CHAPTER 5. BASIC DESIGN

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5.1 Design Principles

The considerations made in developing the basic design are as summarized below;

(1) Careful examination of the proposed schemes and methods of execution in respect of project time and costs implications,

(2) Practicability of the construction schemes within the project context where construction activities on riverbeds can take place only during dry seasons,

(3) Bearing soils in the project areas are deep underground, between 400 and 650 m below surface level. Through bore-hole investigations by the JICA mission, it has been confirmed that the top layer of soils within several 10 meters depth is very poor in bearing strength. This implies that the use of friction piles will need to be considered. It also means that light weight structures should be selected when designing the superstructures so as to avoid unnecessarily heavy foundations,

(4) The importance of seismic resistance in the bridge structures since Nepal is in a seismic zone,

(5) Due attention is paid to the importance of maintenance cost savings in public works design in Nepal, particularly in the selection of bridge types. Where steel structures are involved, the use of corrosion-resistant steel is recommended, and

(6) Due attention is also paid to the necessity of maximizing the use of local manpower in selecting bridge types, methods of construction, and temporary works systems, with an aim to contributing to the activation of local economic activities and practical technological transfer to local parties of interest through project implementation.

Based on the above principles, the basic designs have been developed with the following policies;

(1) To limit the numbers of piers in the riverbed areas as much as possible, in order to minimize the quantity of activities required on riverbeds,

(2) To minimize the height of abutments, as eccentric earth pressures against an abutment, which is the potential cause of deformation during earthquakes, develops in proportion to its height,

(3) To select the lightest bridge types in the design of superstructures and so minimize loads acting upon their respective foundations, and

(4) To design the superstructures in the form of simple girder bridges which can be subject to level adjustment should differential settlement develop in the bridge foundations.

Shankamul and Bagmati Bridges are located at the foot of the Himalaya Mountains, which are called the roof of the world. These bridges across the largest river in the Kathmandu valley linking Patan city and Kathmandu city. Kathmandu city is known all over the world as one of the oldest and most historical sight seeing city. Some old temples are built in the neighborhood of the proposed bridge sites with a history peculiar to the region. In addition, the proposed bridges sites are provided with a

promenade made of stone terrace and stone steps leading to the water's edge. This particular spot is for rest and recreation for the regional residents and at the same time, has been used for religious events since olden times.

Because of this, these bridges are used not only by a large number of local pedestrian but are also sighted by many other people. As described heretofore, it is important to pay attention to the spicular sight of these bridges and their harmony with the surrounding scenery in the preparation of the detail designs.

5.2 Determination of Design Conditions

5.2.1 Design Standards

Design standards adopted for the bridges in this project, as agreed by the Department of Roads (DOR) of GON, are as follows:

(1) Bridge Width

a) Nepal Road Standards (2027)
HMG, MOWT, DOR, 2045 (NRS)

b) Japanese Standards (JS)

(2) Design Live Load

a) Japanese Standards (JS)

b) The American Association of State Highways and Transportation Officials (AASHTO)

(3) Seismic Load

- National Building Code of India, 1970
- Japanese Earthquake Specifications

(4) Others

Where no applicable standard exists in respect of bridge structures and other related design, the relevant Japanese Standards will be used.

Design loads have been classified into principal loads, secondary loads, and special loads, in accordance with their frequency of occurrence and the likely effects of their impact on bridge structures.

a) Principal Loads

Loads taken into account in designing the primary structure of the bridge.

1) Dead Load
2) Live Load
3) Impact Load
4) Influence from creeping of concrete
5) Influence from drying shrinkage of concrete
6) Earth pressure
7) Water pressure
8) Buoyancy or uplift

b) Secondary Loads

Loads taken into account in combination with principal loads.

1) Wind loads
2) Influence of changes in temperature
3) Seismic loads

c) Special Loads

Load taken into account under special conditions.

1) Influence of ground deformation

2) Influence of displacement of support

3) Braking loads

4) Temporary loads during construction

5) Collision loads

6) Others

d) Dead Load

Dead load consists of the weight of the bridge itself and appurtenant objects permanently attached to it (such as water mains, gas pipes, etc).

Table 5.2.1 Unit weights of materials by volume

(in kg/m3)

Material	unit weight	Material	unit weight
- Steel, Cast Steel, Forged Steel	7,850	- Plain Concrete	2,350
- Cast Iron	7,250	- Cement Mortar	2,150
- Aluminium	2,800	- Asphalt Concrete Pavement	2,300
- Reinforced Concrete	2,500	- Concrete Pavement	2,350
- Prestressed Concrete	2,500	- Timber	800

e) Live Loads

Live Loads include vehicular loading (T-loads, and L-loads) and crowd loading on the sidewalks.

(For the design of a bridge slab with floor system)

- Carriageways

Live loads on carriageways are assumed to consist of T-loads. In principle, one bridge is assumed to be loaded with one vehicle in the longitudinal axis, at the point of maximum stress in the member, and with unlimited number of vehicles in the transverse axis.

Table 5.2.2 T-Load

-	Design Load		T-20
-	Total Load	W	20 (t)
-	Front wheel load	0.1 W	2,000(kg)
-	Rear wheel load	0.4 W	8,000(kg)
-	Front wheel-track width	b2	12.5(cm)
-	Rear wheel-track width	b2	50(cm)
-	Wheel tread length	a	20(cm)

- Sidewalks etc

Loading on sidewalks is assumed to be a uniform load of 500 kg/m2.

(For the design of main girders)

- Carriageways

Live loads on carriageways are assumed to consist of one L-load on each bridge, which is the sum of a linear load and a uniform load. Distribution of the L-load is assumed to be that which incurs the most unfavorable stress at any point of any structural member under consideration, with a linear load "P" and a uniform load "p" distributed within a width of 5.5 m, and 1/2 of both, distributed beyond this width.

The design live load adopted herein is basically an application of the Japanese specification TL-20. This is further subject to examination in the light of HS20-44(AASHTO) as required in the Nepalese specification: "Nepal Road Standards (2027), First Revision-2045, His Majesty's Government, Ministry of Works and Transport, Department of Roads, 2045."

