2.3 Outline of the Existing Bridges

2.3.1 General Condition

The existing 40 bridges for which reconstruction was requested, are shown in Table 1-3 and Fig. 2-4.

They are categorized as follows:

Type	Nos
Bailey bridge (Temporary steel panel structure)	26
Steel truss bridge (Pigeaut or Eiffel type)	10
Steel girder bridge	3
Reinforced concrete (RC) girder bridge	1
Total	40

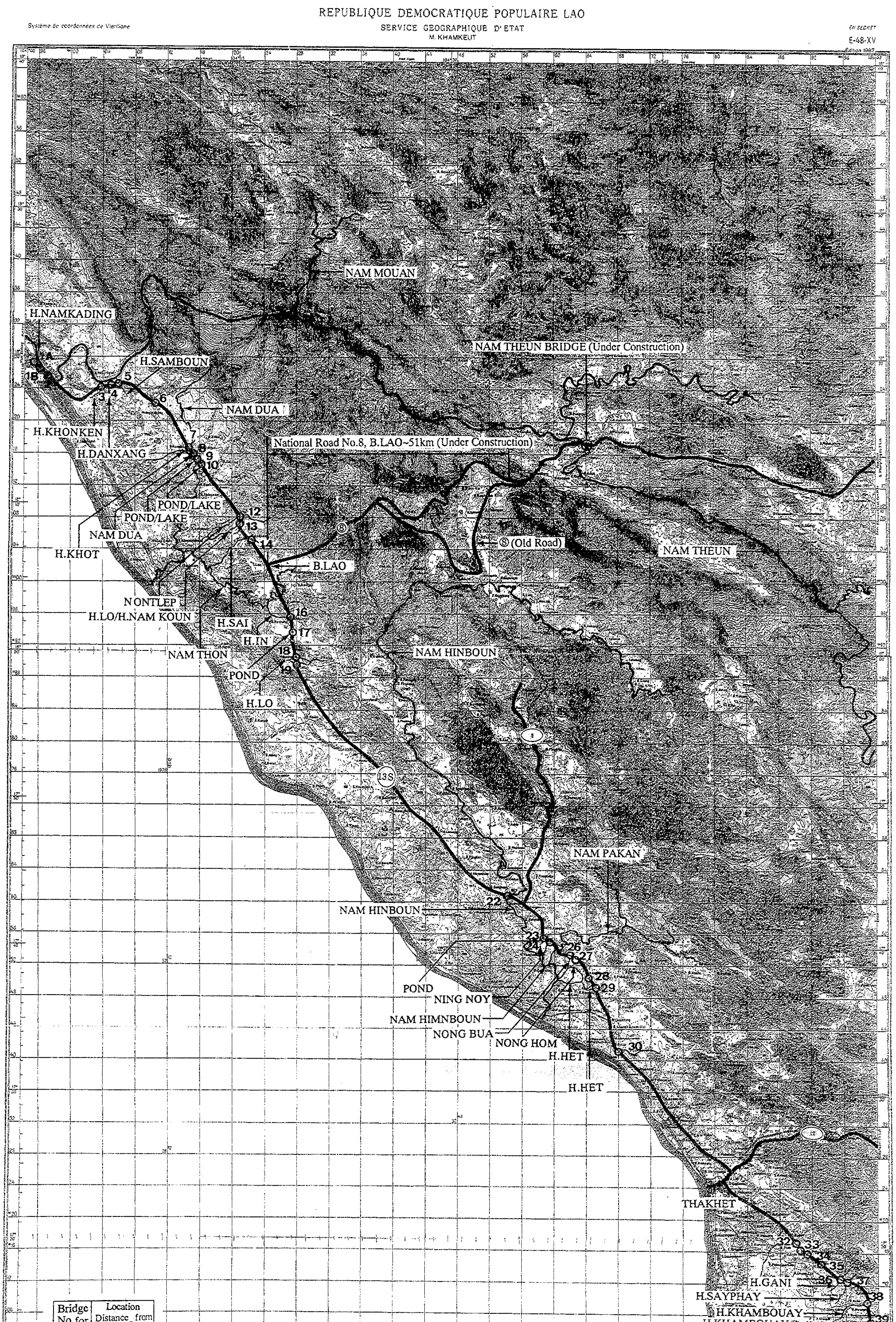
(1) Bailey bridge (Temporary panel bridge)

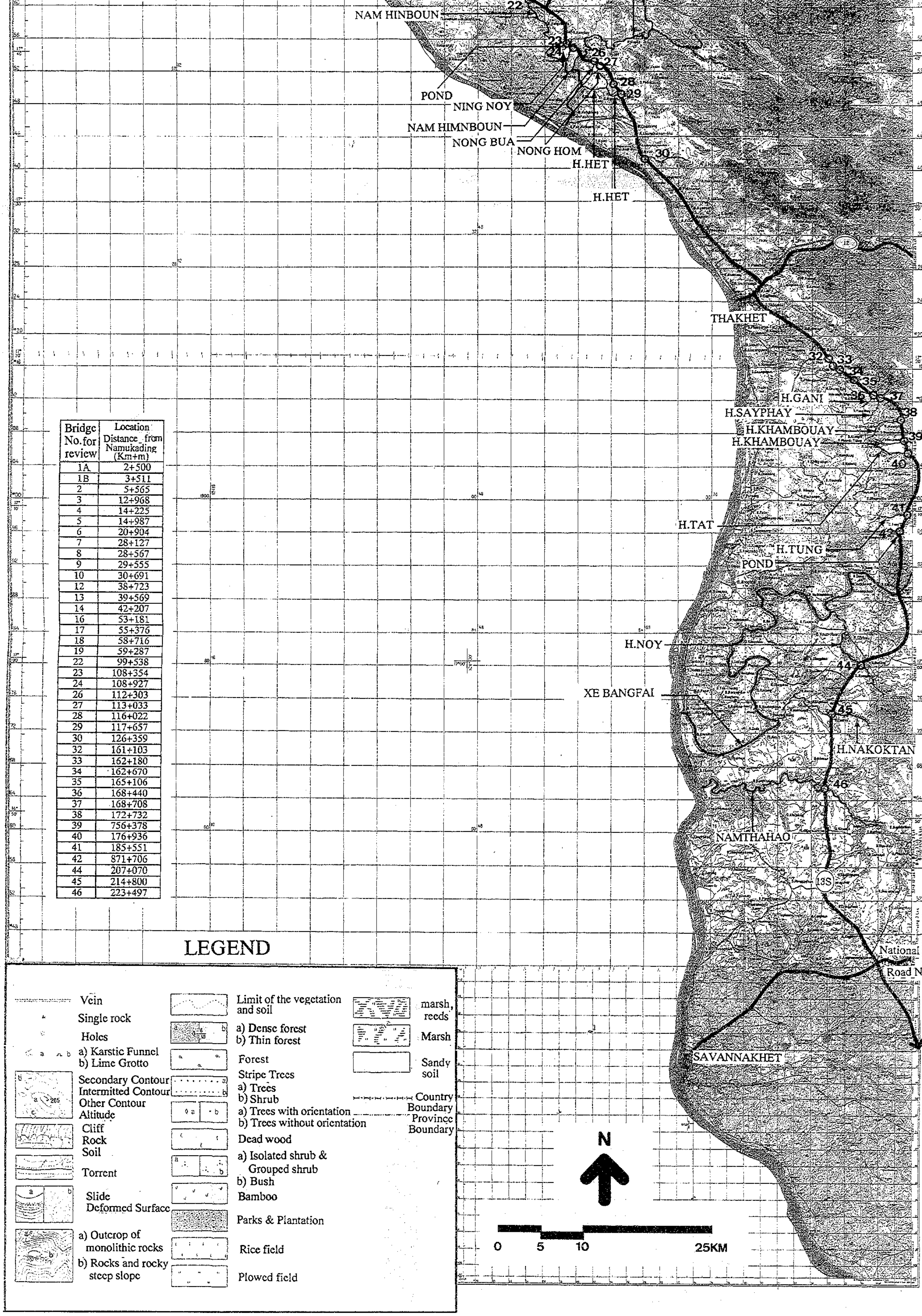
The Bailey bridges with temporary steel panels and wooden deck were all constructed during 1964 - 1975. The span length of the bridges range from 12m to 35m and the width of all is 4m. There are 26 bridges of this type within the project survey section.

All the bridges show relatively large deflection or deformation at their joint pins and members. Although a weight limitation ranging from 15t to 22t has been adopted for vehicles passing over these bridges, heavy cargo trucks with a load exceeding 30t are often observed. Some bridges temporarily erected on unstable abutments or piers are very likely to fall down and collapse during or after heavy floods. Bridge No.22 which was temporarily restored on old and slender piers after a previous collapse, presents a seriously dangerous situation.

(2) Steel truss bridge

There are 10 steel truss bridges (Pigeaut or Eiffel type) presently with wooden deck, which were originally constructed as RC slab bridges during the 1930s (French Protectorate Period). The average width of the bridges is only 3m. The bridge members of this type show general rusting, but there has been no significant decrease of cross sectional area due to the rust. Deformation of members due to repeated collision of vehicles is observed on almost all the bridges, however there is not such a


REPUBLIQUE DEMOCRATIQUE POPULAIRE LAO
SERVICE GEOGRAPHIQUE D'ETAT
M. KHAMKEUT
Système de coordonnées de Vientiane
EN SECRET
E-48-XV
Edition 1987
NAM MOUAN
H.NAMKADING
NAM THEUN BRIDGE (Under Construction)
H.SAMBOUN
NAM DUA
H.KHONKEN
H.DANXANG
National Road No.8, B.LAO~51km (Under Construction)
POND/LAKE
POND/LAKE
NAM DUA
H.KHOT
⑧ (Old Road)
NAM THEUN
B.LAO
N ONTLEP
H.LO/H.NAM KOUN
H.SAI
H.IN
NAM THON
NAM HINBOUN
POND
H.LO
13S
NAM PAKAN
NAM HINBOUN
POND
NING NOY
NAM HIMNBOUN
NONG BUA
NONG HOM
H.HET
H.HET
THAKHET
H.GANI
H.SAYPHAY
H.KHAMBOUAY
Bridge No for
Location Distance from



Bridge No. for review	Location Distance from Namukading (Km+m)
1A	2+500
1B	3+511
2	5+565
3	12+968
4	14+225
5	14+987
6	20+904
7	28+127
8	28+567
9	29+555
10	30+691
12	38+723
13	39+569
14	42+207
16	53+181
17	55+376
18	58+716
19	59+287
22	99+538
23	108+354
24	108+927
26	112+303
27	113+033
28	116+022
29	117+657
30	126+359
32	161+103
33	162+180
34	162+670
35	165+106
36	168+440
37	168+708
38	172+732
39	756+378
40	176+936
41	185+551
42	871+706
44	207+070
45	214+800
46	223+497

Fig. 2-4 Location of Project Surveyed Bridges

Source : MCTPC, December 1993

serious need for immediate repair or reinforcement. The vehicles are all compelled to reduce their traveling speed down to less than 10km/h before crossing the bridges.

(3) Steel girder bridge

There are 3 steel girder bridges with wooden deck which were constructed during the 1930s. Average width of bridge is nearly 3m. A serious reduction of sectional area of the members has not been observed. Deformation of members due to repeated collision of vehicles has been observed, but not so serious as to require immediate repair or strengthening. The vehicles are generally compelled to halt once or to reduce the traveling speed to less than 5km/h before passing the bridges.

2.3.2 Examination of the Conditions of the Existing Bridges

Examination and evaluation of the existing bridges was made based on the following criteria:

(A) Examination of the level of deterioration and degree of safety

This is to examine the level of deflection or deterioration of bridge members, and the degree of safety against passage of vehicles and wash-out forces of floods.

(B) Traffic capacity and allowable load

This includes an examination of the structural strength and traffic capacity of the existing bridges, and evaluation of the level of smoothness and safety of the traffic flow.

(C) Assessment of socio-economic damage caused by abrupt collapse of the bridges

This is to assess the socio-economic impact, in case of collapse of bridges, particularly on the neighboring local societies and economic circles.

The results of examination of the bridges are summarized as follows:

(1) Level of deterioration

1) Bridges which are actually impassable or nearing collapse due to deterioration of structural members are:
No. 1B, 2, 3, 6 and 30

2) Bridges whose foundations, abutments or piers have been washed away by floods are:
No. 8, 34, 35 and 44

3) A bridge which does not appear to have sufficient structural strength against flood forces is:
No. 22

(2) Traffic capacity and allowable load

1) Bridges which have seriously narrow decks are:
No. 4, 5, 6, 7, 9, 10, 12, 13, 14, 16, 17, 18, 19, 25 and 31

2) Bridges whose allowable traffic load is extremely limited only to 20t (for No.22, 15t is applied) at present and which are considered to be in danger of collapse due to current increasing heavy vehicle traffic are:
Nos. 1A, 1B, 2, 3, 8, 22, 23, 24, 26, 27, 28, 29, 30, 32, 33, 35, 36, 37, 38, 39, 40, 41, 42, 44, 45 and 46

Particularly, Bridge No. 22 should be reconstructed as soon as possible.

(3) Socio-economic effects caused by collapse of the bridges

If the bridges collapse, much time will be required to erect a temporary deviation, causing many socio-economic problems to the neighboring local inhabitants:
No. 3, 8, 22 and 46 are in this category.

2.4 Study and Examination of the Request

2.4.1 Appropriateness and Necessity of the Request

The project survey area covers Vientiane municipality and the provinces of Vientiane, Bolikhamsai, Khammouan and Savannakhet. The area is 79,000 km^2 or 33% of the total of the country and its population is estimated to be 1.84 million or 44% of the total population.

250 thousand tons or 26% of total domestic freight and 560 thousand tons or 95% of the international freight are moved through the project surveyed road. The recent traffic trend of the national road network indicates that the importance of the road is increasing significantly.

Since the east-west trunk roads such as National Road Route 8 (RN8), Route 9 (RN9) , and Provincial Road Route 12 (RP12) all join RN13S finally, it is expected that the project will contribute, in particular, to improvement of the socio-economic situation in rural and remote areas along the roads, which are branched off from RN13S.

Thus, the requested contents of the project conforms with the basic policies of the ongoing national development plan of the country, hence, an urgency, importance and repercussions of the project have been recognized to be appropriate.

The project is not expected to provoke any negative effects on the environment assessed from the natural and social aspects.

2.4.2 Criteria for Selection of Project Bridges

All of the existing 40 bridges were surveyed to depth regarding their socio-economic conditions, natural condition, structural strength and traffic capacity, etc. The basic design study team has first confirmed that almost all the bridges shall need to be replaced with new structures as discussed above. However, taking into account the implementation contents of IDA's "Highway Improvement Project", 26 bridges were selected from those 40 bridges for the Project as shown in Table 2-3. Criteria adopted for the selection are as follows:

(1) First Priority

First priority for reconstruction shall be given to such bridges as are likely to collapse in very near future due to the existing structural instabilities against the current increasing heavy vehicles traffic and almost every year's flood:
These are Bridge No. 1B, 2, 3, 6, 8, 22 and 30.

(2) Second Priority

Second priority for selection of Project bridges shall be discussed according to the level of need for physical access or continuity of the section in which the project candidate bridges are located, with other road sections and the principal cities, especially Vientiane municipality. Such priority shall be given in the following order:

1) Bridges which are located in the road section from Namkading to Ban Lao, from where RN8 branches off, and connects Vientiane municipality with Vinh port in Vietnam in the shortest way.

2) Bridges which are located in the section from Ban Lao to Thakhek, from where RP12 branches off toward both Thailand and Vietnam.

Selected bridge sites for the Project are summarized in Table 2-3.

Table 2-2 List of Selected Project Sites

No.	Bridge No.	Distance from Namkading (km)	River/water course	Existing Bridge Length (m)	Existing Bridge Type
Namkading ~ Banglao					
1	1A	3+511	Stream to Namkading	24.40	BBDS
2	1B	4+550	Stream to Namkading	24.40	BBDS
3	2	5+565	Tributary to Namkading	12.35	BBDS
4	3	12+968	Khonken	51.85	BBTS
5	4	14+225	Danxang	18.00	SP
6	5	14+987	Samboun	18.00	SP
7	6	20+904	Khot	15.00	SP
8	7	28+127	Khot	21.00	SP
9	8	28+567	Namdua	61.00	BBDS
10	9	29+555	Pond/Lake	21.00	SP
11	10	30+691	Pond/Lake	21.00	SP
12	12	38+723	Nontlep	21.00	SP
13	13	39+569	Lo/Namoun	15.00	SP
14	14	42+207	Sai	21.00	SP
15	16	53+181	In	12.20	SGC
Banglao ~ Thakhek					
16	17	55+376	Pond	15.00	SP
17	18	58+716	Lo	9.20	SGC
18	19	59+287	Lo	12.53	SGC
19	22	99+538	Namhinboun	103.70	BBDD
20	23	108+354	Pond	30.50	BBDSR
21	24	108+927	NingNoy	30.50	BBDS
22	26	112+303	Nongbua	18.30	BBDS
23	27	113+033	Nonghom	15.15	BBDS
24	28	116+022	Het	21.35	BBDS
25	29	117+657	Het	30.50	BBDS
26	30	126+359	Tributary to Mekong	21.35	BBDS

Note 1:

BBDS : Bailey Br. Double Panel, Single Layer
SP : Steel Br. (Pigeaut type or Eiffel type)
CGB : Concrete Girder Br.
BBTS : Bailey Br. 3 Panel, Single Layer
SGC : Steel Girder Br. with Concrete Slab
BBDD : Bailey Br. Double Panel, Double Layer
BBTS : Bailey Br. 3 Panel, Single Layer
BBDSR : Bailey Br. Double Panel, Single Layer, Centrally Reinforced

Note 2: (shaded) : Bridges of length greater than 50m

2.5 Project Description

2.5.1 Project Executing Agency and Operational Structure

(1) Organization

The executing agency of the Project is the Roads and Bridges Department under the Ministry of Communication, Transport, Post and Construction (MCTPC). There are three principal divisions under the Roads and Bridges Department, i.e., Technical division, Construction division and Maintenance division. The responsibilities of each division are as follows:

Technical division - planning, design, research, etc., which has the Communication, Design and Research Institute (CDRI)

Construction division - implementation of construction projects including management, supervision, execution, etc.

