ATTACHMENT

1. Attendants of the Discussions

Attendants of the discussions are listed in ANNEX-I.

2. Main items discussed

1) The contents of the Draft Report submitted by the Team.
2) Amendments showed in ANNEX-2
3) Incorporation of the amendments in the Basic Design Study Report.

3. Responsible Organization and Implementing Agency

Responsible Ministry : Ministry of Communications
Implementing Agency : Roads and Highways Department

4. Project Site

The Project site and location of the Bridges are as shown in ANNEX-3.

5. Coordination with ADB

1) The Government of People's Republic of Bangladesh (hereinafter referred to as "GOB"), the Team and ADB have underscored the need for the coordination and utmost efforts among three parties are indispensable for smooth implementation of the Project.
2) GOB is responsible for the following items
   a) amendment of design of the bridges which will be constructed under ADB loan
   b) pavement works for the surface course on the 5 bridges which will be constructed by Japan's Grant Aid
   c) modification of alignment of Madhya Baushia Bridge

6. ADB's Representatives Remarks

ADB's representative agreed in principle the revised design to be prepared for ADB's portion of 5 bridges by JICA. He, however, stated that it should be the responsibility of GOB to review the revised design.

7. Japan's Grant Aid System

1) GOB has understood the system of the Japan's Grant Aid explained by the Team.
2) Schedule for implementation stage is shown in ANNEX-4

8. **Further Schedule of the Study**

1) The Team will continue the study in Bangladesh until August 3, 1997.

2) The Team will make a Basic Design Study Report in accordance with the agreed items, and send it to the Bangladesh side around the end of October, 1997

9. **Necessary measures to be taken by the GOB**

In case Japan's Grant Aid is executed, GOB will take the necessary measures for the smooth implementation of the Project, especially of the following items.

1) Contract with the same consulting firm who prepared the basic design of the Project for detailed design and supervising construction works

2) Approval of Detailed Design of the 5 Bridges which will be constructed by Japan's Grant Aid

3) Review of Revised Detailed Design of the 5 Bridges which will be constructed under ADB loan

4) GOB will intimate JICA how much quantity of borrow material for temporary works available from Government land latest by 31 August, 1997. On the basis of this information, the cost estimation of borrow material should be finalized.

5) Other items described in ANNEX-5

10. **Technical cooperation**

GOB has pointed out the need for technical training of counterpart personnel in Japan. GOB also understood that technical cooperation cannot be requested in the Japan's Grant Aid System and that another official request should be submitted through diplomatic channels.

ANNEX-1 : LIST OF ATTENDANTS

Bangladesh Side

1) ERD

Mr. Suhel Ahmed	Additional Secretary
Mr. M. Azizul Islam	Deputy Secretary
Mr. Muhammad Saifullah	Senior Assistant Secretary

2) Ministry of Communication

Mr. Muhamad Abul Quasem	Joint Secretary, Roads and Railways Division
Mr. Md. Nurul Haque	Deputy Chief
Mr. Azizur Rahman	Deputy Secretary

3) Roads and Highways Department

Mr. Moyeen Uddin Ahmed	Chief Engineer
Mr. J. B. Barua	Additional. Chief Engineer, Jamuna Bridge Access Roads Project
Mr. M. A. Jaigirdar	Superintending Engineer, Bridge Design Circle(East)

4) ADB, Bangladesh Resident Mission

Mr. John F. Brooks	Senior Project Implementation Officer

Japanese Side

1) Draft Report Explanation Team

Mr. Shinichiro OMOTE	Leader
Mr. Tatsuya IMAI	Coordinator
Mr. Masahisa KOMIYA	Chief Consultant / Road and Bridge Planner
Mr. Tsuyoshi FURUKAWA	Bridge Planner
Mr. Nobuyuki OKABE	Hydrologist
Mr. Kazuo KATAOKA	Construction Schedule Planner / Cost Estimator

2) JICA Bangladesh Office

Mr. Morimasa KANAMARU	Resident Representative
Mr. Yoshio FUKUDA	Deputy Resident Representative
Mr. Zulfiker Ali	Assistant Director

ANNEX-2: AMENDMENT TO THE PROJECT

1. Sifting location of No.5 Madhya Bausia Bridge (refer Fig. 1)

JICA accept the shifting location of No.5 Madhya Bausia Bridge to down stream side of the exiting bridge, which is requested by GOB.

GOB is requested to inform ADB that the road design shall be modified in accordance with the shifting location of No.5 Bridge.

2. Borrowing soil material from the construction land
- Temporary approach road for pier construction
- Construction yards behind abutments
- Central construction yard

Borrowing soil material for temporary works can be taken from the government land along the existing road if there is not problem on the quality of soil material.

3. Demarcation of the project undertaken by Japan and ADB

The demarcation of the project undertaken by Japan and ADB is as follows:

Scope of the project undertaken by Japan

- Approach road length of 25 m for each abutment shall be undertaken by Japan.The finished elevation of approach roads shall be 130 mm down from design elevation of road i,e, up to the aggregate upper base and its surface should be protected by proper material such as DBST.

Scope of the project undertaken by ADB

- Asphalt concrete pavement on the 5 bridges shall be carried out by ADB.
- Top asphalt surface of 130 mm on approach roads shall be carried out by ADB.

The ADB saving construction cost for ADB portion will be as follows:

Additional cost for the asphalt concrete pavement on the 5 bridges
7.5 m x 649 m x 507 Tk/m2 = + Tk 2,478,000 (= Yen 6,500,000)

Saving cost for the approach road embankment
27,463 m3 x 207 Tk/m3 = - Tk 5,684,000 (= Yen 14,900,000)

Total (Saving) = - Tk 3,206,000 (= Yen 8,400,000)

Since the pavement works for Japan's portion is small amount, the construction cost can be saved for Japan's portion too.

GOB is requested to inform ADB about the demarcation of the project undertaken by Japan and ADB.

4. Preparation of design of 5 bridges for ADB portion

JICA will prepare the design of 5 bridges in accordance with the design concept of JICA, which will be constructed under ADB loan and submit to GOB.

However, GOB has the production liability for the structures which will be constructed according to the design of 5 bridges. Therefore, GOB is requested to authorize the design which will be prepared by JICA and to inform to ADB and ADB consultant.

On the other hand, 25th of July, JICA has already explained to ADB (Mr. Kaminaga and Mr. John R. Cooney, Manila office) regarding the modification of ADB detailed design. ADB has accepted the modification.

5. Type of handrail

ADB design type of concrete posts and shall be adapted for JICA design.

6. Type of newel post

The newel posts proposed by JICA are accepted by GOB as shown in Fig. 3.

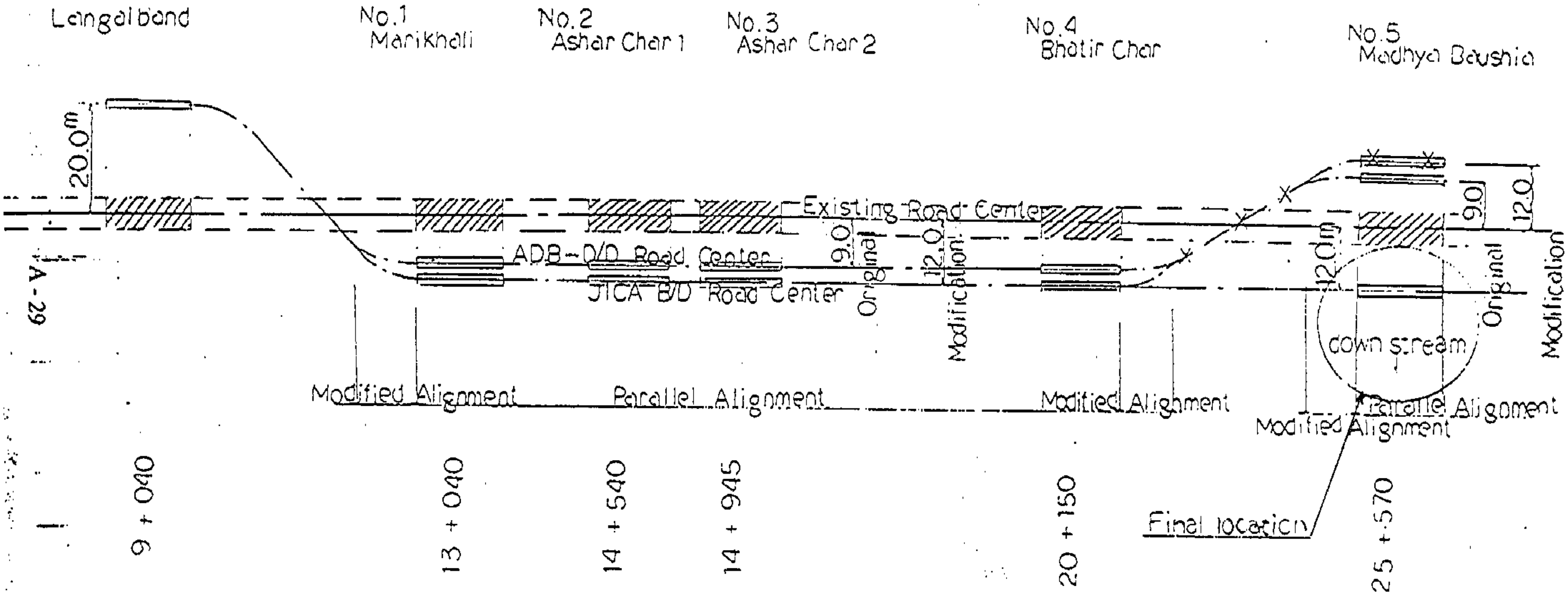


Fig. 1 Location of No.5 Madhya Bausia Bridge

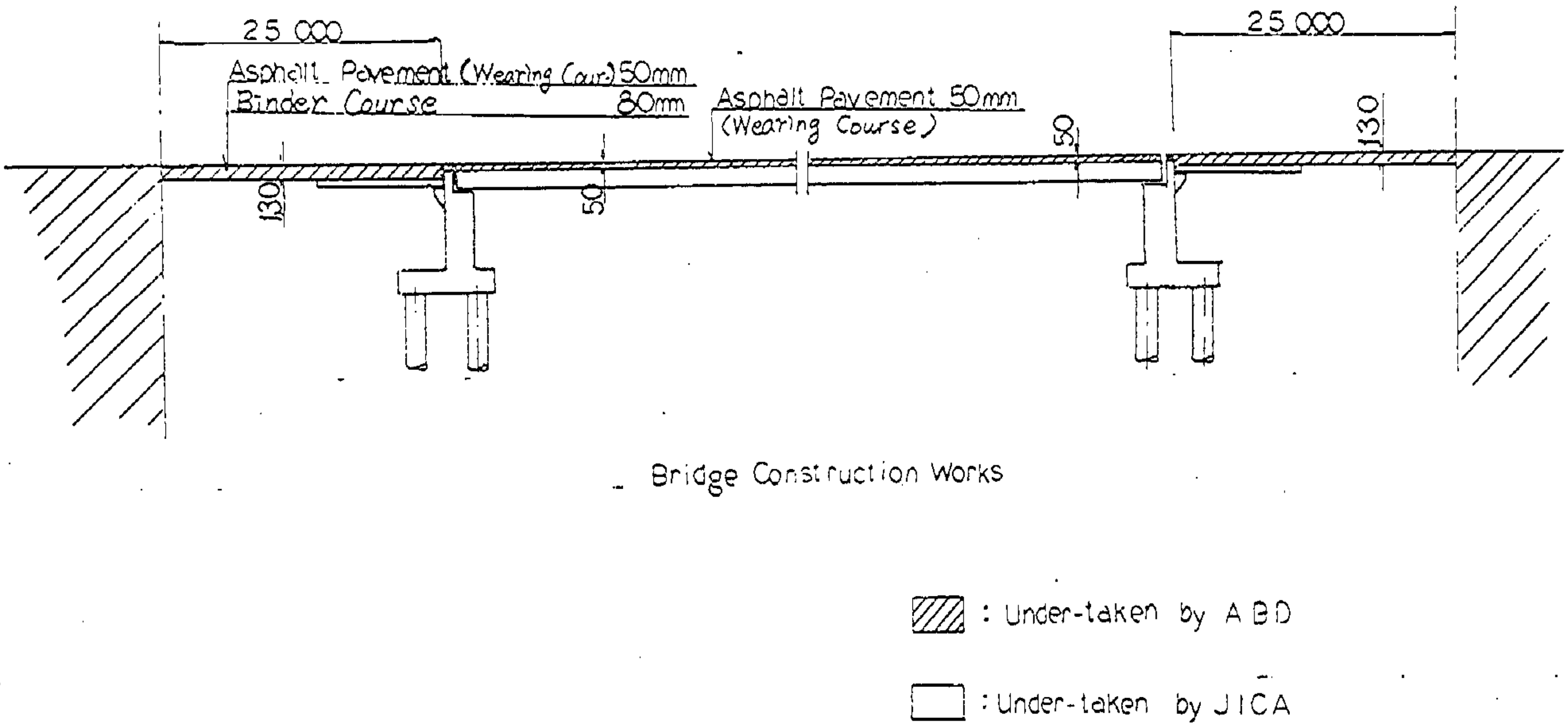


Fig. 2 Demarcation of the Project undertaken by JICA and ADB

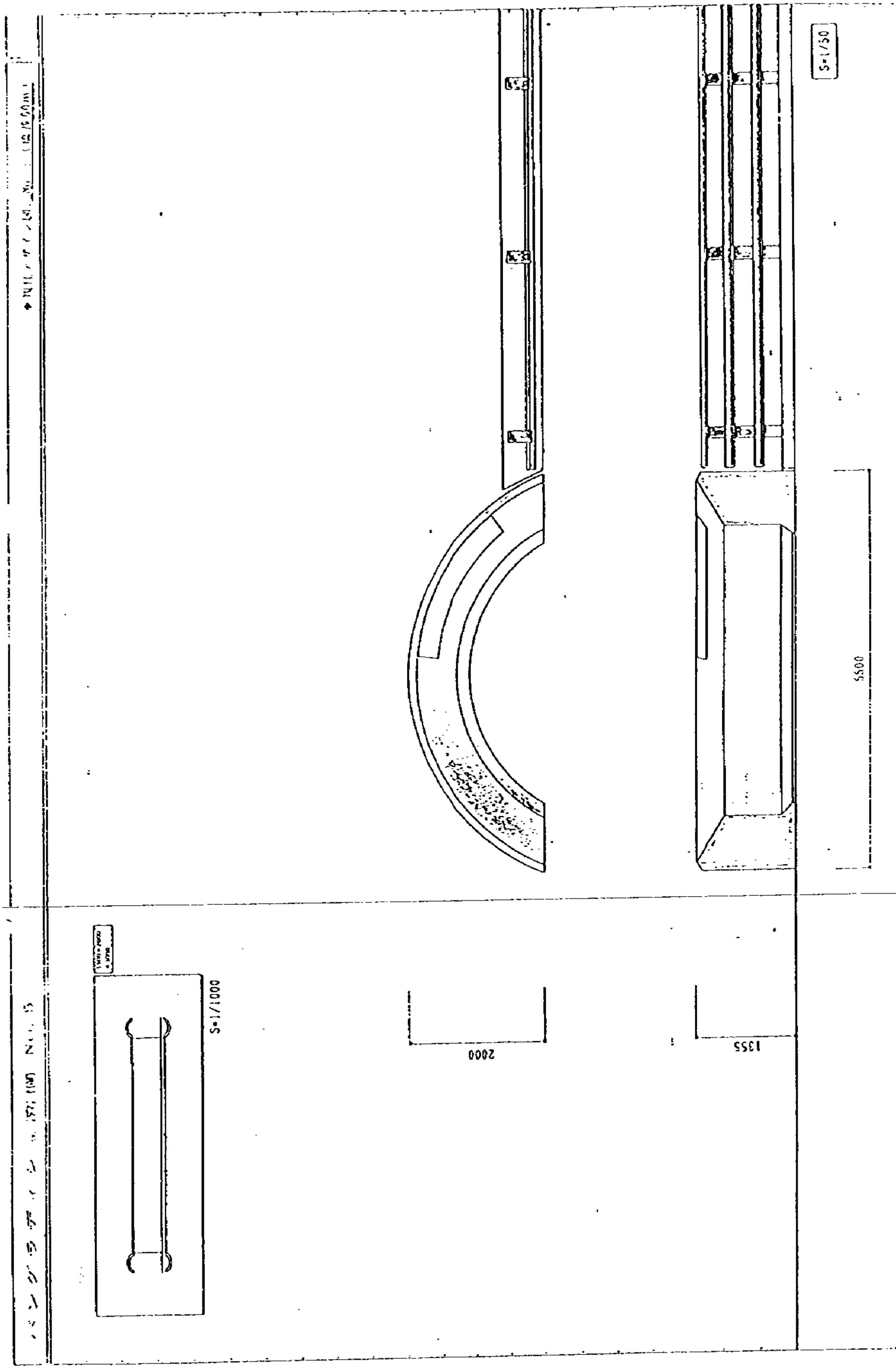
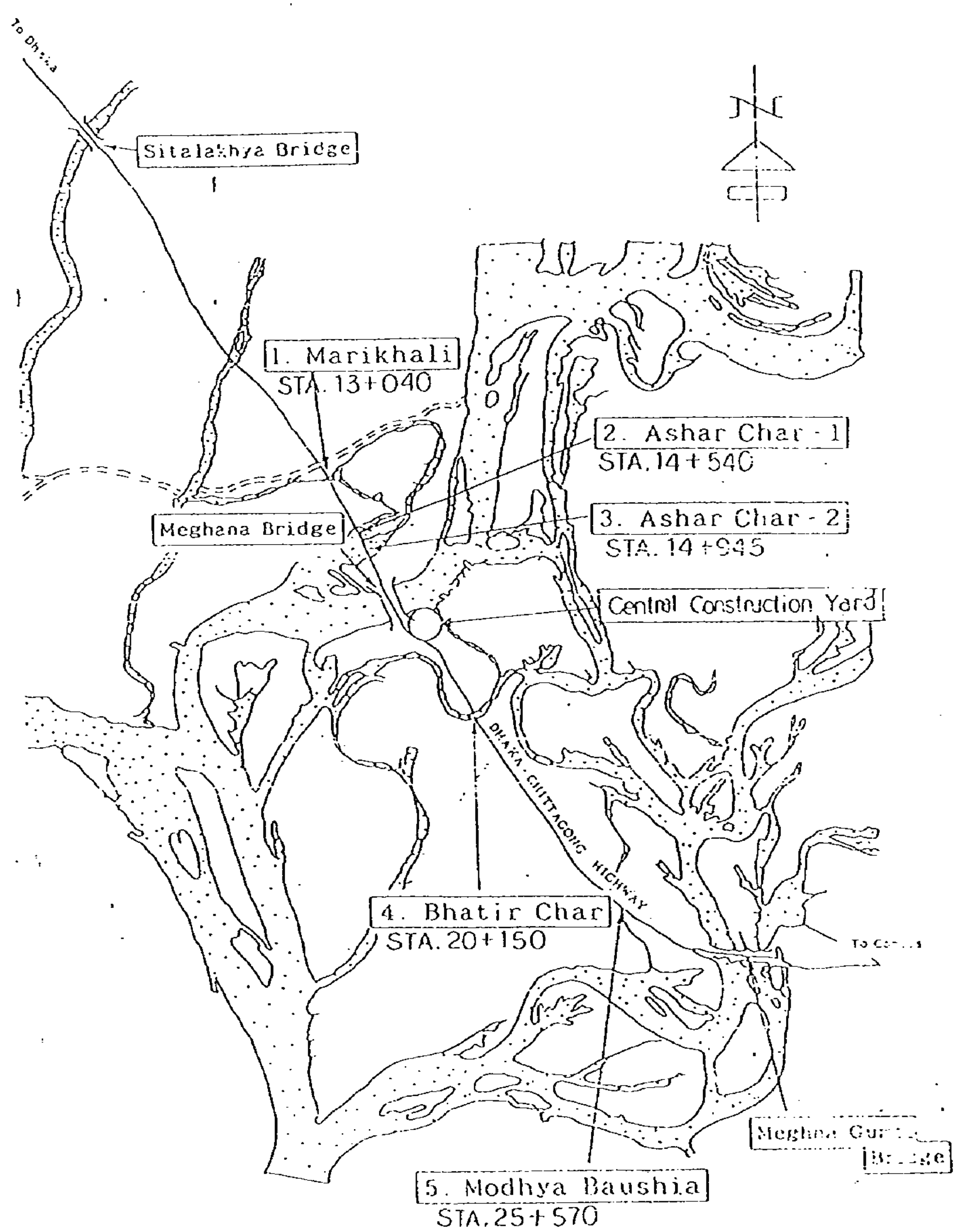