5.2.2 Selection of Bridge Types

(1) Conceivable Bridge Types

Bridge types which can be considered for application within the context of the project specific, natural background situations, implementation, environment, and construction schemes (bridge width, length, construction period, etc) are listed as follows.

a) Reinforced concrete T girder bridge (RC-T)

b) Prestressed concrete T girder bridge (PC-T)

c) Steel plate girder bridge (ST-Gr-I)

d) Steel box girder bridge (ST-Gr-B)

e) Steel truss bridge (ST-Truss)

RC-T girder bridge has the advantage of easy material procurement as most concreting materials are available locally. But it has the intrinsic problems of (1) difficulty in guaranteeing the attainment of adequate strength concrete, and (2) having a very heavy superstructure which imposes great reaction forces on the supports. Besides, there is a limit to the maximum length it can span (about 10 to 15 m).

PC-T bridge is not recommendable for this project, as it is difficult to guarantee the achievement of necessary strength (ck = 350 kg/cm2 or greater) in the concrete under local specific conditions.

ST-Gr-1 Steel plate girder bridge requires the use of imported bridge girders, but it has the advantages of a shorter time requirement for erection and a smaller dead load of the superstructure compared to concrete bridge types.

ST-Gr B Steel box girder bridge and ST-Truss bridge are applicable to greater spans (50 to 70 m) than other bridge types. They are more costly to build due to greater consumption of steel. Also, since they feature in having a smaller number of piers, they involve greater reaction forces at individual supports and thus require heavier substructures.

Selection of Suitable bridge types for this project are based on considerations of such advantages and disadvantages in the light of their respective contextual requirements.

(2) Alternative Bridge Schemes

Alternative bridge schemes identified for comparative evaluation with specified bridge types and span divisions, are as listed in Table 5.2.3 below.

Table 5.2.3 Alternative Bridge Schemes

Code	Bridge Name	Altern.	Bridge Type	Span Division
No. 12	Bagmati	a.	St-Gr-I	3@43.3
	(130 m)	b.	St-Gr-I	4@32.5
		c.	St-Gr-I	5@26.0
		d.	St-Gr-I	6@21.6
No. 13	Kodku Khola	a.	St-Gr-I	22.0
	(22 m)	b.	PC-T	22.0
No. 22	Mahadev Khola	a.	St-Gr-I	30.0
	(30 m)	b.	PC-T	30.0
No. 23	Shankamul	a.	St-Gr-I	3@32.0+19.0
	(115 m)	b.	St-Gr-I	5@23.0
		c.	St-Gr-I	6@16.0+19.0

(3) Basic Conditions of Bridge Type Selection

a) Seismic Resistance

The Kathmandu Valley falls within Seismic Zone V, which is defined as an area subject to the risk of strong earthquakes, according to the Indian Building Code. It is also obvious, based on past records of earthquakes in this country, that seismic resistant features are prerequisite points of consideration in selecting the bridge type for this project.

b) Ground Conditions

As all bridge sites in this project locate in areas of very weak subsoil, it is necessary to reduce the number of bridge piers in order to reduce the amount of works on it, and to select the lightest possible type of superstructure to minimize loads upon

the bridge foundations.

c) River conditions

Riverbeds in the project areas have been rapidly growing deeper during recent years. To avoid the risk of damage by scouring, all bridge piers located in a river bed area need to be properly protected.

d) Construction period

During the monsoon from June to October in Nepal, heavy rainfall prevails, and all rivers in the project areas are flooded. No construction activity can take place on the riverbeds during this period. For this reason, it is necessary to design the bridge works in such a way as to limit time required for working on the riverbeds within that available during dry seasons.

Also, where imported equipment and materials are involved, it is necessary to take into account the possible delay of their delivery. During the wet season, road blockages along the access routes from the international sea ports (specifically national highway route 1 which connects Kathumandu city with the Indian border) can occur.

e) Maintenance Requirements

Budgetary resources and the institutional setting of GON are generally inadequate for the maintenance of roads and bridges. In consideration of this, it is necessary that maintenance cost saving be taken into serious consideration in selecting the project bridge schemes.

f) Project Costs

Cost savings, including that in construction and in future maintenance, is a major determining factor in selecting the bridge schemes. As the shortening of the construction time requirement has a bearing on project costs, it is also given priority consideration.

(4) Selection of Superstructure Construction Scheme

a) Bagmati Bridge (Code No. 12) which is 130 m in total length, is the longest among the four bridges of this project. Its construction involves execution of foundation and superstructure works on the riverbed. A Steel plate girder bridge is therefore selected for its construction because of the short construction time requirement, light dead loads on the foundations, and favorable seismic resistant features.

Of the four alternatives identified for comparison in Table 5.2.3, even though the larger-span Alternatives "a" and "b" appear to be economically more desirable due to the smaller numbers of piers involved, the smaller-span Alternatives "c" and "d" are found to be better choices for the following reasons:

- Total costs of the smaller-span Alternatives "c" and "d" are actually lower than the larger-span Alternatives "a" and "b",
- The larger-span alternatives require a greater height of the main girder and thus reduce the clearance below the bridge girders which is needed for safe accommodation of flood flow during wet seasons.

Between alternatives "c" and "d" identified in table 5.2.3, alternative "c" which has a smaller number of piers on the riverbed (5 x 26 m = 130 m) is selected as the recommended scheme.

b) Kodku Khola Bridge (Code No.13) is only 22 m long. As it is not desirable to put a pier in the middle of the stream at this location, the bridge is proposed to be constructed with one single span. In view of the subsoil condition which is very weak here, it is proposed that its superstructure should be a steel plate girder bridge, which is light weight and therefore structurally advantageous for the bridge abutments and foundations, is seismic resistant, and also best suited for the construction of a bridge 22 m span length.

c) Mahadev Khola Bridge (Code No. 22) is 30 m in total length. It locates at a rapid section of the river where installation of a bridge pier in the channel is not desirable. No such pier exists at present. The new bridge is therefore proposed to be a single span structure with no intermediate support. As the subsoil is soft here, it is proposed to use a steel plate girder bridge for the reasons of light loads on the bridge abutments and foundations, favorable seismic resistant performance, and suitability for a bridge of 30 m span.

d) Shankamul Bridge (Code No. 23) is 115 m long in total. It involves construction of substructures and erection of superstructures on the riverbed. In this case, a steel plate girder bridge is proposed for its superstructure, it is fast to erect, light, and performs well against earthquakes.