Maintenance division - implementation of maintenance projects including management, supervision, execution, etc.

Both construction and maintenance projects are executed by state enterprises specifically assigned to the national roads or provincial authorities, such as Bridges Construction Enterprise for RN1, Roads Construction Enterprises RN2, RN8, RN10, RN20, or Road Maintenance Enterprises for the provinces of Saravan, Luangphrabang, Champasak and Savannakhet.

Roads and Bridges Department has 100 engineers and 580 assistant engineers at central and provincial levels. Numbers of staff are as follows:

Description	Nos
Engineer	100
Assistant Engineer	580
Administration	400
Skilled workers	1,080
Workers	760
Total	2,920

RN13 Bridge Construction Office will be specifically organized for the Project under the Roads and Bridges Department in close cooperation with the existing RN13 Road Improvement Office under "Highway Improvement Project". Operational structure for the implementation is shown in Fig. 2-3.

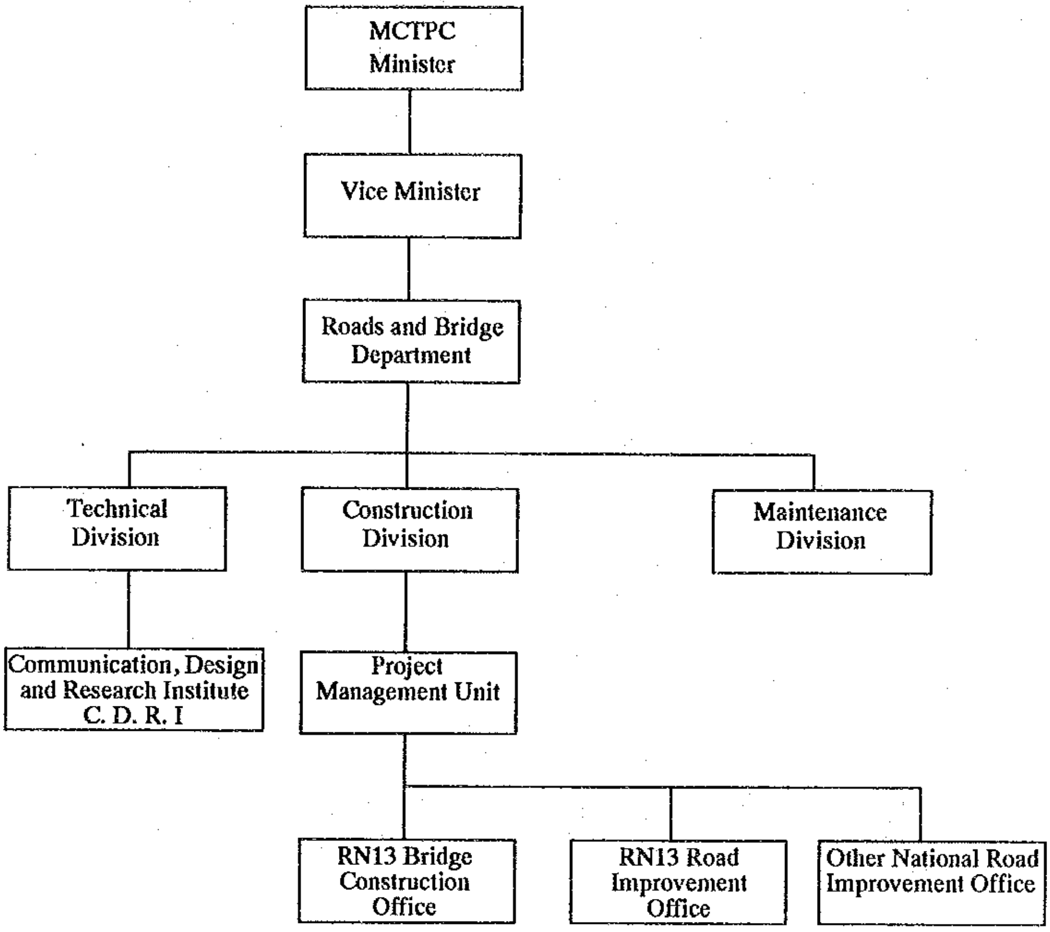


Fig. 2-5 Operational Structure of Project Implementation

(2) Budget

Of US$ 29.3 million total annual expenditure, US$ 21.1 million is allocated for construction/improvement of new roads and US$ 7.0 million for annual maintenance of existing roads. Both construction and maintenance expenditures are basically financed by the revenue from fuel tax, import and sales tax of vehicles, and funds contributed by foreign donor agencies or countries. Revenue and expenditure of the Roads and Bridges Department for the fiscal year 1991/1992 is shown in Table 2-3. The cost for the maintenance of the Project road section including the Project bridges after their completion is estimated at around US$ 120 thousand per year (US$ 800/km).

Table 2-3 Revenue and Expenditure of the Roads and Bridges Department (1991/92)

Item	Amount (US$ million)
Revenue	
Gasoline tax	4.0
Light oil tax	1.7
Lubricant tax	0.1
Import and sales taxes of vehicles	16.4
Import and sales taxes of spareparts	3.0
Driving license fee	0.6
Financial assistance from foreign donors	3.5
Total of Revenue	29.3
Expenditure	
Maintenance of national and provincial roads	7.0
Construction of new roads	21.1
Administration and traffic safety	1.2
Total of Expenditure	29.3

Source: Project Evaluation Report on Fifth Road Improvement Project, ADB, March 1993

2.5.2 Project Operation and Maintenance Plan

The maintenance division of MCTPC has responsibility for maintenance of roads and bridges of national roads and major provincial roads. It has three branch offices i.e., at Luang Phrabang for the northern region, Vientiane municipality for the central region, and Champasak for the southern region. 37 staff at the central office of which 6 engineers, 19 technicians and 4 technical supporting staff are assigned for the maintenance of a total length of 2,997km of roads across the country. Maintenance works are to be contracted with state enterprises specifically assigned to road maintenance, i.e. Saravan Road Maintenance Enterprise, Luang Phrabang Road Maintenance Enterprise, Champasak Road Maintenance Enterprise and Savannakhet Road Maintenance Enterprise.

Routine maintenance of the bridges and box culverts after completion of the Project should consist of checking the drainage system and erosion around the abutments and river piers, particularly before and after the rainy season. The anticipated maintenance operations and the cost level for the project facilities will be as shown in Table 2-4.

Table 2-4 Maintenance Operations and Costs

Description	Cost (US$/Year)
1. Routine Maintenance	
Cleaning of expansion joint	
US$ 5 x 20 man·days/year	100
Cleaning around shoe and pipe drain	
US$ 5 x 40 man·days/year	200
Repairing handrails	
US$ 100 x 50m²/year	5,000
Repairing pavement on bridge surface	
US$ 10 x 300m²/year	3,000
Repairing slope protection around abutment	
US$ 5 x 100 man days/year	500
Sub Total	8,800
2. Re-painting of steel girder	
US$ 80/m² x 1,000m²/year/7~10 years interval	9,400
3. Others (30%) 5,500	5,500
Total	23,700

Source: Estimated by the Basic Design Study Team

2.5.3 Outline of the Facilities

(1) Selection of Type of New Facility

As for the selection of types of new facilities, the following criteria has been applied:

Box culvert types will be adopted where discharge of the water course is judged relatively small in the rainy season, and the possibility of blockage of the water flow by flood debris or avalanche of logs is regarded very small, and where there is no obvious stream except run-off only during rainfall. However, where even natural conditions permit a box culvert type, if the construction cost exceeds that of a bridge type because of the large size of the structure due to a high embankment, a bridge type will be adopted.

A bridge type will be adopted where discharge is comparatively large, and the possibility of blockage by flood debris or avalanche of logs is large.

1) Bridge No. 1A, 1B and 2

The road where the three Bailey bridges are erected is crossing the eroded part of the left bank of Namkading at the foot of steep mountains. Pipe culverts had been originally installed for drainage of the storm rain from mountain side. However, due to heavy rain flows from the mountain side and flooding of the Namkading, the bank was partially eroded. Thus, the existing bridges were constructed temporarily with a height of 9 ~ 10m. If a box culvert type under the high bank had been used, it would have required a large cross section to avoid choking by sand, gravel or logs, and slope protection on the high bank to drain surface water, which would have led to high construction costs. Therefore, a bridge type was adopted for the three sites.

2) Bridge No. 3

The existing bridge is erected over a steep valley of a tributary to the Namkading, whose depth is as high as 13m. The discharge is 315m^3/sec, thus a bridge type was adopted. From observation of a rock outcrop on the river bed, it appears that a spread type foundation can be applied.

3) Bridge No. 4, 6, 9, 12 and 13

As the discharge is relatively small, triple box culverts were adopted for these bridges.

4) Bridge No. 5 and 10

Both existing bridges are of steel truss bridge type (Pigeaut type) with lengths of 15 ~ 21m. The discharge is fairly small (40 ~ 60m^3/sec), thus a box culvert type is applicable for both bridges. However, considering the high depth of the river bed under the existing road formation which reach 7 ~ 8m, a bridge type was adopted.

5) Bridge No. 7

Discharge is very small, thus a single box culvert type was adopted.

6) Bridge No. 8

Discharge of Namdua reaches 425m^3/sec, thus a bridge type was adopted.

7) Bridge No. 14

Because of a significant discharge of 133m^3/sec, a bridge type was adopted.

8) Bridge No. 16, 17, 18 and 19

Discharge is only 30m^3/sec, thus a box culvert was adopted.

9) Bridge No. 23, 24, 26, 27, 28 and 30

No obvious stream in the Namhinboun alluvium plain was observed and the discharge at each bridge in the rainy season only was 20 ~ 30m^3/sec, thus these bridges are to be replaced with a box type culvert facility.

10) Bridge No. 29

The length of the existing bridge is 30m, and discharge is 160m^3/sec. Thus a 2-span bridge type was adopted.

Natural conditions at each existing bridge site together with the proposed facility type are summarized in Table 2-5.

Table 2-5 Location and Condition of Project Site and Proposed Type of Facility

No.	Exist. Bridge No.	Distance from Namkaing (km)	Consition of Existing Bridge				Name of the Stream	Natural Conditions						Proposed Type of Facility
			Type	Length (m)	Nos of Span	Width (m)		Terrain	Catchment of Area (km2)	Discharge	Velocity	Possibility of Debris flood	Possibility of Avalanche of Log	
1	1A	2+500	Bailey	24.4	1	3.8	Stream to Namkading	Mountainous	0.40	15.6	High	High	High	Bridge
2	1B	3+511	Bailey	24.4	1	3.8	Stream to Namkading	Mountainous	0.40	–	High	High	High	Bridge
3	2	5+565	Bailey	24.4	1	4.1	Tributary to Namkading	Mountainous	0.574	22.1	High	High	High	Bridge
4	3	12+968	Bailey	51.85	2	3.6	Khonken	Mountainous	–	315.0	Low	Low	Low	Bridge
5	4	14+225	Steel Truss	18.4	1	3.15	Danxang	Mountainous	5.50	38.0	High	High	High	Box culvert
6	5	14+987	Steel Truss	18.5	1	3.15	Samboun	Mountainous	–	95.0	Mid.	High	High	Bridge
7	6	20+904	Steel Truss	15.5	1	2.9	Khot	Flat	1.85	55.4	Mid.	Low	Low	Box culvert
8	7	28+127	Steel Truss	21.4	1	2.9	Khot	Flat	–	–	Low	Low	Low	Box culvert
9	8	28+567	Bailey	61.0	2	3.9	Namdua	Mountainous	–	425.0	High	Low	Low	Bridge
10	9	29+555	Steel Truss	21.5	1	3.0	Pond	Flat	1.20	34.6	Low	Low	Low	Box culvert
11	10	30+691	Steel Truss	21.5	1	2.97	Pond	Mountainous	2.80	67.0	High	Low	Low	Bridge
12	12	38+723	Steel Truss	21.5	1	2.93	Nontlep	Mountainous	7.00	40.5	Mid.	Low	Low	Box culvert
13	13	39+569	Steel Truss	15.8	1	3.0	Lo/Namthon	Mountainous	4.25	56.8	Mid.	Low	Low	Box culvert
14	14	42+207	Steel Truss	21.5	1	2.97	Sai	Mountainous	18.00	133.1	Mid.	High	High	Bridge
15	16	53+181	Steel Girder	12.2	1	3.0	In	Flat	2.75	29.2	Low	Low	Low	Box culvert
16	17	55+376	Steel Truss	15.7	1	2.9	Pond	Flat	3.99	39.3	Low	Low	Low	Box culvert
17	18	58+716	Steel Girder	9.2	1	3.0	Lo	Flat	1.20	20.2	Low	Low	Low	Box culvert
18	19	59+287	Steel Girder	12.2	1	2.95	Lo	Flat	2.25	30.9	Low	Low	Low	Box culvert
19	22	99+538	Bailey	103.7	3	4.27	Namhinboun	Flat	–	3,420.0	High	Low	High	Bridge
20	23	108+354	Bailey	30.5	1	4.3	Pond	Flat	4.00	19.0	Low	Low	Low	Box culvert
21	24	108+927	Bailey	30.5	1	3.77	Ning Noy	Flat	–	29.0	Low	Low	Low	Box culvert
22	26	112+303	Bailey	18.3	1	3.94	Nongbua	Flat	2.00	14.3	Low	Low	Low	Box culvert
23	27	113+33	Bailey	15.2	1	3.95	Nonghom	Flat	5.00	34.2	Low	Low	Low	Box culvert
24	28	116+22	Bailey	21.3	1	3.99	Het	Flat	7.25	67.7	Low	Low	Low	Box culvert
25	29	117+657	Bailey	30.5	1	4.03	Het	Flat	17.00	16.0	Mid.	High	High	Bridge
26	30	126+359	Bailey	21.3	1	3.85	Tributary to the Mekong	Flat	8.00	37.4	Low	Low	Low	Box culvert

Source: Design of Namkading - Savannakhet Road, MCTPC, March 1991

(2) Location of New Facilities

Location of the reconstructed facilities will be decided based on the following criteria:

Bridges on sections where road partial improvement under the "Highway Improvement Project" has already been completed shall conform with the improved road alignment. Those in the remaining sections except for Bridge No. 22 shall be constructed along the existing road alignment in order to minimize the length of deviation and approach road. As for Bridge No. 22, a new facility will be constructed on the upstream side of the existing facility using the existing bridge as a detour during construction.

(3) Approach Road to the Facilities

As for the approach roads to the 14 sites of reconstructed facilities at the existing No. 1A to No. 14 bridges, a road structure composed of fill up to subgrade level will be constructed with a length of less than 50m on each side of the new facilities.

Each of the approach roads to the 12 sites of new facilities at the existing No. 16 to No. 30 bridges will be constructed on either side of the facilities with a length of less than 50m. The structure will comprise the fill and pavement works up to the bituminous surface treatment (DBST).

They are typically shown in Fig. 2-6.

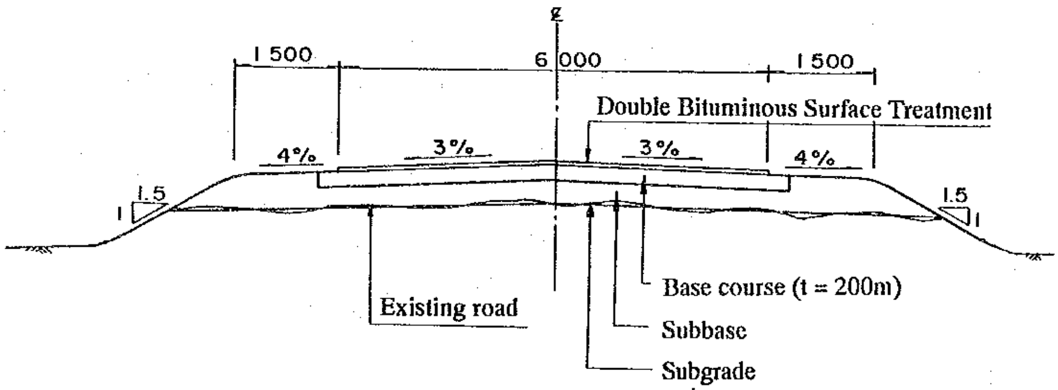


Fig. 2-6 Typical Section of Approach Road

2.5.4 Scope of the Project under the Grant Aid

The Project under Japan's Grant Aid assistance will comprise the following items:

(1) Construction of 10 bridges

(2) Construction of 16 reinforced concrete box culverts

(3) Construction of a total of 2,960 meters of approach road to the facilities

(4) Revetment around the river bank and bridge abutment of the facilities

(5) Protection of the river bed in the area of the facilities

CHAPTER 3 BASIC DESIGN

CHAPTER 3 BASIC DESIGN

3.1 Design Policy

The basic design is to be conducted on the basis of the following policies:

1) Since 26 facilities including 10 steel girder bridges and 16 reinforced concrete (RC) box culverts should be constructed in a rather short period, their basic design will be standardized so that the construction works can be completed in as short as possible a duration.

2) Designs and construction methods to be adopted for the Project shall conform with those which are being applied presently for the "Highway Improvement Project."

3) Taking into account the intensive run-off at the site during the rainy season, adequate protection around the sub-structures and road embankments shall be envisaged.

4) Construction methods available in Laos shall be used to the maximum possible extent.

5) The Project will be implemented over two phases. Each construction shall be completed within the 1st or 2nd 12 calendar months in accordance with the conditions of the Japanese grant aid system.

