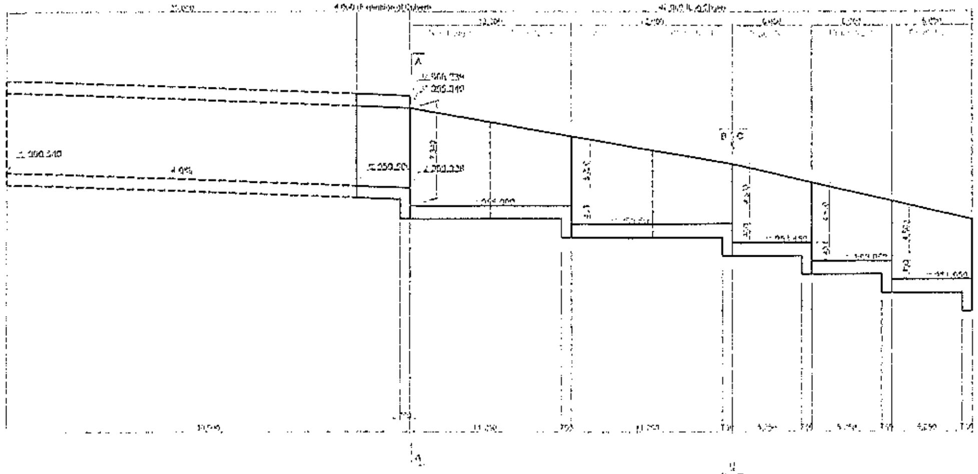
Technical Assistance for Reconstruction Project
of Bridges Damaged by October 8th Earthquake
on The Jhelum Valley Road
SITE NO.3 BRIDGE WORKS

Longitudinal Section of Box Culvert

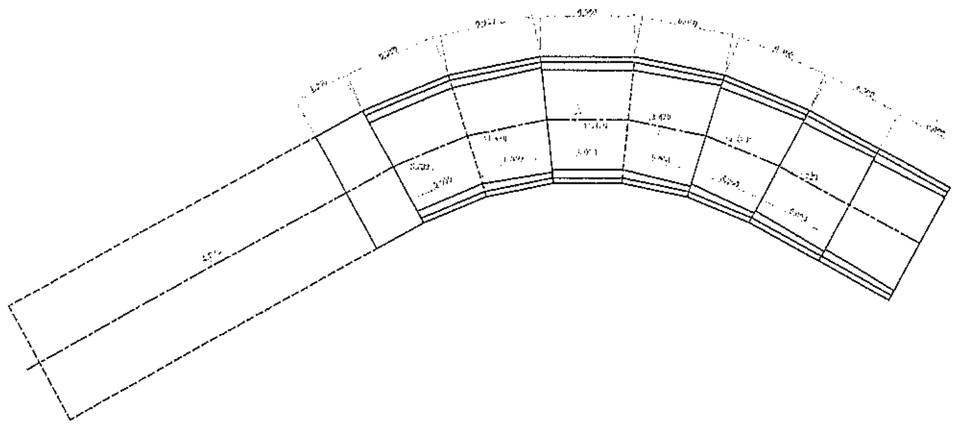
S=1:150

DWG. NO. S3B-02-004

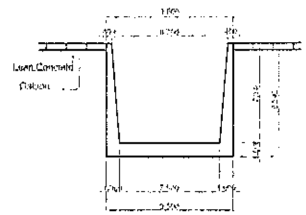
Profile of Log Chute



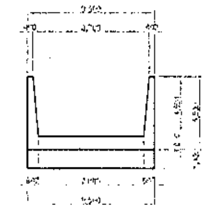
Plane of Log Chute



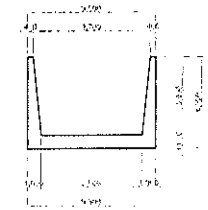
A-A Section



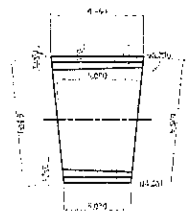
B-B Section



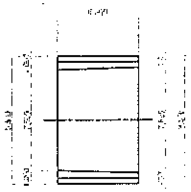
C-C Section



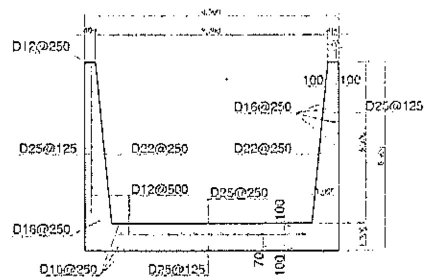
Block No.1 - 5



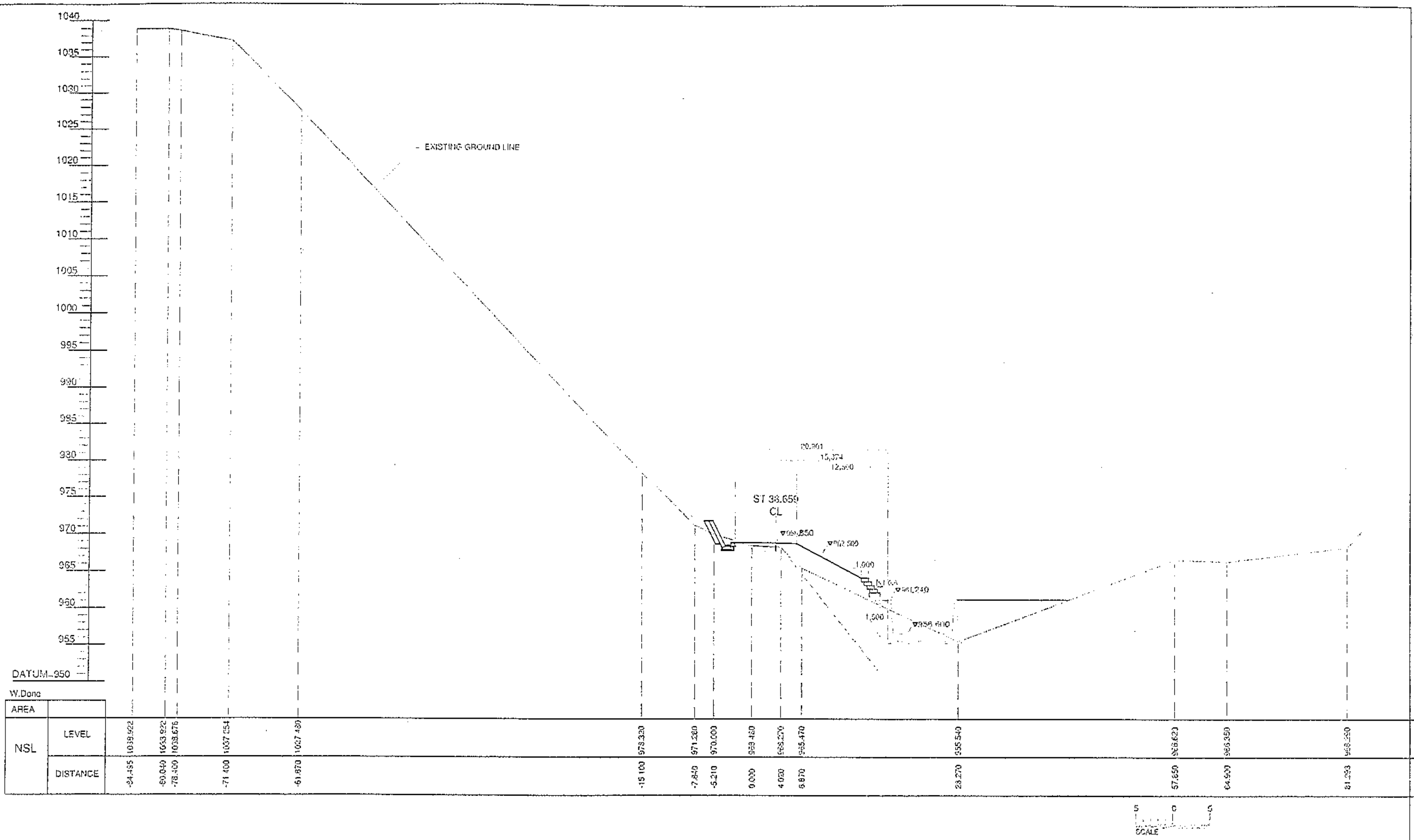
Block No.6 - 7



Reinforcement



GOVERNMENT OF PAKISTAN MINISTRY OF COMMUNICATIONS NATIONAL HIGHWAY AUTHORITY	JAPAN INTERNATIONAL COOPERATION AGENCY ASSIGNED TO: NIPPON KOEI CO., LTD. (NK) ALMEC CORPORATION LTD. (ALMEC)	AS BUILT DRAWING				Technical Assistance for Reconstruction Project of Bridge Damaged by October 8th Earthquake on The Jhelum Valley Road Site No. 3 Slope Protection	DRAWING TITLE Structure of Log Chute Revised
		Date	30 Jan 2008				SCALE 1:400
		Prepared By	Q.S	Mr.Ehsun Munir	[signature]		DWG. NO.
		Checked By	Sambu	Mr.E.J.Lee	[signature]		SLC-001
		Approved By	Nippon Koi	Mr.Yamashita	[signature]		



GOVERNMENT OF PAKISTAN MINISTRY OF COMMUNICATIONS NATIONAL HIGHWAY AUTHORITY	JAPAN INTERNATIONAL COOPERATION AGENCY ASSIGNED TO: NIPPON KOEI CO., LTD. (NK) ALMEC CORPORATION LTD. (ALMEC)

AS BUILT DRAWING

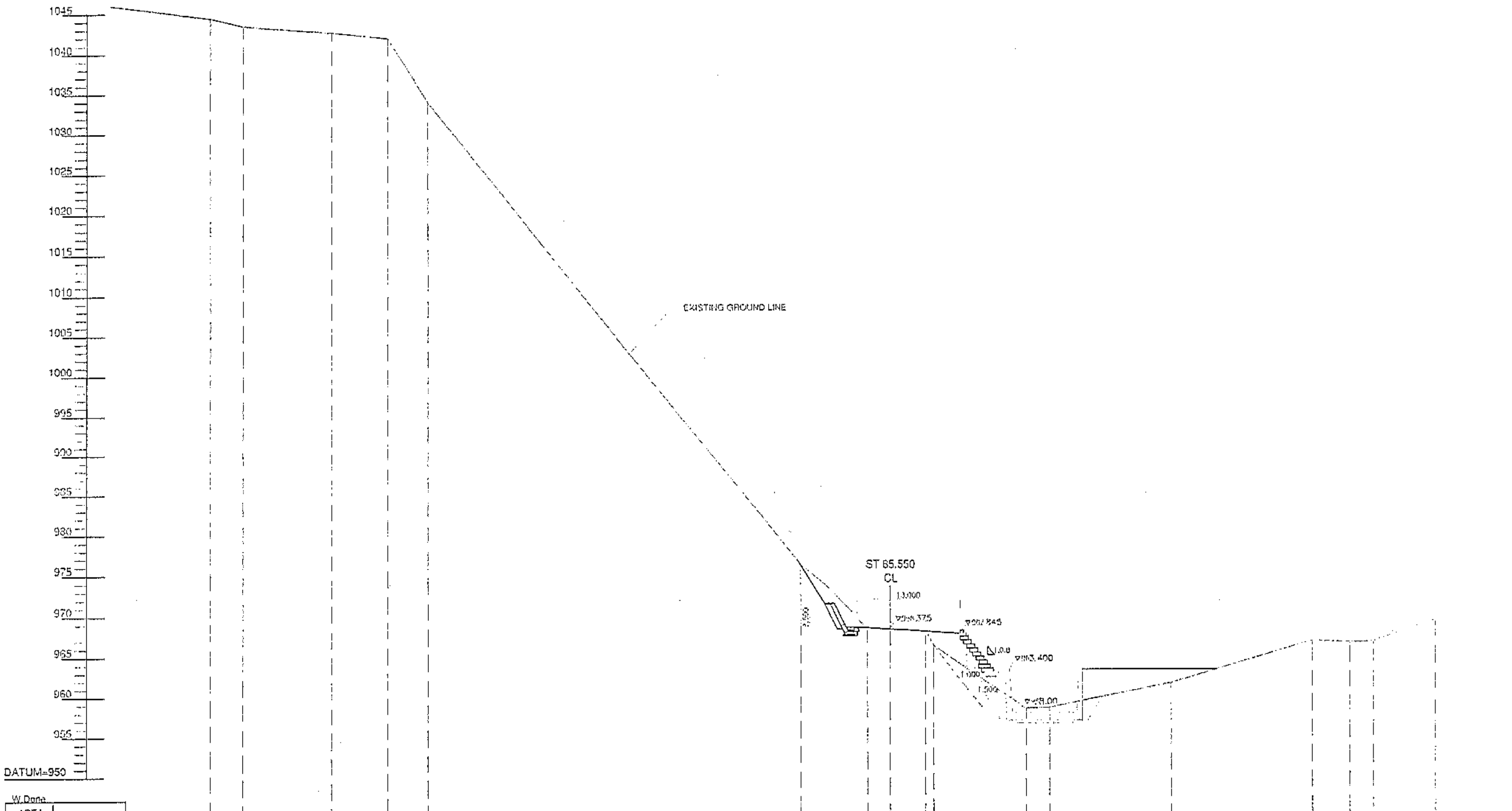
Date	30 Jan 2008		
Prepared BY	Q.S	Mr.Ehsun Munir	
Checked BY	Sambu	Mr.E.J.Lee	
APPROVED BY	Nippon Koi	Mr.Yamashita	