In determining the span division, it is necessary to pay attention to the locations of the incomplete bridge piers which exist along the project bridge. These piers belong to the previously suspended bridge with its foundations completed. To prepare for any possibility of future revival of the suspended project, it is proposed that the new bridge piers be constructed immediately adjacent to the existing ones. This will minimize the disturbance to water flow by the bridge piers if both bridges are completed.

Of the three alternatives identified in Table 5.2.3, "a" and "c" satisfy the above considerations. From the point of general balance of the narrow bridge structure, which is only 2.5 m wide, Alternative "c" with 6 x 16.0 m + 19 m = 115 m span divisions (as against 7 x 16 m = 112 m in the case of the existing piers) is recommended as the better choice.

Figure 5.2.1 : Proposed Spans Division

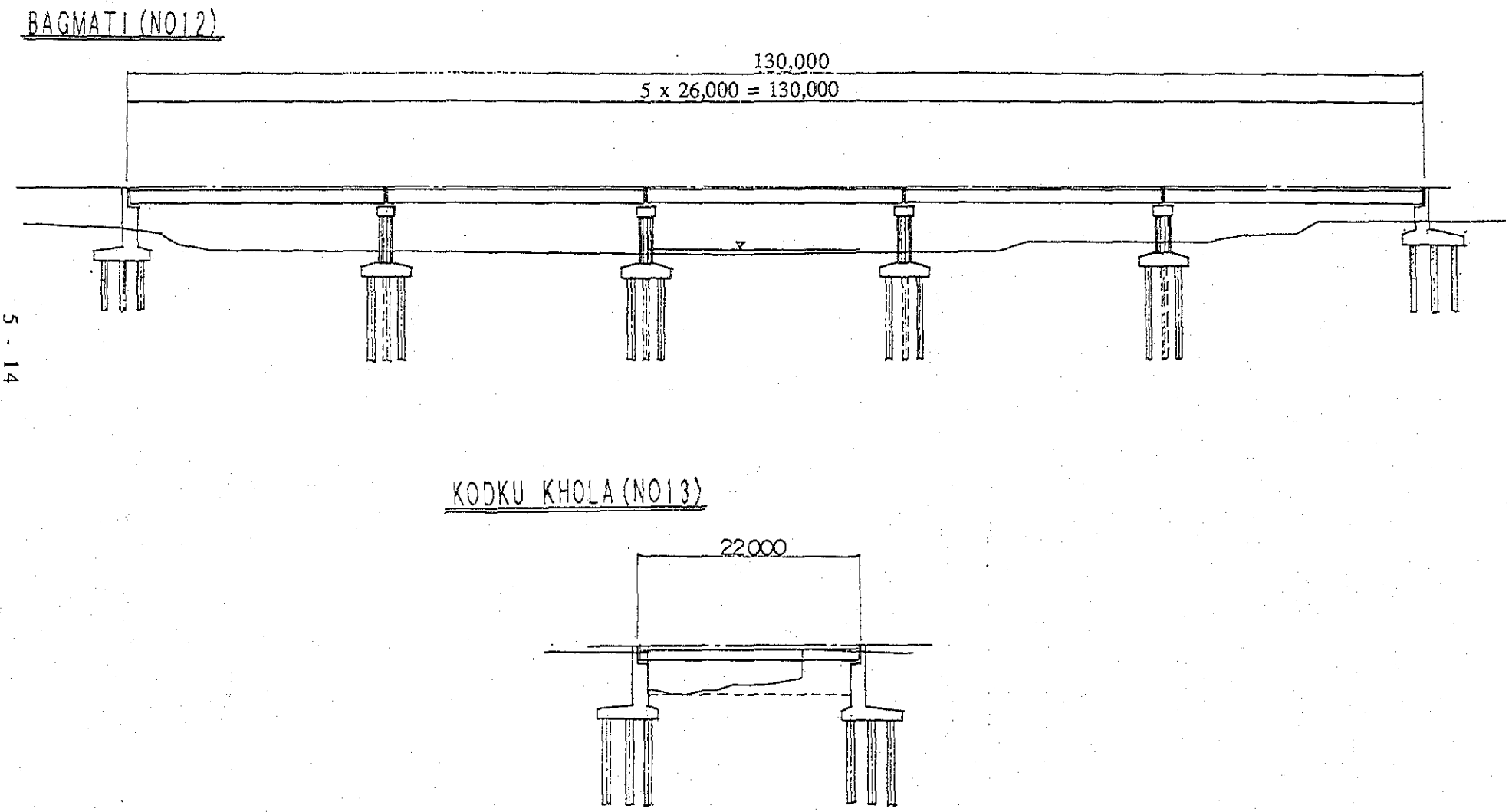
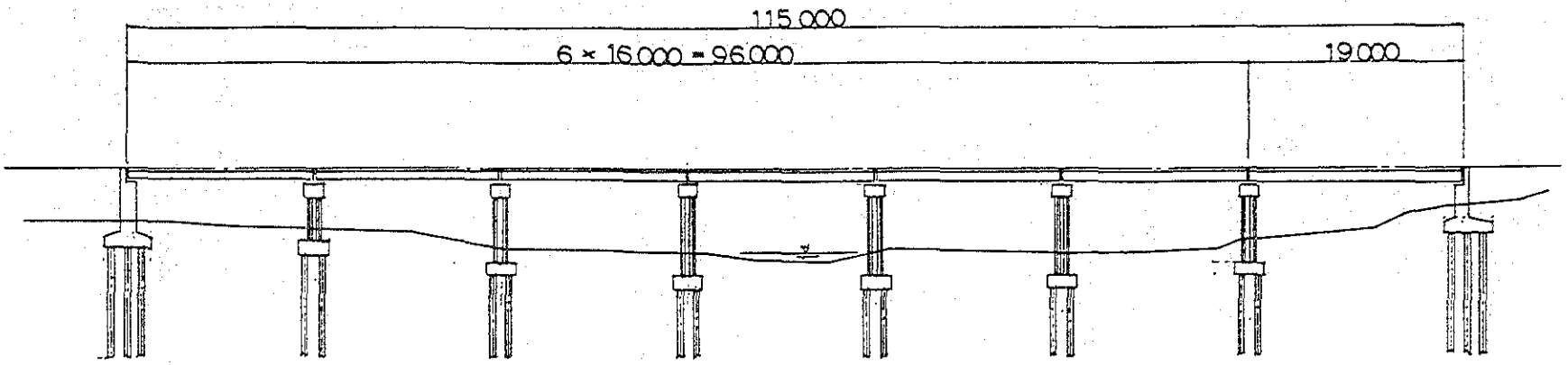
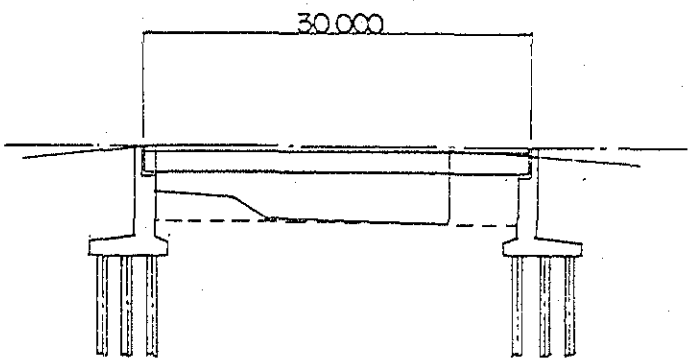