3.2 Design Criteria

(1) Applicable Design Standards

1) As there are no established design standards for bridge and reinforced concrete box culverts, the following Japanese design standards will be applied:

   A. Specifications for Highway Bridges (Dorokyo Shihosho)

   B. Standard for River Control Structures (Kasen Kanrishisetsu Kozorei)

2) For design of geometry, materials, pavement and drainage, the following MCTPC standards shall be applied:

A. Road Design Manual	Part 1:	Geometric design standards for rural roads
B. Road Design Manual	Part 2:	Design standards
C. Road Design Manual	Part 3:	Materials and pavement design standards
D. Road Design Manual	Part 4:	Hydraulic design standards

(2) Geometric Standards of Road

As the project section of National Road 13S is classified as a Class II Road in accordance with MCTPC's Road Design Manual Part 1, the category and main criteria are set forth as follows:

- Traffic volume (ADT) : 300 - 1000/day
- Terrain : rolling
- Design speed : 85 km/h
- Maximum gradient : 8%
- Minimum horizontal curve : 250m

Cross sectional dimension and pavement requirement shall be as follows:

Item	Road Part	Bridge Part
• Carriageway	6.0m	6.0m
• Shoulder	1.5m (outside of villages) ~ 2.0m (in village)	0.25m
• Sidewalk	–	0.75 m
• Pavement slope	3.0%	2.5%
• Pavement	DBST	Cement concrete

note : DBST = Double Bituminous Surface Treatment

(3) Freeboard of Bridge

In accordance with the Japanese Standards for River Control Structures, the freeboard of bridge by discharge shall be set forth as follows:

Discharge (Qm^3/sec)	Freeboard	Existing bridge to be applied
• Q < 200	0.6m	1A, 1B, 2, 5, 10, 14, 29
• 200 ≦ Q < 500	0.8m	3, 8
• 500 < Q < 2,000	1.0m	-
• 2,000 < Q < 5,000	1.0m	22

(4) Design Live Load of Bridge

"TL-A loading " of Japanese Specifications for Highway Bridges shall be applied:

1) For design of slab : 20 ton of axle load

2) For design of main girder : 1.05 ton of uniform lane loading (per linear meter)

: 18 ton of concentrated lane loading (6.0 meter of loaded length)

: 0.5 t/m^2 on footpath

(5) Seismic Force for Bridge Design

As there was no recorded earthquakes in the Project area , seismic force is not taken into account for the design of structures.

(6) Other Loads for Bridge Design

1) Principal Loads

The following loads are to be considered for the designs:

A. Dead load

B. Impact load

C. Earth pressure

D. Hydraulic pressure

E. Buoyancy

F. Effect of shrinkage of concrete

2) Subsidiary Loads

The following loads combined with the above principal loads are to be considered for the designs:

A. Wind load

B. Dynamic water pressure

(7) Design Method of Bridge

As there are no established design methods in Laos, the service load design method (allowable stress design method) combined with the strength design method (load factor design method) will be used for bridge design in accordance with the Japanese Specifications for Highway Bridges.

(8) Material Strength

According to the experimental records of the strength of the materials used in on-going "Highway Improvement Project", the strength of the major materials to be used under the Project are set forth as follows:

1) Compressive strength of concrete (cylindrical specimen)

- For the design of slab : 240kgf/cm^2
- For the design of abutments and piers : 210kgf/cm^2
- For the design of cast-in-place piles : 210kgf/cm^2

2) Reinforcing bar (SD295A , JIS G3112)

- Yield strength : 3,000kgf/cm^2

3) Rolled steel for general use (SS400, JIS G3101)

- Yield strength : 2,400kgf/cm^2

4) Rolled steel used for welded structure (SM490Y, JIS G3106)

- Yield strength : 3,600kgf/cm^2

(9) Permissible Stresses

1) Concrete

- Flexural compressive stress for: Slab : 80kgf/cm^2

  Abutment and pier : 70kgf/cm^2

2) Reinforcing bar

• Tensile stress for:	Slab	:	1,400kgf/cm^2
	Abutment and pier	:	1,800kgf/cm^2
	Cast-in-place pile	:	1,600kgf/cm^2

3) Structural steel

• Tensile stress for:	SS400	:	1,400kgf/cm^2
	SM490Y	:	2,100kgf/cm^2

(10) Formation of Road

Longitudinal and horizontal alignments of the roads and structures under the Project shall conform with those under the ongoing "Highway Improvement Project".

(11) Design Flood Level

Design flood levels at proposed bridge sites have been calculated based on the highest recorded flood levels of the Mekong river at Paksan (13.54m above the zero point in September, 1980) and Thakhek (14.63m above the zero point in September, 1966). The water level of main tributaries of Namkading, Namdua and Namhinboun is affected by backwater from the Mekong river. Water level at the mouth of the tributaries is schematically demonstrated in Fig. 3-1, and the design flood level of major bridges on the tributaries is estimtimated respectively as follows:

- Bridge No. 3 (Namkading) : 155.2m a.s.l
- Bridge No. 8 (Namdua) : 153.0m a.s.l
- Bridge No. 22 (Namhinboun) : 147.5m a.s.l

Here, the design flood level for each bridge site is calculated provided that gradient of backwater curve on the tributary be simply assumed to be 0.01% between the junction with the Mekong and the site.

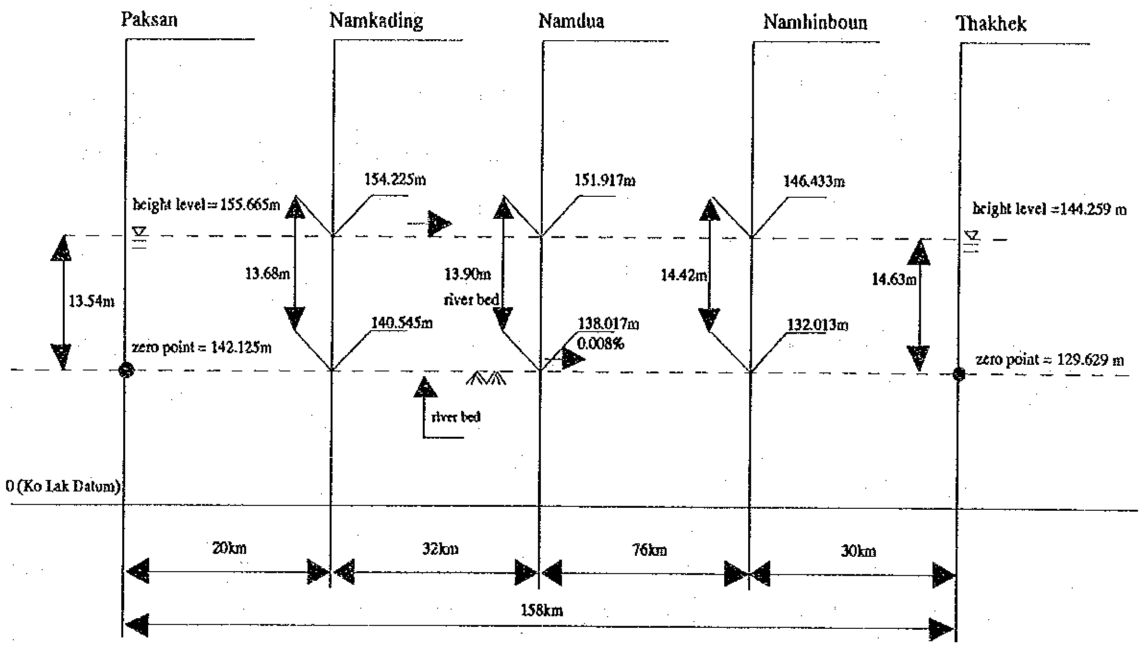


Fig. 3-1 Water Levels at the Junction of Main Tributaries of the Mekong River

3.3 Basic Design

3.3.1 Box Culvert

The following items were considered for design of box culvert:

1) Minimum over-burden shall be more than 30cm at the shoulder of box culvert.
2) Single or three cells of box culvert will be adopted so that the stream center may pass the central hollow part of the box culvert.
3) Gabion mattress shall be placed at both the inlet and outlet.
4) Crushed rock or river gravel will be used for backfill materials.
5) Allowable bearing capacity of the foundation is assumed to be $10t/m^2$ or more. Where soft soil with a lower bearing capacity is encountered, it shall be replaced with selected materials from borrows with a sufficient bearing capacity.
6) Embankment slope shall be protected with concrete blocks and stone masonry.

Typical cross section of box culvert is shown in Fig. 3-2.

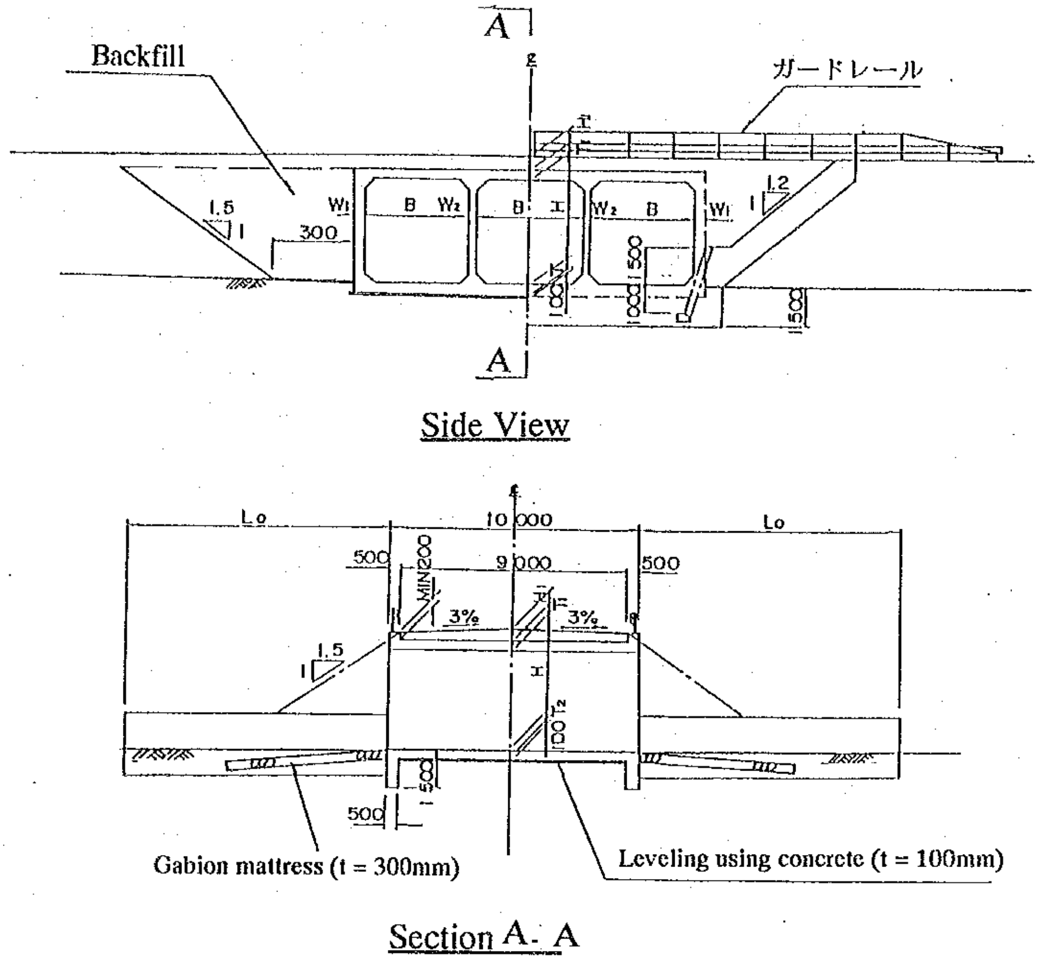


Fig. 3-2 Typical Cross Section of Box Culvert

3.3.2 Bridge Superstructure

Span length of the proposed bridge is standardized to 17m, 20m and 25m except Bridge No. 22. Steel girder and reinforced concrete (RC) or prestressed concrete (PC) girder bridge will all be applicable for the bridges with such span length. Comparison of such steel girder type (Alternative 1) and concrete girder type (Alternative 2) for the Project are made as shown in Table 3-1. As for Bridge No. 22, the following three alternative types are compared as shown in Figure 3-3.

Alternative 1: Three -span simply supported prestressed concrete (PC) T-girder type
Alternative 2: Three -span continuous prestressed concrete (PC) box girder type
Alternative 3: Three -span continuous steel plate girder type

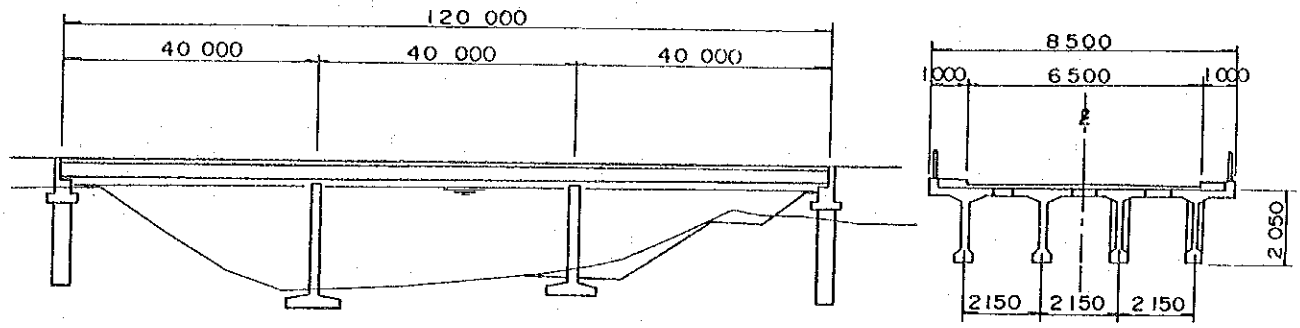
Comparison of these three alternatives is summarized in Table 3-2.

Table 3-1 Comparison of Steel Girder and Concrete Girder for Project Bridges except for Bridge No.22

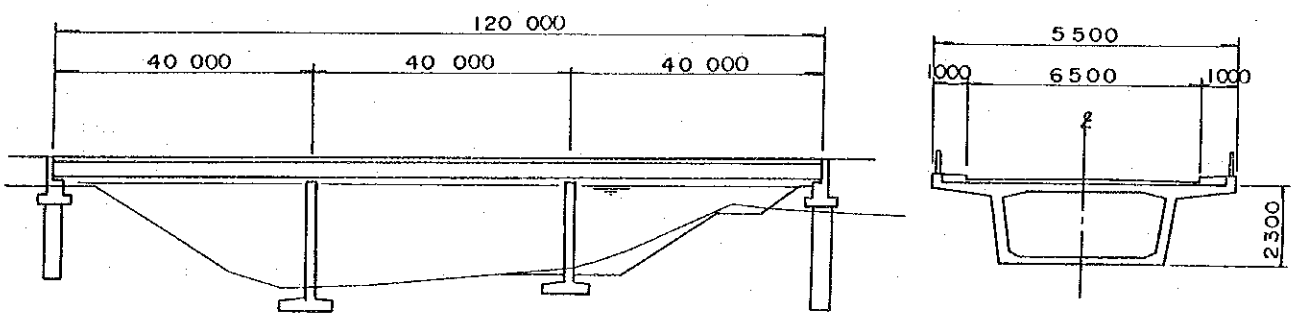
Description	Steel Girder	Concrete Girder (RC or PC)
(1) Construction period	Construction period is short because of fabrication of girders. Erection of girders can be done in fairly shorter period. ◎	Fairly long construction period is required due to complicated and heavy works for casting girders on site and their erection. ○
(2) Safety of construction	No difficulties exist in transportation, and erection of girder (rolling out by launching nose is very easy). ◎	There are risks in handling of very heavy girders. ○
(3) Quality control	Good quality can be secured by fabrication of girder at factory. ◎	Special care is required in production of high strength concrete, tensioning of PC tendons, erection and launching of girders. ○
(4) Construction Cost	Cost of fabrication and transportation are relatively high. ○	Costs of casting girder on site and its erection are relatively high. ○
(5) Maintenance operation and cost	Relatively low maintenance cost is required, but repainting of the girders at 6~7 year interval is required. ○	Maintenance is almost free. ◎
(6) Technical transfer	Local workers can be trained in techniques, particularly of heavy works. ◎	Local workers can be trained in techniques, particularly of concrete works. ◎
(7) Effects on local economy	Large local employment opportunity will be created. ◎	Large local employment opportunity will be created. ◎

Note : ◎ means "Favorable"
○ means "Not so favorable"

Alternative 1 Three -Span Simply Supported PC T girder



Alternative 2 Three -Span Continuous PC Box Girder



Alternative 3 Three -Span Continuous Steel Plate Girder

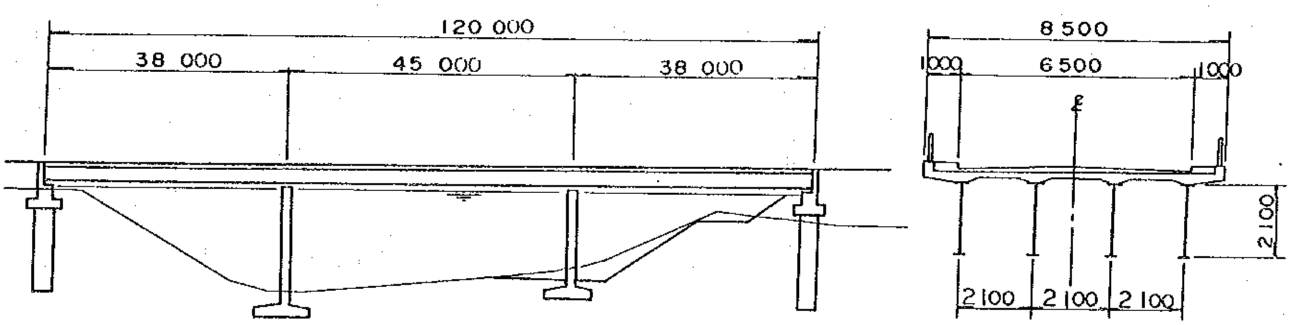


Fig. 3-3 Alternative Type of Superstructure for Bridge No. 22

Table 3-2 Comparison of Superstructure Type for Bridge No. 22

Description	Alternative 1 PC T-Girder Bridge	Alternative 2 PC Box Girder Bridge	Alternative 3 Steel Plate Girder Bridge
(1) Erection method	Erection girder method can be applied, easily. ○	Launching method (push-out method) can be applied, easily ○	Launching nose method can be applied, very easy. ◎
(2) Construction period	Coffering & piling 2month Abutment & pier 3month Erection 4month Decking 3month Total 12month ○	Sub-structure 5month Erection 4month Flooring 3month Total 12month ○	Temporary close & piling pile 2month Abutment & pier 3month Erection 4month Decking 3month Total 10month ◎
(3) Structural Aesthetics	Fair ○	Good ◎	Good ◎
(4) Construction cost	Low ◎	Medium ○	Medium ○
(5) Quality control	Provision of high stress concrete and tensioning techniques of PC cables requires special care. ○	Provision of high stress concrete and tensioning techniques of PC cables require special care. ○	Main girders are fabricated at factory, which secures good quality. ◎
(6) Safety of construction	Special care for erection is required. ○	High technology is required in fabrication and erection. ◎	There are no difficulties. ◎
(7) Smoothness of bridge surface for traffic	Less comfortable. ○	comfortable. ◎	comfortable . ◎
(8) Maintenance aspect	Almost maintenance free. ◎	Almost maintenance free. ◎	Repainting required at interval of 7-8 years. ○

Note : ◎ means "Favorable"
○ means "Not so favorable"

From the above comparative study a steel girder bridge type is selected for the bridges with span length of 17m, 20m and 25m. As for bridge No. 22, three span continuous steel girder structure is selected as the most optimal type.