Technical Assistance for Reconstruction Project of Bridge Damaged by October 8th Earthquake on The Jhelum Valley Road
Site No. 3 Slope Protection

DRAWING TITLE: Cross Section F3-F3

SCALE 1:700

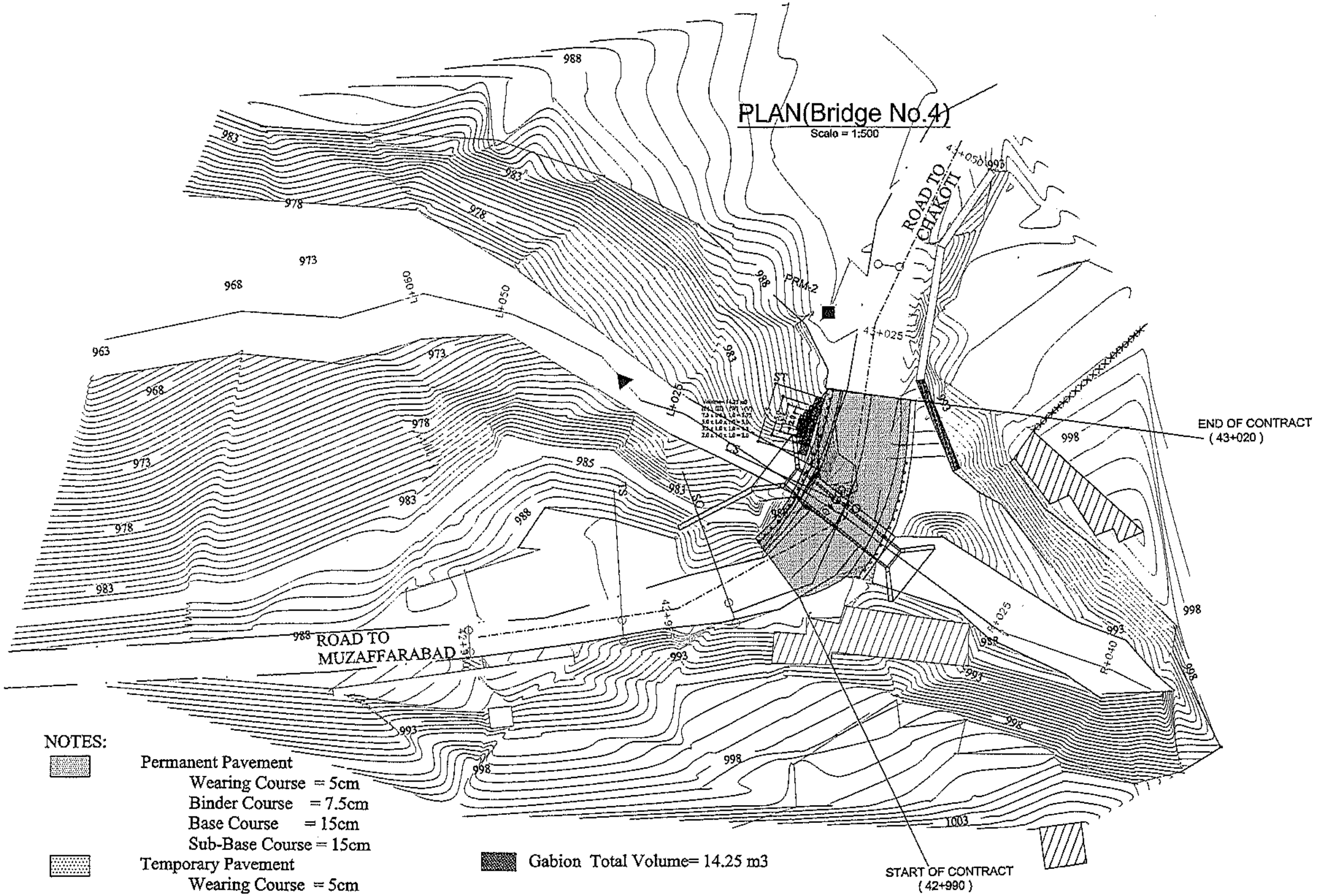
DWG. NO. S3S-01-001



W.Done AREA																			
NSL	LEVEL	1044.428	1043.428	1042.589	1041.934	1033.950	970.280	973.280	968.400	968.340	968.280	965.410	958.530	958.620	961.710	966.500	966.670	966.770	969.400
	DISTANCE	-65.000	-60.940	-69.940	-62.940	-57.500	-11.200	-7.330	-2.800	0.000	4.500	5.493	17.160	20.030	35.300	53.000	57.650	60.570	68.290

5 0 5
SCALE

GOVERNMENT OF PAKISTAN MINISTRY OF COMMUNICATIONS NATIONAL HIGHWAY AUTHORITY	JAPAN INTERNATIONAL COOPERATION AGENCY ASSIGNED TO: NIPPON KOEI CO., LTD. (NK) ALMEC CORPORATION LTD. (ALMEC)	AS BUILT DRAWING			Technical Assistance for Reconstruction Project of Bridge Damaged by October 8th Earthquake on The Jhelum Valley Road Site No. 3 Slope Protection	DRAWING TITLE Cross Section H2-H2	SCALE 1:700
		DATE: –	30 Jan 2008				
		Prepared BY: –	O.S	Mr.Ehsan Munir		DWG. NO.	
		CHECKED BY	Sambu	Mr.E.J.Lee			
		APPROVED BY	Nippon Koi	Mr.Yamashita			S3S-01-002

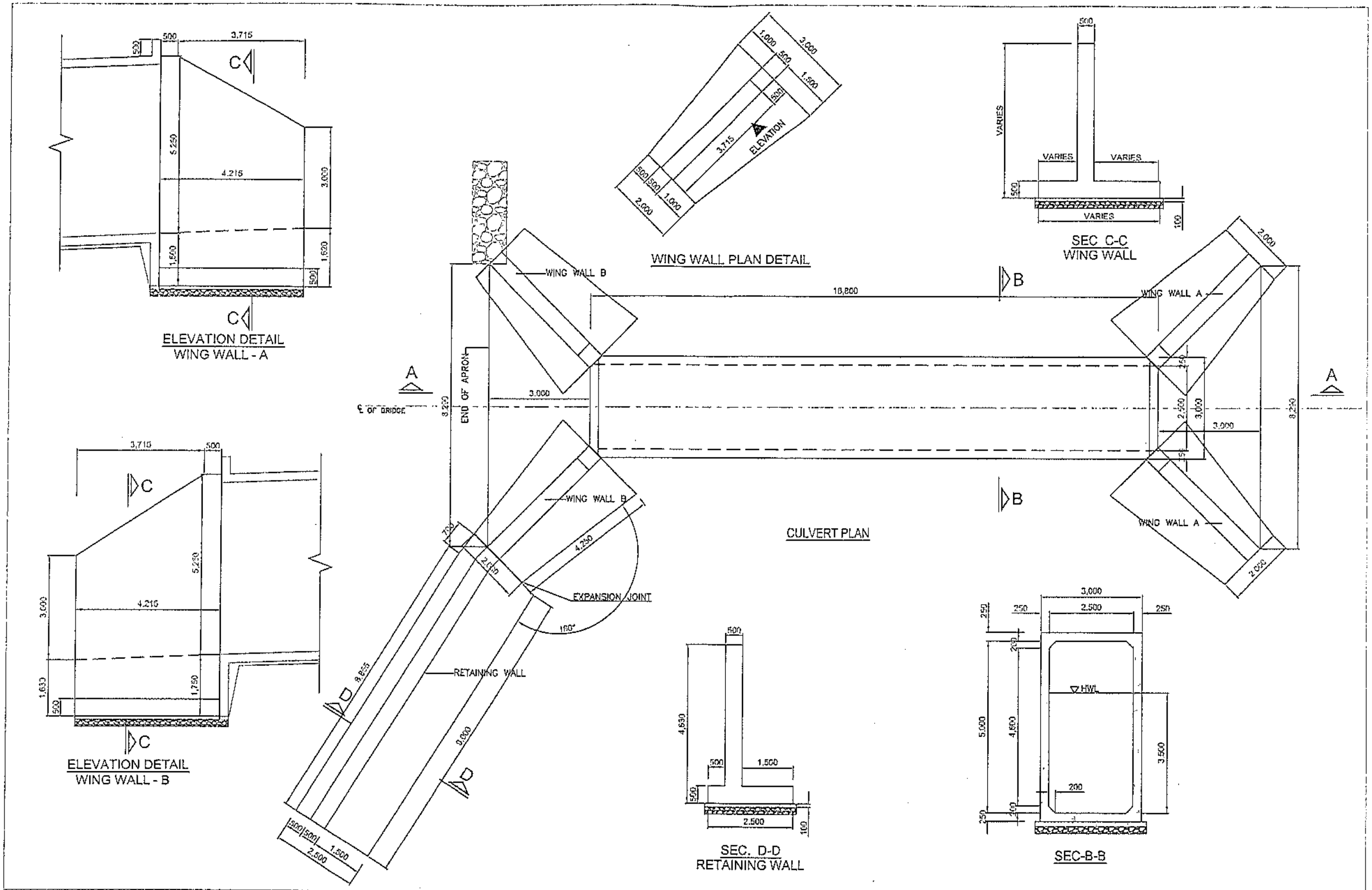


NOTES:

- Permanent Pavement
  - Wearing Course = 5cm
  - Binder Course = 7.5cm
  - Base Course = 15cm
  - Sub-Base Course = 15cm
- Temporary Pavement
  - Wearing Course = 5cm
  - Base Course = 15cm
- Lane Mark (Yellow)

Gabion Total Volume= 14.25 m3

GOVERNMENT OF PAKISTAN MINISTRY OF COMMUNICATIONS NATIONAL HIGHWAY AUTHORITY	JAPAN INTERNATIONAL COOPERATION AGENCY ASSIGNED TO: NIPPON KOEI CO., LTD. (JAPAN) CONSTRUCTED BY: SAMBU CONSTRUCTION CO.LTD. (KOREA)	AS BUILT DRAWING Date:- 10 Nov 2007 Prepared By: Q.S Mr.Ehsun Munir Checked By: Sambu Mr.E.J.Lee Approved By: Nippon Koi Mr.Yamashita	Technical Assistance for Reconstruction Project of Bridges Damaged by October 8th Earthquake on The Jhelum Valley Road SITE NO.1 BRIDGE WORKS	General View of Site No. 4 DWG. NO. S1B-01-001	Scale 1:1,000