Figure 5.2.2 : Proposed Spans Division

SHANKAMUL NO.23



MAHADEV KHOLA (No.22)



5.3 Basic Design

The Basic designs for the project bridges are developed in accordance with the planning conditions, bridge types, and design standards discussed in the previous sections, and based on a careful study of the construction materials and superstructure design requirements.

In selecting steel materials for the superstructures, the need of corrosion resistance, to render the structure maintenance-free, is given due consideration.

In determining the design of the superstructures, alternative concepts including simple non-composite steel plate girder bridge (S.N.C.-ST-Gr-I), simple composite steel plate girder bridge (S.C.-ST-Gr-I), and simple composite steel H-beam girder bridge (S.C.-ST-Gr-H) are compared.

In determining the substructure design, various alternatives including RC slab pier, cantilever pier, rigid frame pier are studied and compared.

For the design of the pier foundations, steel pipe piles, cast in-place piles, and precast concrete piles are studied and compared, and selected accordingly.

5.3.1 Superstructures

To select the most suitable type of the alternatives identified above, a comparative study is made based on the model case of Bagmati Bridge. As this bridge has a typical span length of 26 m which is roughly common to all the project bridges, its structural evaluations are deemed applicable to all the other cases. Comparison of the three alternative superstructure design concepts are as summarized below.

Altern. concept	Girder Height	Cost Ratio	Ease of Work
S.N.C.-ST-Gr-I	1400 mm (1.00)	1.05	Normal
S.C.-ST-Gr-I	1300 mm (0.92)	1.00	Less easy
S.C.-ST-Gr-H	912 mm (0.65)	1.33	Less easy

All bridges in this project are meant to replace existing ones at the respective sites. It is therefore desirable that the design bridge surface levels be adjusted to that of their existing approach roads. A common feature of the new project bridges is that their girders require greater depths than the original ones to comply with their design standards, thus reducing the vertical clearance under the bridges. This seems to contradict common practice in reconstruction of bridges as efforts would normally be made to maintain, if not to increase such clearance, to secure extra allowance for safe accommodation of flood flows below. Within the project specific contexts however, river valleys are deepening under the process of erosion and riverbeds are progressively becoming lower in elevation at all bridge sites. The effects of increases in girder depths are therefore not a subject of concern. In such a case, the simple composite steel plate girder structure is the most suitable type to construct because of its economic advantages.

Based on the above considerations, a simple composite steel plate girder bridge structure is proposed for Bagmati Bridge (No.12), Kodku Khola Bridge (No.13), and Mahadev Khola Bridge (No.22).

Shankamul Bridge (No. 23) belongs to a completely different category of bridge from the others. Being far shorter, only 16 m in total length, and being meant for exclusive use of pedestrians, it involves a different system

of live loads to be coped with. In this case, an H-beam girder bridge is considered most suitable from the economic point of view. Hence, the "simple composite steel H-beam bridge type" is selected for its construction.

Bridge maintenance is institutionally inadequate in Nepal. Steel bridges should be maintenance-free with the use of corrosion resistant materials which do not require periodic repainting. The corrosion resistant steel is a special type of structural steel having suitable contents of phosphorous and chrome which together form a very fine and stable layer of rust on its surface. This fine layer of rust serves as film to isolate the inner material from the atmosphere as in the case of a paint, thus preventing it from further rusting. Due to such mechanism, its life span can be prolonged without painting.

Although the use of corrosion resistant steel implies higher initial cost due to higher material price, it would be cheaper in the long term with maintenance costs taken into account. In total cost, a corrosion resistant bridge can become cheaper after 10 years of service compared to one of common steel, with the latter subject to periodic repainting.

5.3.2 Design of Bridge Piers

The design of bridge piers is based on considerations of balance between reaction forces sustained from the superstructure and the pier foundation system. Subjects of consideration in selecting the type of piers to be designed include directions and magnitudes of reaction forces sustained from the superstructure, compatibility with the forms of the superstructure, flowing direction of the river, seismic design requirements, and location and embedment depth of the footing.

Three alternative types of piers are identified for selection. They are; slab

type, rigid frame type, and cantilevered cylindrical column type. Table 5.3.1 is a summary of their comparison based on relative evaluations by structural characteristics, ease of construction, hydraulic performance against water flow, aesthetic qualities, and cost.

Among the four project bridges, two involve piers in the riverbed. These are: Bagmati Bridge and Shankamul Bridge. Bagmati Bridge locates at a curve section of the river where the water flow direction is complicated. Cylindrical column piers which are omnidirectional are therefore proposed for this bridge. For Shankamul Bridge which locates at a straight river section, the use of slab piers is recommended.