Type selected for each bridge is summarized as follows:

(1) Single span steel girder:

Span Length = 20(m) : No. 1B, 5, 14

Span Length = 25(m) : No. 1A, 2, 10, 29

(2) Three span simple steel girder:

Span Length = 3@17 = 52(m) : No. 3

Span Length = 3@20 = 60(m) : No. 8

(3) Three span continuous girder:

Span Length = 39+46+39 = 124(m) : No. 22

The deck slab shall be of composite type for all simply supported bridges.

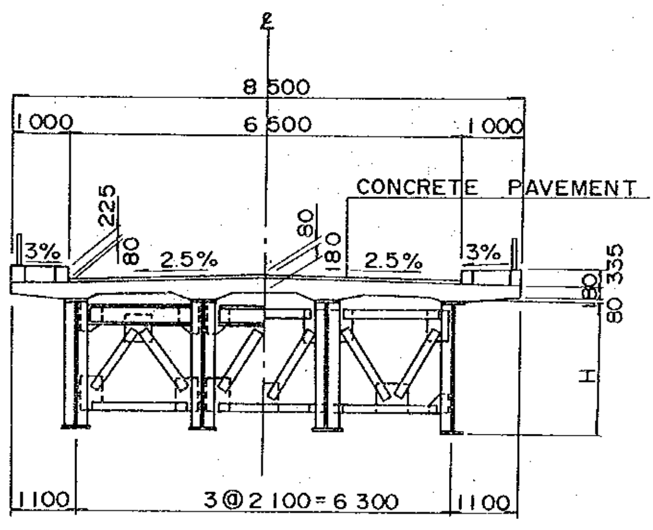


Fig. 3-4 Typical Cross Section of Steel Girder Bridge

3.3.3 Bridge Substructure

(1) Foundation

As bearing layers which are generally composed of sandstone or limestone are found at depths of 4m ~ 13m below the ground level at the sites as shown in borehole logs (see Appendix 6), the pile foundation type can be applied for the abutments and piers of the bridge, except where outcrops of sound rock exist at shallow level and spread type foundations type can be applied.

The pile foundations which are applicable for such depths are classified into following three groups:

Group (1) Driven ready-made piles

There are three types of piles for this group i.e., RC, PC and Steel piles. Viewed from the high cost, steel pile will be first eliminated. Then, PC pile is selected from this group for comparative study, because it can be handled much more easily and safely during driving operation than the RC pile.

Group (2) Cast-in-place reinforced concrete (RC) piles

These are sub-grouped into the following 4 types according to execution methods:-

a. Bored pile by hand excavation (Shinso method)

b. Bored pile by drilling machine (Earth drill method)

c. Bored pile by drilling machine (Reverse circulation drill method)

d. Bored pile by hammer grab (Benoto all casing method)

Group (3) Open caisson

While, the following construction conditions at sites shall be taken into consideration for the comparison of type of pile foundation from the above (2) and (3) groups:

- The length of piles required ranges from 5 to 13 meter and almost all the piling works should be carried out on fairly steep slopes of river banks.
- According to the soil investigation of the Project sites, there exist generally thick clayey soil layers above the foundation bedrock, within which there are no confined aquifers.

- There is no runoff in the water courses of the Project sites in the dry season (November ~ April), except for NO. 22 bridge site (Namhinboun).

- As the existing road for access to the construction site (RN13S) and its construction detours are not in improved condition, and the loading capacity of the existing bridges all appear to be less than 10 ton ~ 20 ton, the mobilization of large and heavy equipment such as pile drivers, reverse circulation drillings, etc. to and at the sites will be very difficult, especially in the rainy season.

- As the Project bridges are relatively small sized and the sites are scattered over a relatively long distance within the Project area, construction methods for foundations requiring heavy equipment will be uneconomical.

Accordingly, the method (2)-c "Bored pile by drilling machine" (Reverse circulation drill method) and (2)-d "Bored pile by hammer grab" (Benoto all casing method) will be omitted for the purpose of this study. Therefore, the method (2)-a "Bored pile by manual excavation" (Shinso method), and (2)-b "Bored pile by drilling machine" (Earth drill method) which require only light equipment will be taken up from among Group (2) "Cast-in-place RC piles methods."

The Group (3) "Open Caisson "is not taken up, either, for the comparative study, because it suits primarily large sized foundations requiring large bearing capacity.

Thus, three alternatives for pile foundation selected above are shown in Table 3-3. A hammer driven PC pile (Alternative 2) appears to be actually impossible due to difficulties of transporting the piles to and within the site. A bored pile using drilling machine (Alternative 1) costs very much because it requires a very special compact and light machine, consequently it is been eliminated. Therefore, a bored pile by manual excavation (Alternative 3) which has no construction demerits, has been adopted.

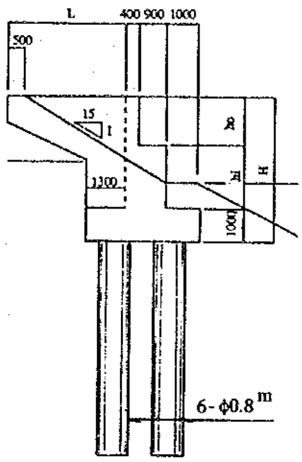
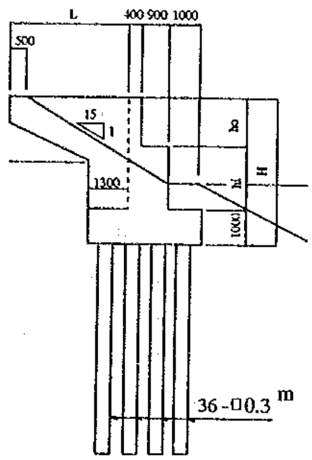
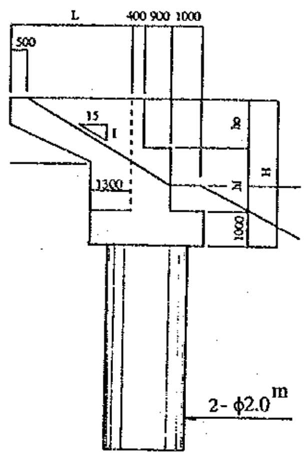
(2) Abutment

A pile-bent type abutment is adopted in terms of construction ease and cost. Front face of abutments shall be protected from scouring by concrete block pitching and gabion mattress.

(3) Pier

A wall type pier shall be adopted for the design in order to minimize disruption of flow. Top of footings shall be 2.0m below the riverbed according to Japanese "Standard for River Control Structures".

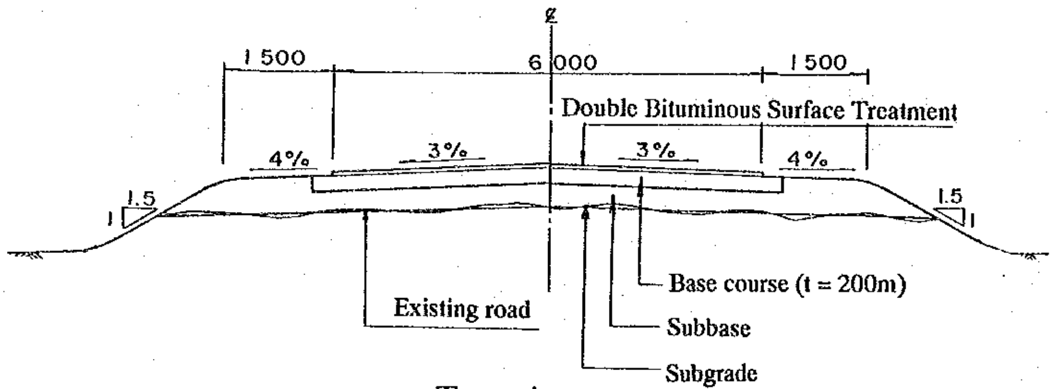
Table 3-3 Comparison of Pile Foundation Type

<table>
<tr><th>Description</th><th>Alternative 1
Bored pile by drilling machine</th><th>Alternative 2
Driven pile
(PC pile)</th><th>Alternative 3
Bored pile by hand excavation</th></tr>
<tr><td>Sketch of foundation</td><td>
</td><td>
</td><td>
</td></tr>
<tr><td>Contents of required equipment and preparation availability</td><td>•Rotary type drilling machine (6.5t)
• Wheel crane (20t)
A special typed light drilling machine is not so popular.
○</td><td>• Crawler crane (35t)
• Diesel pile driver (2.5t)
• Wheel crane (20t)
All equipment are very popular.
◎</td><td>• Crane (3-4t)
• Air compressor (7m^3/min.)
• Power generator (45KVA)
No need of special equipment.
◎</td></tr>
<tr><td>Construction period and possibility of parallel execution</td><td>10 days to complete single foundation (4-pile). (2 days to accomplish one pile)
Parallel construction is limited by the development number of equipment..
Δ</td><td>9 days to complete single foundation (36-pile).
(4 days to drive one pile)
Parallel construction is limited by the development number of equipment.
Δ</td><td>15 days to complete single foundation (2-pile).
(10 days to accomplish one pile)
No limitation to proceed the parallel construction.
◎</td></tr>
<tr><td>Construction cost</td><td>Highest cost among the alternatives due to high equipment cost. Δ</td><td>Cost stands between Alternative 1 and 3.
○</td><td>Cost is the least among the alternatives.
◎</td></tr>
<tr><td>Ease of access and mobilization within bridge sites</td><td>Not difficult due to lighter equipment than the Alternative 2.
◎</td><td>Difficult due to heavy equipment which has to cross over the weight controlled existing bridges. Δ</td><td>Very easy.
◎</td></tr>
<tr><td>Structural and constructional characteristic</td><td>Reliable confirmation of bearing strata can be done.
◎</td><td>Complicated treatment of joints is required. It may face difficulties of pile driving due to possible hard soil layer.
○</td><td>Bearing strata can be reliably confirmed.
Construction difficulties are expected in soil having high pressured aquifer or ground water. ◎</td></tr>
</table>

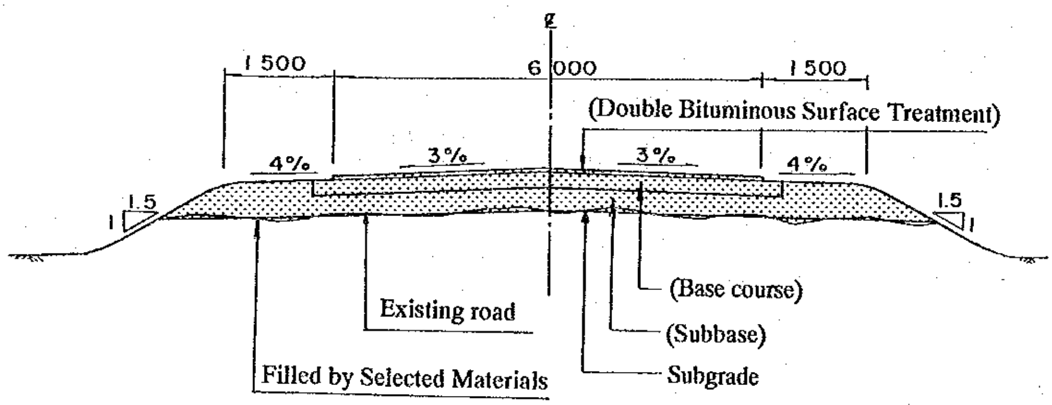
Note: ◎ means "Favorable"
○ means "Not so favorable"
Δ means "Not favorable"

3.3.4 Approach Road

Typical cross section of approach road for the completed bridges are shown in Fig. 3-5. Type A is applied for the 12 sites from existing bridge No. 16 to 30, and Type B for the 14 sites form Bridge No. 1A to 14.



Type A



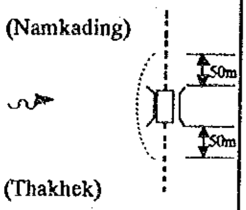
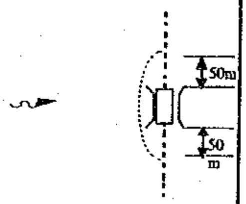
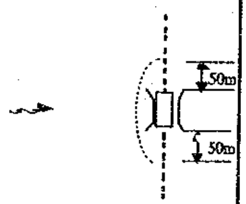
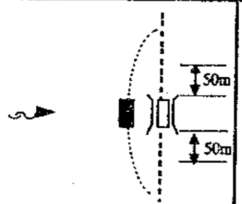
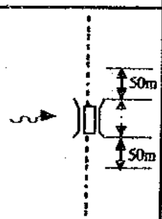
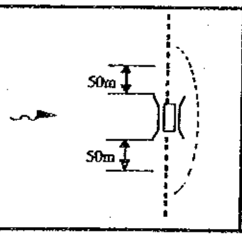
Type B

Fig. 3-5 Typical Cross Section of Approach Road

3.3.5 Basic Design Drawings

Arrangement of each site of new facilities including approach roads are shown in Table 3-4 and Basic Design drawings of the facilities are given in Figures 3-6 to 3-12.

Table 3-4 Arrangement at Each Site of New Facilities (1/5)

Existing Bridge No.	Distance from Namkadin (Km)	Arrangement	New Facility	Approach Road	Treatment of Existing bridge
1A	2 + 500		Single span steel plate girder bridge (L=25.6 m)	Type B, 100m	Dismantled under the Project (Bailey bridge, L = 24.4 m)
1B	3 + 511		Single span steel plate girder bridge (L=20.5 m)	Type B, 100m	Dismantled under the Project (Bailey bridge, L = 24.4 m)
2	5 + 565		Single span steel plate girder bridge (L=25.6 m)	Type B, 100m	Dismantled under the Project (Bailey bridge, L = 24.4 m)
3	12 + 968		Singly supported three span steel plate girder bridge (L=52.0 m)	Type B, 100m	Dismantled under the Project (Bailey bridge, L = 51.9 m)
4	14 + 225		Box culvert (3 - 5.0 x 5.0)	Type B, 100m	Dismantled under the Project (Steel truss bridge, L = 14.8 m)
5	14 + 987		Single span steel plate girder bridge (L=25.6 m)	Type B, 100m	Dismantled under the Project (Steel truss bridge, L = 14.8 m)

Legend:
- : Existing bridge
- : New Bridge/BoxCulvert
- : Temporary bridge during the work
- : Direction of water flow
- : Detour

Approach road:
Type A (——): Constructed up to the Layer of DBST
Type B (-----): Constructed up to the Layer of Subgrade (Fill selected material temporarily for the pavement layers above the Subgrade)

Table 3-4 Arrangement at Each Site of New Facilities (2/5)

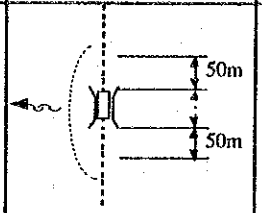
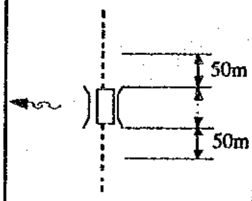
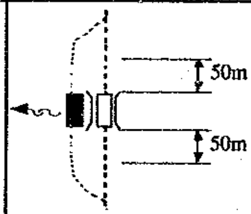
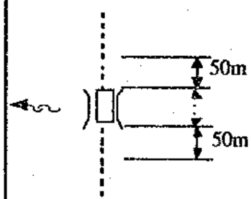
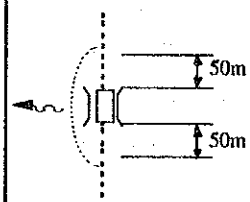
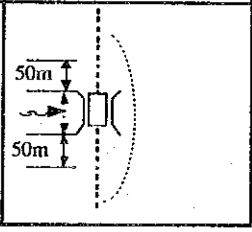
Existing Bridge No.	Distance from Namkadin (Km)	Arrangement	New Facility	Approach road	Treatment of Existing bridge
6	20 + 904		Box culvert (3 - 4.0 x 4.0)	Type B, 100m	Dismantled under the Project (Steel truss bridge, L = 18.5 m)
7	28 + 127		Box culvert (5.0 x 5.0)	Type B, 100m	Dismantled under the Project (Steel truss bridge, L = 21.4 m)
8	28 + 567		Singly supported three span steel plate girder bridge (L=60.0 m)	Type B, 100m	Dismantled under the Project (Bailey bridge, L = 61.0 m)
9	29 + 555		Box culvert (3 - 5.0 x 5.0)	Type B, 100m	Dismantled under the Project (Steel truss bridge, L = 21.5 m)
10	30 + 691		Single span steel plate girder bridge (L=25.6 m)	Type B, 100m	Dismantled under the Project (Steel truss bridge, L = 21.5 m)
12	38 + 723		Box culvert (3 - 5.0 x 4.0)	Type B, 100m	Dismantled under this Project (Steel truss bridge, L = 21.5 m)