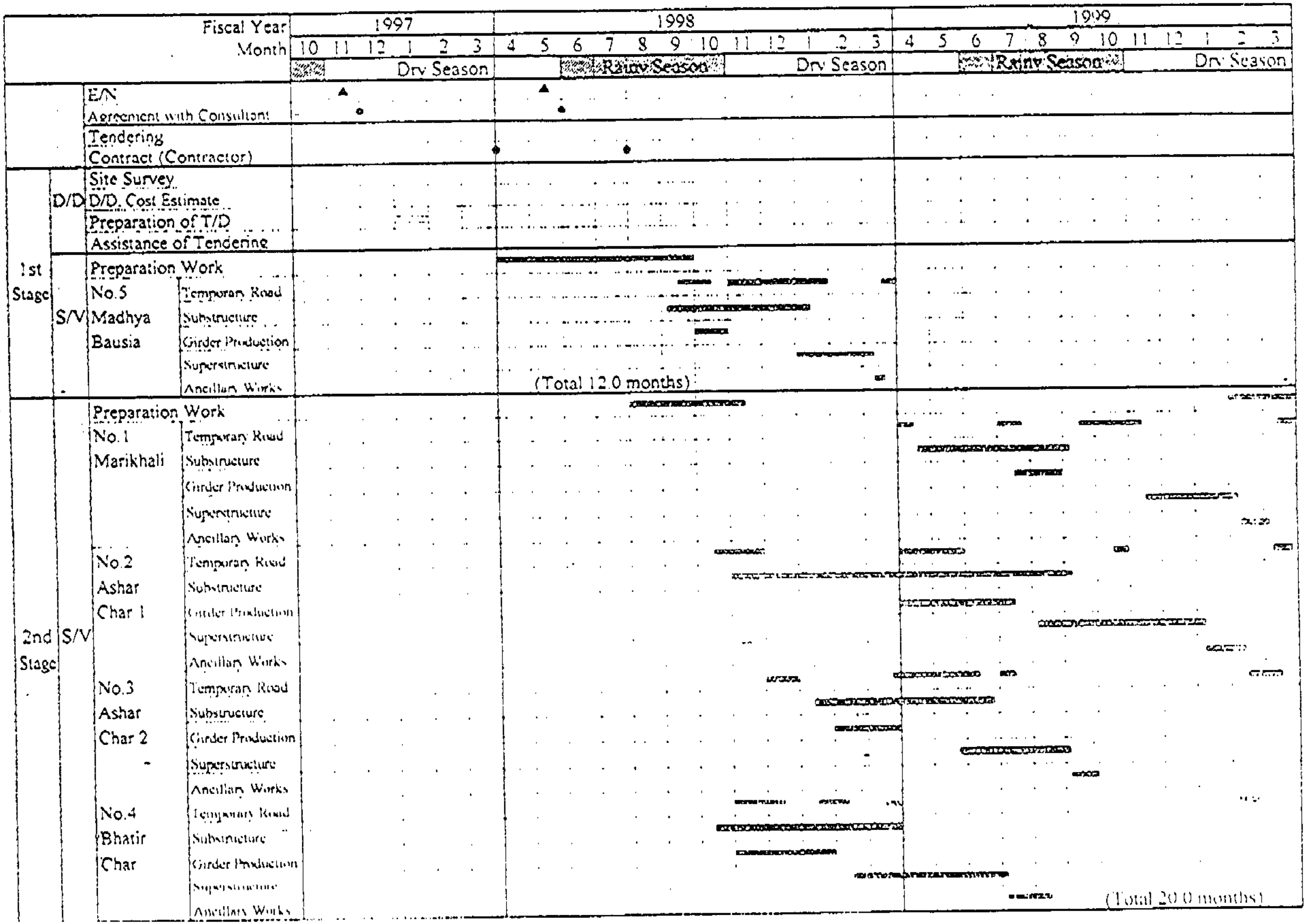
Fig. 3 Newel Post for No.5 Madhya Bausia Bridge

9 表

ANNEX 3 : PROJECT SITE



ANNEX 4 IMPLEMENTATION SCHEDULE



ANNEX-5: NECESSARY MEASURES TO BE TAKEN BY BANGLADESH SIDE

The following necessary measures should be taken by the Government of Bangladesh on condition that the Grant Aid by the Government of Japan is extended to the Project.

1. To secure the land necessary for the execution of the Project, such as the land for bridges, temporary offices, working areas, storage yards and others;

2. To make all passable roads and bridges leading to the Project sites before the commencement of inland transportation of materials and equipment;

3. To undertake the incidental works, such as gardening, fencing, lightning and other incidental facilities in and around the Project sites, if necessary;

4. To ensure prompt unloading and customs clearance at ports of disembarkation in Bangladesh and internal transportation therein of the products purchased under the Grant;

5. To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in Bangladesh with respect to the supply of the products and services under the Verified Contracts;

6. To accord acceptance to Japanese nationals whose services may be required in connection with the supply of the products and services under the Verified Contracts such facilities as may be necessary for their entry into Bangladesh and stay therein for the performance of their work;

7. To maintain and use facilities constructed under the Grant properly and effectively for the Project;

8. To bear commissions to the Japanese foreign exchange bank for its banking services based upon the Banking Arrangement, namely the advising commission of the "Authorization to Pay" and payment commissions;

9. To ensure no toll charge for Meghna Bridge and Meghna Gumti Bridge for the vehicles, trucks etc. of Japanese consultants and contractors to be appointed for the construction of 5 bridges. However, prior approval for the such vehicles shall be taken by Chief Engineer, RHD.

10. To bear all the expenses, other than those covered by the Grant, necessary for the Project; and

11. To coordinate and solve any issues related to the Project which may be raised from third parties or inhabitants in the Project area during implementation of the Project.

5. Design Criteria

BASIC DESIGN CONSIDERATIONS

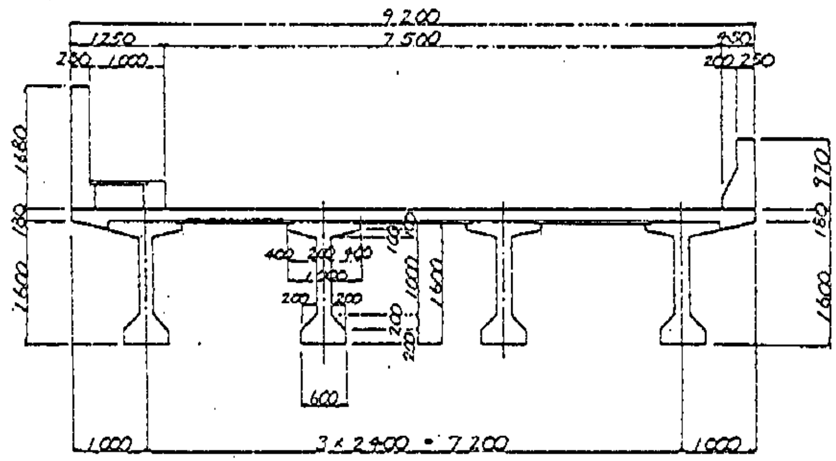
Regarding

The Project for Reconstruction of Five Bridges on Dhaka-Chittagong Highway

March 1997

Japan Bridge and Structure Institute, Inc., Japan

ITEMS	DETAILS	REMARKS
1. General	There are some small bridges on Dhaka-Chittagong Highway which are old and deteriorated. Among these, the five (5) bridges existing between the Meghna-Gumti bridge and Sitalakhya bridge are substantially damaged, and are going to be replaced under Asian Development Bank (ADB) road improvement project named "Jamuna Access Roads Project" referred to as "ADB project". The detail design of this project has already been completed including above mentioned five bridges.	
	In ADB project "AASHTO Standard Specifications for Highway Bridges, 1992" have been adopted for the design the bridge structures, and the same specifications are followed for bridge design in Bangladesh in general.	
	The location of five new bridges which are under consideration for Basic Design Study by JICA is adjacent to the existing old bridges which are going to be replaced under ADB project.	
Main structure	The basic design of bridge superstructure and substructure will be carried out following AASHTO specifications with some modifications reflecting the climatic and traffic conditions peculiar to the location in accordance with Bangladesh regulations.	
Bridge Accessories	Auxiliary items such as, bearing pads, expansion joints, railings, drainage, etc., shall comply with the Japan Road Association specifications in principal with some modifications reflecting the local conditions in Bangladesh.	
Drawings	All structural drawings shall be drawn up in accordance with the drawing standards of the Japan Society of Civil Engineers, 1976.	

1.1 Superstructure		
Type of structure	Simply supported composite T-girder bridge	
Length of bridges	Variable	
Proposed elevation of bridge (As per ADB)	Bridge # / Elevation (El.) Left, Right	
	1: 11.2, 11.2	
	2: 10.8, 10.8	
	3: 10.8, 10.8	
	4: 11.0, 11.0	
	5: 10.0, 10.0	
Horizontal alignment	Straight - no curve	
Centerline of bridge	Assumed same as that of road section	
Components of road cross-section		
Width	Total width = 9.2 meters	
Pavement	Carriageway width = 7.5 meters	
Slope	Cross-slope = 2.5%	
Gap treatment	Temporary structure is required to handle the gap between old and new approach roads leading to bridge structures.	
Construction method	Erection by launching girder	

2

1.2 Substructure Type of foundation Construction method	Japan Road Specifications will be followed - Allowable stress method Bored pile foundation, pile dia = 1000 mm (Cast-in-place concrete pile) Reverse circulation drilling method using stand pipe (steel casing) for protecting inside collapse of bore hole.	
2. Loads	Structures shall be designed to carry the following loads and forces: Dead Load; Live load; Impact; Wind loads Other forces as: Longitudinal forces, thermal forces, earth pressure, buoyancy, shrinkage and creep stresses, erection stresses, and earthquake stresses.	
2.1 Dead load (AASHTO Clause 3.3)	The dead load shall consist of the weight of the entire structure, including the roadway, sidewalks, car tracks, pipes, conduits, cables, and other public utility services. In the absence of more specific information, the densities shown opposite may be used in computing dead loads:	

	lbs/cu.ft	(tf/cu.m)
Steel or cast steel	490	(7.85)
Cast iron	450	(7.20)
Aluminum alloys	175	(2.80)
Timber (treated or untreated)	50	(0.80)
Concrete, plain or reinforced	150	(2.40)
Compacted sand, earth, gravel, or ballast	120	(1.92)
Loose sand, earth , and gravel	100	(1.60)
Macadam or gravel, rolled	140	(2.24)
Cinder filling	60	(0.96)
Pavement, other than wood block	150	(2.40)
Stone masonry	170	(2.72)
Asphalt plank, 1 in (2.5 cm) thick	9 lbs/sq.ft (44 kg/sq.m)	

2.2 Live load (AASHTO Clause 3.4)	The live load shall consist of the weight of the applied moving load of vehicles, cars, and pedestrians.	
HS Loading (Clause 3.7.6)	The HS Loading consists of a tractor truck with semi-trailer or the corresponding lane load as illustrated in Figures 2.1 and 2.2. The variable axle spacing has been introduced in order that the spacing of axles may approximate more closely the tractor trailers now in use. The variable spacing also provides a more satisfactory loading for continuous spans, in that heavy axle loads may be so placed on adjoining spans as to produce maximum negative moments.	
2.3 Impact (AASHTO Clause 3.8)	Highway live loads shall be increased for those structural elements in Group A. Impact allowances shall not be applied to items in Group B.	
Group A	a) Superstructure b) Piers c) The portions above the ground line of concrete piles that support the superstructure	
Group B	a) Abutments, retaining walls b) Foundation pressures and footings c) Sidewalk loads	
Impact formula	$I = \frac{50}{L+125}$ in which I = impact fraction (maximum 30%) L = length in feet of the portion of the span that is loaded to produce the maximum stress in the member.	