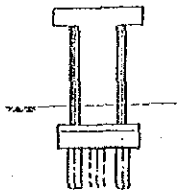
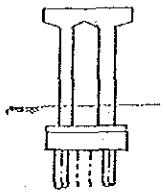
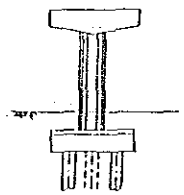
5.3.3 Design of Foundations

The selection of foundation types is made in accordance with specific site ground conditions, with ease of work and equipment availability taken into consideration. In this project, precast pile foundations (PC piles, steel pipe piles) and cast-in-place pile foundations are considered.

- The use of RC piles has the advantages of easy materials procurement and effective technological transfer. It also has the disadvantages of; difficulty in pile driving particularly where long piles are involved, and being a source of nuisance to the neighborhood, by generating vibration and noise during construction.

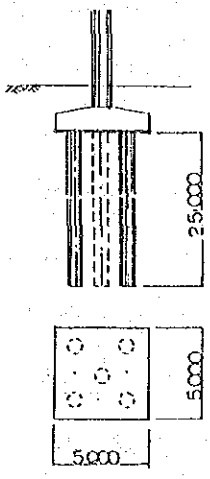
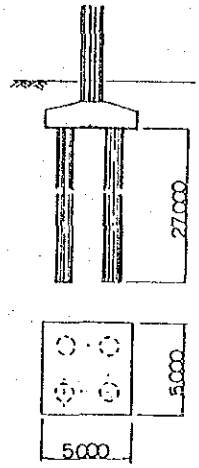
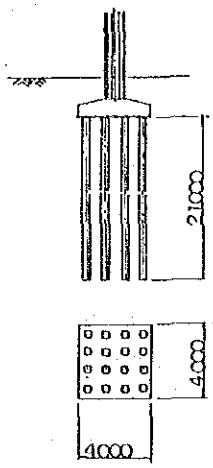
  (It should be noted that, while 14 m was the maximum length of concrete piles used in phase 1, much longer piles of over 20 m would be required for this project, i.e. Phase 2, in which bridge sites generally involve weaker subsoils and deeper bearing strata.)
- The use of cast-in-place piles is desirable in urban areas from an environmental point of view, for the low levels of noise and vibration

Table 5.3.1 Comparison of Alternative Pier Types

Pier type		Structural Characteristics	Ease of execution	Hydraulic performance (Water flow obstruction)	Aesthetic quality	Cost ratio	Overall evaluation
Slab type		- Is the most common type. Ends of the slab in the horizontal section is normally round-shaped if constructed in waterbed. - Good in seismic resistant performance o	- Needs round shaped forms and timbering Δ	- No specific problem - Does not suit curved river section o	o	1.00	o
Rigid frame type		- Used for tall piers where light-weight is a requirement - The lower the structure, the greater stress would be sustained from temperature change X	- Needs timbering - Involves dense reinforcement and demands proper concrete quality control Δ	- Tends to catch driftwood and obstruct water flow X	X	1.05	Δ
Cantilevered cylindrical column type		- Only the pier top is enlarged to bear the supports - Smaller column section can provide larger space for other use Δ	- Needs timbering Δ	- Suits curved section of river but interferes with water flow more than slab piers o	Δ	1.10	Δ

o Good Δ Fair X Poor

Table 5.3.2 Comparison of Alternative Types of Piles

	Steel pipe pile	cast-in-situ pile	R C pile
Standard form			
Structural characteristics	Pile size is confined to D776mm, the diameter of a medium size steel pipe. Is the best balanced shape ○	Min. pile size: D1000 mm Min. number of piles determines the footing design ○	Easy to adjust to requirements of loads due to small pile size △
Ease of work	Being lighter and easier to handle than concrete, and not as easily damaged ○	Handling of spoil and mud water is a problem △	Time consuming depending on method of driving partly due to the large number normally involved Generates noise and vibration X
cost ratio	1.00 ○	1.10 △	1.15 X
Overall evaluation	○	△	X

○ Good △ Fair X Poor

generated during construction. Its disadvantages are; difficulty in treatment of spoil and mud water and higher cost and longer construction period compared to steel pipe piles.

- Steel pipes are versatile piling materials, being usable both as bearing piles and as friction piles. They have the advantages of having great sectional rigidity, being highly resistant against bending moments and hence also against horizontal forces, being light weight compared to concrete piles and therefore easier to handle, and are less prone to damage. By driving with vibrohammers, which feature low noise and vibration, they can be of far better environmental performance than driving concrete piles with diesel hammers. Besides, steel piles can be fabricated in-situ by using steel plates transported to the work sites, thus rendering them more economic than concrete piles.