GOVERNMENT OF PAKISTAN
MINISTRY OF COMMUNICATIONS
NATIONAL HIGHWAY AUTHORITY

JAPAN INTERNATIONAL COOPERATION AGENCY
ASSIGNED TO:
NIPPON KOEI CO., LTD. (JAPAN)
CONSTRUCTED BY
SAMBU CONSTRUCTION CO; LTD. (KOREA)

As Built Drawing

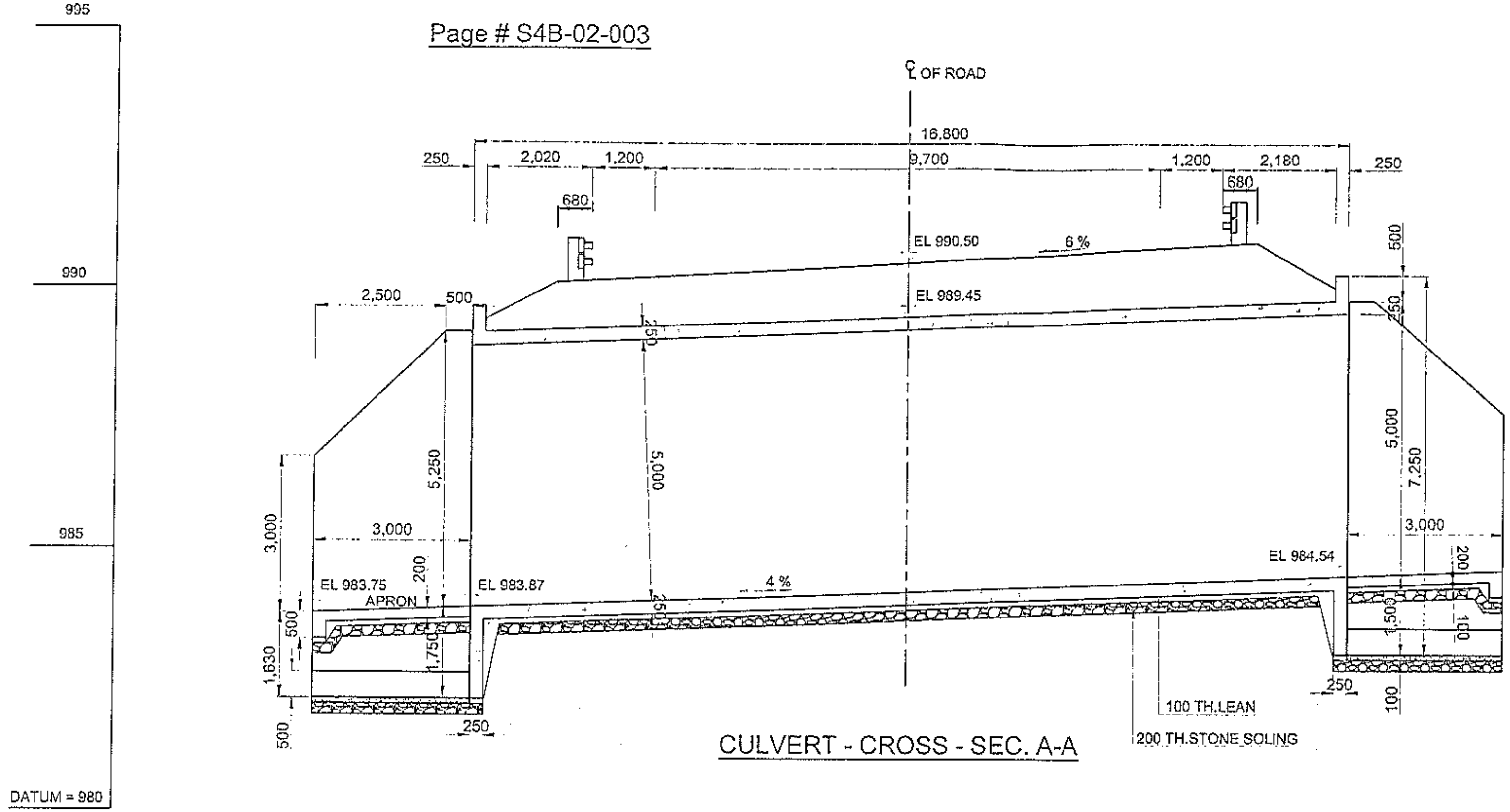
Date:-	10 Nov 2007		
Prepared By:	O.S	Mr.Ehsan Munir	
Checked By:	Sambu	Mr.E.J.Lee	
Approved By:	Nippon Koi	Mr.Yamashita	

Technical Assistance for Reconstruction Project
of Bridges Damaged by October 8th Earthquake
on The Jhelum Valley Road
SITE NO.4 BRIDGE WORKS

General View of Structure No.4 S=1:100

DWG. NO. S4B-02-002

Page # S4B-02-003



CULVERT - CROSS - SEC. A-A

NSL						
LEVEL	983.37	984.02	985.64	987.37	990.47
DISTANCE	-12.19	0.00	5.43	10.84	20.16

GOVERNMENT OF PAKISTAN
MINISTRY OF COMMUNICATIONS
NATIONAL HIGHWAY AUTHORITY

JAPAN INTERNATIONAL COOPERATION AGENCY
ASSIGNED TO:
NIPPON KOEI CO., LTD. (JAPAN)
CONSTRUCTED BY
SAMBU CONSTRUCTION CO: LTD. (KOREA)

As Built Drawing			
Date:-	10 Nov 2007		
Prepared By:	Q.S	Mr.Ehsan Munir	[signature]
Checked By:	Sambu	Mr.E.J.Lee	[signature]
Approved By:	Nippon Koi	Mr.Yamashita	[signature]

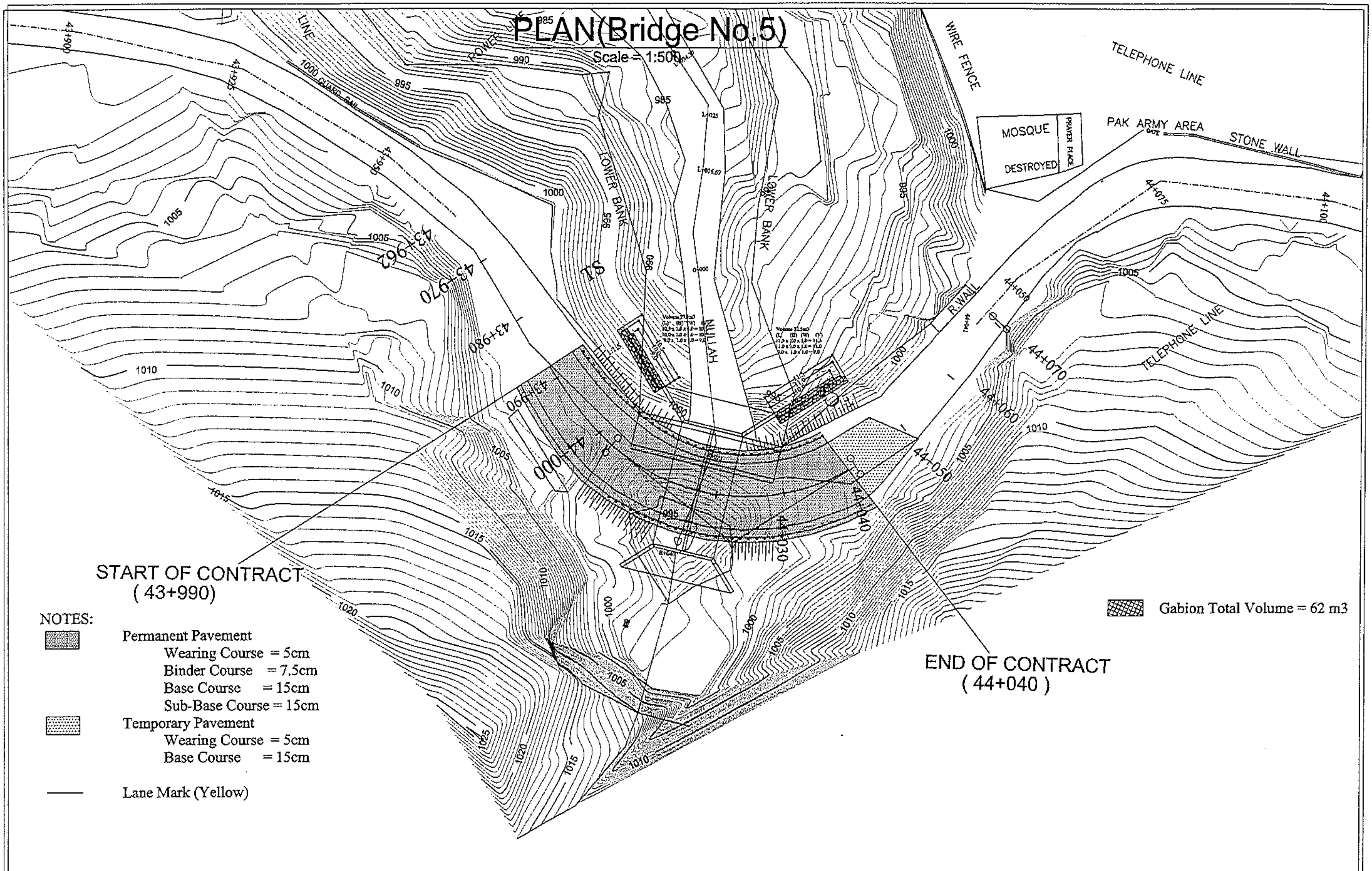
Technical Assistance for Reconstruction Project
of Bridges Damaged by October 8th Earthquake
on The Jhelum Valley Road
SITE NO.4 BRIDGE WORKS

Longitudinal Section of Box Culvert S=1:100

DWG. NO. S4B-02-003

PLAN(Bridge No.5)

Scale = 1:500

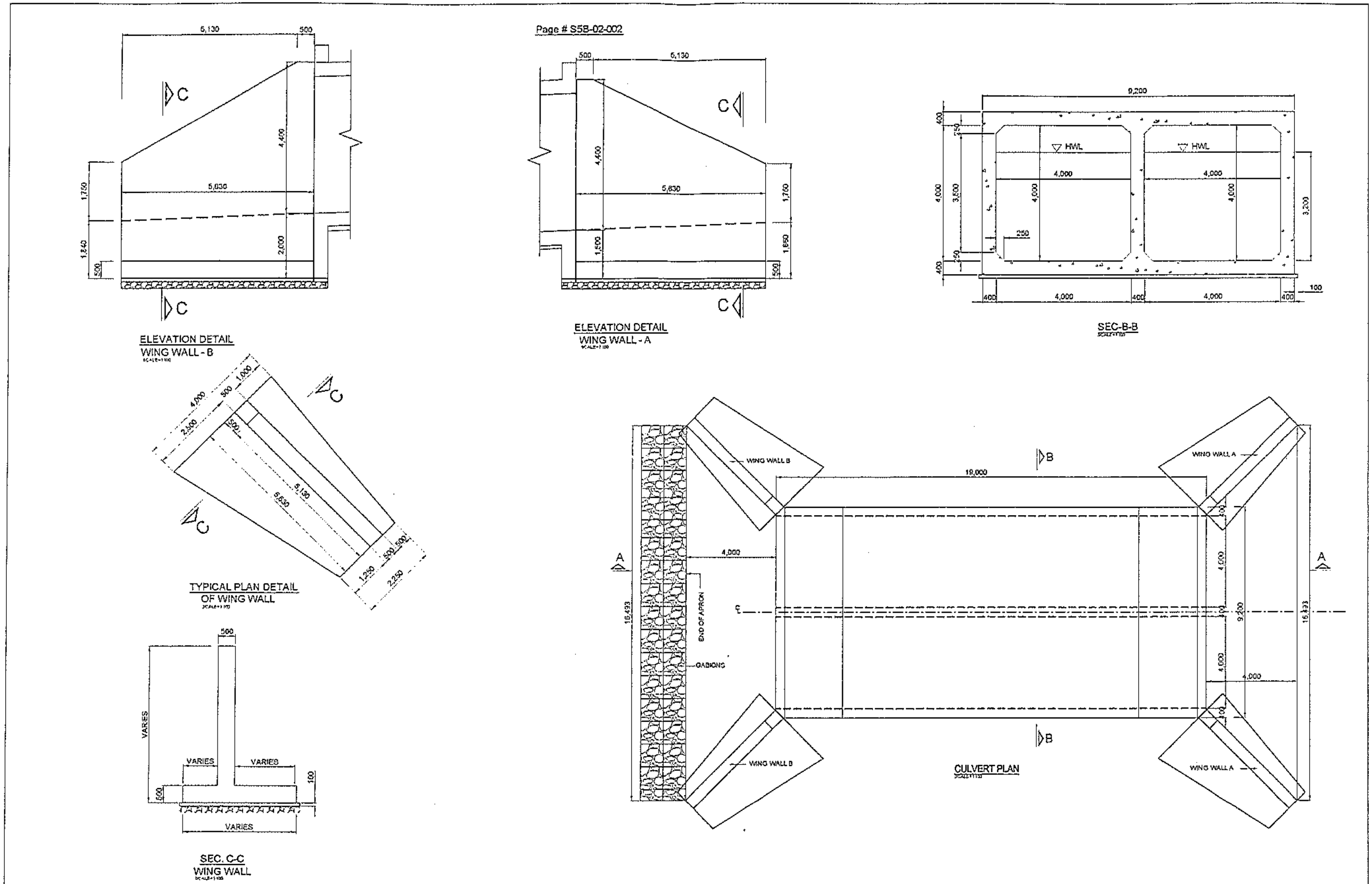


NOTES:

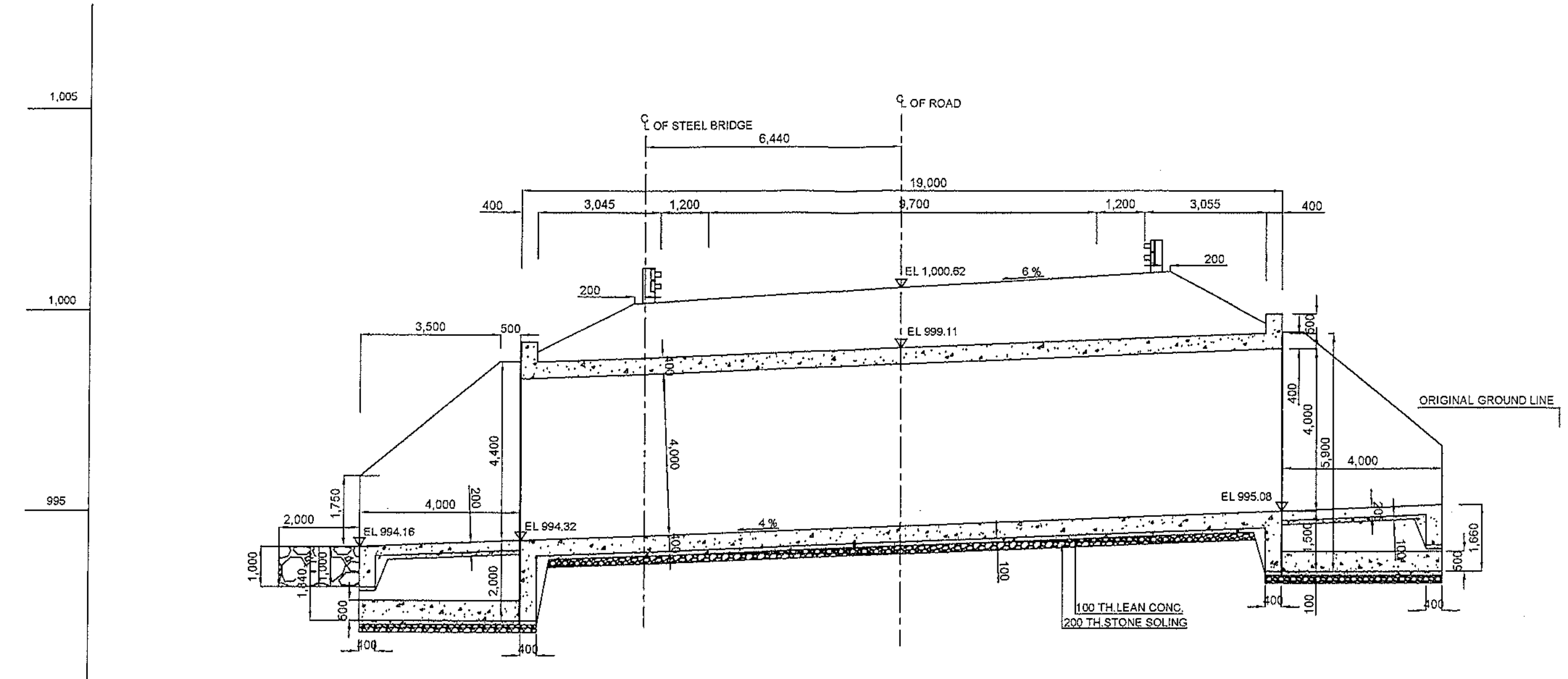
- Permanent Pavement
  - Wearing Course = 5cm
  - Binder Course = 7.5cm
  - Base Course = 15cm
  - Sub-Base Course = 15cm
- Temporary Pavement
  - Wearing Course = 5cm
  - Base Course = 15cm
- Lane Mark (Yellow)

GOVERNMENT OF PAKISTAN MINISTRY OF COMMUNICATIONS NATIONAL HIGHWAY AUTHORITY	JAPAN INTERNATIONAL COOPERATION AGENCY ASSIGNED TO: NIPPON KOEI CO., LTD. (JAPAN) CONSTRUCTED BY: SAMBU CONSTRUCTION CO.LTD. (KOREA)	AS BUILT DRAWING			Technical Assistance for Reconstruction Project of Bridges Damaged by October 8th Earthquake on The Jhelum Valley Road SITE NO.1 BRIDGE WORKS	General View of Site No. 5 Scale 1:1,000 DWG. NO. S1B-01-001
		Date:-	10 Nov 2007			
		Prepared By:	Q.S	Mr.Ehsun Munir		
		Checked By:	Sambu	Mr.E.J.Lee		
		Approved By:	Nippon Koi	Mr.Yamashita		

Page # S5B-02-002



GOVERNMENT OF PAKISTAN MINISTRY OF COMMUNICATIONS NATIONAL HIGHWAY AUTHORITY	JAPAN INTERNATIONAL COOPERATION AGENCY ASSIGNED TO: JICA NIPPON KOEI CO., LTD. (JAPAN) CONSTRUCTED BY: SAMBU CONSTRUCTION CO. LTD. (KOREA)	AS BUILT DRAWING			Technical Assistance for Reconstruction Project of Bridges Damaged by October 8th Earthquake on The Jhelum Valley Road SITE NO.5 BRIDGE WORKS	General View of Structure No. 5	SCALE AS SHOWN
		Date:-	10 Nov 2007			DWG. NO.	S5B-02-002
		Prepared By:	Q.S	Mr.Ehsan Munir			
		Checked By:	Sambu	Mr.E.J.Lee			
		Approved By:	Nippon Koi	Mr.Yamashita			



CULVERT - CROSS - SEC. A-A

NSL																	
LEVEL	991.07	999.394	999.394	1,000.63	1,000.63	999.07	997.07	996.57	995.57	995.07	995.07	995.57	996.07	996.57	997.07
DISTANCE	-21.77	-16.00	-8.54	-8.54	-4.34	-3.50	0.00	0.58	2.25	4.51	8.84	10.00	11.64	13.27	14.68

GOVERNMENT OF PAKISTAN
MINISTRY OF COMMUNICATIONS
NATIONAL HIGHWAY AUTHORITY

JAPAN INTERNATIONAL COOPERATION AGENCY
ASSIGNED TO:
NIPPON KOEI CO., LTD. (JAPAN)
CONSTRUCTED BY:
SAMBU CONSTRUCTION CO; LTD. (KOREA)

AS BUILT DRAWING			
Date:-	10 Nov 2007		
Prepared By:	Q.S	Mr.Ehsun Munir	
Checked By:	Sambu	Mr.E.J.Lee	
Approved By:	Nippon Koi	Mr.Yamashita	

Technical Assistance for Reconstruction Project of Bridges Damaged by October 8th Earthquake on The Jhelum Valley Road
SITE NO.5 BRIDGE WORKS

Longitudinal Section of Box Culvert — S=1:150

DWG. NO. SSB-02-003

APPENDIX - B

B-2: Justification of the Modifications in the No.3 Bridge Slope Protection Work

Jhelum Valley Road No.3 Cut Slope Protection for the Access Road of Srei Bridge

03/Jul/2006
JICA Study Team Geologist
Yasushi MOMOSE

1. Background

The Jhelum Valley Road plays an important role on the road network not only in the AJK but in the northern part of Pakistan. The October 8 earthquake caused serious damages on the Jhelum Valley Road. The reconstruction of the following damaged structures will start in the current fiscal term.

- ✓ No.1 Subri Bridge on Km 6+600
- ✓ No.2 Tundali Bridge on Km10+100
- ✓ No.3 Seri Bridge on Km31+200
- ✓ No.4 Box Culvert on Km41+300
- ✓ No.5 Kucha Bridge on Km42+600

The No.3 Seri Bridge on Km31+200 is situated on the left bank of the Jhelum River. As a consequence of the October 8 Earthquake (M-7.6), the approach road of the No.3 Seri Bridge was either destroyed by landslides or blocked by landslide materials. Even now some collapse-prone slopes are the existent hazard along the road.

On the basis of the layout of the new road and bridge, the center line of the existing road will be shifted 5.0 to 8.0 m into the mountainous side; therefore, further excavation at the mountain side needs to be performed to widen the existing road.

In order to effectively mitigate the road slope disasters, more detailed study with slope stability analysis is required for maintaining the traffic operation of the new road; it is thus crucial issue to protect the cut slope against further local collapses as the long-term safety.

The purposes of this technical assistance are the following;

- To conduct detailed geotechnical investigation on No.3 approach road slope,
- To clarify the slope failure mechanism during earthquake condition as well as in ordinary condition for disaster mitigation,
- To estimate the stability gradient of the slope for suitable slope design, and
- To design the necessary slope protection.

2. Topography

No.3 Seri Bridge is located across a left branch of the Jhelum River at sp. 31,200. The studied slope of sp. 31,025-sp. 31, 200 is approximately 60 to 80 m high and 10 to 50 m deep below the road, forming a gradient slope of about 50 to 60 degrees. A high terrace plain with an elevation of approximately 1,040 m spreads above the road slope. The plain is used for paddy field or residences partially. A small ditch for local irrigation lies on the middle of the slope, although it is not in use due to the damage by the October 8th earthquake.

Based on the site observation, gradient of natural slope applied at No.3 approach road is shown as below.

Slope Type	Applied gradient（V:H）
Covered by vegetation:	1:0.8~1:1.0
Without vegetation:	1:1.2 and above

3. Geology

The study site is underlined by Miocene sandstone and siltstone, and the bed rocks are covered by thick terrace deposits.

The terrace deposits are composed of sub-angular to sub-rounded gravels (average size: 2-10 cm in diameter, maximum: 200 cm in diameter) with clayey matrix. According to the previous study carried out in March 2006, SPT value of the deposits shows more than 50 and the deposits are well cemented and very stiff.

Water seepage has been observed at the foot of the road slope near the abutment of the bridge.

4. Results of Geological Investigation

4.1 Slope failure during October 8th Earthquake

Four small scale collapses occurred at the study site during October 8th Earthquake. Relatively a large scale slope failures is observed about 70 m upstream of the Seri Bridge. Slope failures are summarized in Table 1 and the locations are illustrated in Figure 1.