Table 3-4 Arrangement at Each Site of New Facilities (3/5)

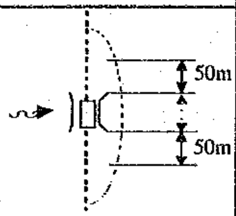
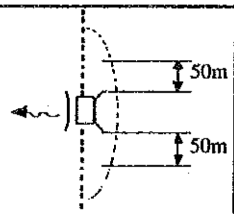
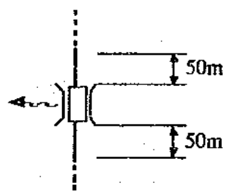
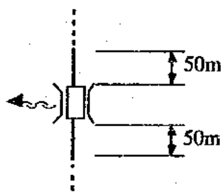
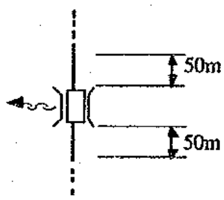
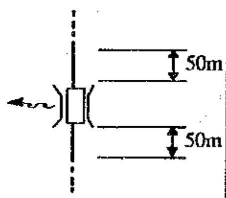
Existing Bridge No.	Distance from Namkadin (Km)	Arrangement	New Facility	Approach road	Treatment of Existing bridge
13	39 + 569		Box culvert (3 - 5.0 x 5.0)	Type B, 100m	Dismantled under the Project (Steel truss bridge, L = 15.8 m)
14	42 + 207		Single span steel plate girder bridge (L=20.5 m)	Type B, 100m	Dismantled under the Project (Steel truss bridge, L = 21.5 m)
16	53 + 181		Box culvert (3 - 4.0 x 3.5)	Type A, 100m	Dismantled under the Project (Steel girder bridge, L = 12.2 m)
17	55 + 376		Box culvert (3 - 4.0 x 3.5)	Type A, 100m	Dismantled under the Project (Steel truss bridge, L = 15.7 m)
18	58 + 716		Box culvert (3 - 4.0 x 3.5)	Type A, 100m	Dismantled under the Project (Steel girder bridge, L = 9.2 m)
19	59 + 287		Box culvert (3 - 4.0 x 3.5)	Type A, 100m	Steel girder bridge, (L = 12.2 m)

Table 3-4 Arrangement at Each Site of New Facilities (4/5)

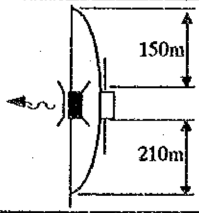
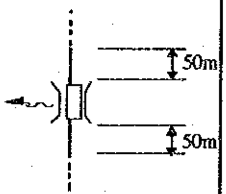
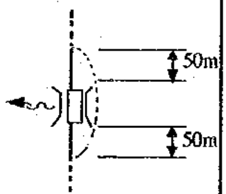
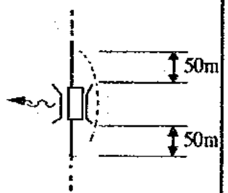
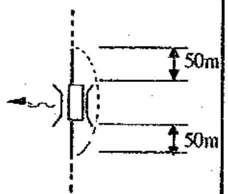
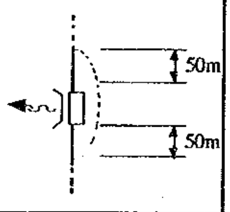
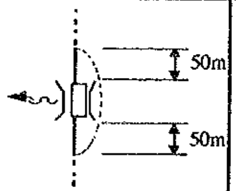
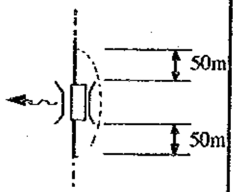
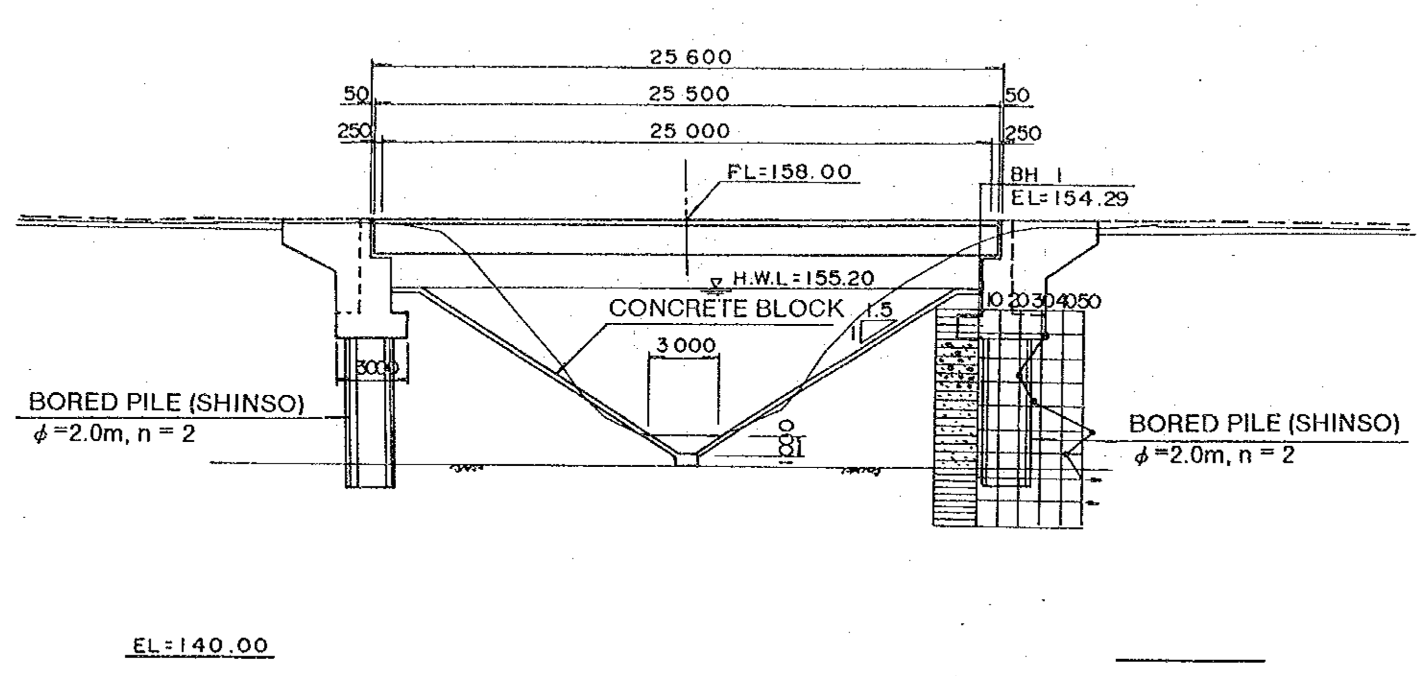
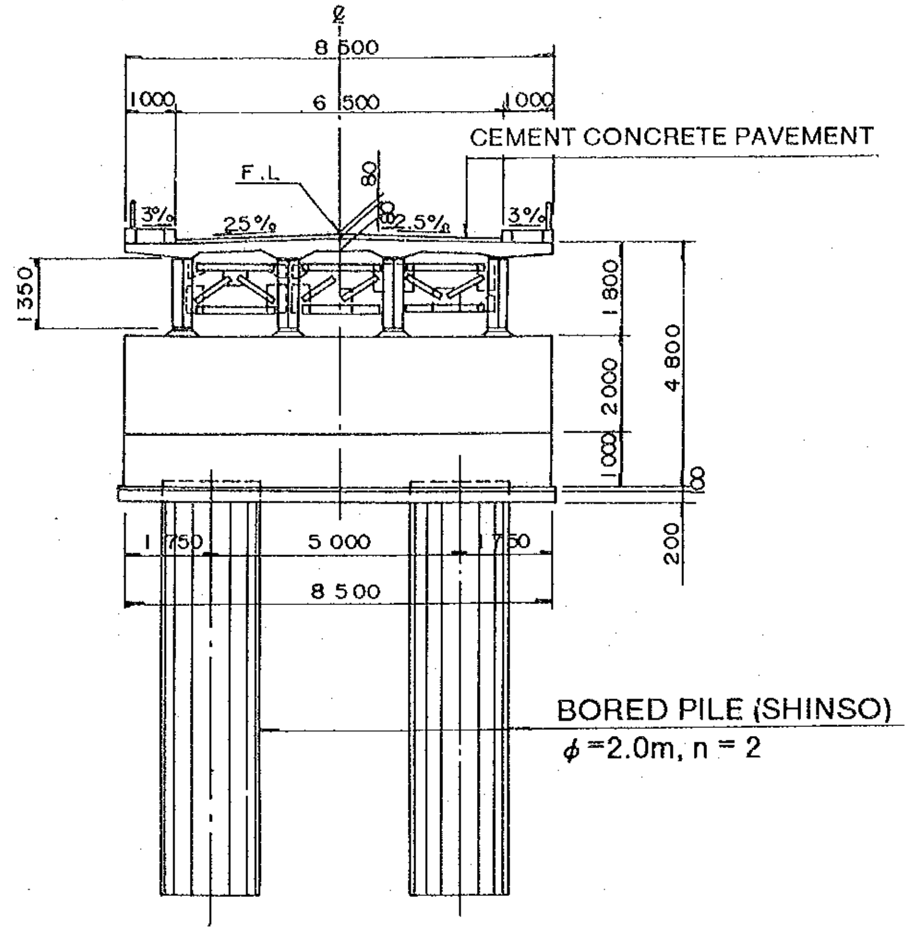
Existing Bridge No.	Distance from Namkadin (Km)	Arrangement	New Facility	Approach road	Treatment of Existing bridge
22	99 + 538		Three span continuous steel plate girder bridge (L = 124.0 m)	Type A, 360m	Dismantled by Laotian side (Bailey bridge, L=103.7m) after completionof Project bridge
23	108 + 354		Box culvert (3 - 5.0 x 5.0)	Type A, 100m	Dismantled under the Project (Bailey bridge, L = 30.5 m)
24	108 + 927		Box culvert (3 - 5.0 x 5.0)	Type A, 100m	Dismantled under the Project (Bailey bridge, L = 30.5 m)
26	112 + 303		Box culvert (3 - 4.0 x 3.5)	Type A, 100m	Dismanteld under the Project (Bailey bridge, L = 18.3 m)
27	113 + 033		Box culvert (3 - 4.0 x 3.5)	Type A, 100m	Dismantled under the Project (Bailey bridge, L = 15.2 m)
28	116 + 022		Box culvert (3 - 4.0 x 3.5)	Type A, 100m	Dismantled under the Project (Bailey bridge, L = 21.3 m)

Table 3-4 Arrangement at Each Site of New Facilities (5/5)

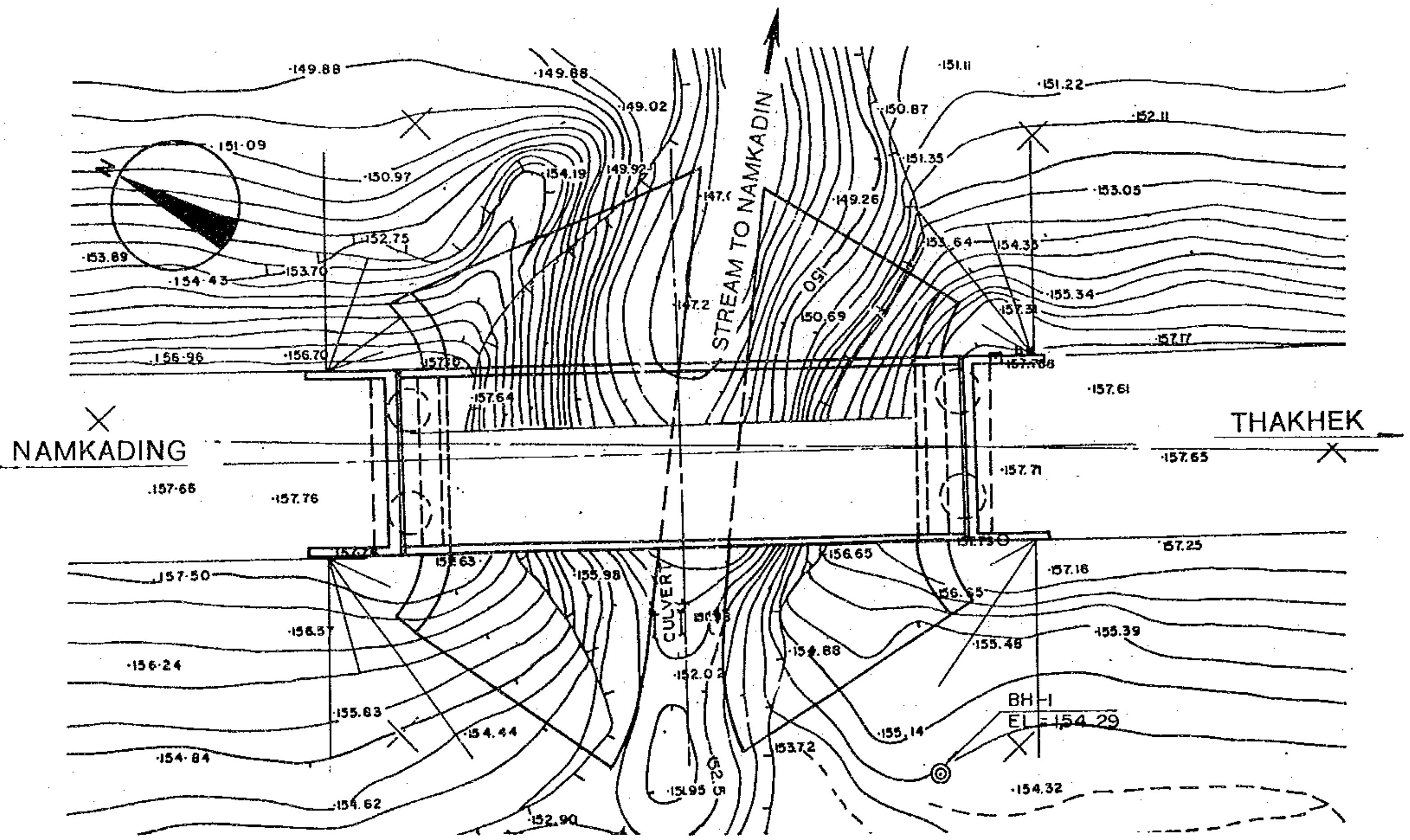
Existing Bridge No.	Distance from Namkadin (Km)	Arrangement	New Facility	Approach road	Treatment of Existing bridge
29	117 + 657		Single span steel plate girder (L = 25.6)	Type A, 100m	Dismantled under the Project (Bailey bridge, L = 30.5 m
30	126 + 359		Box culvert (3 - 5.0 x 4.5)	Type A, 100m	Dismantled under the Project (Bailey bridge, L = 21.3 m)
Total			Bridge 10 Nos Box culvert 16 Nos Total 26 Nos	Type A 1,460m Type B 1,400m Total 2,860m	Dismantled under the Project: Bailey bridge 12 Nos Steel truss bridge 10 Nos Steel girder bridge 3 Nos Concrete bridge 1 No Dismantled by Laotian side: Bailey bridge 1 No Total 26 Nos