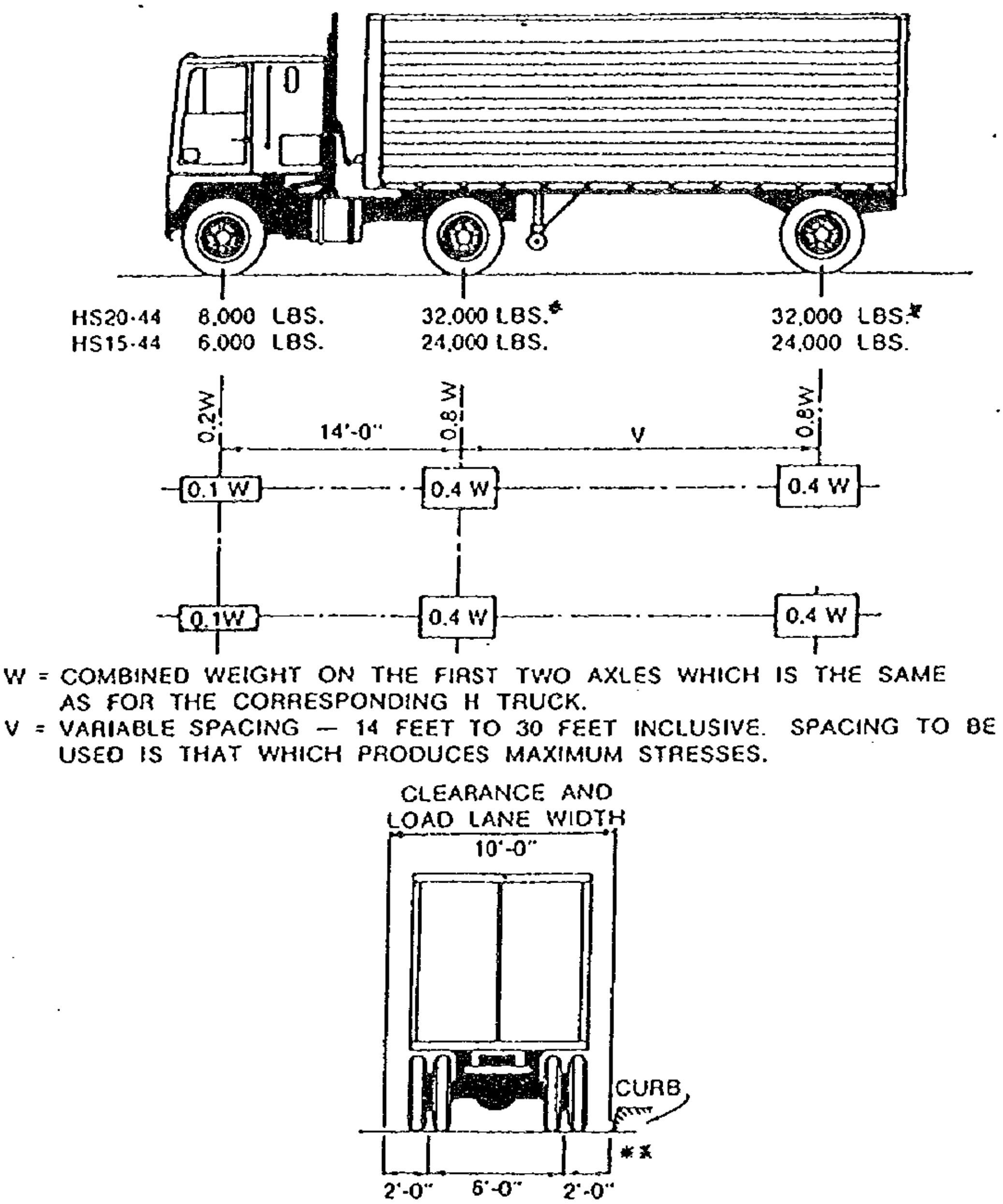


Fig. 2.1 Standard HS Trucks

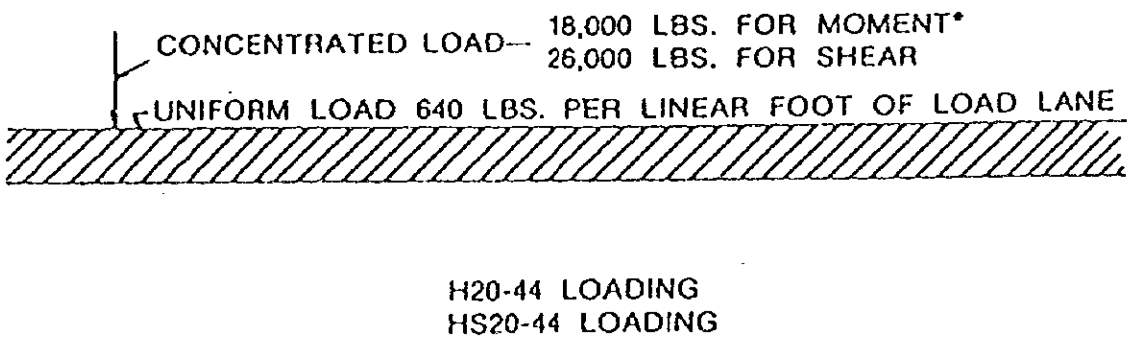


Fig. 2.2 Lane Loading

2.4 Longitudinal forces (AASHTO Clause 3.9)	Provision shall be made for the effect of a longitudinal force of 5 % of the live load in all lanes carrying traffic headed in the same direction. The load used, without impact, shall be the lane load plus the concentrated load for moment, with reduction for multiple-loaded lanes. The center of gravity of the longitudinal force shall be assumed to be located 6 feet above the floor slab and to be transmitted to the sub-structure through the superstructure.	
2.5 Sidewalk, curb, loading		
Sidewalk loading (AASHTO Clause 3.14.1)	Sidewalk floors, stringers and their immediate supports shall be designed for a live load of 85 lbs per sq. ft. (0.42 tf/sq.m) of sidewalk area. Girders, and other members shall be designed for the following sidewalk loads: Spans 0 to 25 ft. (7.62 m) in length 85 lb/sq.ft (0.42 tf/sq.m) Spans 26 (7.92) to 100 ft. (30.48m) in length 60 lb/sq.ft (0.29 tf/sq.m) Spans over 100 ft. (30.48 m) in length according to the formula $P = \left(30 + \frac{3000}{L}\right)\left(\frac{55-W}{50}\right)$ in which P = live load per square foot, max. 60-lb/ sq. ft. (0.29 tf/sq.m); L = loaded length of sidewalk in feet; W = width of sidewalk in feet.	
Curb loading (AASHTO Clause 3.14.2)	Curbs shall be designed to resist a lateral force of not less than 500 lbs/ ft. (0.74 tf/m)of curb, applied at the top of the curb, or at an elevation 10 in. (25 cm) above the floor if the curb is higher than 10 in. (25 cm).	

2.6 Wind Loads (AASHTO Clause 3.15)	The wind loads shall consist of moving uniformly distributed loads applied to the exposed area of the structure. The exposed area shall be the sum of the areas of all members, including floor system and railing, as seen in elevation at 90 degrees to the longitudinal axis of the structure. The values of wind loads are obatained from the following equation (JSCE, clause 4.2.7). (see Annex 1) $W = 1/2 \times \rho \, Vz^2 \, C$ (kgf/m^2) where, ρ : the dencity of air = 0.125 ($kgf \cdot s^2/m^4$) Vz : the design speed of wond = 50 m/s C : the coefficient of drag Flat plate, or other section similar to flat plate = 2.2 $W = 1/2 \times 0.125 \times 50^2 \times 2.2 = 344$ kgf/m^2	
2.7 Thermal forces (AASHTO Clause 3.16)	Provision shall be made for stresses or movements resulting from variations in temperature. The rise and fall in temperature shall be fixed for the locality in which structure is to be constructed and shall be computed from an assumed temperature at the time of erection. The range of temperature shall generally be as follows, see Fig. 2.3 for temperature variation in Dhaka city: Concrete Structures — Temp. rise — Temp. fall Moderate climate — 5°C — 5°C	
2.8 Uplift (AASHTO Clause 3.17)	Provision shall be made for adequate attachment of the superstructure to the substructure by ensuring that the calculated uplift at any support is resisted by tension members engaging a mass of masonry equal to the largest force obtained under one of the following conditions: a) 100% of the calculated uplift caused by any loading or combination of loading in which the live plus impact loading is increased by 100%. b) 150% of the calculated uplift at working load level.	

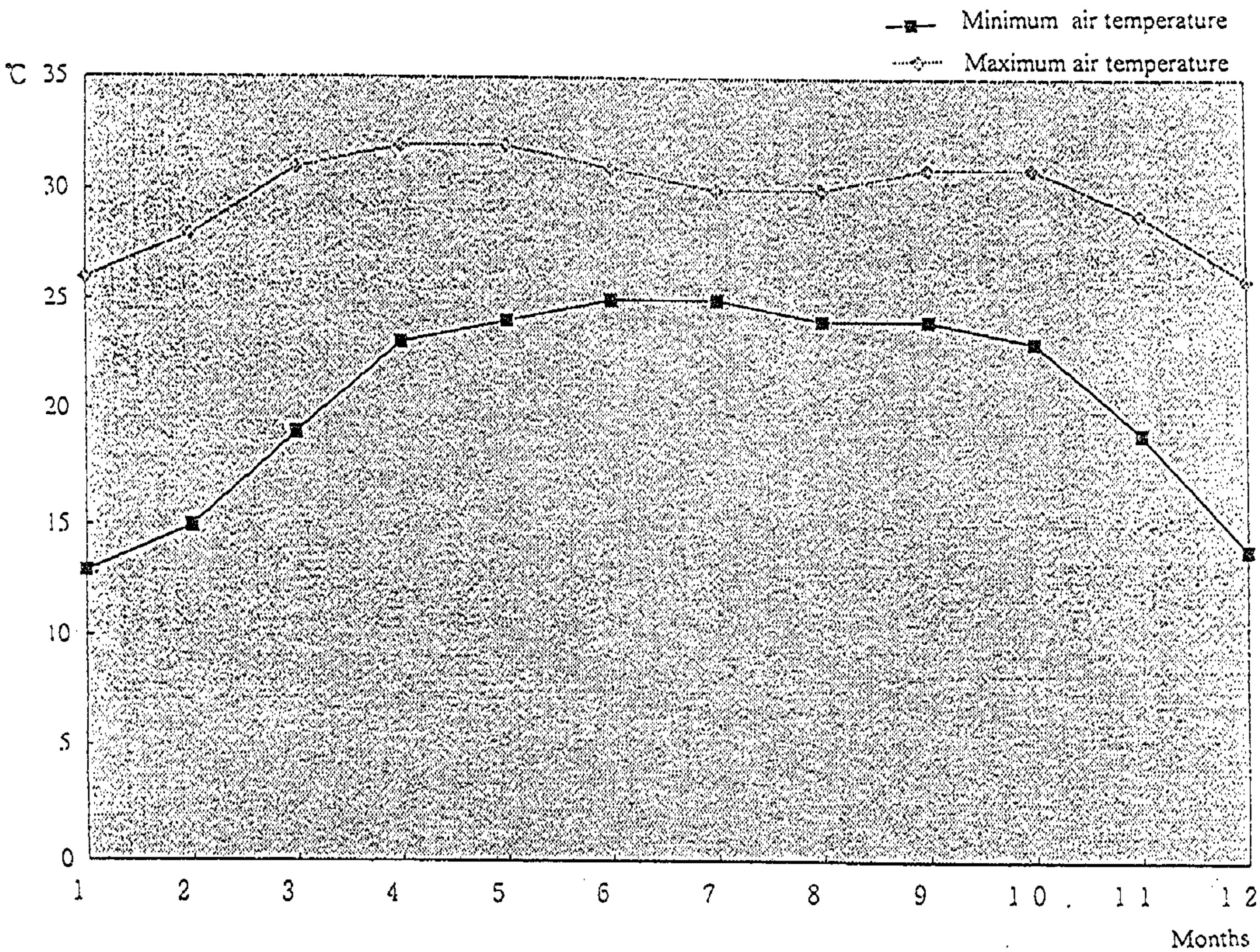
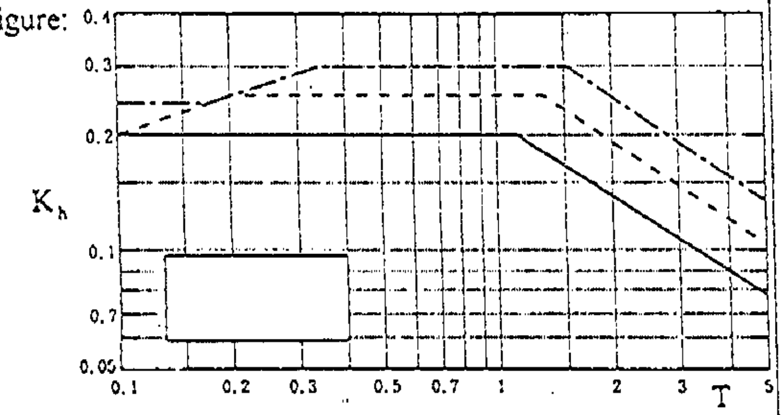


Fig. 2.3 Dhaka city monthly maximum and minimum temperatures

<table>
<tr><td>2.9 Force of stream current on piers
(AASHTO Clause 3.18.1)</td><td></td><td></td></tr>
<tr><td>2.10 Buoyancy
(AASHTO Clause 3.19)</td><td>Buoyancy shall be considered where it affects the design of either substructure, including piling, or the superstructure.</td><td></td></tr>
<tr><td>2.11 Earthquakes</td><td>Structures shall be designed against earthquake following the Bangladesh building code. Seismic Force: $V = \frac{Z.I.C}{R}.W$ where W = total seismicload; Z = seismic zone coefficient = 0.150; I = structure importance coefficient = 1.25; R = response modification coefficient for structural systems = 8 for intermediate moment resisting frames (IMRF); $C = \frac{1.25.S}{T^{2/3}}$; S = site coefficient for soil characteristics = 1.5; T = fundamental period of vibration of the structure in seconds. |	Longitudinal	Transverse
D/D (ADB)	1.88 sec	0.84 sec
T/P (JBSI)	1.07 sec	0.62 sec | Equivalent static seismic coefficient, K_h = Z.I.C / R |	Longitudinal	Transverse
D/D (ADB)	0.028	0.048
T/P (JBSI)	0.042	0.060 |</td><td></td></tr>
</table>

In accordance with Japanese Seismic Regulations, design seismic coefficient for grade III soil, similar to this project site, is shown in the following figure:



Design seismic coefficient for longitudinal and transverse direction should be of the same value, therefore, design seismic coefficient is selected as 0.06.

2.12 Differential settlement

Differential settlement is disregarded since the superstructure is simply supported.

2.13 Prestressing force

The prestressing force shall be calculated by the following equation:

$$P(x) = P_i - [P_i(x) - P_t(x)]$$

where

$P(x)$ = tensile force in prestressing tendon at design section

P_i = tensile force in prestressing tendon at jack location

$P_t(x)$ = decrease in tensile stress immediately after prestressing due to

a) elastic deformation of concrete

b) friction loss between sheaths and prestressing tendon

c) slip at anchors, and others.

	$P_t(x)$ = time-dependent decrease in tensile force due to a) creep of concrete b) shrinkage of concrete c) relaxation in prestressing tendon	
2.14 Effect of shrinkage and creep	For the calculation of the effects of shrinkage and creep on the prestressing force and on the bending moments and forces of the structure, the respective coefficients and characteristics shall be determined in accordance with CEB Manual on Structural Effects of Time-Dependent Behavior of Concrete, 1984.	
2.15 Earth pressure	The earth pressure acting on a wall surface shall be calculated by Coulomb's formula, taking account of effect of soil cohesion for cohesive soil.	
2.16 Characteristics of backfill	Internal friction angle, $\phi = 30°$ Unit weight γ = 19 kN/cu.m (1.94 tf/cu.m) Cohesion c = 0.0 kN/cu.m (0.00 tf/cu.m) Inclination angle at the back of wall For the design of the wall of abutment $\delta = 0°$ For the verification of the safety of foundation $\delta = \phi = 30°$	
2.14 Rainfall	Rainfall data for the Dhaka city is shown in Fig. 2.4.	

11

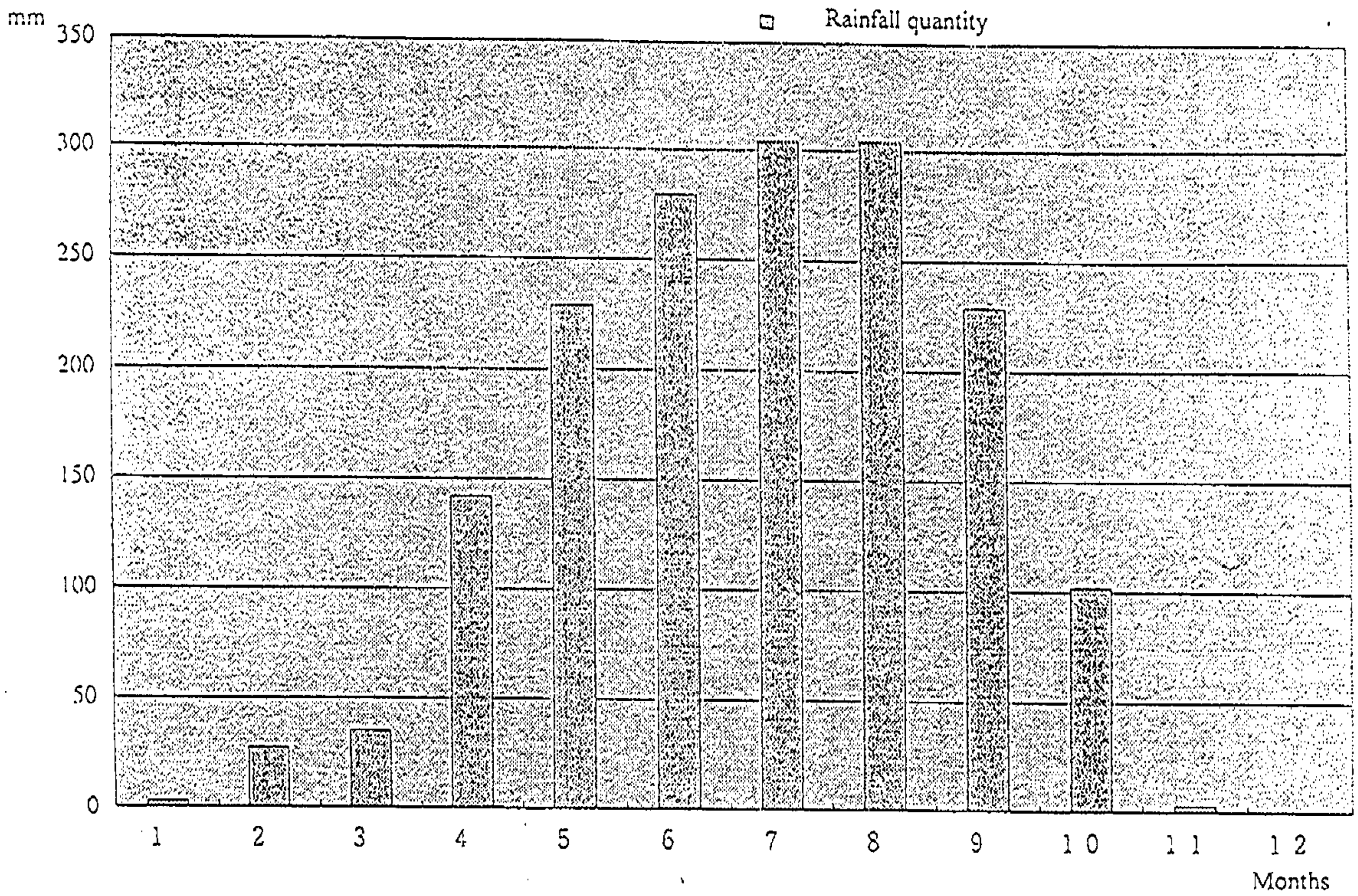


Fig. 2.4 Dhaka city monthly rainfall quantity

<table>
<tr>
<td>3.0 Combinations of loads
(AASHTO 3.22)</td>
<td>The following Groups represent various combinations of loads and forces to which a structure may be subjected. Each component of the structure, or the foundation on which it rests, shall be proportioned to withstand safely all group combinations of these forces that are applicable to the particular site or type. In general, group loading combinations for Service Load Design and Load Factor Design are given by:

$$Group(N) = P + \gamma[\beta_D.D + \beta_L(L+I) + \beta_E.E + \beta_B.B + \beta_S.SF + \beta_W.W + \beta_{WL}.WL + \beta_L.LF + \beta_R(R+S+T) + \beta_{EQ}.EQ]$$
where
N = group number;
γ = load factor (see AASHTO Table 3.22.1A);
β = coefficient (see AASHTO Table 3.22.1A);
P = prestress force;
D = structure dead load only (DL) + superimposed dead load (SDL);
L = live load;
I = live load impact;
E = earth pressure;
B = buoyancy;
W = wind load on structure - as per Bangladesh local conditions
WL = wind load on live load - 100 pounds per linear foot;
LF = longitudinal force from live load;
R = rib shortening including creep effects;
S = shrinkage;
T = thermal-rise or fall (TRF) + thermal differential (DT);
EQ = earthquake;
SF = stream flow pressure.</td>
<td></td>
</tr>
</table>

3.1 Construction stage	During construction the following load combination shall be investigated for ultimate limit state: P + 1.30 (DL+ER) where P = effect of prestressing including secondary time-dependent action; DL = dead load of structure only; ER = erection load.	
3.2 Serviceability limit state Superstructure (AASHTO)	The combinations of design loads are given in the following: %age of basic unit stress 1) $P + D + (L + I) + \beta_E . E + B + SF$ — 100% 2) $P + D + E + B + SF + W$ — 125% 3) $P + D + (L + I) + \beta_E . E + B + SF + 0.3W + WL + LF$ — 125% 4) $P + D + (L + I) + \beta_E . E + B + SF + (R + S + T)$ — 125% 5) $P + D + E + B + SF + W + (R + S + T)$ — 140% 6) $P + D + L + I + \beta_E E + B + SF + 0.3W + WL + LF + R + S + T$ — 140% 7) $P + D + E + B + SF + EQ$ — 133% 8) $P + D + (L + I) + E + B + SF$ — 140% where β_E = 1.0 for vertical and lateral loads on all other structures; β_E = 1.0 & 0.5 for lateral loads on rigid frames (AASHTO Clause 3.20)	

Substructure Abutment	Two different investigations are necessary namely: Investigation I: Stability of foundations for combination of nominal loads 1) DL + SDL + E 2) DL + SDL + E + BU 3) DL + SDL + E + L + LF 3) DL + SDL + E + L + LF + BU Investigation II: Structural design for combination of loads including factors 1) DL + 1.1SDL + E 2) DL + 1.1SDL + E + BU 3) DL + 1.1SDL + E + L + LF 3) DL + 1.1SDL + E + L + LF + BU where DL = dead load of structural section; SDL= superimposed dead load; E = earth pressure; L = live load; LF = longitudinal force; B = buoyancy.	