Table 1 Slope Failure List caused by October 8th Earthquake

No.	Location	Scale (approx.)				Topographic feature
		length (m)	Width (m)	depth (m)	Volume (m^3)	
1	31+070 ~31+080	10	10	2-3	200	Convex slope, shoulder
2	31+085 ~31+095	5	10	2-3	100	Shoulder
3	31+100 ~31+110	20	10	2-3	300	Convex slope
4	31+135 ~31+145	25	10	2-3	300	Convex slope, shoulder
5	70 m upstream of the Seri Bridge	40	25	<10	5,000	Convex slope, shoulder

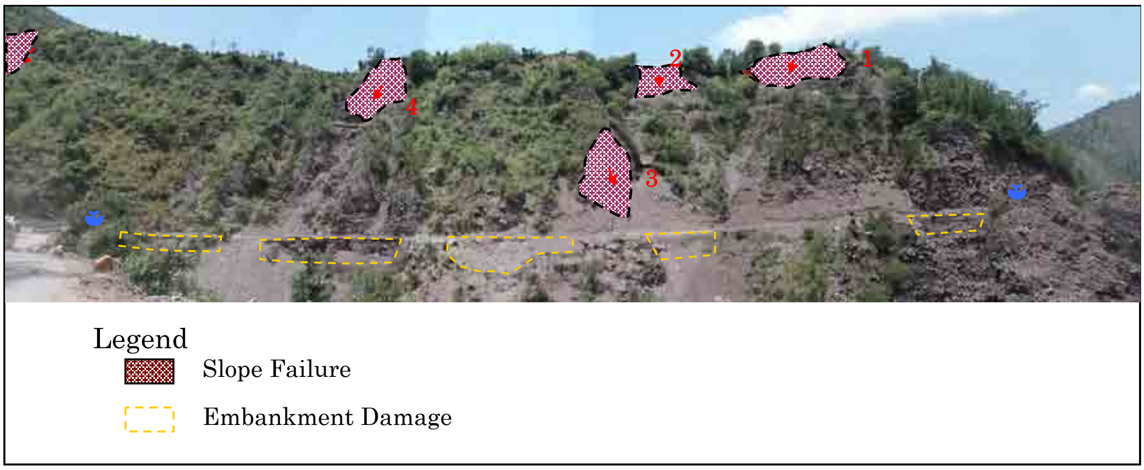


Figure 1 Slope Failure during October 8th Earthquake

The characteristics of the slope failures during the October 8th Earthquake are as follows:

- Convex slopes or slope shoulders were damaged.
- Almost of collapse at the slope is flaking of 2-3 m in thickness.
- Visible slipped planes indicate open cracks had occurred before the earthquake.

Therefore the following measures are necessary for earthquake-proof safe slope.

- Cutting the convex slope and smoothening the surface of the slope
- Removing loose zone of the slope shoulders or overhangs where open cracks are observed.

4.2 Present Slope Condition (After October 8th Earthquake)

Collapse-prone slopes at the project site are summarized in Table 2 and their locations are illustrated in Figure 2.

Table 2 Collapse-prone Slope List after October 8th Earthquake

No.	Location	Collapse-prone Area (approx.)					Protection measure	Remarks
		length (m)	width (m)	thick-ness (m)	volume (m^3)	Height from the road (m)		
1	31+000 ~31+040	15	40	1-3	1,000	15		Out of the contract area
2	31+020 ~31+025	5	7	1-2	50	60	Remove	
3	31+025 ~31+033	5	8	1-2	50	65	Remove	
4	31+050 ~31+065	15	15	2-3	300	30	Remove	
5	31+135 ~31+145	25	10	<1	200	60	Remove	
6	31+25 ~31+	5-20	5	1-2	25-125	5-15	Remove	
7	31+170 ~31+200	25	30	3-4	2,500	20	Remove Retaining wall	
8	70 m upstream of the Seri Bridge	40	40	20+	30,000+	70	Filling cracks and gabion works	Although out of contract area, it would cause debris flow and might damage the new bridge.

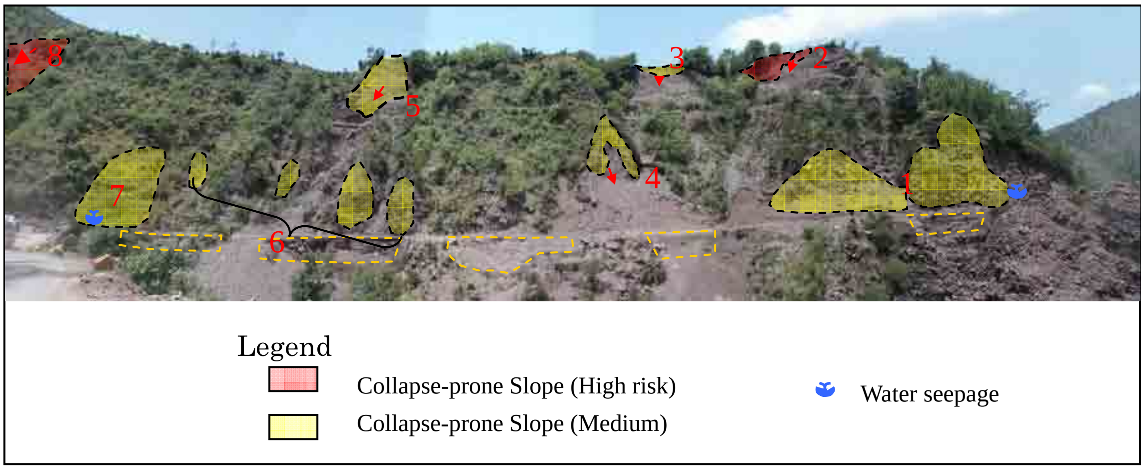


Figure 2 Present Slope Condition

All collapse-prone slopes at the project site are relatively small sized and can be removed by excavation work.

However, water seepage is observed at the foot of the collapse-prone slope No.7, where the materials of the sediment are relatively soft. Construction of a retaining wall at the foot of the cut slope is necessary to ensure the stability of this section.

Although collapse-prone slope No.8 is situated out of the project area, several open cracks, about 2 to 5 cm wide, are observed on the top plain surface. These cracks are parallel to the cliff face.

The cracks on the cliff face are likely to collapse again in the future earthquakes and during heavy rainfall.

The collapsed debris partially dammed the stream. During a rainy season, the collapsed materials are muck likely to form a debris flow, which will cause a considerable damage to the bridge. Further, the cracked portions of the valley wall have a high potential for collapse during rainfall or earthquakes.

In order to guarantee the safety execution, therefore, the following works are required

- Removal of collapse debris at the lower portion of the slope.
- Crack filling with clay to prevent infiltration of surface water through these open cracks.
- Gabion work at the foot of the slope (about 100 m long).

5. Stable Gradient for Slope Stability

Most appropriate gradient of natural slope at No.3 Bridge approach road is V:H= 1:0.8~1:1.0. The slope is almost stable at the gradient of V:H=1:0.8 except for small-scale slope failures expected in some barren portions due to erosion and scoring by surface water.

Terrace deposits at the site are well-cemented, very stiff and solid as if soft rock. In addition, low ground water level and dry condition of the site contributes conditions towards the slope stability.

Considering the above site condition, slope gradient of V:H=1:1.0 (Steeper limit of dense sandy soil) for the cut slope is thus best applicable according to the past experience in Japan as shown in the following Table 3, although slope protection work is necessary to prevent surface erosion and succeeding small-scale collapses due to erosive characteristics of the ground condition.

Stable gradient with no measures or unreliable measures of slope protection should be gentler.

Table 3 Standard gradients of cut slopes

Character of soil or bedrock		Height (m)	Gradient (V:H)
Hard rock			1:0.3 ~ 1:0.8
Soft rock			1:0.5 ~ 1:1.2
Sand	Those not dense, not solid and of bad grade distribution.		1:1.5 ~
Sandy soil	Those are dense and solid.	Less than 5 m	1:0.8 ~ 1:1.0
		5~10 m	1:1.0 ~ 1:1.2
	Those not dense, not solid.	Less than 5 m	1:1.0 ~ 1:1.2
		5~10 m	1:1.2 ~ 1:1.5
Sandy soil mixed with gravel or rock mass	Those that are dense and solid or of good grade distribution.	Less than 10 m	1:0.8 ~ 1:1.0
		10~15 m	1:1.0 ~ 1:1.2
	Those not dense, not solid or of bad grade distribution.	Less than 10 m	1:1.0 ~ 1:1.2
		10~15 m	1:1.2 ~ 1:1.5
Cohesive soil		Less than 10 m	1:0.8 ~ 1:1.2
Cohesive soil mixed with rock mass or cobble stones		Less than 5 m	1:1.0 ~ 1:1.2
		5~10 m	1:1.2 ~ 1:1.5

5. Design Concept of Cut Slope

5.1 Basic concept of slope protection measures for cut slope

Basic concepts of slope protection measures for cut slope are:

- To ensure the cut slope stability to secure road transportation,
- To apply suitable slope protection measures adequate for the capacity of local contractor and sustainable maintenance of road slope by local contractor,
- To conduct a technology transfer of widely applicable slope protection measures for cut slopes in Pakistan, and
- To mitigate road disaster during earthquake for earthquake-proof transportation

5.2 Selection of slope protection measures

Earthquake and rainfall frequently cause collapses in cut slopes. Many cut slopes are stable during normal conditions but become unstable during or after heavy rainfall or earthquake. To prevent slope collapses, either the sliding force must be decreased or sufficient resistance to overcome the sliding force must be added by protective structures. Table 4 shows the classification of countermeasures for protecting cut slope collapses.

An adequate and effective measure for preventing cut slope collapses should be selected in consideration of the anticipated causes, shape, mechanism, and scale of failures, as well as appearance. Figure 4 gives a flow chart of the selection of cut slope protection measures, which was prepared from the results of past execution in Japan.

Generally, the following criteria are used for selection.

Wherever possible, cutting work should be selected, especially in the cases of overhanging slopes and highly jointed or weathered rock slopes. In planning cutting work, slope stability and harmony with the surrounding environment should be considered.

Retaining wall works should be selected if the foot of a slope needs to be stabilized or if it is to be used as the foundation of other measures.

Table 4 Classification of Preventive Measures against Cut Slope Collapses

CLASSIFICATION		TYPE OF WORK
1. Earth Work	Earth Work	Cutting
		Filling
2. Vegetation	Seed	Seed Spraying
		Seed Mud Spraying, etc.
	Sod	Sodding
		Sod matting, etc.
3. Water Drainage	Surface Drainage	Subsoil Drainage Hole
		Drain Ditch and Cascade
	Subsurface Drainage	Culvert
		Horizontal Drain Hole

4. Slope Work	Pitching Work	Stone Pitching
	Shotcrete Work	Mortar spray
		Shotcrete (concrete)
	Concrete Crib Work	Crib work (Mortar or Concrete)
5. Anchoring	Anchoring	Soil Nail
		Rock Bolt
		Ground Anchor
6. Wall and Resisting Structures	Retaining Wall	Gabion Wall
		Masonry Wall (Stone, Wet, Dry)
		Concrete Block Wall
		Concrete Retaining Wall
	Catch Work	Catch Concrete Wall
7. Piling Work	Piling Work	Steel Pipe Pile
		Concrete Pile

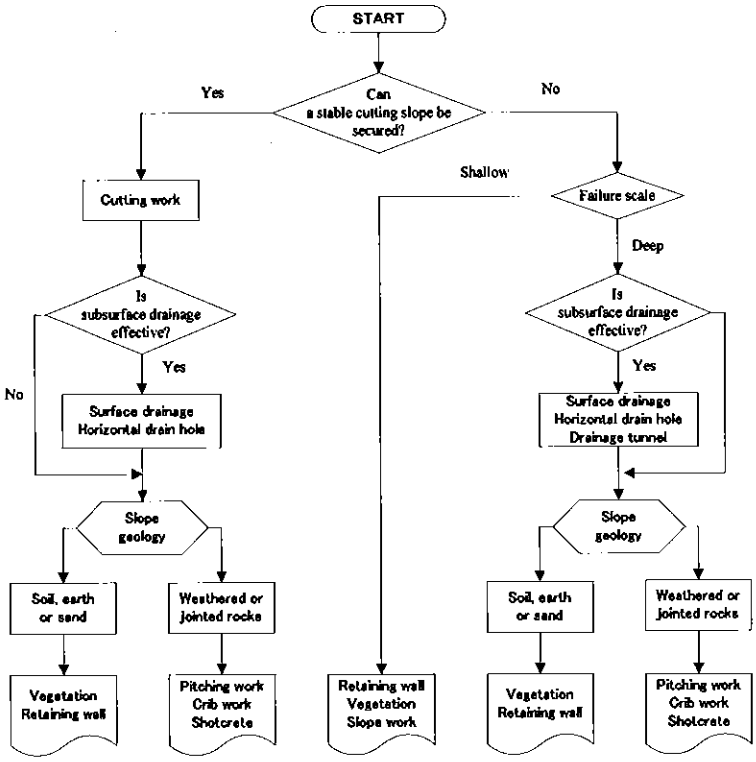


Figure 4 Selection of cut slope protection works

In principle, surface drainage work should be planned positively. Subsurface drainage works should be adopted if spring water exists during normal time and/or rainfall, or a depression exists near the top of the slope.