ELEVATION SCALE 1:300

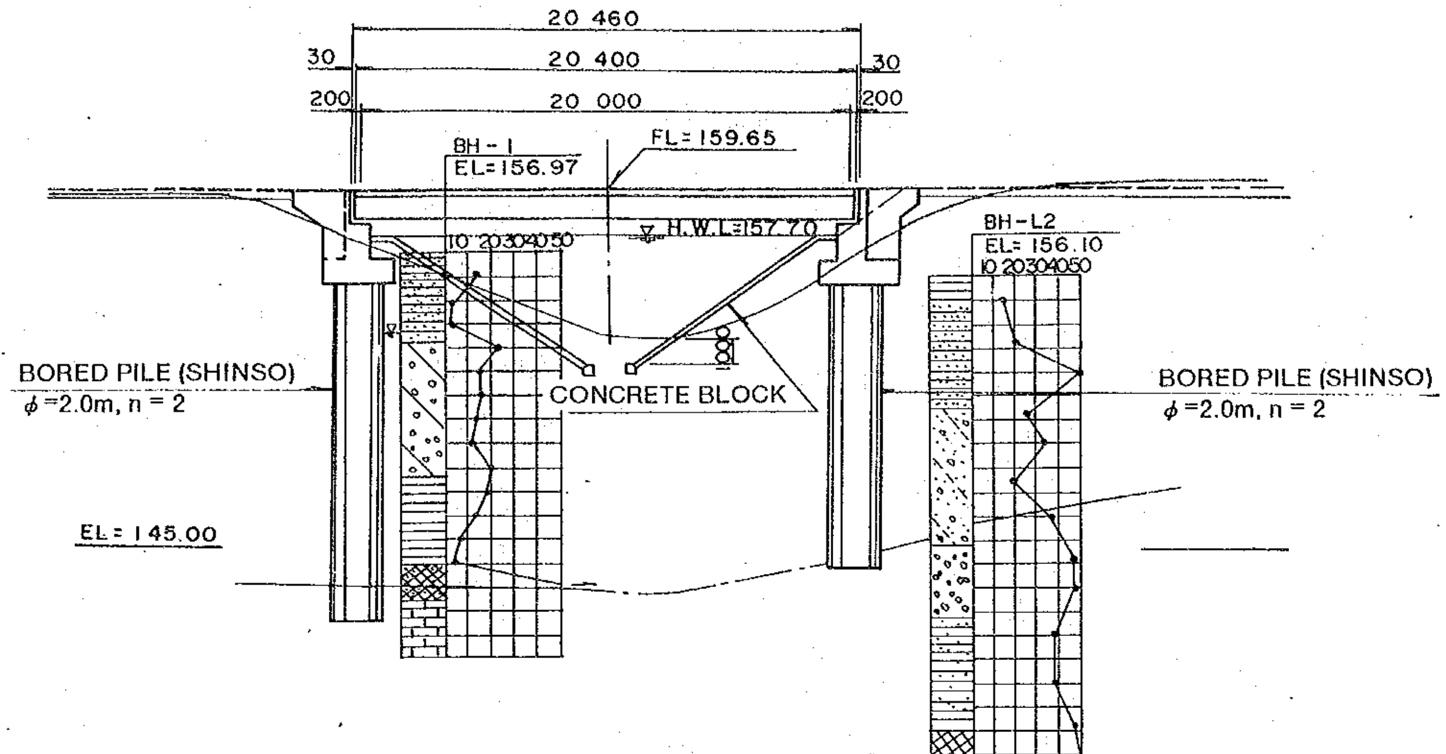


SECTION OF ABUTMENT SCALE 1:150

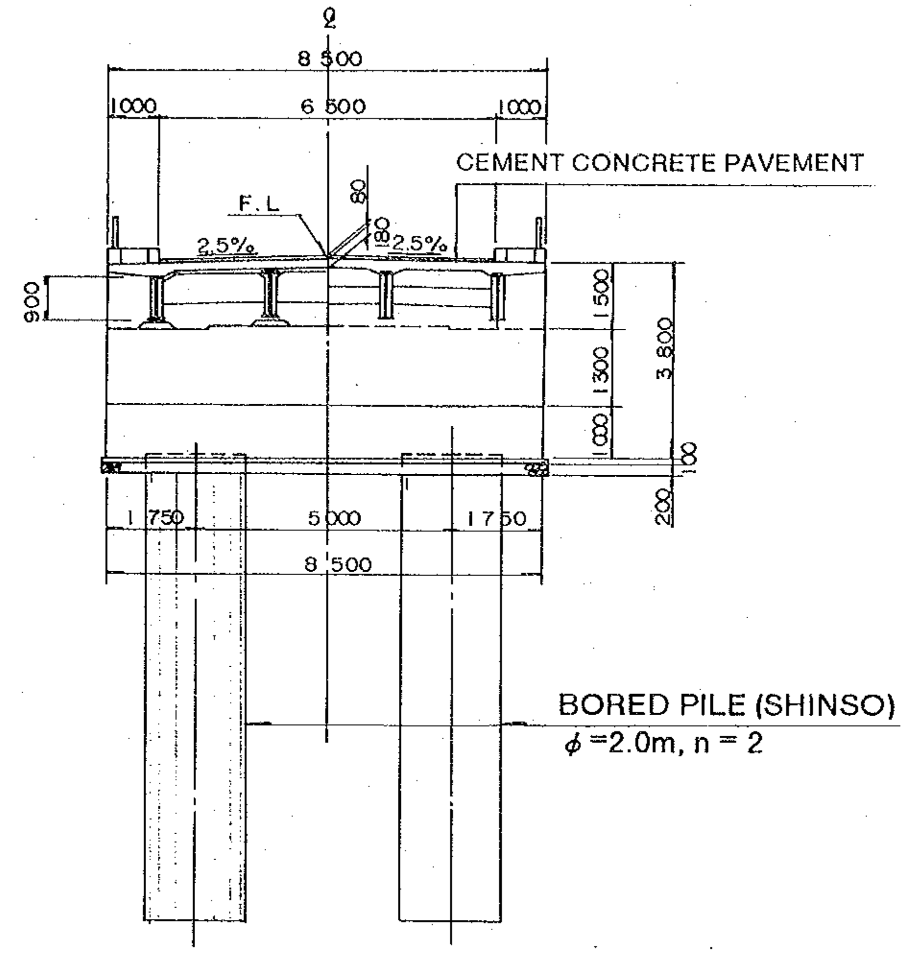


PLAN SCALE 1:300

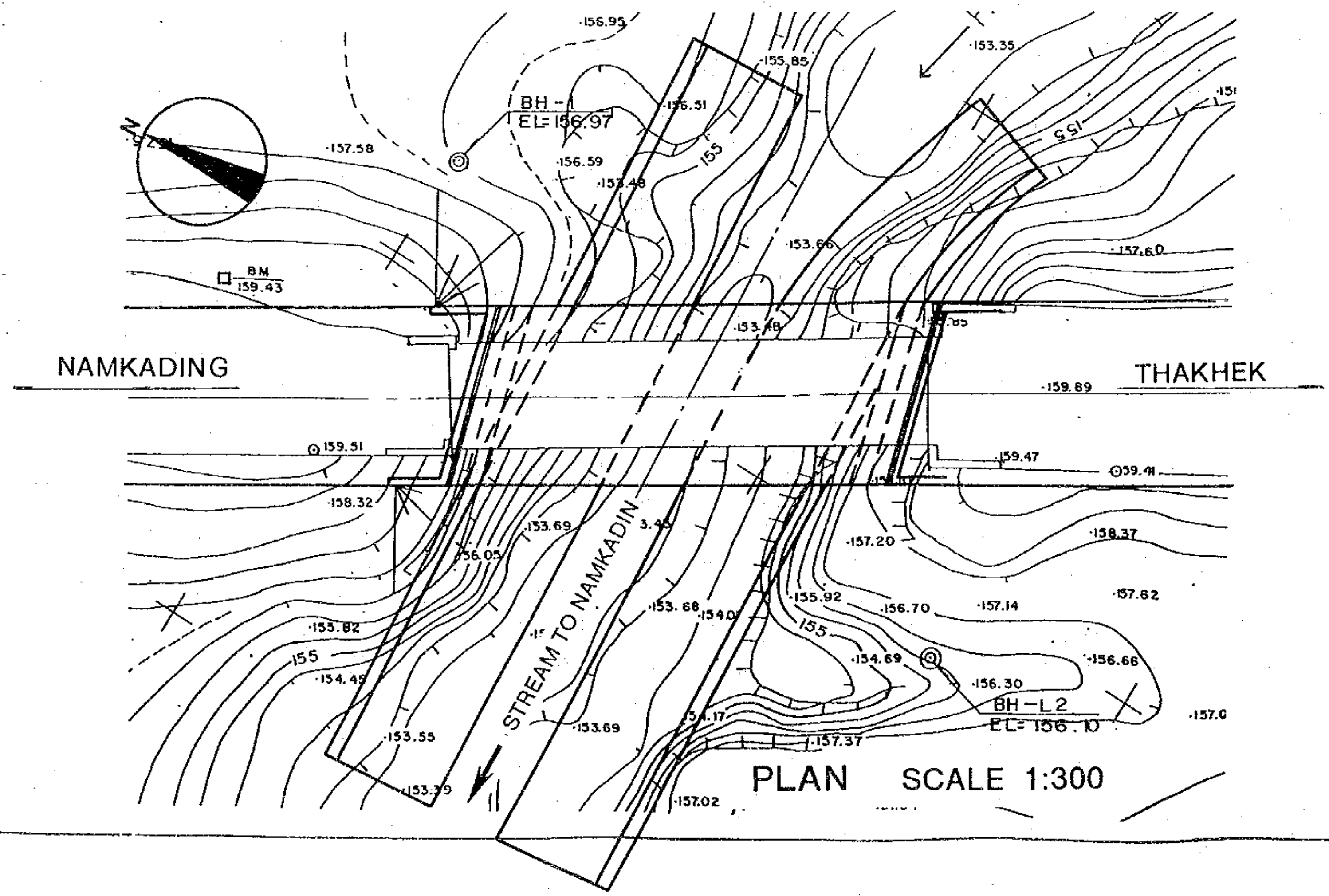
Fig.3-6 Basic Design Drawing for Bridge No.1A, 2, 5, and 10 (Standardized for Single Span Steel Plate Girder)



ELEVATION SCALE 1:300



SECTION OF ABUTMENT SCALE 1:150



PLAN SCALE 1:300

Fig.3-7 Basic Design Drawing for Bridge No.1B, and 14 (Standardized)

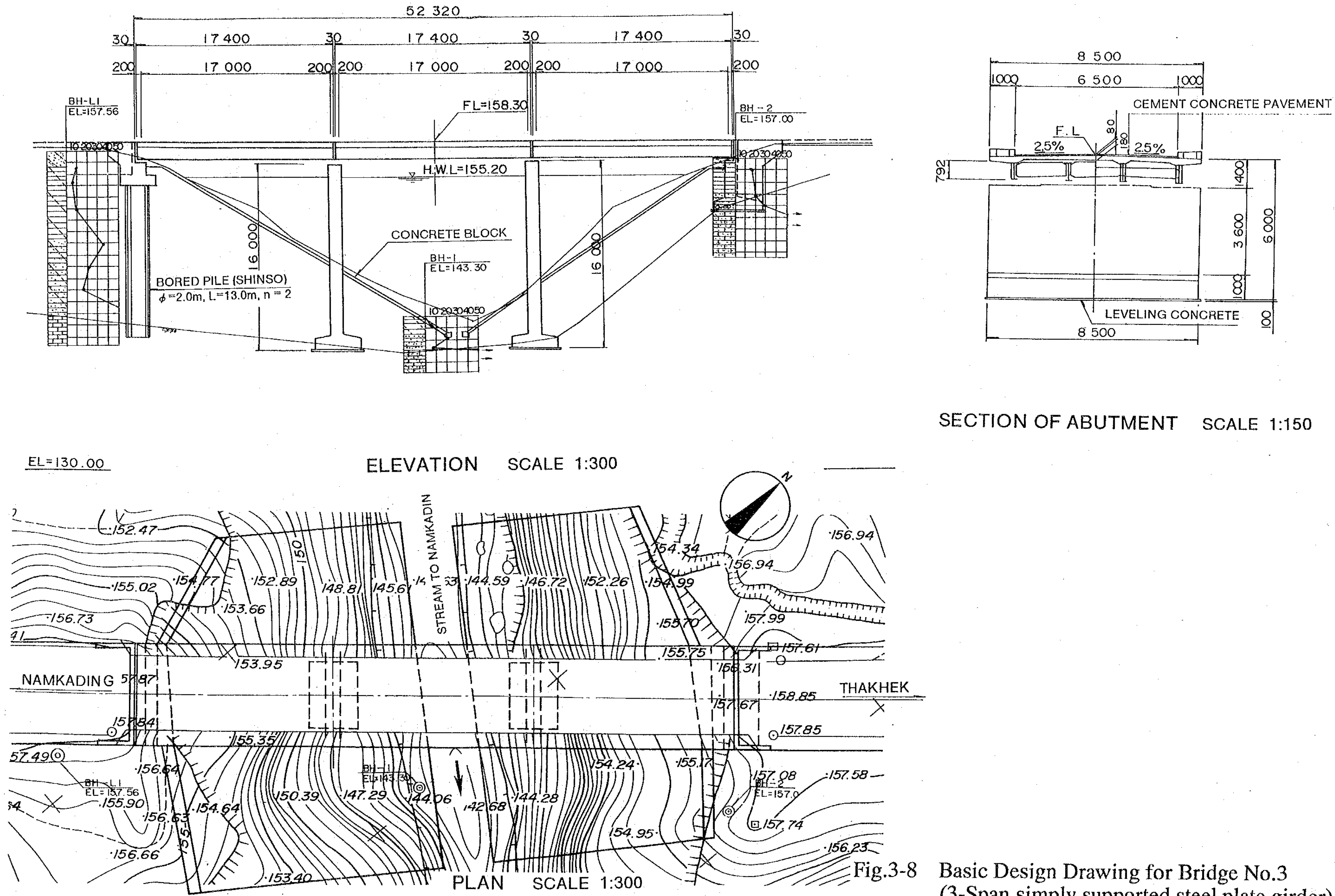
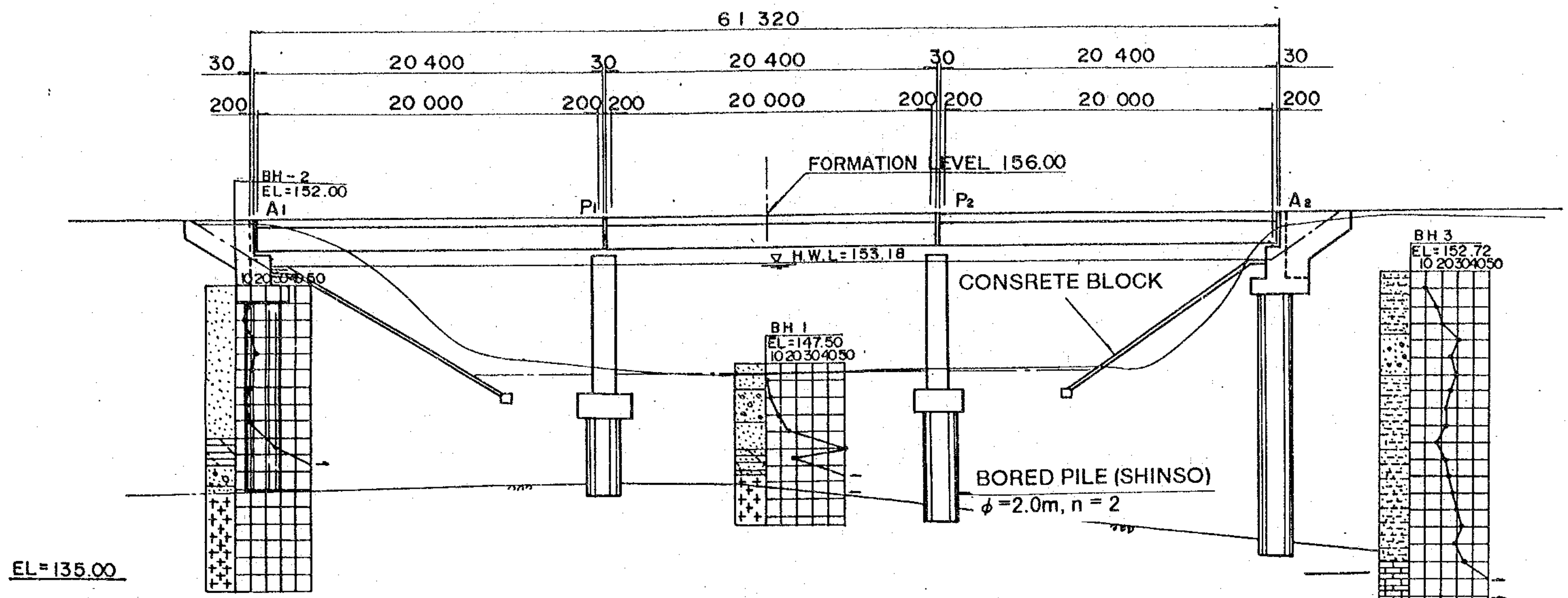
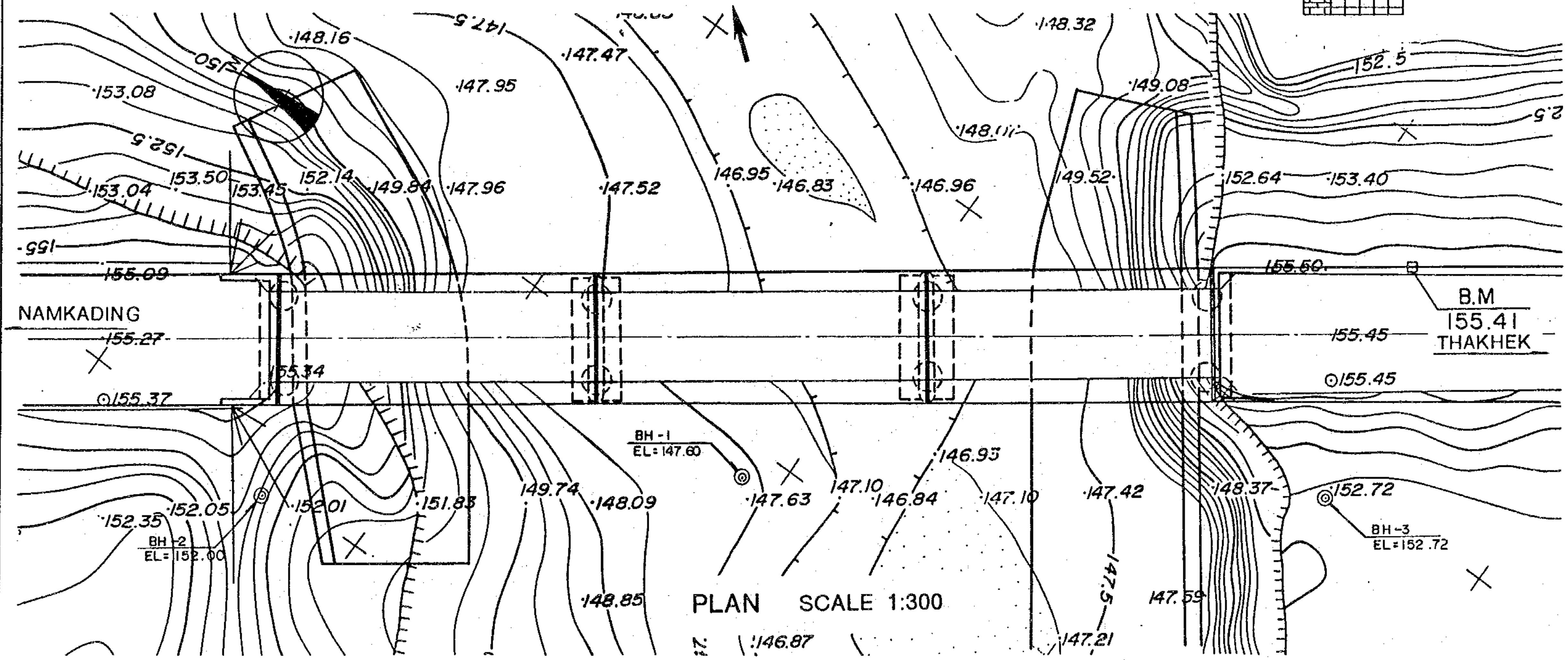