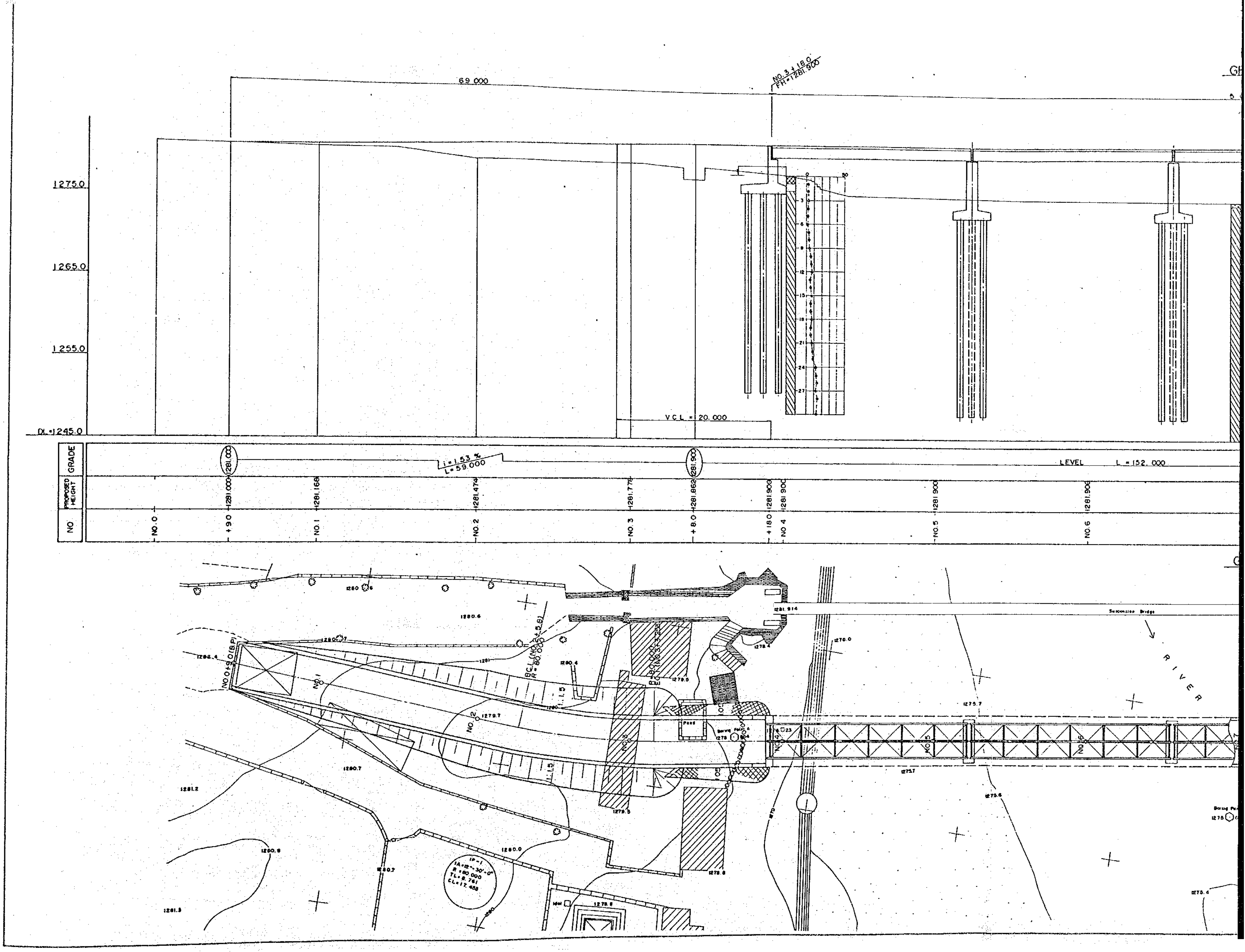
  Based on the above considerations, it is recommended that steel pipe piles should be used in this project.

5.4 Basic Design Plans

Outline concepts of the basic designs are developed to such detail as required to provide for gross quantity and cost estimations. These include mainly General Plans (scale = 1:200 in principle) and structural drawings, supplemented with schematic illustrations as required for cost estimation.

5.5 Outline of Design Quantities

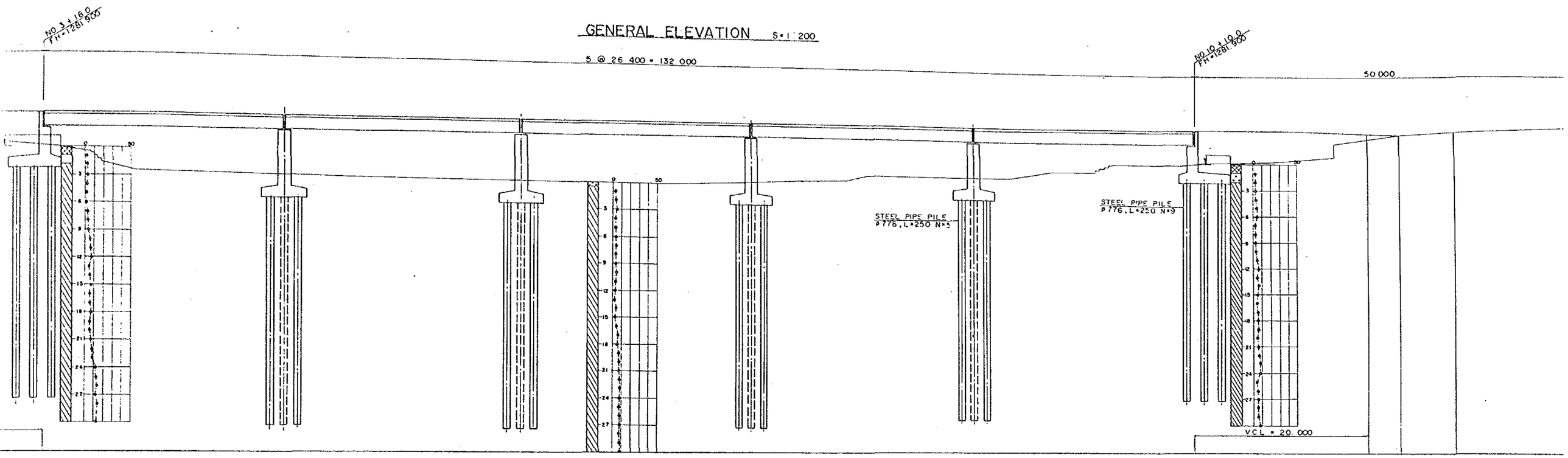
Design quantities are taken from the basic design plans to provide data basis for cost estimation. The Following is a summary of such quantities.



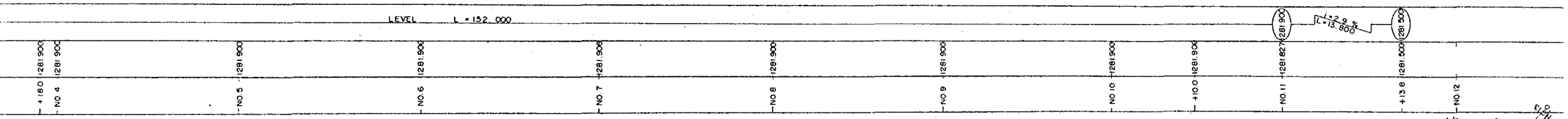
69.000
NO.3 + 18.0'
FH = 1281.900
1275.0
1265.0
1255.0
DL = 1245.0
VCL = 20.000
GRADE
PROPOSED HEIGHT
NO
1281.000
i = 1.53 %
L = 59.000
1281.900
LEVEL L = 152.000
1281.000
1281.166
1281.474
1281.779
1281.862
1281.900
1281.900
1281.900
1281.900
NO.0
+90
NO.1
NO.2
NO.3
+8.0
+18.0
NO.4
NO.5
NO.6
1280.6
1281.914
Suspension Bridge
RIVER
1279.7
1280.7
1281.2
1280.0
1281.3
1278.8