Even though these are costly, anchoring or piling works should be planned if other methods are not expected to control collapses.

4.3 Comparison of Alternative Measures

On the basis of the above basic concept and selection criteria as well as the slope situation, the following four alternatives are conceivable as preventive measures to secure the stability of cut slope at the Site:

- ✓ Plan A: Cutting work + Vegetation + Retaining wall
- ✓ Plan B: Cutting work + Concrete crib work with rock bolt + Retaining wall
- ✓ Plan C: Ground Anchor + Retaining wall
- ✓ Plan D Cutting work + Mortar spray +Retaining wall (partial)

The technical comparison is explained below and summarized in Table 5.

The plan A and D is intended to form a stable cut slope with a standard gradient, by cutting the overall unstable parts of the slopes above the road, whereas the plan B is to cut the partial unstable parts of the slope and then stabilize it by using concrete crib work with rock bolt to reduce the excavation volume. The plan C is intended to stabilize, by using ground anchor, the overall unstable parts of the slopes above the road besides simple reformation of slope. In the plan B and plan C, the slope to be formed has a gradient steeper than the standard gradient, and is thus to be stabilized or protected by concrete crib work with rock bolt or by ground anchor work. It should be noted that the all plans must include the shift of the telegraph tower installed on the top plain surface. Other technical and geotechnical aspects to be considered are as follows.

a) Plan A

In the plan A, the slope is flatted into a standard gradient－a stable gradient. After excavation, erosion and associated local collapses on the cut slope will cause the instability of the cut slope, therefore, appropriate vegetation and its maintenance is a key to the stability of the cut slope. However, the slope is not good for the growth of vegetation topographically and agronomically; auxiliary work therefore needs to be determined according to its execution possibility and effectiveness. Furthermore the road traffic possibly suffers from rock falls.

b) Plan B

The plan B is applied for small and shallow soil collapse of about 3 to 5 m in thickness. When a large-scale soil collapse probably happens due either to big earthquake or to heavy rainfall, additional preventive measures should be considered. After excavation, the road traffic possibly suffers due to the rock falls until a full recover of vegetation.

c) Plan C

Because ground anchor will be installed into soil mass, the skin frictional resistance between the ground (soil mass) and grout is difficult to be estimated correctly. Therefore the safety of the ground anchor is unreliable..

After excavation, the road traffic possibly suffers due to the rock falls until a full recover of vegetation.

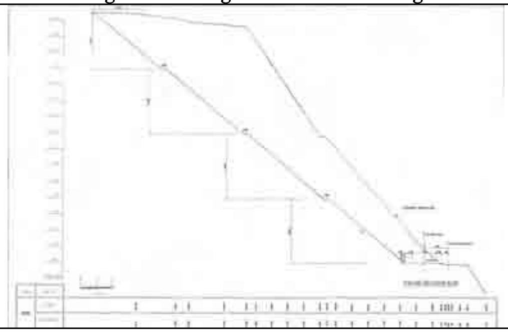
Plan C is the most difficult and expensive among four measures.

c) Plan D

In the plan D, the slope was flatted into a standard gradient－a stable gradient. After excavation, all excavated area is mortar sprayed to prevent erosion and associated local collapses on the cut slope. The plan D will not cause any soil collapse after excavation and this measure is relatively easy to be conducted and is widely applicable also for similar type of slope failures.

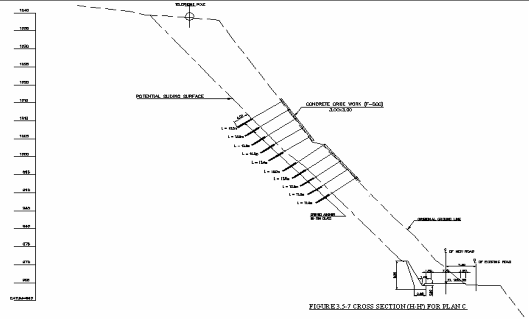
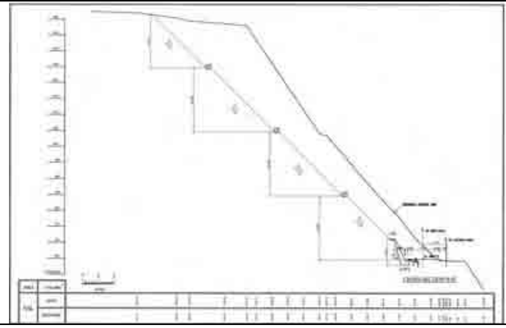
Alternative plans are summarized in Table 5 and the results of evaluation are shown in Table 6.

Table 5 Summary of Alternative Plan (1)

<table>
<tr><th>Plan</th><th>Plan A
Cutting work + Vegetation + Retaining wall</th><th>Plan B
Cutting work + Concrete Crib work with Rock Bolt + Retaining wall</th></tr>
<tr><td>Cross Section</td><td></td><td></td></tr>
<tr><td>Technical Description</td><td>1. This plan is to form a stable cut slope with a standard gradient, by cutting the overall unstable parts of the slopes above the road.
2. Vegetation work is used to prevent the cut slope from erosion and associated local collapses.
3. This plan will cause a great quantity of excavation volume and topographic change because of the overall cut of the unstable parts.
4. Construction cost of this plan is cheapest among the three plans, but this plan involves land acquisition of big area.
5. After excavation, the road traffic possibly suffers due to the rock falls until a full recover of vegetation.</td><td>1. The plan is to cut the partial unstable parts of the slope and then stabilize it by concrete crib work with rock bolt.
2. Compared to Plan A, this will lead to largely reduced excavation volume and topographical change.
3. Large quantities of big boulders will make the execution of rock bolt difficult.
4. After excavation, the road traffic possibly suffers due to the rock falls until a full recover of vegetation.</td></tr>
<tr><td>Cost Estimate</td><td>
<table>
<tr><th>No.</th><th>Items</th><th>Unit</th><th>Unit Price (Rs)</th><th>Q'ty</th><th>Amount x1000 Rs</th></tr>
<tr><td>1</td><td>Cut work</td><td>m3</td><td>63</td><td>16,000</td><td>1,008</td></tr>
<tr><td>2</td><td>Vegetation</td><td>m2</td><td>111</td><td>10,500</td><td>1,166</td></tr>
<tr><td>3</td><td>Concrete</td><td>m3</td><td>12,895</td><td>1,925</td><td>24,823</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>TOTAL</td><td></td><td></td><td></td><td>26,996</td></tr>
</table>
</td><td>
<table>
<tr><th>No.</th><th>Items</th><th>Unit</th><th>Unit Price (Rs)</th><th>Q'ty</th><th>Amount x1000 Rs</th></tr>
<tr><td>1</td><td>Cut work</td><td>m3</td><td>63</td><td>122,140</td><td>7,695</td></tr>
<tr><td>2</td><td>Vegetation</td><td>m2</td><td>111</td><td>9,050</td><td>1,005</td></tr>
<tr><td>3</td><td>Concrete</td><td>m3</td><td>12,895</td><td>2,510</td><td>32,366</td></tr>
<tr><td>4</td><td>Re-bar</td><td>m3</td><td>16,763</td><td>25</td><td>419</td></tr>
<tr><td>5</td><td>Rockbolt</td><td>m</td><td>734</td><td>6,369</td><td>4,675</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td>TOTAL</td><td></td><td></td><td></td><td>46,160</td></tr>
</table>
</td></tr>
<tr><td>Evaluation</td><td>Medium</td><td>Medium</td></tr>
</table>

Note: Total cost is roughly estimated by using the data as of March 2005 for comparison of alternative plans. The quantities and its unit price mentioned above are subject to revision in the course of the study depending on new findings.

Table 5 Summary of Alternative Plan (2)

Plan	Plan C Ground Anchor +Retaining Wall	Plan D Cutting work +Mortar spray with wire mesh + Retaining wall
Cross Section		
Technical Description	1. This plan is to stabilize the overall unstable parts of the slope by ground anchor work. 2. Estimation of the skin friction resistance between the ground (soil mass) and therefore the safety of the ground anchor is unreliable. 3. Execution of ground anchor is not only costly but also difficult. 4. After excavation, the road traffic possibly suffers rock falls until a full recover of vegetation.	1. This plan is to form a stable cut slope, by cutting the overall unstable parts of the slopes above the road. 2. Mortar spray is used to prevent the cut slope from erosion and associated local collapses. 3. Compared to Plan A, this will lead to largely reduced excavation volume and topographical change. 4. Compared with Plan B and C, this is relative easy to be conducted and widely applicable also for similar type slope failures 5. This plan will not cause any soil collapse after excavation.
Cost Estimate	see Plan C cost table below	see Plan D cost table below
Evaluation	**Poor**	**Good**

Cost Estimate – Plan C

No.	Items	Unit	Unit Price (Rs)	Q'ty	Amount x1000 Rs
1	Cut work	m3	63	4,000	252
2	Vegetation	m2	111	7,200	799
3	Ground anchor	m2	7,500	6,138	46,035
4	Concrete Crib		40,500	770	31,185
5	Concrete		12,895	1,925	24,823
	TOTAL				103,094

Cost Estimate – Plan D

No.	Items	Unit	Unit Price (Rs)	Q'ty	Amount x1000 Rs
1	Cut work	m3	63	144,383	9,096
2	Mortar+mesh	m2	1800	16,930	30,474
3	Concrete	m3	12,895	451	5,816
	TOTAL				45,386

Note: Total cost is roughly estimated by using the data as of March 2005 for comparison of alternative plans. The quantities and its unit price mentioned above are subject to revision in the course of the study depending on new findings.

Table 6 Summary of Results for Comparison of Protection Measures

Item	Plan A	Plan B	Plan C	Plan D
1. Safety of slope	Medium	Medium	Low	High
2. Construction Difficulty	Easy	Difficult	Difficult	Medium
3. Technology Transfer	Medium	Low	Low	High
4. Earthquake-proof	Low	Medium	Low	High
5. Construction Period	Short, however auxiliary work is necessary for vegetation	Medium	Medium	Medium
6. Cost Performance	High	Medium	Low	Medium
7. Environment Aspect	Medium	Medium-Low	Low	Medium-Low
8. Evaluation Ranking	3	2	4	1

6. Conclusion

As a result of evaluation, the plan D as being most appropriate, technically and economically, is recommended for implementation, because all plans except plan D are unreliable for slope stability until a full recover of vegetation... Furthermore the plan A involves large quantities of excavation material and paddy field, and plan B and C are difficult for construction as well as are low in cost performance.