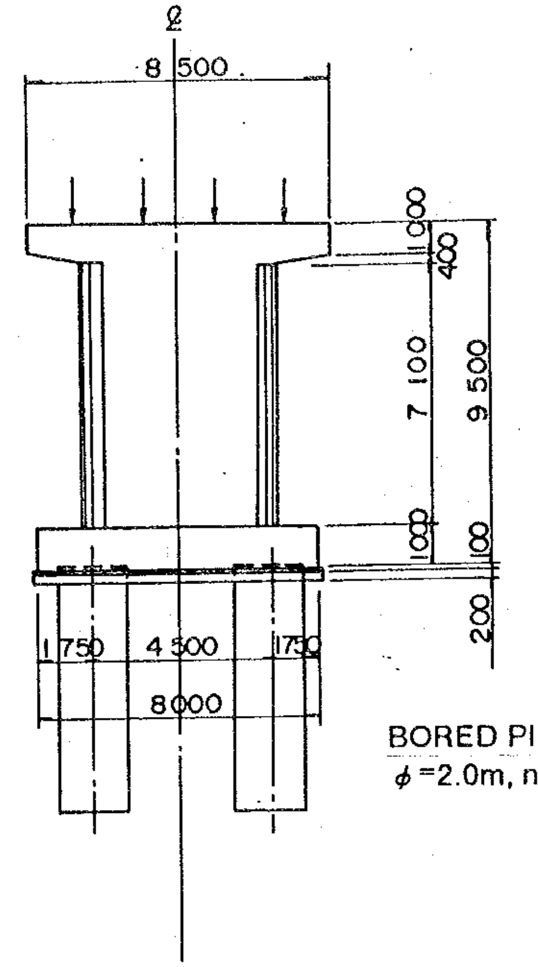
Fig.3-8 Basic Design Drawing for Bridge No.3
(3-Span simply supported steel plate girder)



ELEVATION SCALE 1:300



PLAN SCALE 1:300



FRONT ELEVATION OF PIER

SCALE 1:200

Fig.3-9 Bas
(3-

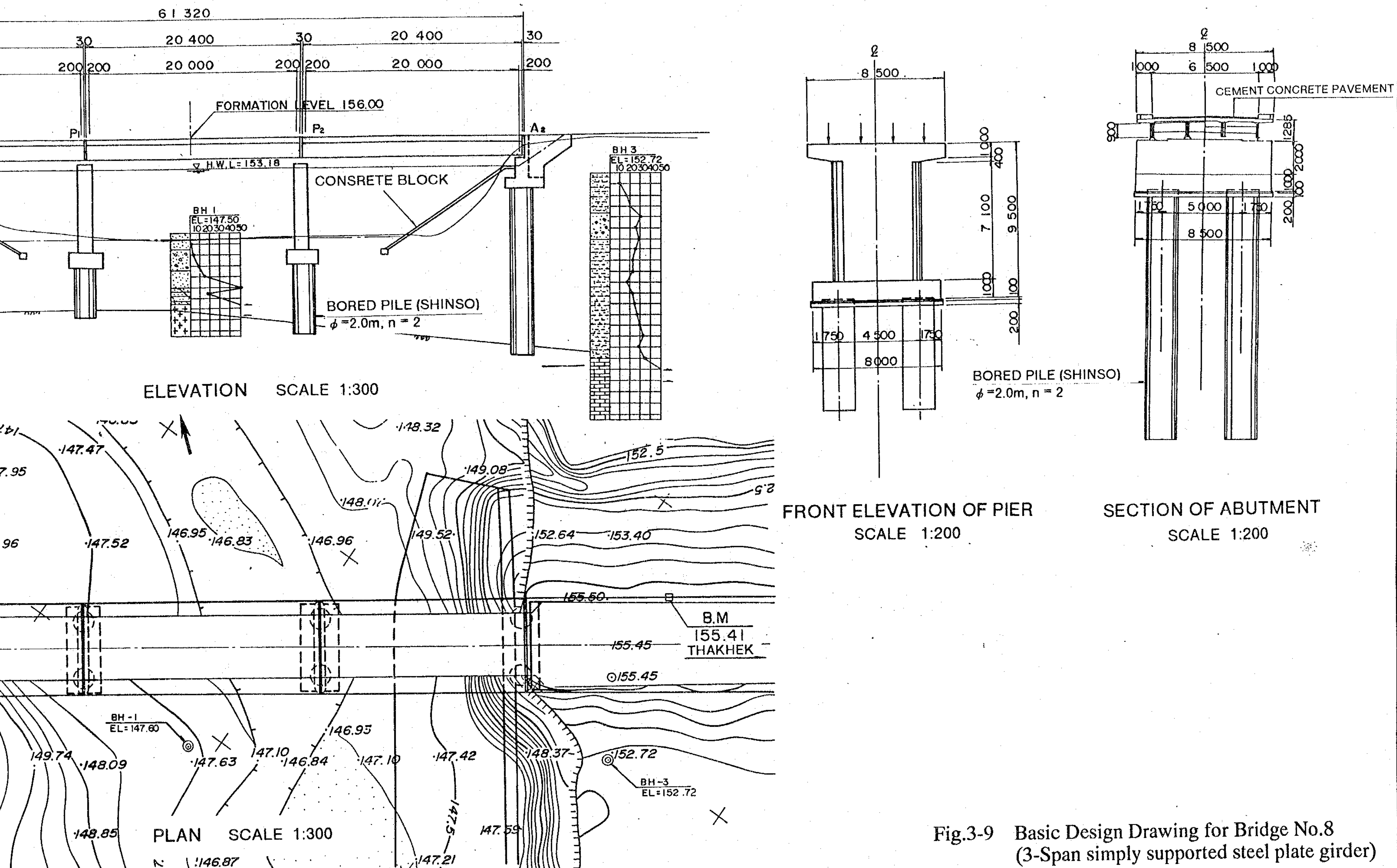
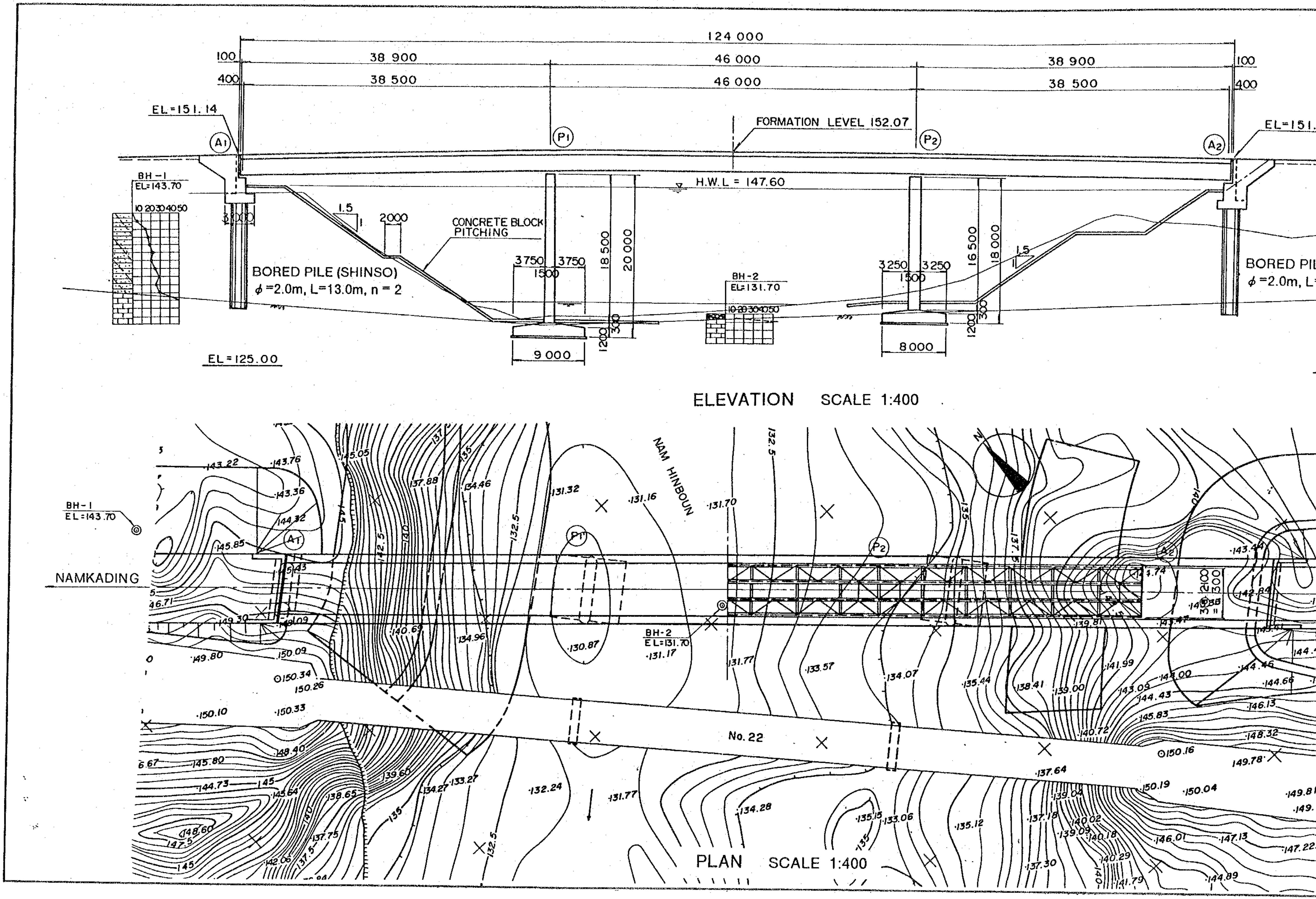
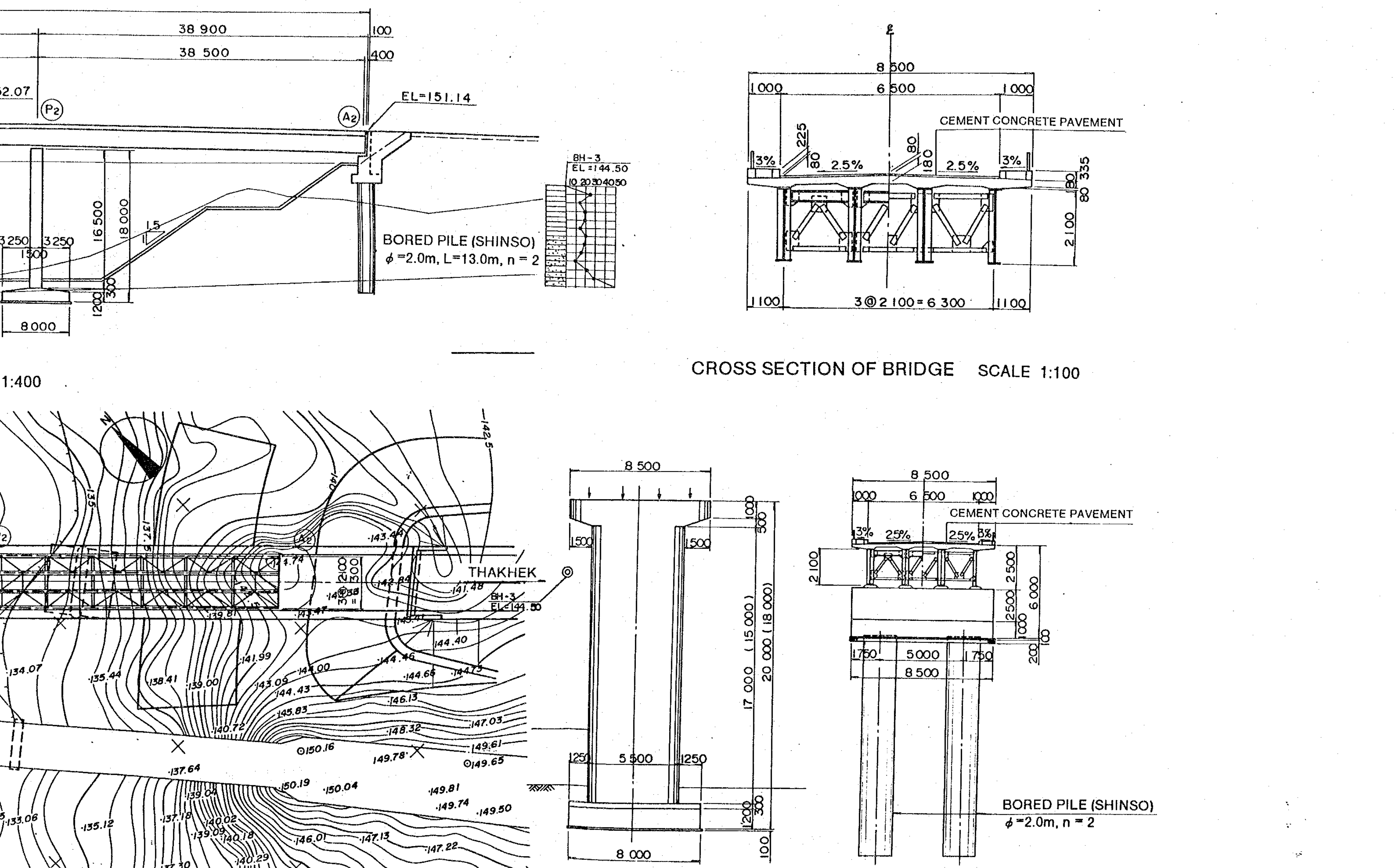


Fig.3-9 Basic Design Drawing for Bridge No.8
(3-Span simply supported steel plate girder)

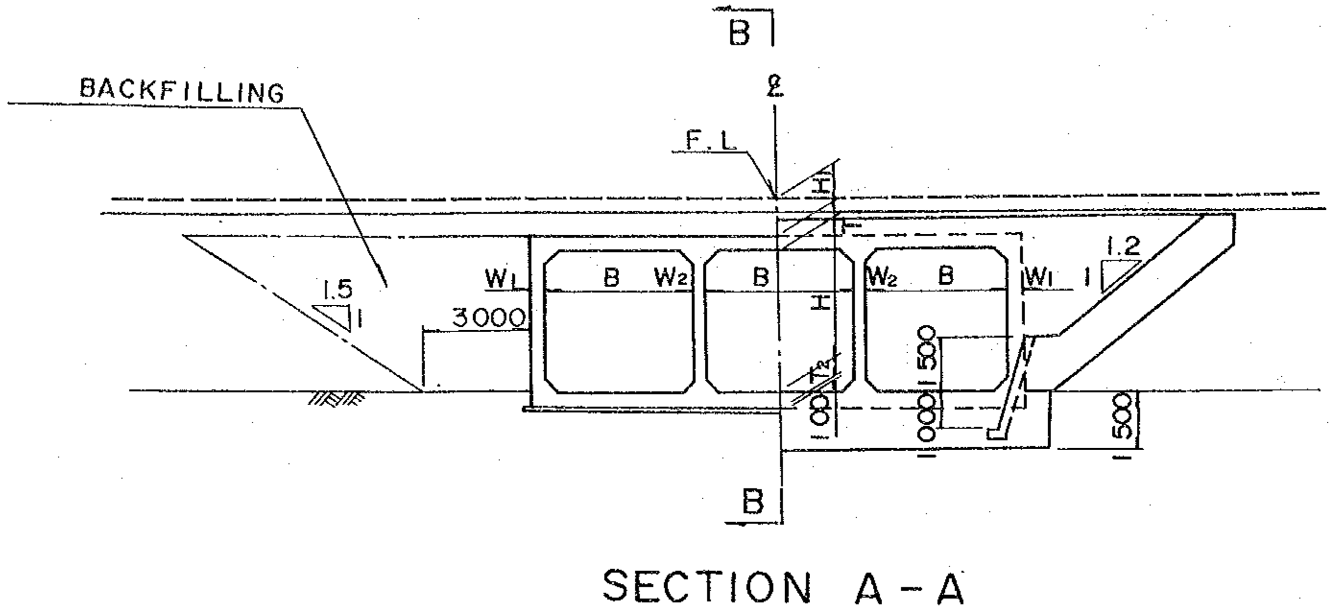


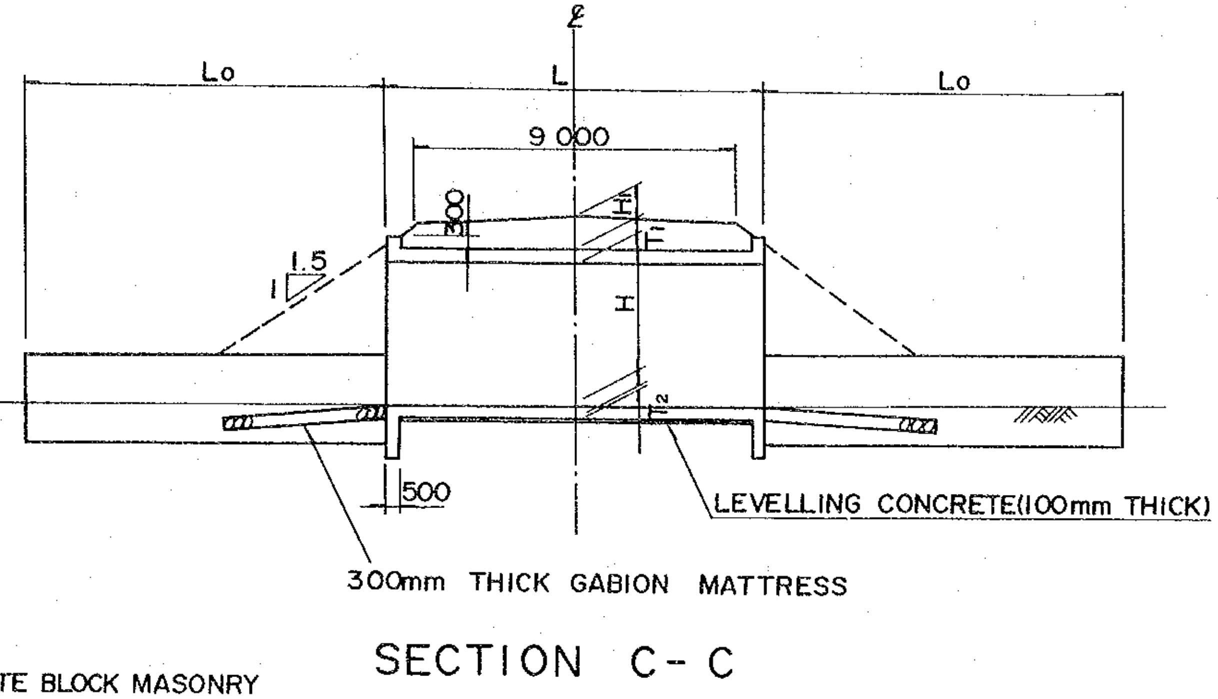
124 000
38 900
46 000
38 900
38 500
46 000
38 500
EL=151.14
FORMATION LEVEL 152.07
H.W.L = 147.60
BH-1
EL=143.70
CONCRETE BLOCK PITCHING
BORED PILE (SHINSO)
ϕ =2.0m, L=13.0m, n = 2
BH-2
EL=131.70
9 000
8 000
EL=125.00
ELEVATION SCALE 1:400
NAM HINBOUN
NAMKADING
No. 22
PLAN SCALE 1:400