Pier		
Longitudinal direction	Investigation I: Stability of foundations for combination of nominal loads 1) DL + SDL 2) DL + SDL + BU 3) DL + SDL + (L+I) + LF (I = impact) 3) DL + SDL + (L+I) + LF + BU Investigation II: Structural design for combination of loads including factors 1) DL + 1.1SDL 2) DL + 1.1SDL + BU 3) DL + 1.1SDL + (L+I) + LF 3) DL + 1.1SDL + (L+I) + (LF + BU	
Transverse direction	Investigation I: Stability of foundations for combination of nominal loads 1) DL + SDL + WL 2) DL + SDL + WL+ BU 3) DL + SDL + WL + (L+I) + LF 3) DL + SDL + WL + (L+I) + LF + BU Investigation II: Structural design for combination of loads including factors 1) DL + 1.1SDL + WL (wind load) 2) DL + 1.1SDL + WL + BU 3) DL + 1.1SDL + WL + (L+I) + LF 3) DL + 1.1SDL + WL + (L+I) + LF + BU	

3.3 Ultimate limit state Superstructure (AASHTO)	The combinations of design loads are given in the following: 1) $1.3\,[P + \beta_D.D + 1.67(L + I) + \beta_E.E + B + SF]$ 2) $1.3\,[P + \beta_D.D + \beta_E.E + B + SF + W]$ 3) $1.3\,[P + \beta_D.D + (L + I) + \beta_E.E + B + SF + 0.3W + WL + LF]$ 4) $1.3\,[P + \beta_D.D + (L + I) + \beta_E.E + B + SF + (R + S + T)]$ 5) $1.25\,[P + \beta_D.D + \beta_E.E + B + SF + W + (R + S + T)]$ 6) $1.25\,[P + \beta_D D + L + I + \beta_E E + B + SF + 0.3W + WL + LF + R + S + T]$ 7) $1.3\,[P + \beta_D.D + \beta_E.E + B + SF + EQ]$ 8) $1.3\,[P + \beta_D.D + (L + I) + \beta_E.E + B + SF]$ where β_E = 1.3 for lateral earth pressure for retaining walls and rigid frames excluding rigid culverts; β_E = 0.5 for lateral earth pressure when checking positive moments in rigid frames(AASHTO Clause 3.20); β_E = 1.0 for vertical earth pressure; and β_d = 0.75 when checking member for minimum axial load and maximum moment or maximum eccentricity - for column design; β_d = 1.0 when checking member for maximum axial load and minimum moment - for column design; β_d = 1.0 for flexural and tension members.	

Substructure Abutment	The investigation for structural design shall be conducted for the following combination of loads: 1) $1.3DL + 1.3SDL + \beta_E E$ 2) $1.3DL + 1.3SDL + \beta_E E + 1.25(L+I+LF)$ where DL = dead load of structural section; SDL= superimposed dead load; E = earth pressure; L = live load; I = impact; LF = longitudinal force.	
Pier Longitudinal direction	The investigation for structural design shall be conducted for the following combination of loads: 1) $1.3DL + 1.3SDL$ 2) $1.3DL + 1.3SDL + 1.25(L+I+LF)$	
Transverse direction	The investigation for structural design shall be conducted for the following combination of loads: 1) $1.3DL + 1.3SDL + 1.3WL$ (wind load) 2) $1.3DL + 1.3SDL + 1.3WL + 1.25(L+I+LF)$	

4.0 Properties of materials	Following properties for concrete and steel are selected from the Japan Society of Civil Engineers (JSCE) specifications, 1986.	
Concrete		
Superstructure	Concrete compressive strength : 350 kg/cm^2 (5,000 psi) Modulus of Elasticity (JSCE Clause 3.2.5): $2.95x10^5$ kg/cm^2	
Substructure	Concrete compressive strength : 240 kg/cm^2 (3,500 psi) Modulus of Elasticity (JSCE Clause 3.2.5): $2.5x10^5$ kg/cm^2	
Cast in RC piles	Concrete compressive strength : 300 * kg/cm^2 (4250 psi) Modulus of Elasticity (JSCE Clause 3.2.5): $2.5x10^5$ kg/cm^2 *compressive strength is considered 240 kg/cm^2 for design analysis and calculation , because the compressive strength of 200 kg/cm^2 will be reduced by mixed impurities.	
Other properties	Poisson's ratio (JSCE Clause 3.2.6): 0.2 Temperature Coefficient (JSCE Clause 3.2.7): $10x10^{-6}$/°C Stress-strain curve: JSCE - Part I -Fig. 3.2.1 (Fig. 4.1) Shrinkage & Creep: CEB-Manual on Structure Effects on Time -Dependent Behavior of Concrete, 1984	

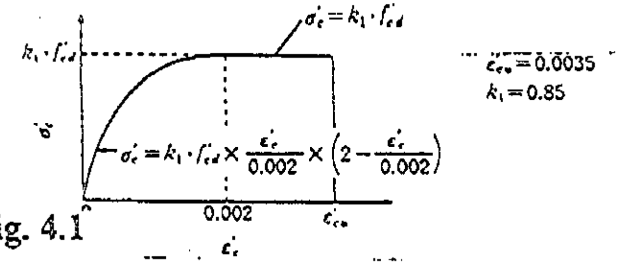


Fig. 4.1

Idealized stress-strain curve for concrete

Steel

Ordinary reinforcement

Cold works steel bars

Minimum yield strength: 4200 kg / cm² (60,000 psi)

Modulus of Elasticity (JSCE Clause 3.3.5): 2.1×10^6 kg / cm²

Stress-strain curve: JSCE - Part I - Fig. 3.3.1 (see Fig. 4.2)

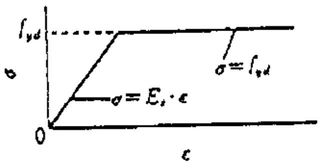


Fig. 4.2 Stress-strain curve for reinforcing bar and structural steel

Prestressing steel

Wires

Minimum ultimate strength: T12.7 - 19000 kg / cm² (270,000 psi)

T21.8 - 18500 kg / cm² (263,000 psi)

Modulus of Elasticity (JSCE Clause 3.3.5): 2.0×10^6 kg / cm²

Relaxation (JSCE Clause 3.3.8): 5%

Stress-strain curve: JSCE - Part I - Fig. 3.3.1 (see Fig. 4.3)

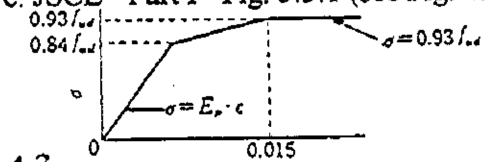


Fig. 4.3 Stress-strain curve for prestressing steel (Wire, wire strand and steel bar No.1)

Bars

Minimum ultimate strength: $\phi 26 / \phi 32$ 12000 kg / cm² (170,000 psi)

Relaxation (JSCE Clause 3.3.8): 3%

Stress-strain curve: JSCE - Part I - Fig. 3.3.1 (see Fig. 4.4)

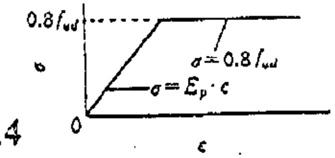


Fig. 4.4 Stress-strain curve for prestressing steel bar No.2

5.0 Structural analysis General analysis	The structural analysis shall always be carried out according to the theory of elasticity for both limit states, serviceability and ultimate. The distribution of load applied after completion of structure shall be analyzed by theory of lattice structure.	
Time dependent analysis	The time-dependent effects on the composite bridge built by segmental construction method shall be evaluated by the computer program developed by the Consultants. The analytical expressions used for the computations of creep and shrinkage developed in concrete with the passage of time in normal air are the same as those given in the CEB Manual on structural effects of time-dependent behavior of concrete, 1984.	
6.0 Detailing (AASHTO Clause 8.22) Concrete cover to reinforcement	Concrete deck slabs which have not positive corrosion protection and are frequently exposed to deicing salts: NA 62.5 mm - top reinforcement 25 mm - bottom reinforcement Concrete exposed to earth or weather: Superstructure 50 mm - primary reinforcement 37.5 mm - stirrups, ties & spirals Concrete cast against and permanently exposed to earth : Substructure and Piles 75 mm.	
Minimum percentage of main reinforcement	As specified in AASHTO.	

4. 2. 6 Effect of earthquake

The effect of earthquake shall be considered according to CHAPTER 9 "SEISMIC DESIGN".

4. 2. 7 Wind load

(1) Wind loads which apply to structures shall be determined according to types of structures, environmental conditions, dimensions of structural members, etc.

(2) The characteristic values of wind loads, in general, may be obtained by Eq. (4. 2. 3).

$$W=\frac{1}{2}\rho v_z^2 CA \quad \text{(kgf)} \tag{4.2.3}$$

where, ρ : the density of air, 0.125 ($kgf \cdot s^2/m^4$)

v_z : the design speed of wind (m/s), which shall be determined according to intended limit states

A : the cross-sectional area of a structural member projected to the direction of wind (m^2)

C : the coefficient of drag, which shall be determined according to the shape of cross section of a structural member

[Comment]

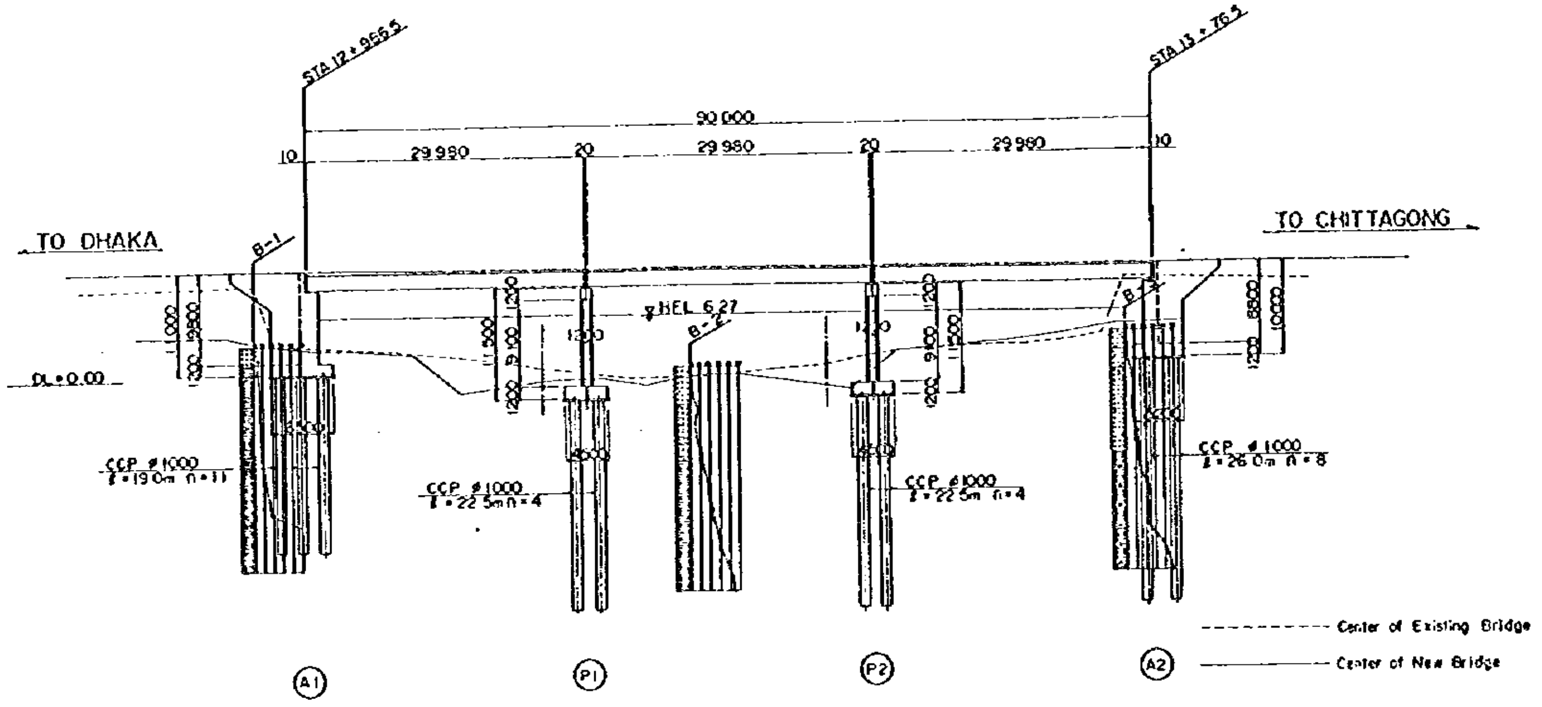
By considering observed records concerning wind speed, design lifetime of a structure, recurrence period of wind speed, etc., the design speed of wind is generally obtained based on the average wind speed of 10 minutes at an altitude of 10 meters above the surface of the ground or sea, and multiplied by the correction factors concerning the height and the horizontal or vertical length of a structure.

The coefficient of drag may be regarded as the values represented in Table C4. 2. 2 according to the shape of cross section of a structural member.