523

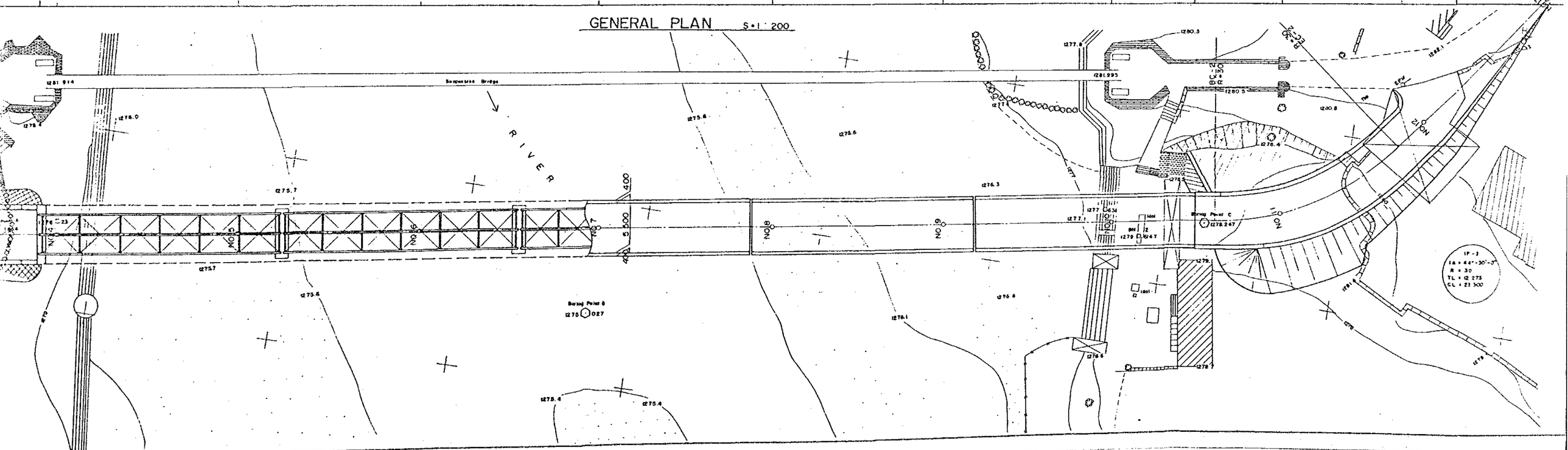
GENERAL ELEVATION S=1:200



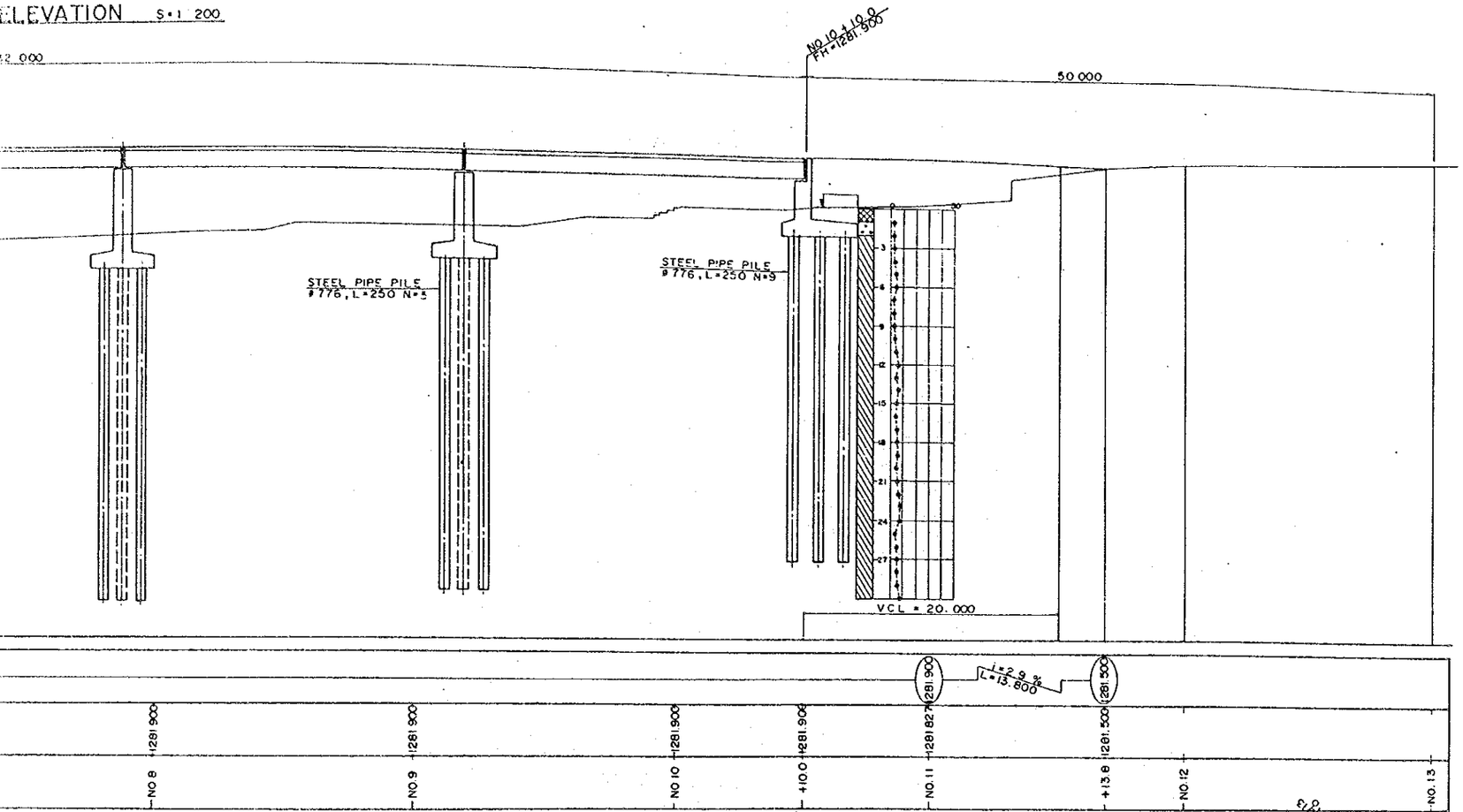
LEVEL L = 152.000



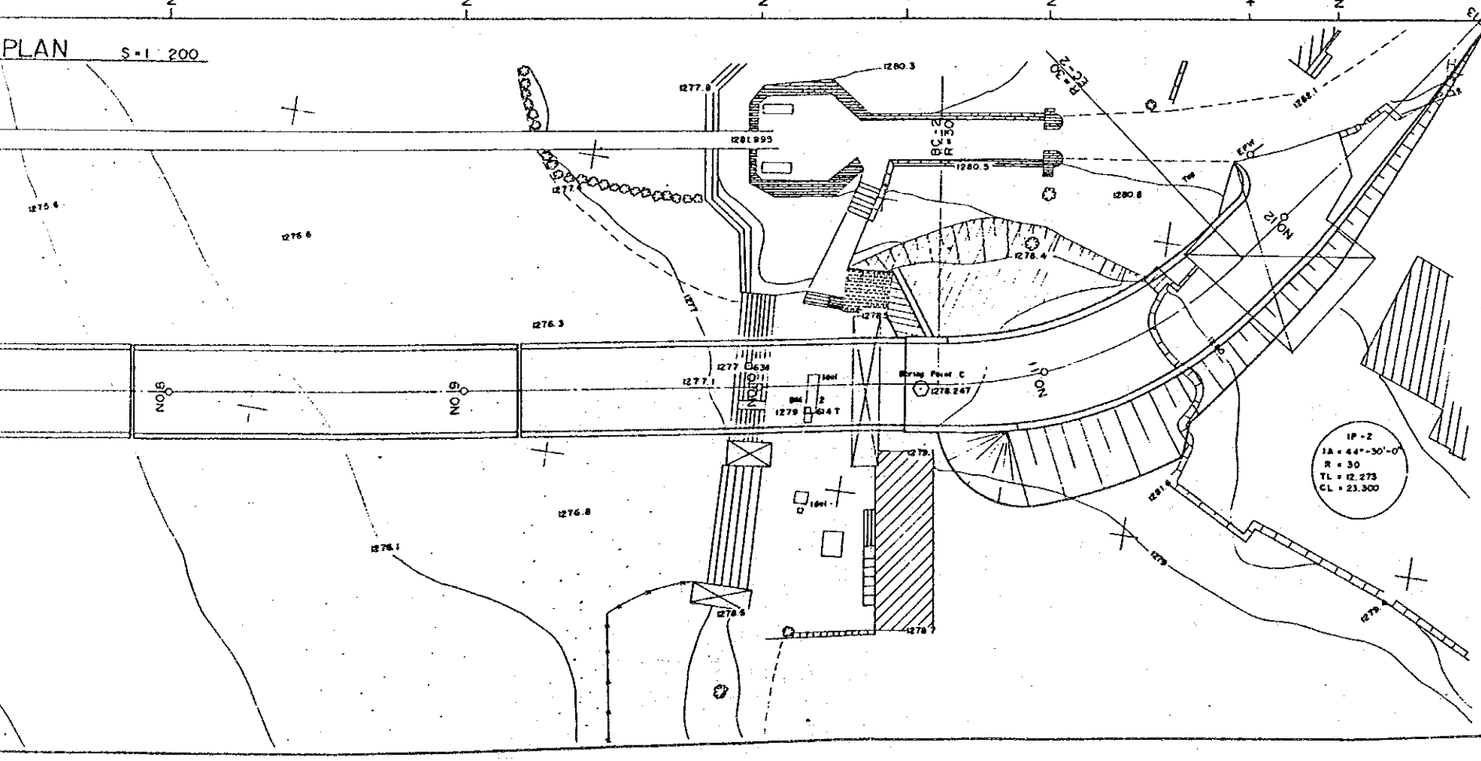
GENERAL PLAN S=1:200