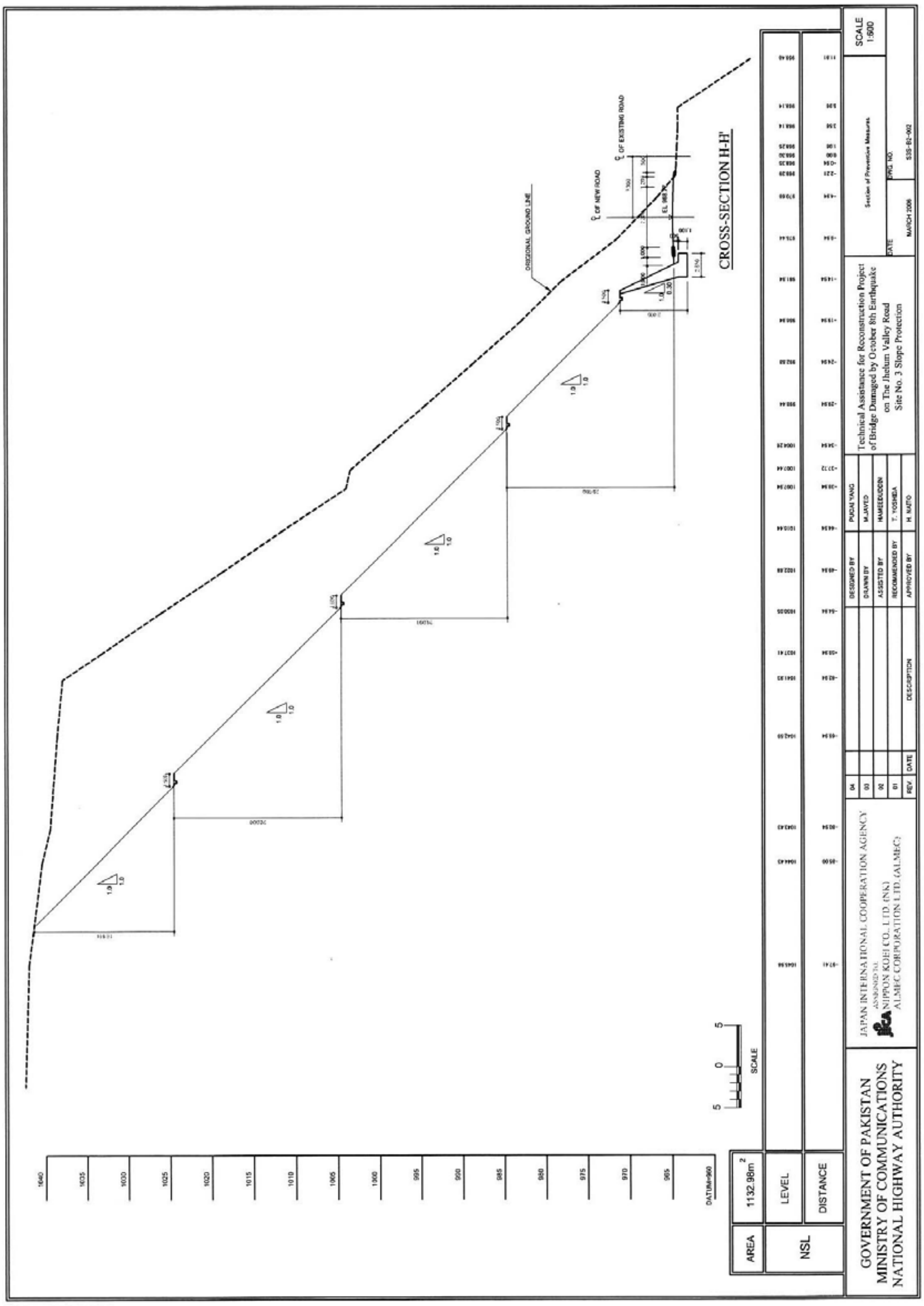
Annex

Figures

- Typical Section of Countermeasure
- General Plan of Countermeasure

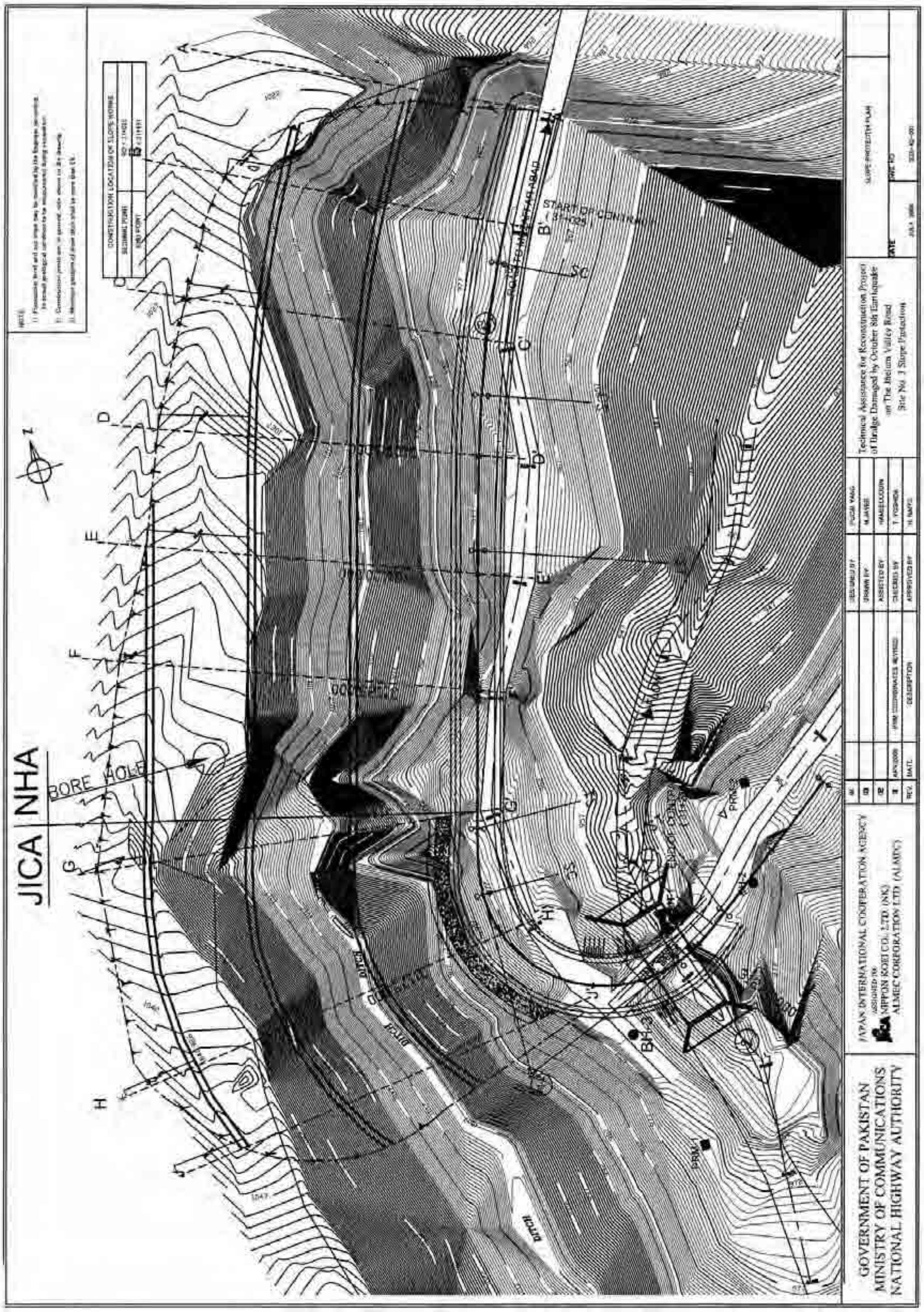
Photographs of No. 3 Cut Slope Protection Site

- No.3 Seri Bridge and its Approach Road
- Collapse-prone Slope



Typical Section of the Countermeasures

Note: Foundation level and cut slope may be modified according to actual geological condition to be encountered during excavation



General Plan of Countermeasure

Note: Foundation level and cut slope may be modified according to actual geological condition to be encountered during excavation

Photographs of No. 3 Cut Slope Protection Site

No.3 Seri Bridge and its Approach Road

This picture shows the Seri Bridge and natural slope prior to the slope cutting work

Collapse-prone Slope

No.1

Flaking, open cracks are observed.
Collapse area will gradually expand.

No.2

An open crack is visible at the top of cliff. About 2 m thick and 5 m wide mass is suspected to collapse.
Gradient of natural slope is 60-70 degrees.

No.3

Expected collapse area at the top of the slope. Gradient of natural slope is 60-70 degrees.

No.4

A relatively wide collapse-prone slope, forming overhang. Some open cracks are observed.
2-3 m thick mass might slide.

No.5

Expected collapse area forming overhang. Some open cracks are observed.
2-3 m thick mass will slide.

No.6

A loosened convex slope, about 5 m in width, forming overhang, rock falls and 1-2 m thick flaking is feared to collapse.

No.7

About 20 m long and 20 m wide collapse-prone slope. Water seepage is observed at the foot of the slope. The deposits are relatively soft.

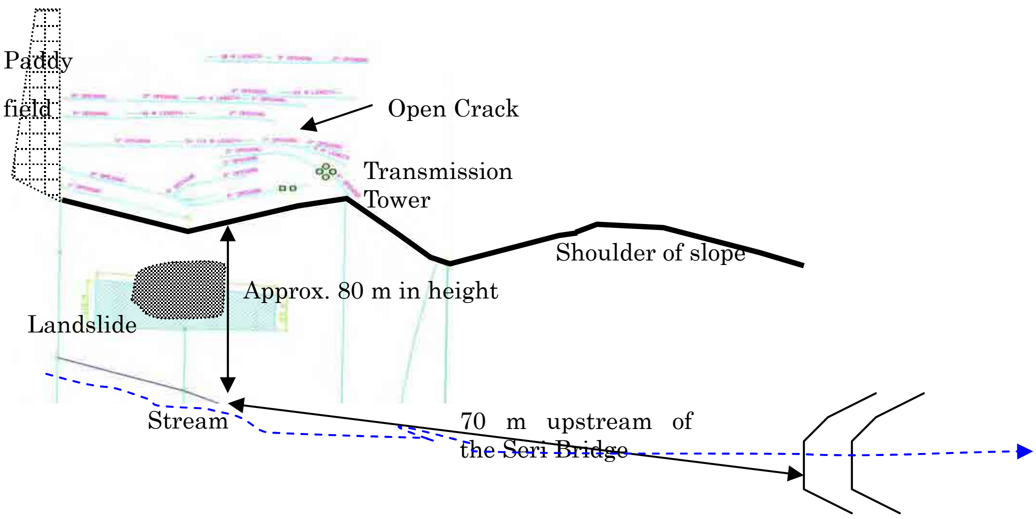
No.8

A landslide approximately 70 m upstream of the Seri Bridge. The size of collapsed mass is about 40 m wide, 40 m long and 7-10 m thick. The collapsed debris partially dammed about 100 m long section of the stream.

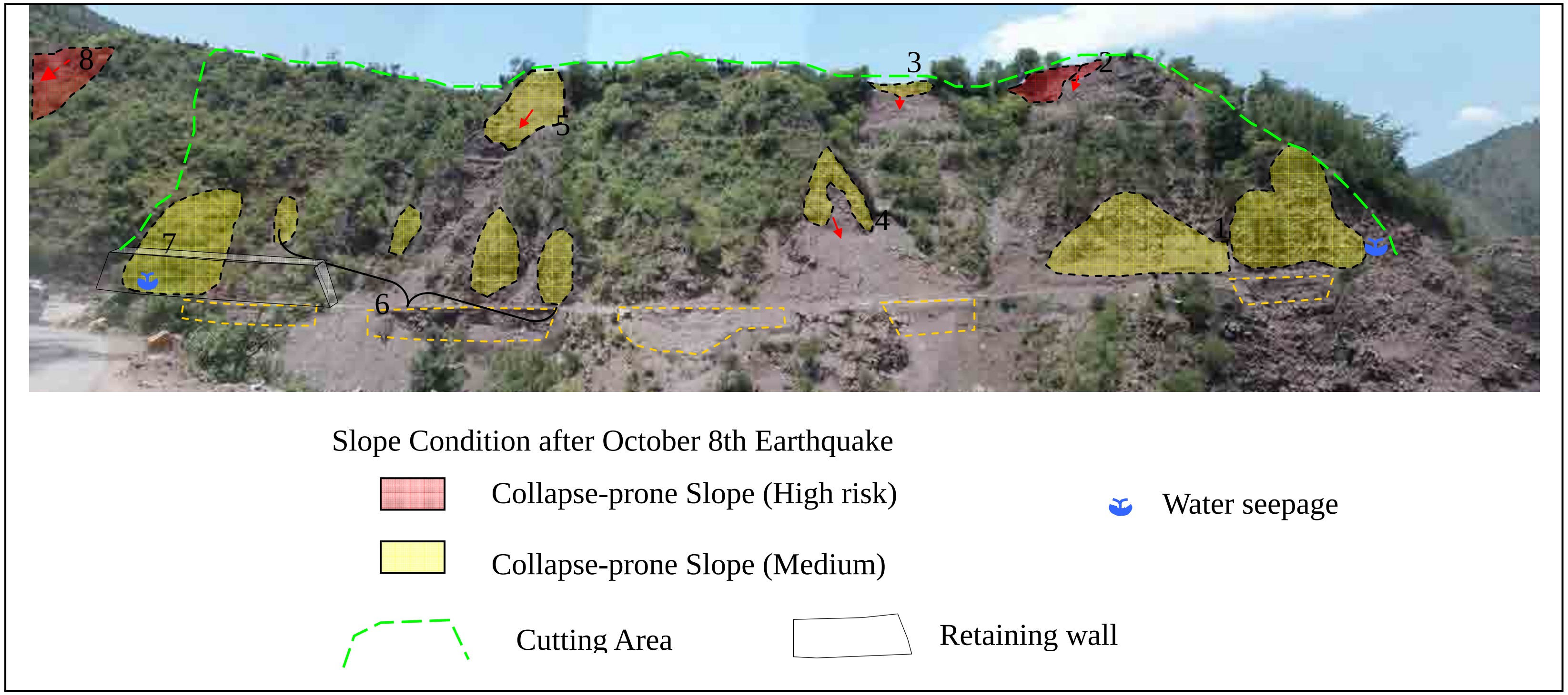
Six lines of open crack, about 2 to 5 cm wide, are observed on the top plain surface. These cracks are parallel to the cliff face.