6. Basic Design Drawings

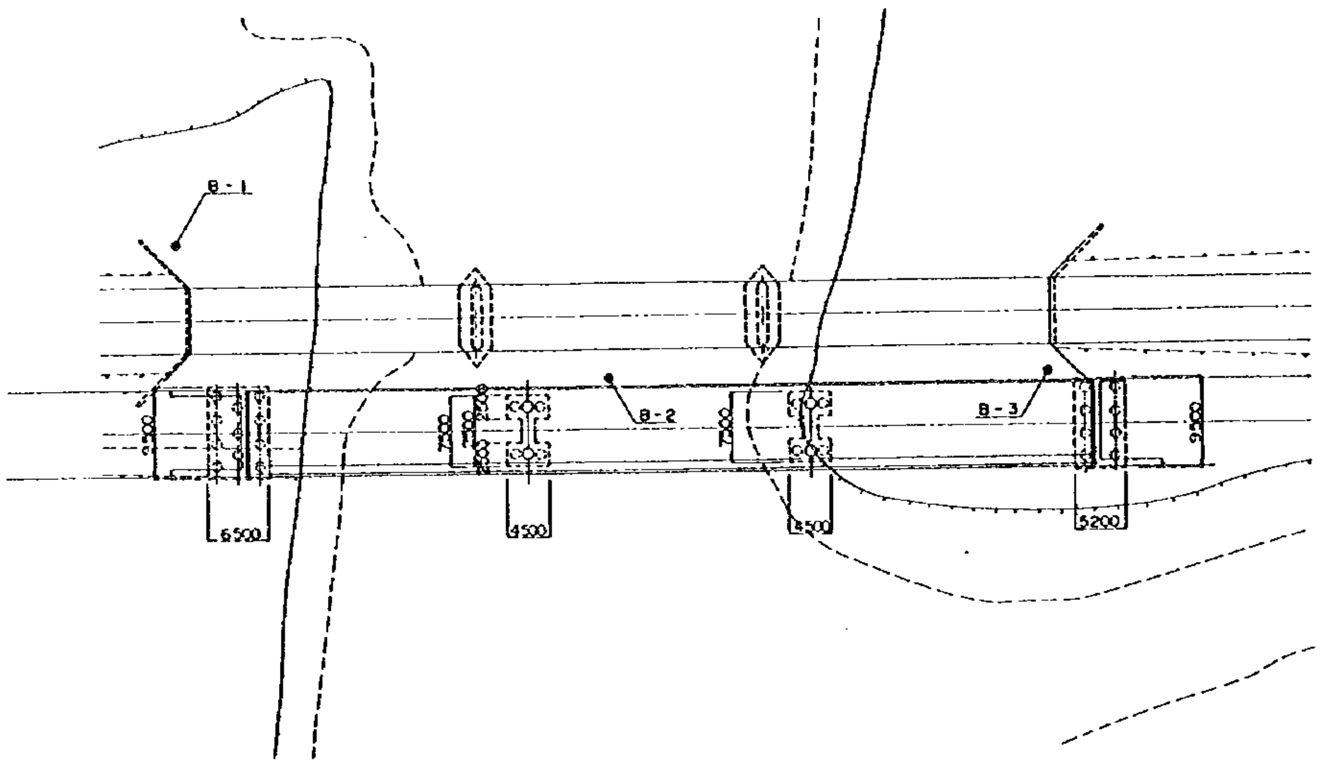
General View of 5 Bridges

No.1 Marikhali Bridge S=1:400

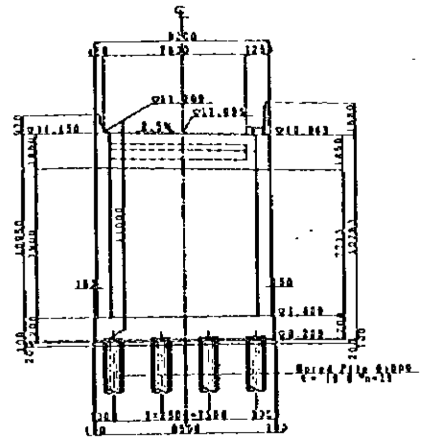


SLOPE	▽11.200				LEVEL					▽11.200
PROPOSED HEIGHT	11.200	11.200	11.200	11.200	11.200	11.200	11.200	11.200	11.200	11.200
ORIGINAL GROUND LEVEL										
ACCUMULATIVE DISTANCE										
STATION No.	STA.12 +980.0	(A1) +986.5	STA.13 +0.0	(P1) +16.5	+21.0	+40.0	+46.5 (P2)	+60.0	(A2) +76.5	+80.0