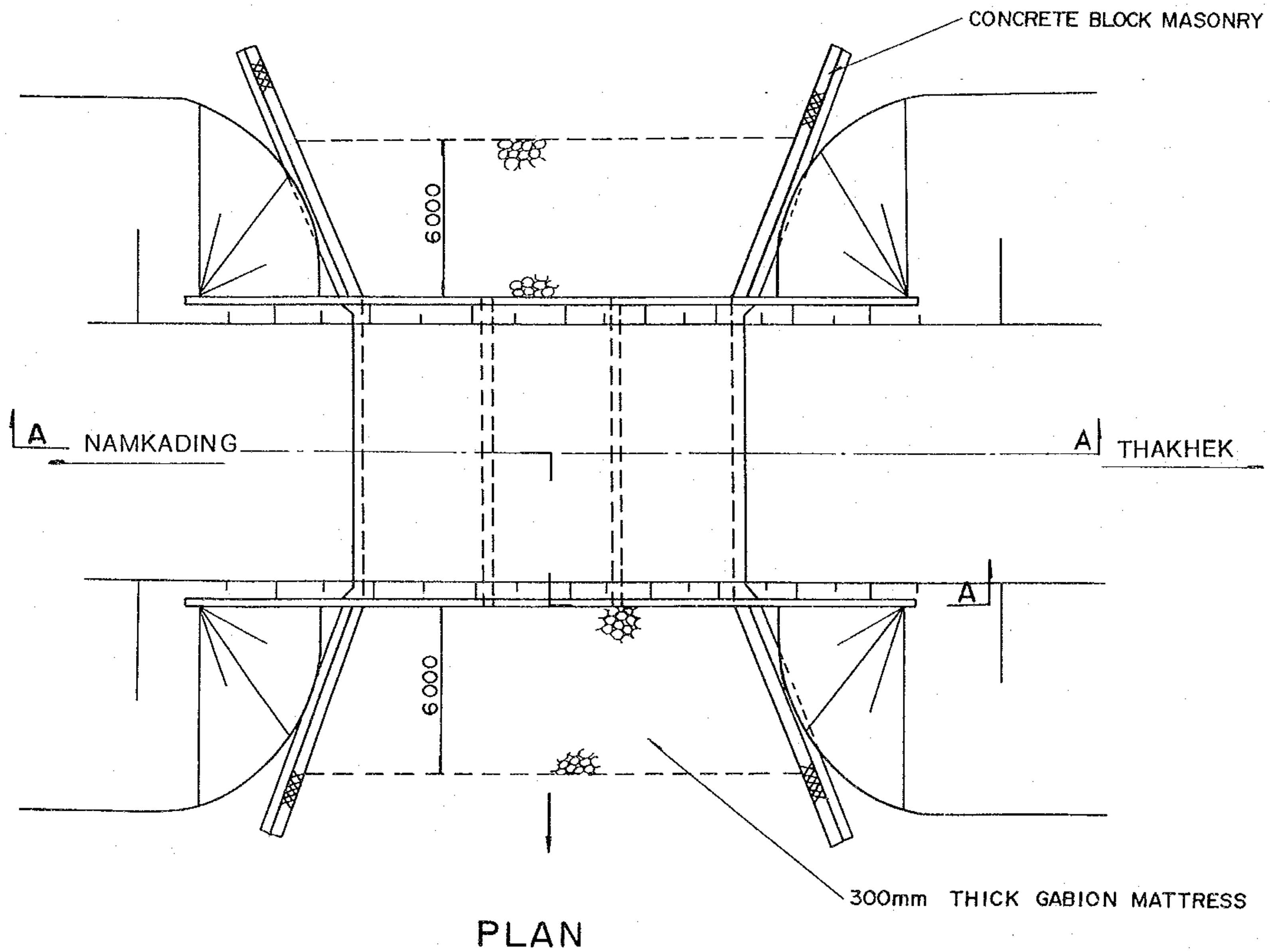


FRONT ELEVATION OF PIER SCALE 1:200

Fig.3-10 Basic Design Drawing for Bridge No.22





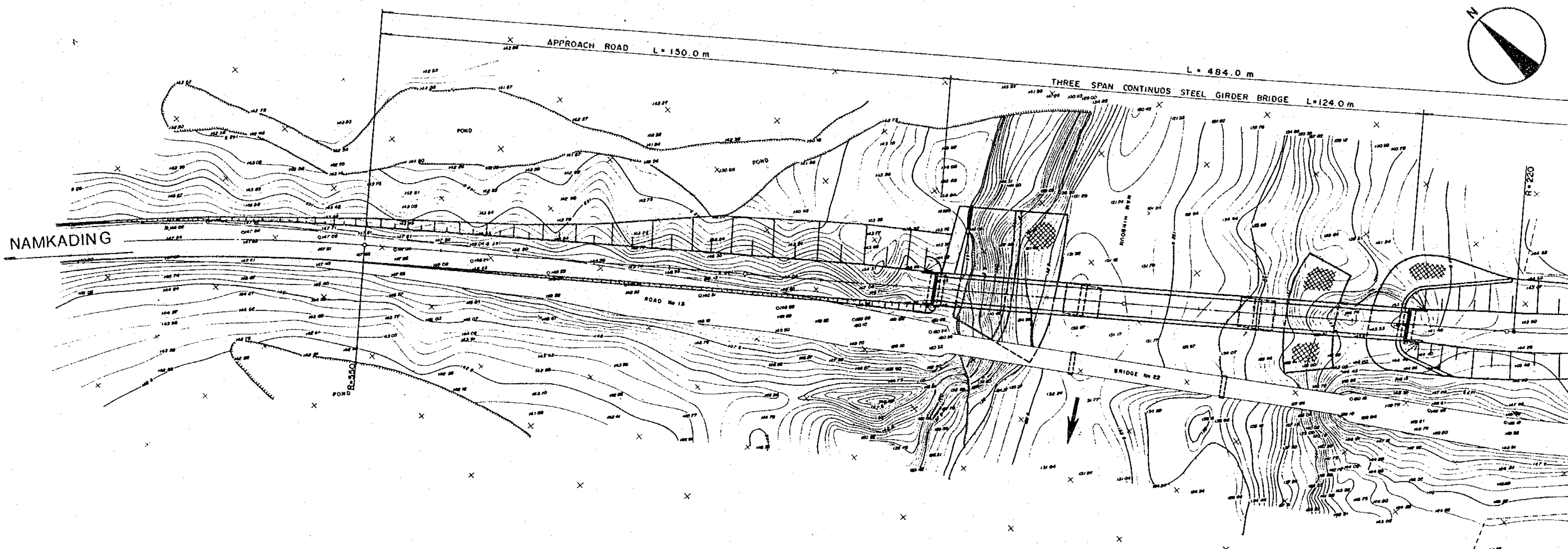


DIMENSION OF 3-CELL BOX CULVERT

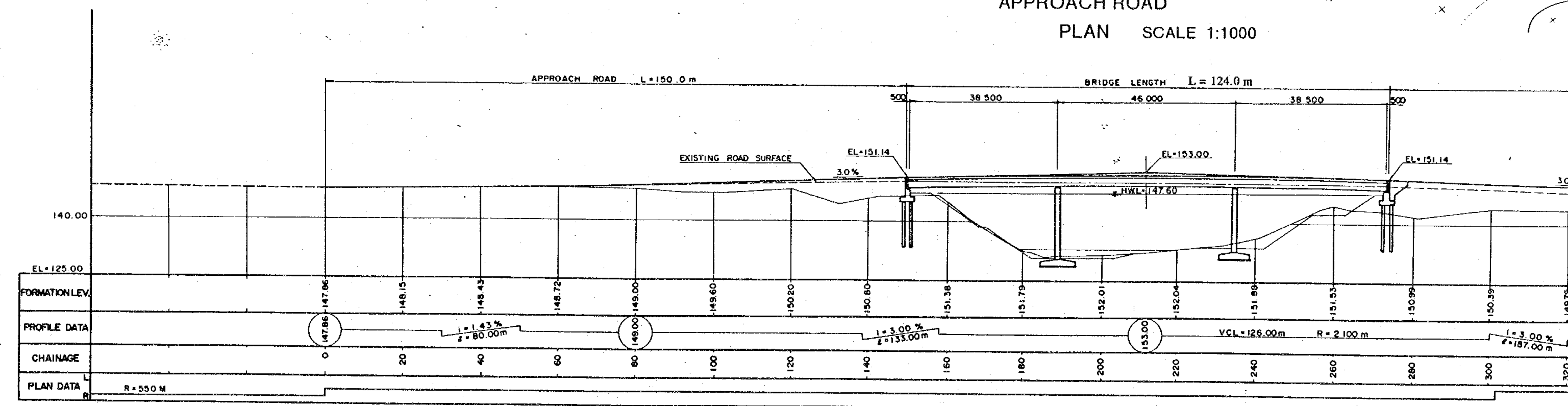
BRIDGE NO.	CHAINAGE (km)	SIZE OF BOX CULVERT (m)							H1 (m)	FORMATION LEVEL	INVERT LEVEL	H.W.L
		B	H	T1	T2	W1	W2	L				
4	14+225	5.00	5.00	0.45	0.55	0.50	0.30	13.5	1.30	158.30	151.55	158.40
6	20+904	4.00	4.00	0.40	0.50	0.45	0.30	13.2	1.30	172.85	167.15	169.44
7	28+127	5.00	5.00	0.45	0.55	0.50	-	13.2	1.35	156.60	149.80	153.43
9	29+555	5.00	5.00	0.45	0.55	0.50	0.30	15.2	2.00	156.40	148.95	153.43
12	38+723	5.00	4.00	0.40	0.45	0.35	0.30	10.0	0.30	160.27	155.78	158.31
13	39+569	5.00	5.00	0.50	0.60	0.50	0.30	12.0	0.90	158.52	152.10	155.69
16	53+181	4.00	3.50	0.35	0.40	0.35	0.30	10.0	0.63	161.90	157.42	160.16
17	55+376	4.00	3.50	0.35	0.40	0.35	0.30	10.0	0.63	161.70	157.22	160.26
18	58+716	4.00	3.50	0.35	0.40	0.35	0.30	10.0	0.30	166.00	161.85	163.05
19	59+287	4.00	3.50	0.35	0.40	0.35	0.30	10.0	0.63	168.40	163.92	167.00
23	108+354	5.00	5.00	0.45	0.55	0.50	0.30	10.0	0.70	146.90	140.75	146.40
24	108+927	5.00	5.00	0.45	0.55	0.50	0.30	10.0	0.85	146.90	140.60	146.40
26	112+303	4.00	3.50	0.35	0.40	0.35	0.30	10.0	0.30	146.10	141.95	145.60
27	113+33	4.00	3.50	0.35	0.40	0.35	0.30	10.0	0.63	146.10	141.62	145.60
28	116+22	4.00	3.50	0.35	0.40	0.35	0.30	10.0	0.64	146.27	141.78	145.60
30	126+359	5.00	4.50	0.40	0.55	0.50	0.30	12.0	1.00	147.55	141.60	143.78

Note : Box Culvert at No.7 Bridge is of Single Cell Type

Fig.3-11 Basic Design Drawing for Box Culvert No.4, 6, 7, 9, 12, 13, 16, 17, 18, 19, 23, 24, 26, 27, 28, 29, and 30 (Standized)



APPROACH ROAD
PLAN SCALE 1:1000



PROFILE OF APPROACH ROAD SCALE 1:1000

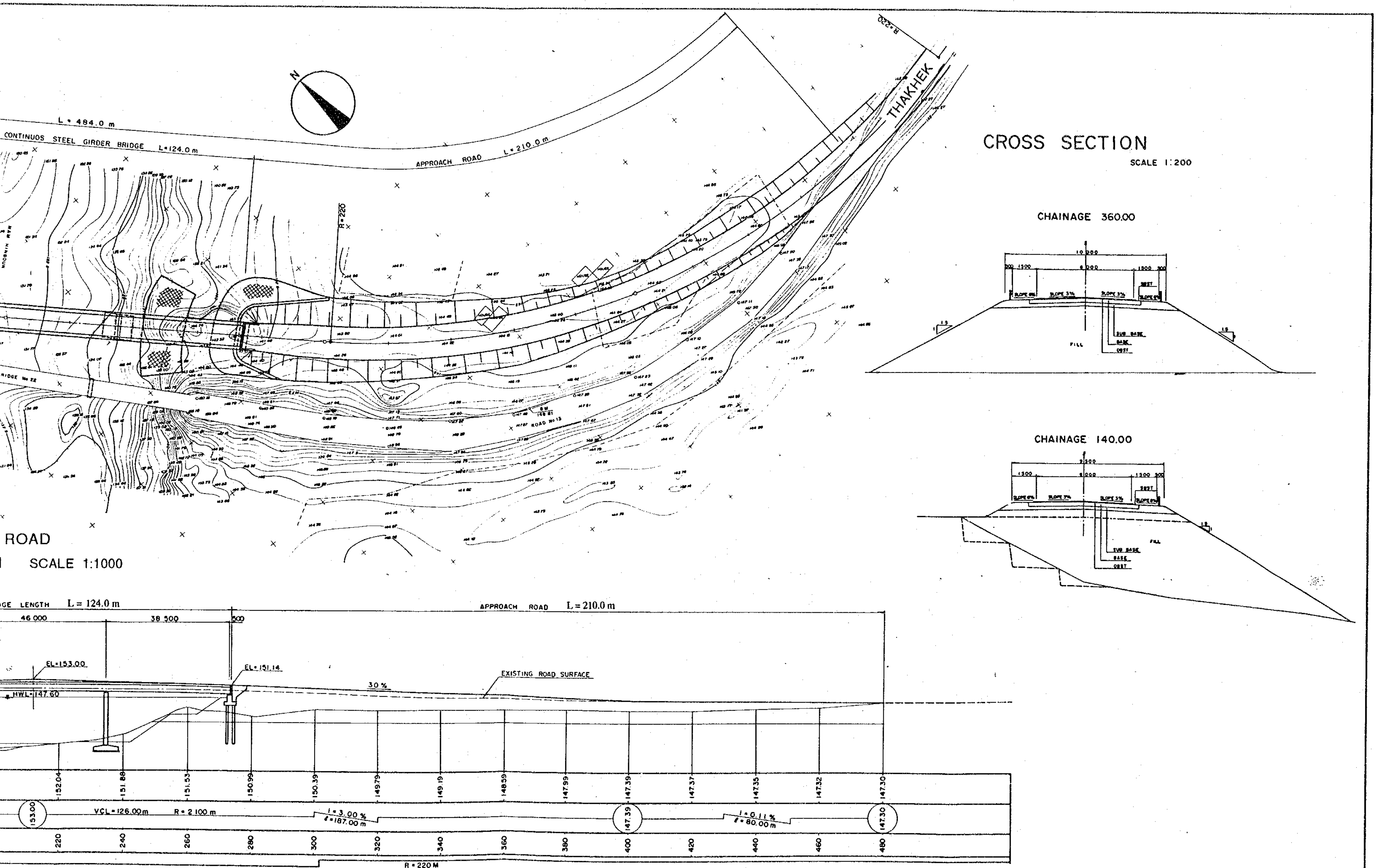


Fig. 3-12 Basic Design Drawing for Approach Road for Bridge No. 22

3.3.6 Estimates of Work Quantities

Approximate work quantities estimated in the basic design study are as follows;

(1) Bridge and Box Culvert

1) Superstructure

Item	Quantity
Single span steel plate girder, L = 20.46m	2 Nos
Single span steel steel plate girder, L = 25.60m	5 Nos
Three-span simply supported steel plate girder, L = 52.32m	1 No
Three-span simply supported steel plate girder, L = 61.32m	1 No
Three-span continuous steel plate girder, L = 124.00m	1 No
Total	10 Nos

2) Substructure

Item	Quantity
Foundation	
Bored pile (Sinso), 2.0m dia.	42 Nos
Abutment	
H=3.8m-6.0m (with bored pile)	19 Nos
H=6.0m	1 No
Pier	
H=6.0m (with bored pile)	2 Nos
H=16.0m	2 Nos
H=18.0 and 20.0m	2 Nos

3) Box Culvert

Item	Quantity
Single cell (5.0mx5.0m)	1 No
3 - cell (5.0x5.0m)	15 Nos
3 - cell (5.0x4.0m)	1 No
3 - cell (4.0x4.0m)	2 Nos
3 - cell (4.0x3.5m)	7 Nos
Total	16 No

4) Slope Protection

Item	Quantity
Gabion mattress	2,900 m^2
Concrete block pitching	9,900 m^2
Concrete block masonry	300 m^2

(2) Demolition of Existing Bridge and Approach Road

Item	Quantity
Demolition of existing bridge	
Bailey bridge	12 Nos
Steel truss	10 Nos
Steel girder	3 No
Concrete bridge	1 No
Approach road	2,860 m