The cracks on the cliff face are likely to collapse again in the future earthquakes or during heavy rainfall.

This collapsed area is situated in a transition between mountain and terrace. The bedrock and ground water level in this area are relatively shallow. The above geological condition and submerged soft soil probably might have caused to multiply the damage in this area during October 8th Earthquake.



Sketch of open cracks above No.8 landslide area



Cut Slope Image (V:H=1.0:1.0, 1.5 m wide berms at intervals of 20 m in height)

Modification in the Design Concept of the No.3 Bridge Approach Road and Slope Protection Works

1. Anticipated Geological Condition and Proposed Slope Stabilization Works in the Detailed Design Stage

In the Detailed Design, cut slope of 1:1.0 with mortar spray was selected for slope stabilization of the No.3 Seri Bridge Site slope, taking into consideration of the following geological conditions and the selection criteria of Slope Protection Works as recommended by Japan Road Association (JRA).

[Geological Condition of the No.3 Seri Bridge Site Slope]

- Natural slope gradient: 1:0.8 to 1:1.0 (V:H)
- Hardened and well-cemented gravely soil can be classified as "Soft Rock" based on the observation of the existing slope surface.

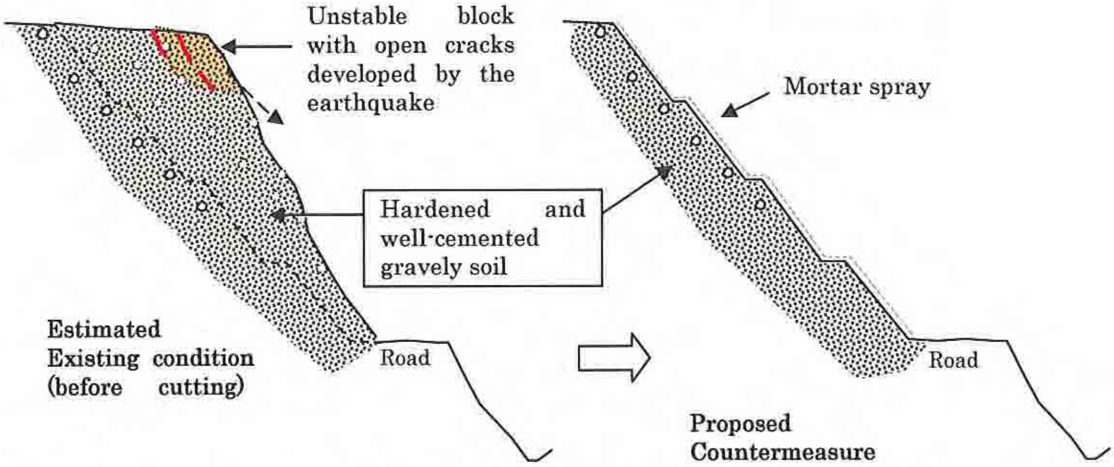


Figure 1 Anticipated geological condition and proposed slope stabilization works at the No.3 Seri Bridge Site Slope in the Detailed Design Stage

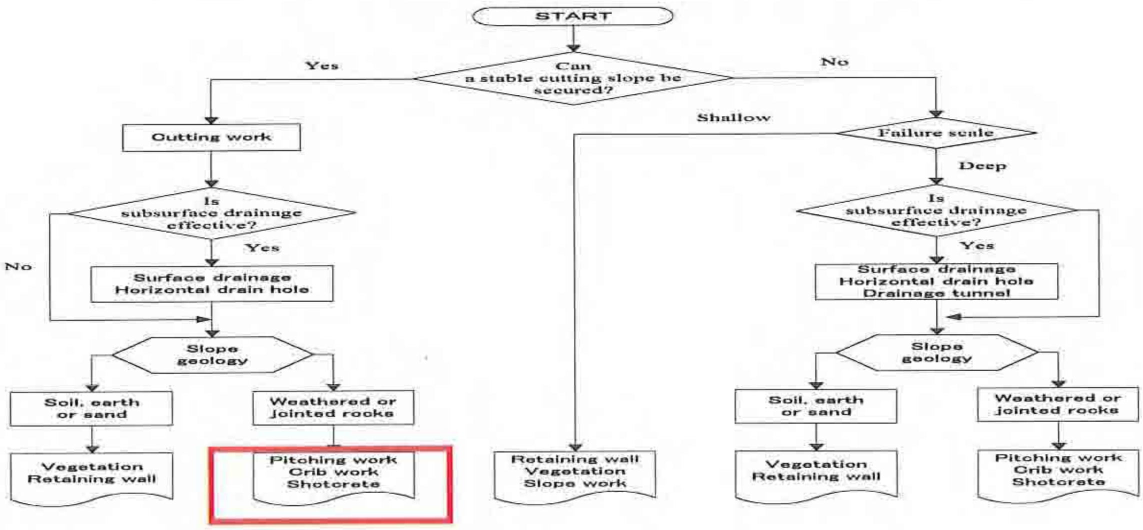


Figure 2 Selection Criteria of Slope Protection Works Recommended by JRA

2. Actual Geological Condition and Issue on Application of the Mortar Spray Works on the Slope

However, excavation of the slopes revealed that it consisted of loose stiff clayey soil with sub-angular boulders having diameter between 0.3 to 2.0m at the top step of the cut slope instead of the hardened and well-cemented gravely soil.

For such loose stiff clayey soil with sub-angular boulders, Mortar Spray Work is not applicable and the Crib Works should be selected as the countermeasure for slope stabilization in consideration to frequent rock falling due to erosion of soil surface as described in Figure 2 and Table 1 below.

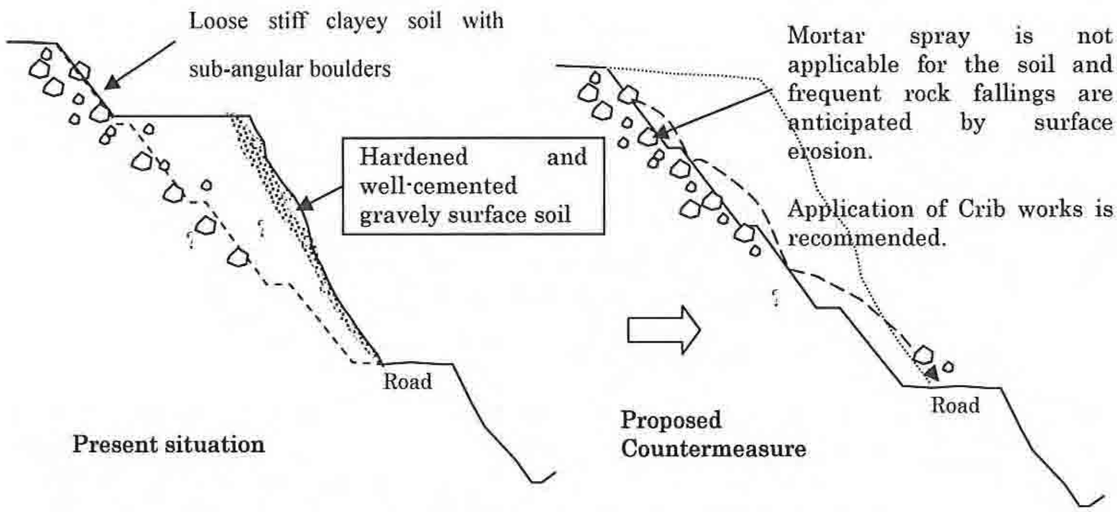


Figure 3 Actual geological condition and proposed countermeasure

Table 1 Selection Criteria of the Rock-falling Prevention Works

Major Protection measure	Size of Falling Rocks (Diameter)					
	Large (More than 1 m)		Medium (Around 0.4 m)		Small (Less than 0.3 m)	
	Flaking	Rock fall	Flaking	Rock fall	Flaking	Rock fall
Removal	fair	fair	fair	fair	fair	fair
Drainage work	fair	good	fair	good	fair	good
Shotcrete /Mortar spray	poor	**NA**	fair	**NA**	good	**NA**
Vegetation	NA	NA	NA	fair	NA	NA
Crib work	fair	poor	fair	**fair**	fair	**fair**
Anchoring + with Crib work/Shotcrete	fair	fair	fair	fair	fair	fair

Reference: Rakuseki-Binran, Japan Road Association

Photograph


Above photographs show the actual cut slope condition with boulders of 1-2 m in diamenter.


Above photographs show the surface condition observed along the existing road. The slopes are covered by sub-angular to sub-rounded gravels (average size: 2-10 cm in diameter, maximum: 200 cm in diameter) with hardened and well-cemented gravely soil.

3. Issues in Application of the Crib Works

As experienced in the Tendering Stage, the modification of the slope protection work from mortar spray to crib works would cause a considerable increase of the construction cost and would eventually abandon the slope protection works. This would make the road slope prone to frequent and large rock falling.

Furthermore, preventing big-boulder (diameter 1-2m) falling is technically very difficult and it is not completely possible to avoid rock-falling even after treated slopes. Endless maintenance works on the slope is anticipated.

4. Recommendation

Taking into account the budgetary constraint and cost-efficiency, it is recommendable to modify the concept of improvement of the site (the slope protection section) as below.

- To stabilize the existing slope by removal of the top soil loosened by the earthquake,
- To apply the suitable slope protection works for the cutting slope established by the above top soil removal work,
- To minimize cutting works along the existing road and carry out widening as much as possible within the existing road using common and locally available methods.

Based on the above modified concept, Nippon Koei would propose to change the improvement plan as shown in Figure 4, 5 and 6. Main points in the proposed modified plan are as follow:

- To sift the alignment at the corner using 25m radius curvature to avoid the massive cutting in the JICA Section,
- To extend the box-culvert about 5m in length and construct U shaped channel (Log Chute) about 66m in length,
- To widen the narrow section (G-F-E section) of the existing road toward valley side by filling work protected by gabion and founded on the U shaped channel,
- To widen the existing road (A-E section) as much as possible within the existing road using wet-masonry wall at mountain and valley side (see Figure 7, 8 and 9).

Since existing slope gradient is 1:0.8 to 1:1.0 (V:H) and it's surface are covered by sub-angular to sub-rounded gravel (average size: 2-10cm in diameter, maximum 20cm in diameter) with hardened and well-cemented gravel soil, it is not anticipated to have serious slope failures by normal natural forces basically. However, remaining of the risk and occurrences of minor slope failures and rock fallings are not avoidable in the geological and topographical circumstance of the site.

Photograph