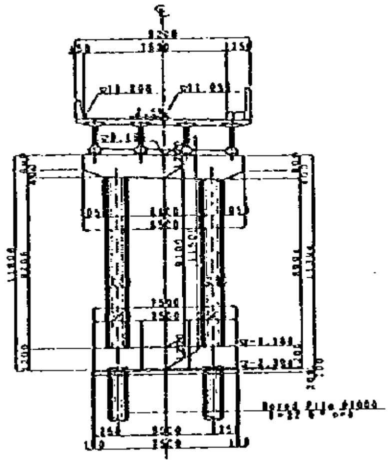
PLAN



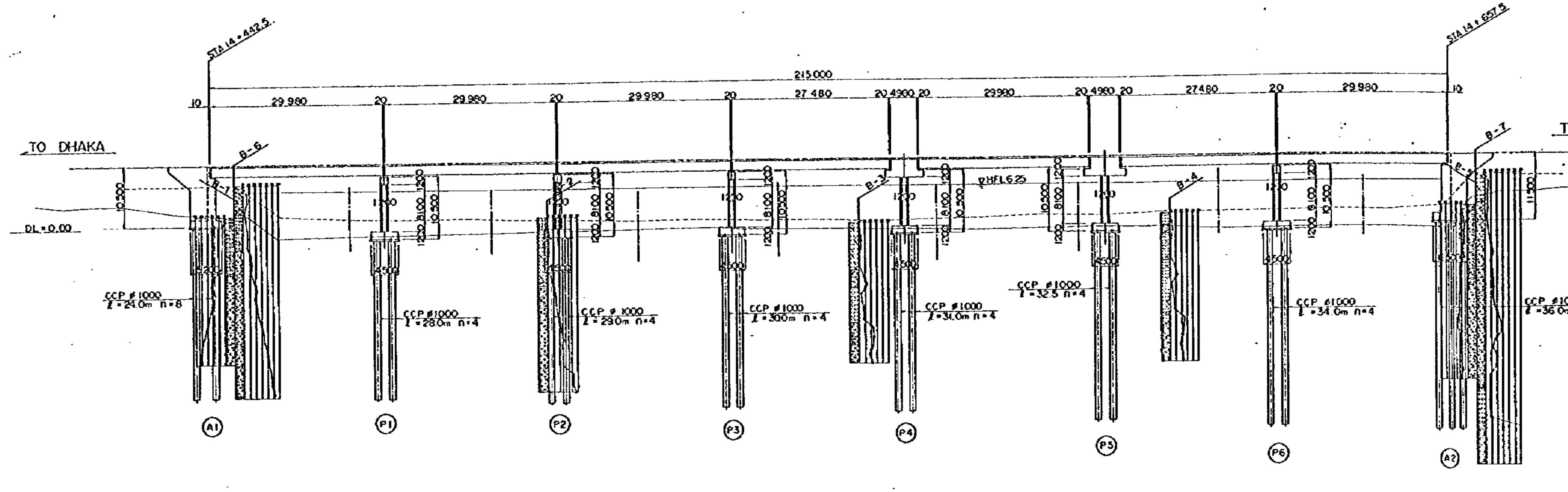
A1 ABUTMENT

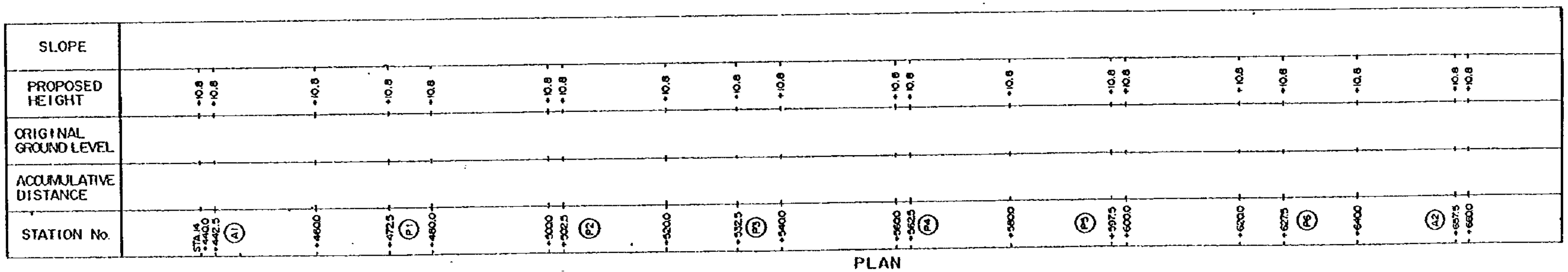


P1 PIER

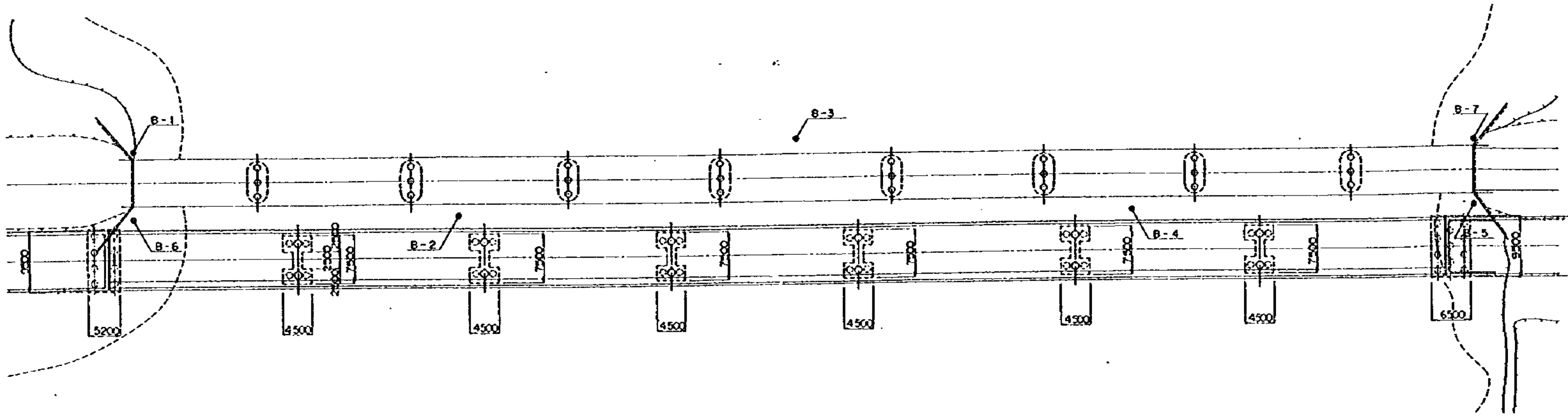


No.2 Ashar Char 1 Bridge S = 1:400

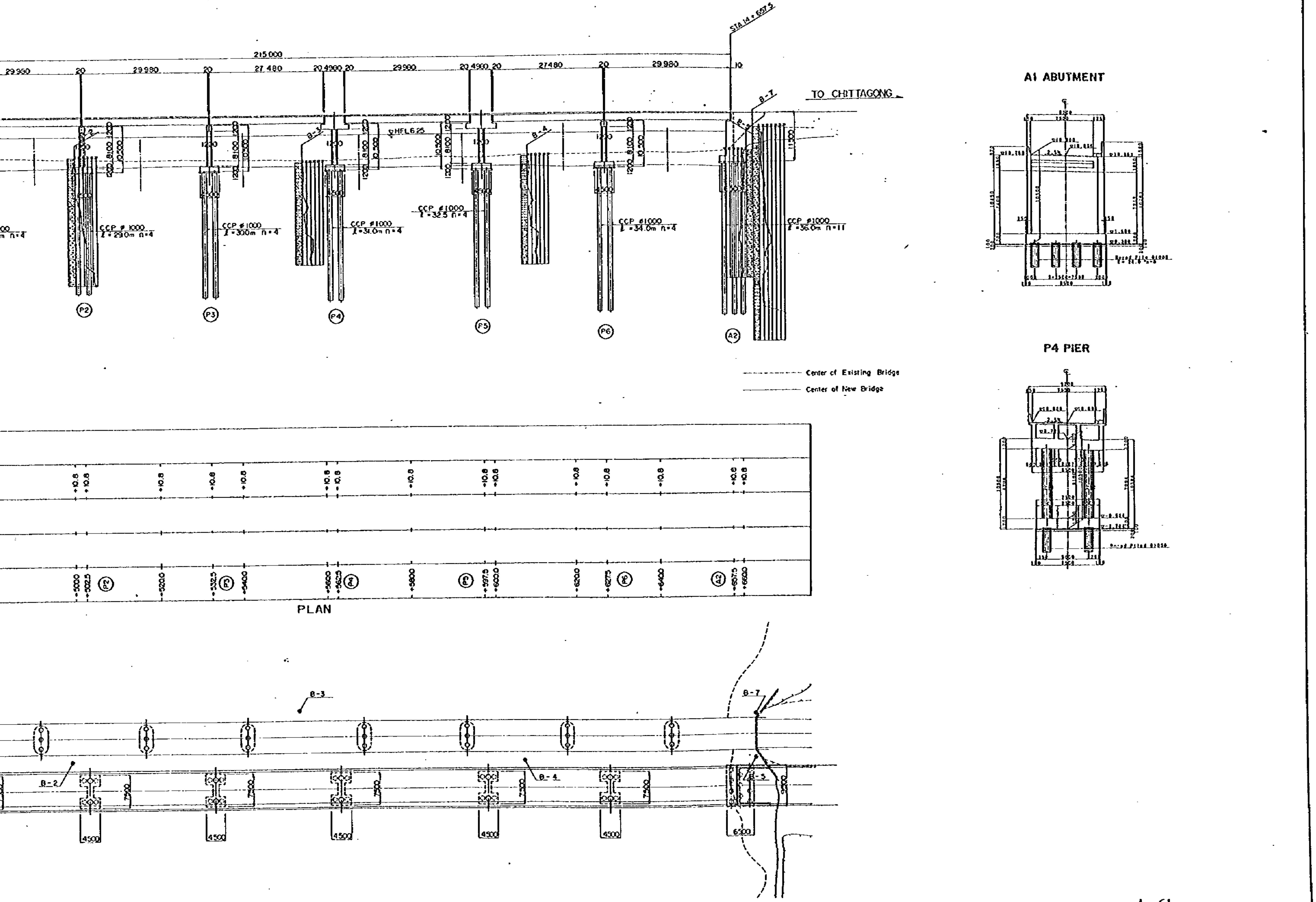




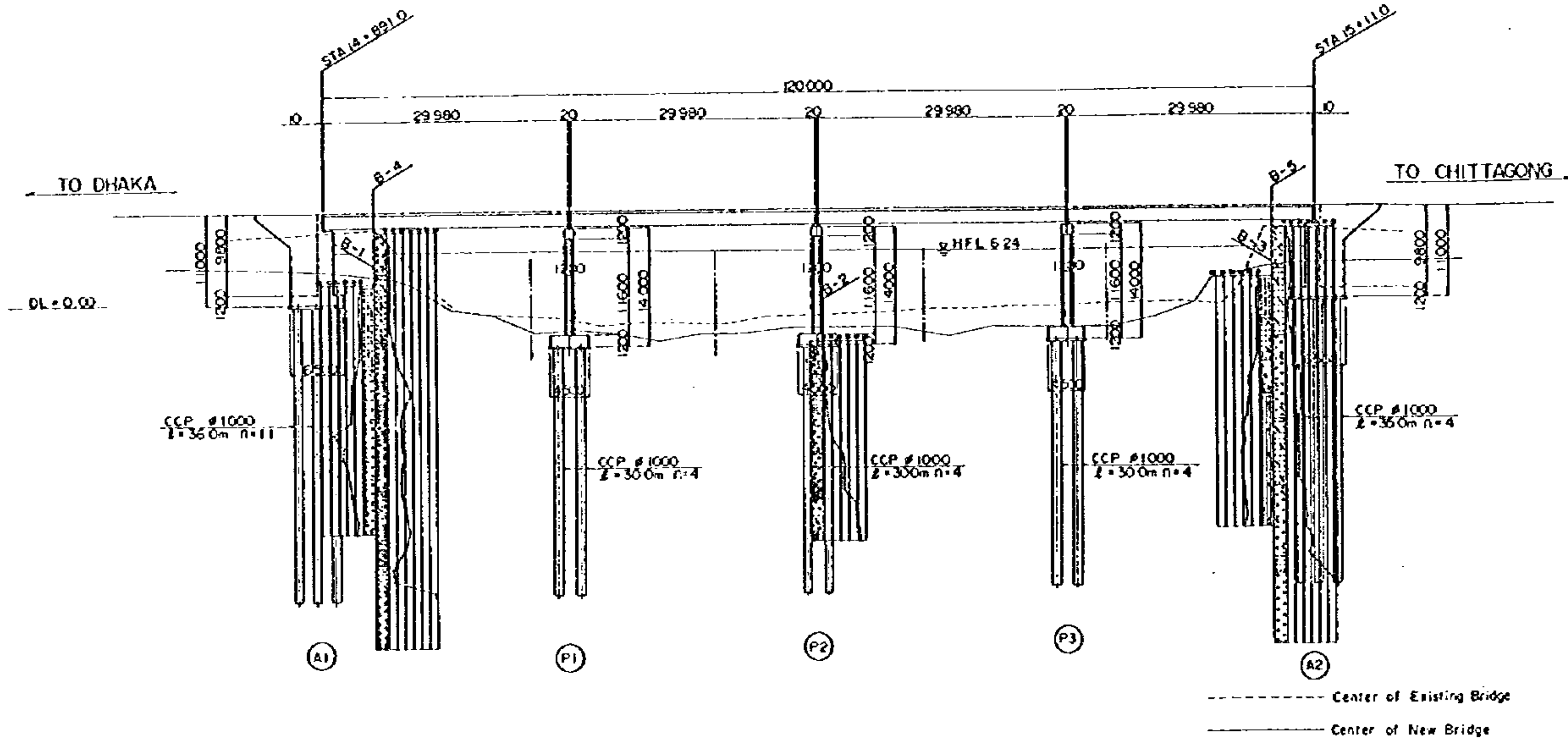
PLAN



No.2 Ashar Char 1 Bridge S = 1:400

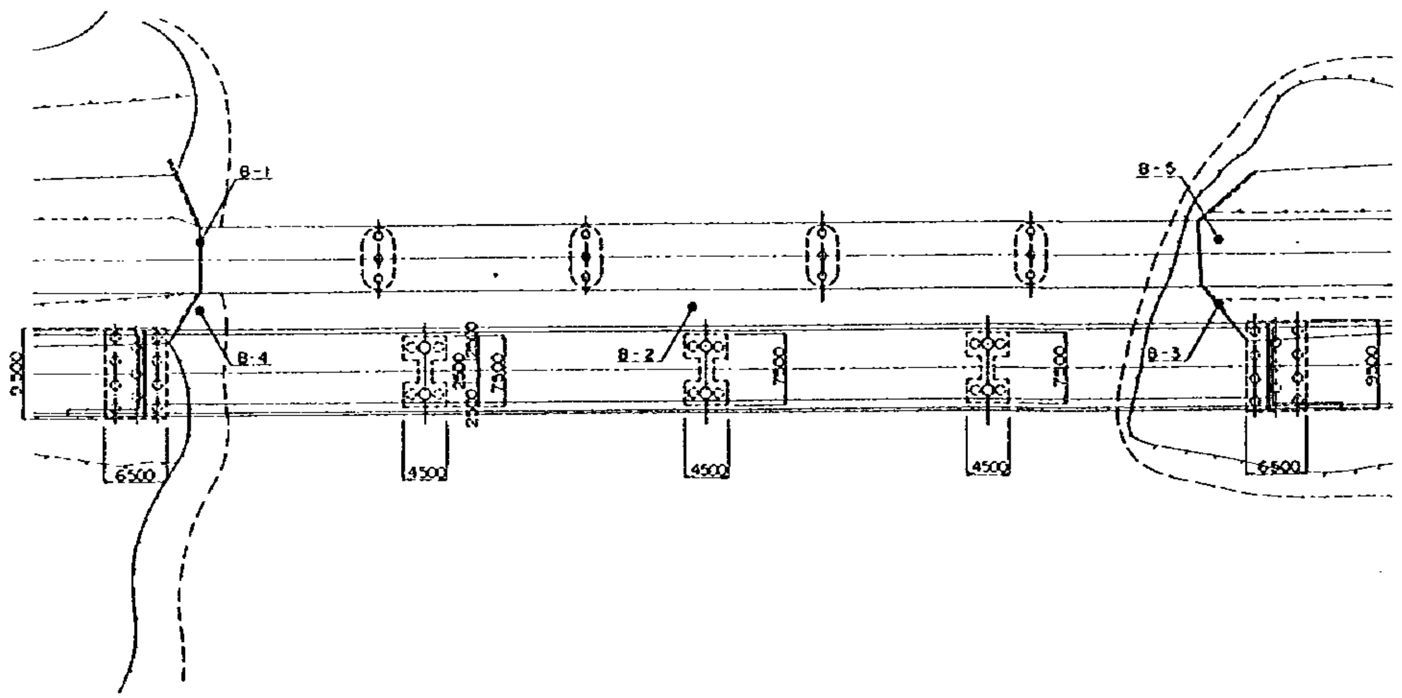


No.3 Ashar Char 2 Bridge S・1: 400

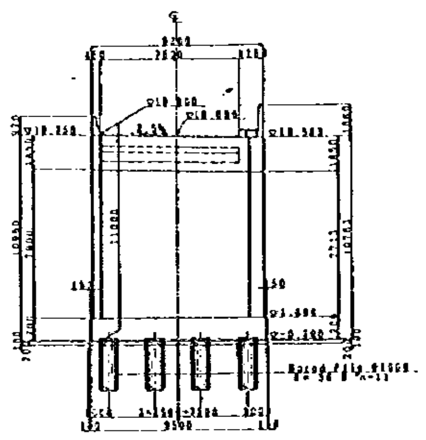


SLOPE										
PROPOSED HEIGHT	+10.8	+10.8	+10.8 +10.8	+10.8	+10.8	+10.8	+10.8 +10.8	+10.8	+10.8	+10.8
ORIGINAL GROUND LEVEL										
ACCUMULATIVE DISTANCE										
STATION No.	STA 14 +891.0 (A1)	+900.0	+920.0 +921.0 (P1)	+940.0	+951.0 (P2)	+960.0	+980.0 +981.0 (P3)	STA 15 +0.0	+11.0 (A2)	+20.0

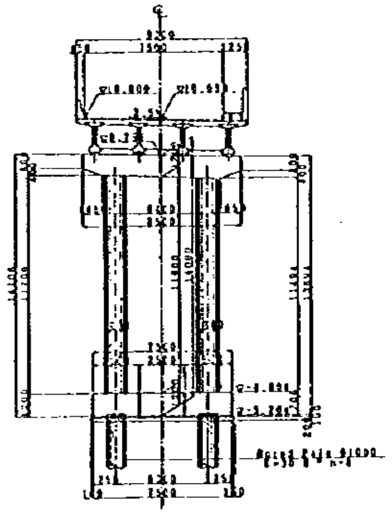
PLAN



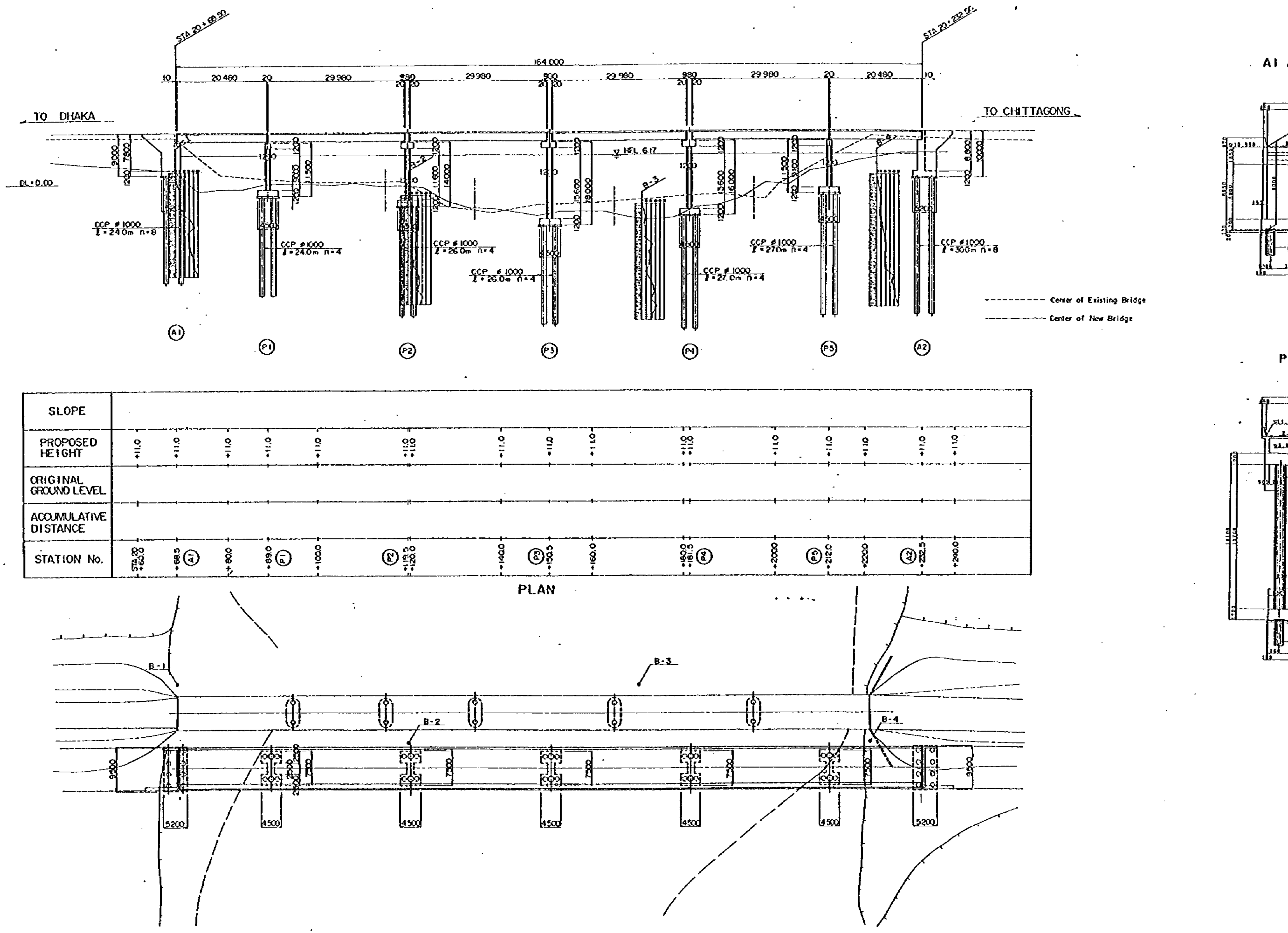
A1 ABUTMENT



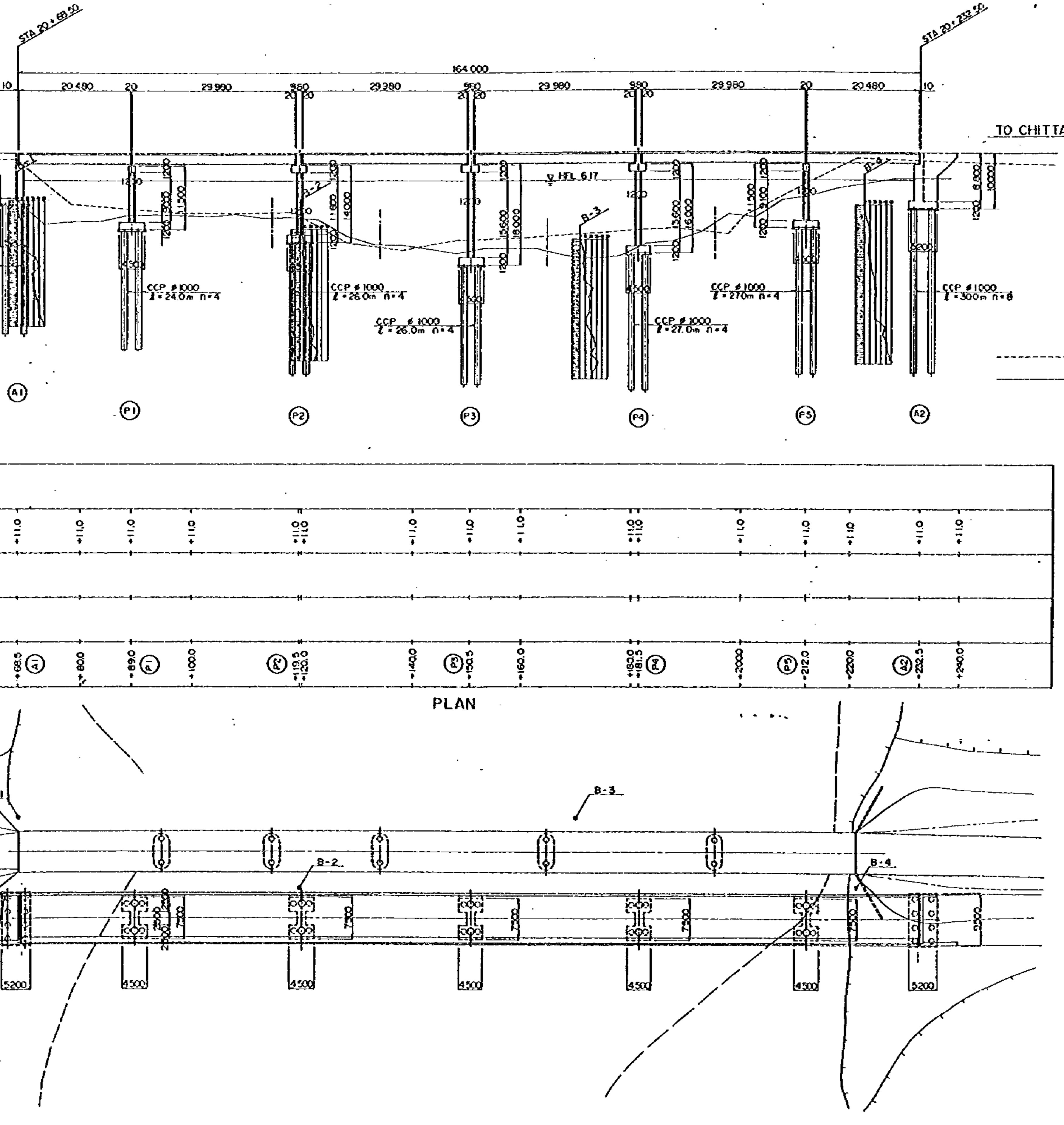
P1 PIER



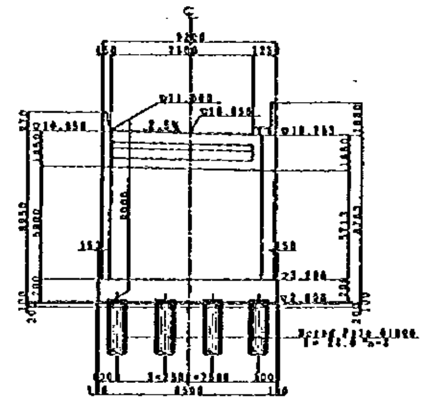
No.4 Bhatir Char Bridge S = 1:400



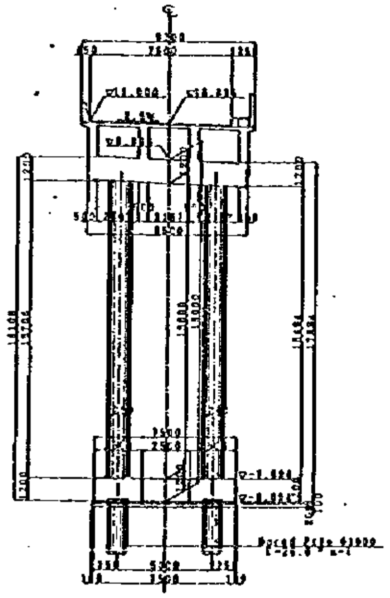
No.4 Bhatir Char Bridge S = 1:400



A1 ABUTMENT

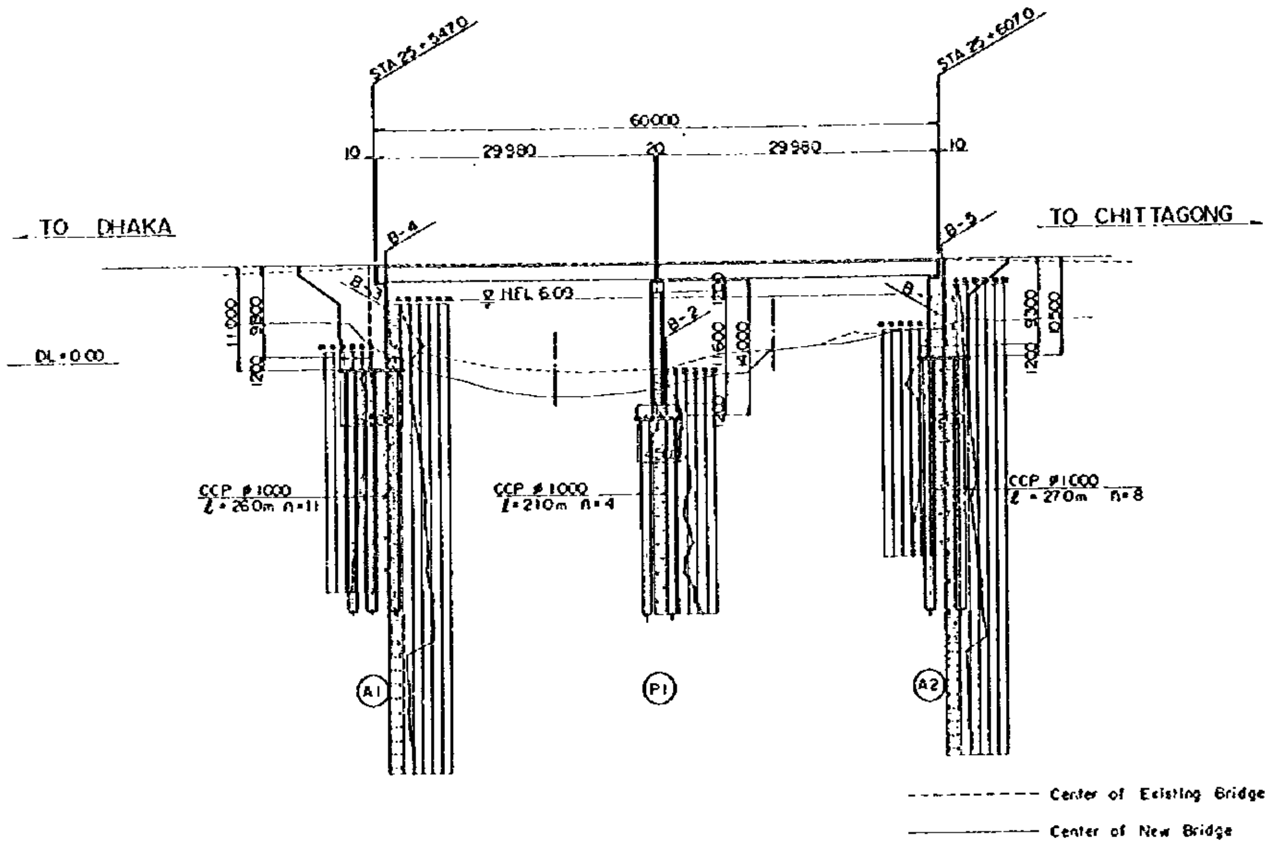


P1 PIER



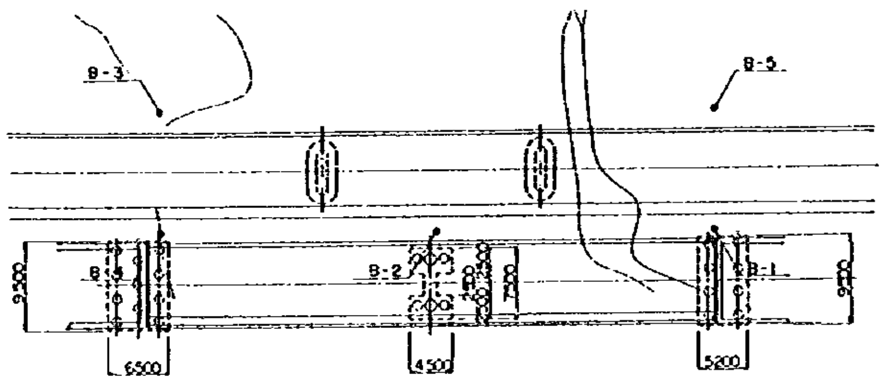
No.5 Madhya Baushia Bridge

S = 1: 400

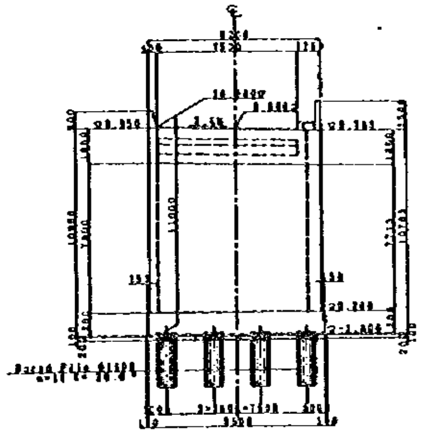


SLOPE									
PROPOSED HEIGHT	10.0	10.0	10.0		10.0	10.0	10.0	10.0	10.0
ORIGINAL GROUND LEVEL									
ACCUMULATIVE DISTANCE									
STATION No.	STA 25 +540.0	+547.0 (A1)	+560.0	(P1)	+577.0	+580.0	+600.0	+607.0 (A2)	+620.0

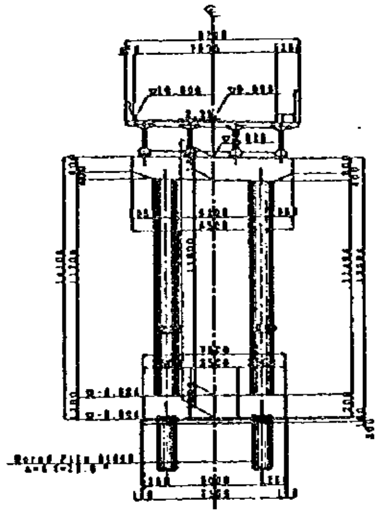
PLAN



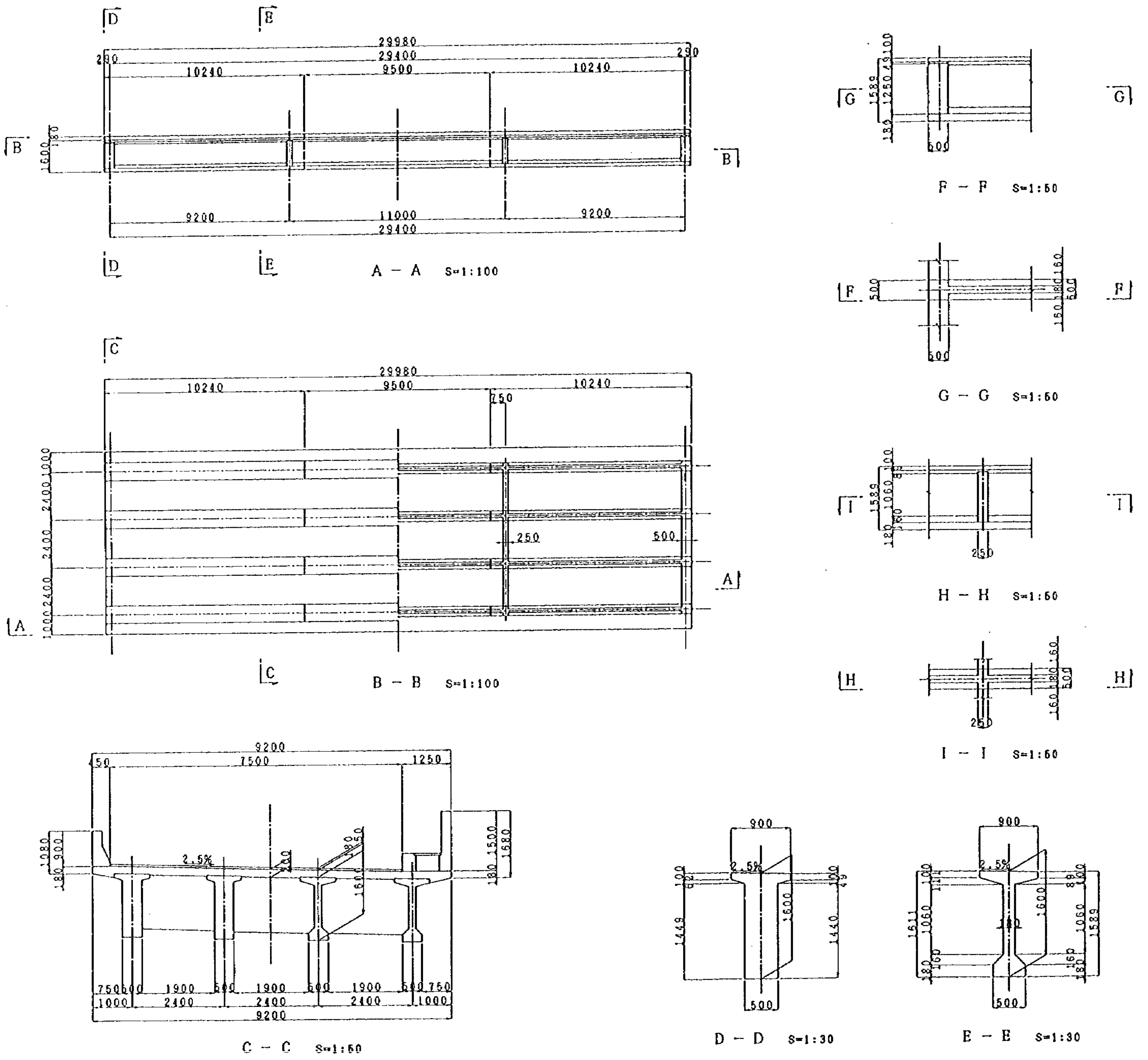
A1 ABUTMENT



P1 PIER



DETAILED DIMENSIONS OF GIRDER (1) [L300]



MKD	DATE	DESCRIPTION	BY

REVISIONS

GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH
MINISTRY OF COMMUNICATIONS
ROADS AND HIGHWAYS DEPARTMENT

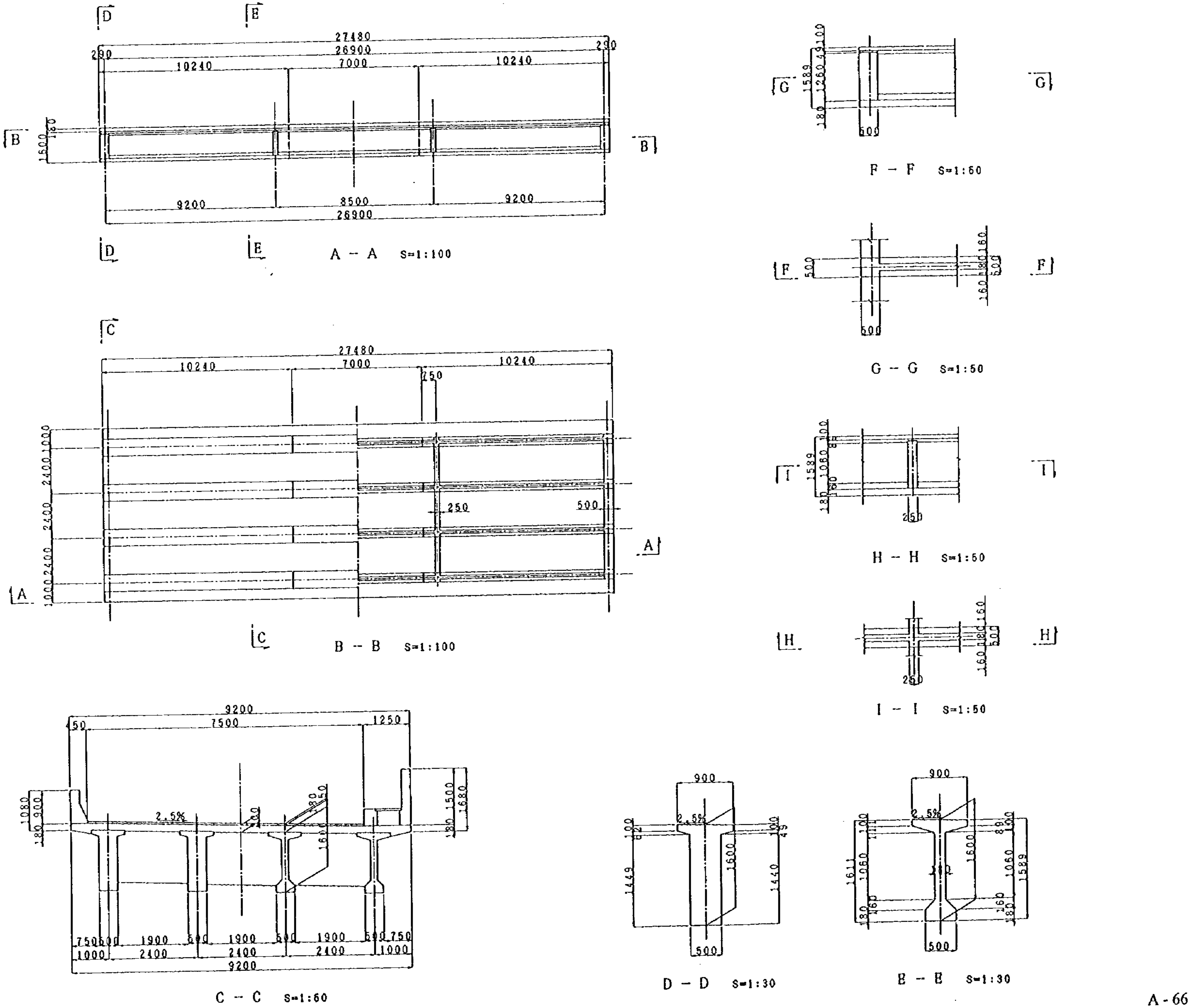
JAPANESE GRANT AID PROJECT
THE PROJECT FOR THE RECONSTRUCTION OF
FIVE BRIDGES ON DHAKA-CHITTAGONG HIGHWAY

ROAD NAME: DHAKA-DAUDKANDI

(DRAWING TITLE)

JAPAN BRIDGE & STRUCTURE INSTITUTE, INC.

DETAILED DIMENSIONS OF GIRDER (2) [L275]



A-66

MK	DATE	DESCRIPTION	BY

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JAPANESE GRANT AID PROJECT
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DRAWING TITLE

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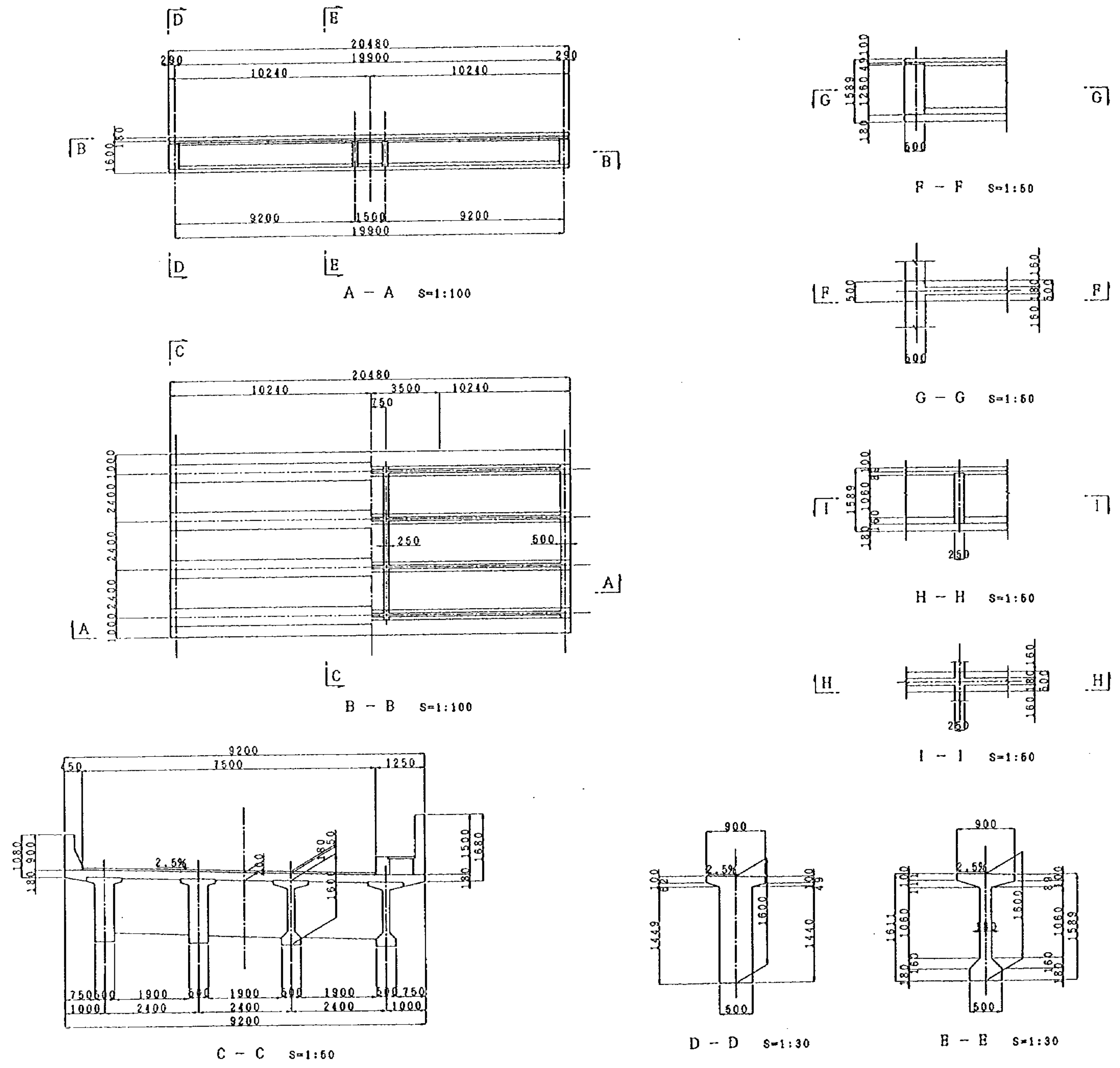
DETAILED DIMENSIONS OF GIRDER (3) [L205]



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JAPANESE GRANT AID PROJECT
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ROAD NAME: DHAKA-DAUDKANDI

DRAWING TITLE:

JAPAN BRIDGE & STRUCTURE INSTITUTE, INC.

7. Summary of Jamuna Bridge Access Roads Project's Main Report

SUMMARY

of

JAMUNA BRIDGE ACCESS ROADS
PROJECT' S MAIN REPORT

JUNE 1996

1. GENERAL

* Bangladesh

Area:	144000 Sq. Km
Population:	120 Million 85% Rural areas - Agriculture
Per capita income:	US$ 120

* Project implementation agency
  Roads and Highways Department (RHD) under the control of Road & Road Transport Division of the Ministry of Communication responsible for construction and maintenance of major road networks:
  - National H/ways
  - Regional H/ways
  - Feeder type 'A' Roads
* One (1) bridge for 3 Km of roads - reinforced concrete
* Four (4) ferry crossings linking National Highways:
  - Aricha-Nagarbari
  - Bhuapur-Sirajganj
  - Aricha-Daulatdia
  - Mawa-Bhanga
* Detailed pavement assessment undertaken by Road Master Plan Project (RMPP)
* Various measures to improve existing important road network:
  - Rehabilitation and maintenance
  - Bridging the major river gaps
  - Streamlining ferry system where bridges are not available
  - Constructing thana connecting feeder roads
* Various Projects:

Road Rehabilitation and Maintenance Project (RRMP) -	IDA
Road Improvement Project (RIP) -	ADB
Feeder Road Improvement Project (FRIP) -	ADB
Road Overlay & Improvement Project (ROIP) -	ADB

* Dhaka-Daudkandi Road Section:
  Four (4) lane carriageway - new bridges adjacent to old bridges
  Economic review was conducted to evaluate the feasibility of constructing this section to 4-lane standard
  4-lane road provides more attractive returns and a more robust performance
* Dhaka-Meghna Bridge subsection of Dhaka-Daudkandi road:
  Considerable traffic volume is expected in future
* Vertical profile:
  The design road level has been calculated taking the subgrade level at 30 cm above the design HFL.
* Minimum vertical clearance:
  One (1) meter above highest flood level (HFL) with a return period of 50 years
* Sub-soil investigation for bridges:
  Piled or well foundation required to transmit load from superstructure and substructure to the ground

2. SOILS AND MATERIALS

2.1 Compaction properties of subgrade soils
(Tables 3.1.3 ~ 3.1.6)

Maximum dry density (MDD)	= 1.71 - 1.92	t/cu.m	(range)
	1.84	t/cu.m	(mean)
Optimum moisture content (OMC)	= 11.6 ~ 17.8%		(range)
	15.1 %		(mean)
Field dry density (FDD)	= 1.46 - 1.70	t/cu.m	(range)
	1.59	t/cu.m	(mean)
Field moisture content (FMC)	= 16.0 ~ 28.0%		(range)
	22.0 %		(mean)
Relative subgrade compaction (RSC)	= 78.0 ~ 92.0%		(range)
	87.0 %		(mean)
CBR of subgrade soils at MDD & OMC	= 2.0 ~ 19.0%		(range)
	9.0%		(mean)
CBR of subgrade soils at FDD & FMC	=		(range)
	2.0%		(mean)

2.2 Suitability criteria & design parameters for soils & materials
(see Table 3.1.9)

2.3 Sub-soil investigation
Geotechnical investigation at sites of bridges for Dhaka-Daudkandi Road Section
(see Table 3.2.1.3)

The bridge sites (in chainage) on different road sections of the project along with the total number of bore holes (BH) drilled at a bridge site, range of borehole depths and probable foundation depths at the site are listed in Table 3.2.1.3.

Standard penetration tests (SPT)

Conducted at 1.5 m interval down the depth

SPT-N values used to estimate: Angle of shearing resistance for cohesionless soil, ϕ
Undrained shear strength for cohesive soil, Cu

Engineering parameters; ϕ and Cu, are required for the design of shallow & deep foundations

2.3.1 Bridge sites on Dhaka-Daudkandi Road Section
Foundation soil strata (12 bridge sites) belongs to geologically recent alluvial deposits of young & older Meghna upper strata composed of mainly;

Soft to medium stiff
Low to medium plastic silt
Clayey silt/ silty clay
Very loose to loose to lower medium dense (N < 20)
Nonplastic fine sandy silt/ silty fine sand to considerable depth
= 10 to 25 m (often up to 30 ~ 40 m)

Dense sand strata

Deep foundation of suitable type and dimensions will have to be adopted to support the proposed bridge structures at the abutments and piers (where necessary).

(see Table 3.2.2.3 - pages: 3-44 to 3-65)

2.3.2 Suggested foundation depth

(see Table 3.2.1.3 - page: 3-33)

3. HYDROLOGICAL STUDY

* Hydrological investigation:
  - Bangladesh Water Development Board (BWDB)
  - Water Resources Planning Organization (WARPO)
* Data was processed to find:
  - Water level
  - Flow velocity
  - Discharges
    - For setting the level of road embankment
    - For design of bridges and cross-drainage structures
* Flood:
  - 20 ~ 25 years' magnitude for design of road embankment
  - 20 ~ 25 years' magnitude for small to medium bridges and culverts
  - 100 years' magnitude for major bridges
* Finally,
  - Road levels were set with respect to (w.r.t) water level of 1987 flood
  - Design discharges of bridges estimated based on high water level of 1988 flood
  - Design height of smaller bridges were fixed w.r.t. normal flood with a free board of 1 m

3.1 Hydrological setting of project roads

Dhaka-Daudkandi Road

* Seven (7) bridges on this road which require to be replaced as per program
* Physical verification of site and channel condition showed that slight increase or decrease in the length of bridges may be made considering the present day hydrological condition
* Accordingly, in consultation with bridge engineer, length of bridges have been fixed

3.2 Provision of navigation under bridges

* Dhaka-Daudkandi Road Section passes through flood plains and intercept a good number of rivers and flood overflow channels
* Due to changed hydrological condition and changes in mode of transportation it is observed that some adjustments are now necessary
* In fixing the height, local information on boat traffic, their size and volume and all other relevant information were used for fixing vertical clearance
* Usually structural depth is added to the design flood level and to it the clearance height according to the class of navigable route is added
* The provision of both vertical and horizontal clearances has been fixed according to the size of the channel and category of boats using them and cost effectiveness of the structure

See Table 4.3 - Page: 4-15

4. TRAFFIC STUDIES

* Traffic surveys
* Demand forecasting procedures
* Calculation of pavement damage factor
* The data have been identified as volume, vehicle mix and equivalent standard axles (ESA) likely to be encountered on project road sections approximately ten years after completion of construction targeted to year 2010.
* Jamuna bridge study
  Bridge volume in year 2020 = 11,300 vehicles per day (vpd)
* Meghna-Gumti bridge project
  Bridge traffic volumes (year 1994) = 4500 - 5000 vehicles/day
  Bridge traffic volumes (year 2020) = 12000 vehicles/day

4.1 Traffic volume

4.1.1 Existing conditions

Dhaka-Chittagong Corridor
(see Table 5.1)

* Highest volumes are found near Dhaka-Daudkandi segment/ section: 16700 vehicles/ day
* Additional count in early 1995 about 1 Km south of Sylhet junction confirmed that total daily volume north of Meghna bridge is among the highest found on the Bangladesh inter-urban road system (see Table 5.2)
* Dhaka-Daudkandi road segment volume (North of Sylhet Junction)
  * Daily demand: 16700 vehicles
    34% (5600) vehicles: buses
    37% (6100) vehicles: trucks
  * Hourly demand: 1000 vehicles between 10:00 & 20:00 hours (relatively constant)
  * Late night volumes are considerable
    (see Fig. 5.2)
  * Peak hour pattern
    (see Fig. 5.3)
  * Hourly passenger car units (pcu) demand
    (see Fig. 5.4)
  * Cumulative hourly pcu pattern
    (see Fig. 5.5)

4.1.2 Forecast demand

* Feasibility study forecasts
  Sensitive to truck types: large (3+axle) units after turn of century
* Approach used to develop forecasts for current study
  * Apply feasibility study growth rates to observed conditions
  * To assist economic feasibility studies, forecasts be available until 20 years
  * Road design will be governed by a 10 year horizon (year 2010) since, over the post-2010 decade, additional road improvements may be implemented, to include resurfacing

* Absolute number of vehicles forecast over this horizon will invariably be limited at some point by roadway capacity
* Road capacities (World Bank, ADB) are used to estimate road section capacities
* Capacities will vary by road section due to:
  - Carriageway width
  - Shoulder width
  - Roadside activity
  - Traffic mix
* 7% peak hour factor is adopted to estimate daily capacities
* Forecasting process
  (see Table 5.3)
  * Upon reaching saturation, forecast activity is constrained by the maximum capacity expected to occur throughout Dhaka-Chittagong corridor by 2010
  * Dhaka-Meghna Bridge sub-section of Dhaka-Daudkandi road is assumed to feature 4 lanes

4.2 Vehicle damage factors
(see Table 5.4)

* Average vehicle weight getting heavier with the passage of time
* Estimation of year 2010 ESA factors
  * Hinges on likely increase of larger (3 or more axle) trucks in traffic stream, cargo loading practices, status of bridge weight limitations, and degree of "on-the-road" enforcement of maximum truck weights by the authorities
  * To ensure a conservative and safe approach to engineering design

	Year 2010 ESA factors
* Small truck (2 axle)	2.0
* Large truck (3+ axle)	3.0
* Cars/utilities/vans	0.003
* Buses	0.280
* Auto rickshaws/ motorcycles	0.001

  * Resultant ESA per day
    (see Table 5.5)
  * Year 2010 ESA values
    Dhaka-Chittagong Corridor 20000 ESA per day

5. ROAD GEOMETRY

Geometric design of road alignment:

Horizontal alignment:

Design speed:

Desirable:	100 Km/hr
Absolute minimum:	65 Km/hr

Dhaka-Daudkandi Section

* RHD proposes to construct 4-lane bridges at these locations, which will require some shift of alignment
* Road alignment at 7 places (varying lengths) has been shifted to right side by about 9 m from the center line of the existing bridges for accommodating 4-lane bridges

6. BRIDGES AND CULVERTS STRUCTURES

6.1 Existing Structures

6.1.1 Culvert structures (Cs) - 216 Nos.

* R. C. pipe (P)
* Steel Armco pipe (A)
* Culverts with R.C. deck supported on brick abutments
* Single cell or multiple cell R.C. box culverts (C)
* Brick masonry arches (Ar)

6.1.2 Bridges (Br) - 76 Nos.

* PC superstructure (s/s) over R.C. piers & abutments on piled/well foundation
* Simply supported R.C. T-beam s/s over R.C. piers & abutments on piled/well foundation
* R.C. balanced cantilever s/s over R.C. piers & abutments on piled/well foundation
* Japanese plate girder thru-type s/s supported on brick masonry piers & abutments on brick walls
* Thru-type truss bridge of single lane with brick masonry piers & abutments supported on brick walls
* R.C. deck slab supported on rolled steel joists with brick masonry piers & abutments

6.1.3 Available information

"As built" drawings are very few:

* Only information about accessible parts of the structures
* No information of foundation structures
* Partial information on reinforced concrete components and abutment structures

6.1.4 Brief description of Dhaka-Daudkandi Road

* Located in between Sitalakkha bridge (400 m) & Meghna Gumti bridge (1410 m)
* 12 bridges excluding Meghna bridge (930 m) - all need replacement
* Meghna & Meghna-Gumti bridges:

  Prestressed concrete cantilever bridges founded on bored piles
  Constructed recently by progressive cantilever method
  Carriageway width = 7.2 m

6.2 Evaluation

Assessment: Visual examination:

* Structural adequacy & safety
* Functional adequacy & serviceability
* Residual life of structure

6.2.1 Evaluation of structural adequacy

* Deck condition: Severity of cracks
  Sapling of concrete
  Delimitation of concrete
  Corrosion in reinforcement
  Cracks &/or excessive sag
  Excessive movement of bearings, if any, was recorded

* Bearing: Condition & performance
  - Noticing displacements
  - Noticing cracks
  - Corrosion &/or
  - Rusting in case of steel bearings
* Substructure & Foundation: Distress in substructure
  - Sign of movement:
    - Lateral
    - Vertical
  - Deterioration of concrete
  - Corrosion of steel
  - Collision damage etc.

  Distress in foundation
  - Sign of:
    - settlement
    - lateral movement
    - sliding
    - scour

6.2.2 Assessment of functional adequacy & serviceability

* Findings of hydrological investigations were considered while evaluating the adequacy of linear waterway and head-room clearance
* Suitable protective measures adopted where signs of scour near foundation level
* Footpaths - necessary near villages and towns
* Bridges with substandard approach alignments:
  - Suggested for reconstruction from geometric point of view of road
  - In case of large structures modify approach geometry

6.2.3 Assessment of residual life

* Design life: 50 years (Normally)
* Life expectation
* Faster aging: Lack of maintenance, accidents
  - Shorter residual life than estimated from design

6.3 Replacement Criteria

* Structural inadequacy: Underdesign
  - Weakened over service life
* Functional/ Serviceability Deficiency: One lane to two lanes
* Change in road alignment: Horizontal
  - Vertical - rise in deck level

6.4 Rehabilitation

* Highly specialized techniques
* Ascertain present condition of the structures
* Correct diagnosis crucially important in devising the process & techniques for carrying out the scheme of rehabilitation - high degree of expertise in implementation

6.5 Structures for New Construction

6.5.1 Type of structures

On appraisal of the various forms of structure, the following structure types have been selected for adoption within the physical limits indicated:

Type of structure	Length of structure along road C/L
* Concealed R.C. box culvert	1.0 to 4.5 m & one 2x4.5m
* R.C. box culvert	1.0 to 6.0 m or multiple max. 4 vents
* R.C. T-beam & slab deck supported on R.C. abutments & wingwalls	15 m single span
* PSC girders & R.C. slab deck supported on R.C. abutments & wingwalls	20 to 45 m or multiple (Single span or with intermediate piers)

6.5.2 Criteria of selection

* Hydraulic parameters
* Foundation parameters
* Physical parameters
* Materials of construction
* Construction methods

6.5.2.1 Hydraulic parameters

* More reliance of structure's past performance in assessing their hydraulic design parameters
* Where existing structures inadequate, the opening suitably increased on the basis of hydraulic analysis
* In certain areas, the hydrology of the region has since changed due to implementation of the flood control/ irrigation/ drainage projects:
  - Due to this, the waterway widths of some structures have been found to be greater than the present requirements;
    - Relevant structures have been proposed to be either closed down or replaced by a structure of significantly less vantage determined from analytical assessment of the new drainage basin

6.5.2.2 Foundation parameters

* Permissible bearing capacity at the foundation level is low = 5 to 10 t/sq.m.
  - R.C.C. box structure
* For span greater than 10 m pile/well foundation adopted
* No bridge foundation on open excavation:
  - Loose soil for top few meters
  - Future scouring effect in the channel bed

6.5.2.3 Physical parameters

* Height of the approach embankment
* Uniformity in bed level of the waterway
* Magnitude of the waterway
* Period for which waterway keeps dry
* Obstacles - like discarded foundations of structures being replace
* Box culverts - suitable and economical where following physical parameters are satisfied:

Embankment height is between 2.5 to 5.5 m
Bed is of uniform level
The waterway keeps dry for reasonable periods in a year

* Bridges preferred over box culvert where a structure is required to span a waterway having a gorge.

6.5.2.4 Materials of construction

* Brick masonry
* Reinforced concrete
* Prestressed concrete - most bridges of prestressed concrete deck
  P.C. simply supported girder bridges - economical for span ranging from 30 to 50 m for reasonable good foundation conditions
* Brick masonry arch culverts

6.5.2.5 Construction methods

* Conventional construction methods
  In situ reinforced concrete construction for sub-structures
* For 4-lane bridge on Dhaka-Daudkandi road 2 bridges of 2 lanes each side by side which will eliminate the necessity of costly diversion bride on each site
* Piers and abutments are designed on cast-in-situ bored piles
* Minimum distance between first and second phase bridge foundation piles: = 2 m (3 times the proposed pile dia)
  So no difficulty in driving the board piles by usual pile driving equipment
  Precaution taken in retaining earth behind the abutments by sheet piling in between two foundations until 2nd phase bridge is completed
* New bridges located on the old bridge locations, staggered position of abutments and piers are proposed for new bridges, so that old and new foundations do not interfere - old bridge foundation dismantled for clearance of channel bed
* Length of new bride has adequate provision for waterway not to interfere in the channel flow due to double set of piers during 1st phase construction

6.6 Design Standards

6.6.1 Loading

* Live load: AASHTO HS20-44 loading + impact + traction forces
* Seismic forces: Zone II in seismic zoning map of Bangladesh
* Wind load: Per wind speed map of Bangladesh
* Others: Stipulations of AASHTO
* Combination of forces: Stipulations of AASHTO

6.6.2 Roadway width over structures

* Structure with total length equal or less than 10 m: Full roadway width adopted
  = 12.2 m for new structures decided by RHD
  = 12.2 to 7.2 m for existing structures retained
* Structures with total length over 10 m
  2-lane: 7.5 m carriageway & 1.25 m sidewalk on each side of deck
  4-lane: 7.5 m carriageway on each side with 1 m median and 1.25 m sidewalk on each side of bridge deck

* Reduced pavement width
  2-lane: 6.7 m

6.6.3 Vertical clearance

* Navigation clearance: Minimum 7.6 m (25 ft) under a new bridge across National waterways as stipulated by Bangladesh Inland Water Transport Authority (BIWTA) - not applicable in present case
* Others: Minimum vertical clearance of 1 m above HFL with a return period of 50 years where no navigational vertical clearance is necessary

6.7 Design of Various Structures & Elements

6.7.1 R.C.C. box structures

* Opening: 1 to 6 m
* Continuous box structure: Maximum of 4 vents
* Concrete: Grade C25
* Reinforcement: High yield deformed bars
* Economy: 5 to 7% in using above concrete and reinforcement

6.7.2 R.C. T beam and slab

* Span: 15 m
* Concrete: Grade C25
* Reinforcement: High yield deformed bars

6.7.3 Abutments and piers

6.7.3.1 Abutments

* Designed for retaining full earth
* Spill-through type abutments avoided in view of the possible danger of erosion and lack of maintenance
* Buried abutments with earth-cone in front have been devised where active earth pressure becomes excessive
* R. C. abutments proposed - suitably designed inverted filter layers placed against the inner faces of the abutments have been recommended - the fill behind the abutments shall be selected granular material
* All bridge structures provided with U-Type wing walls at both upstream & downstream

6.7.3.2 Piers

* Twin columns, circular in shape with pier cap
* R.C. structures for piers

6.7.3.3 Foundations

* Piled foundations for bridges over streams where the expected scouring effect is not significant
* Bridges over rivers where scouring is anticipated, brick masonry well foundations may be adopted

6.7.4 Pedestrian/ traffic railing & parapets

* Category A: R.C.C.
  Designed as combined traffic & pedestrian railing to withstand the specified load of 10 Kips applied at a height of 1.2 m
* Category B: R.C.C. parapets
  Used for single span box culverts
* Category C: For use in rehabilitated constricted two-lane bridge decks, with hand railings provided on top of crash barriers

6.7.5 Erosion control

* Brick flat pitching
* Sodding
* Adequate erosion control measures with brick filled gabions where erosion of banks prominent.

7. ENVIRONMENT

Short-term construction impacts

* Short-term construction phase impacts include disturbance of river sediments in the vicinity of reconstructed bridges and culverts, suspension of sediments in water column and potential disruption of aquatic communities
* Construction phase activities require:
  Temporary occupation of land for construction offices and camps
  Construction material excavation
  Brick manufacturing
  Material stockyards
  Construction material handling
  Movement of construction vehicles and machinery
  These operations would result in the short-term destruction of vegetation, disturbance of soils, and increase in noise levels, air pollutants emitted from vehicles and machinery, and dust - local and short lived
* Short-term impacts on public health may result from water supply and sanitation practices particularly at construction camps - diseases
* Long-term implications of construction phase activities
  Excavation of borrow materials and brick manufacturing
  Employment opportunities during project construction depend on:
  Construction methods
  Construction material requirements
  Borrow area and brick yield locations
  Construction scheduling

Long-term impacts

* High flood periods: Mid-August to Mid-October
* Drainage pattern and flooding is significantly affected by man-made structures, in particular communication infrastructure
* Existing railway and road embankments detain and impound flood waters
* The height of the embankments and the design characteristics and condition of associated drainage structures determine the effects of the structures on flood elevations
* The proposed roadway improvements, bridge and culvert reconstruction are being designed

to maintain the existing drainage patterns and minimize impacts to the timing, frequency, and duration of flood events

* Traffic volumes:
  These are expected to increase on the project roadways over the next several decades
  The projected traffic increases, and the resulting, long-term increases in noise and air pollution levels in the vicinity of the project, therefore are not evaluated as impacts of the proposed action.
* Long-term, permanent impacts of the proposed action would comprise the removal of existing trees from the right-of-ways of the project roadways, the involuntary resettlement of households and the displacement of agricultural and fishery resources.

8. References

No.	Name of Reference	Year	Issued
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3	Road Map of Bangladesh		Roads and Highways Department
4	Report and Recommendation on a Proposed Loan and TA for the Jamuna Bridge Access Roads Project	1996	Asian Development Bank
5	A Short Note on Jamuna Multipurpose Bridge	1994	Jamuna Multipurpose Bridge Authority
6	Salient Features of Jamuna Multipurpose Bridge Project	1996	Jamuna Multipurpose Bridge Authority (Hyundai)
7	Second Buriganga Bridge Construction Project		Roads and Highways Department (Bangladesh Consultants)
8	Draft Document on RHD Fifth Five Year Plan (1997/98-2001/02)	1997	Roads and Highways Department
9	Schedule of Rates for Road/Bridge Works	1994	Roads and Highways Department
10	The Customs Act, 1969 (Act No. IV of 1969)	1995	Alimuzzaman Choudhury
11	Bangladesh Customs Tariff	1995	National Board of Revenue, Ministry of Finance

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