ELEVATION S=1 200



PLAN S=1 200



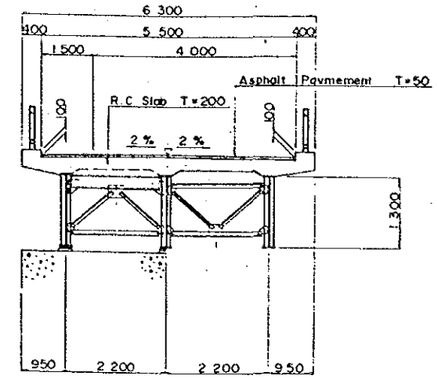
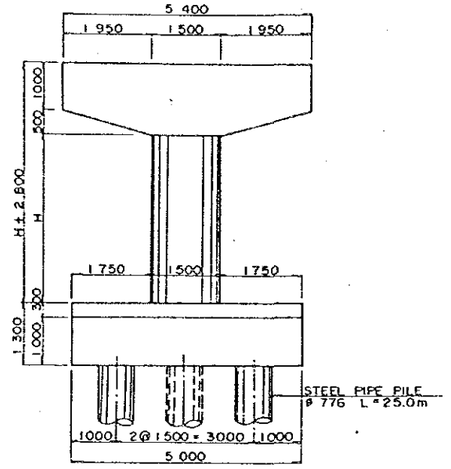
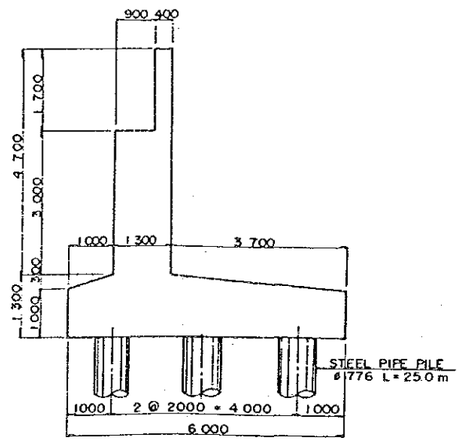


PLATE GIRDER S=1:60



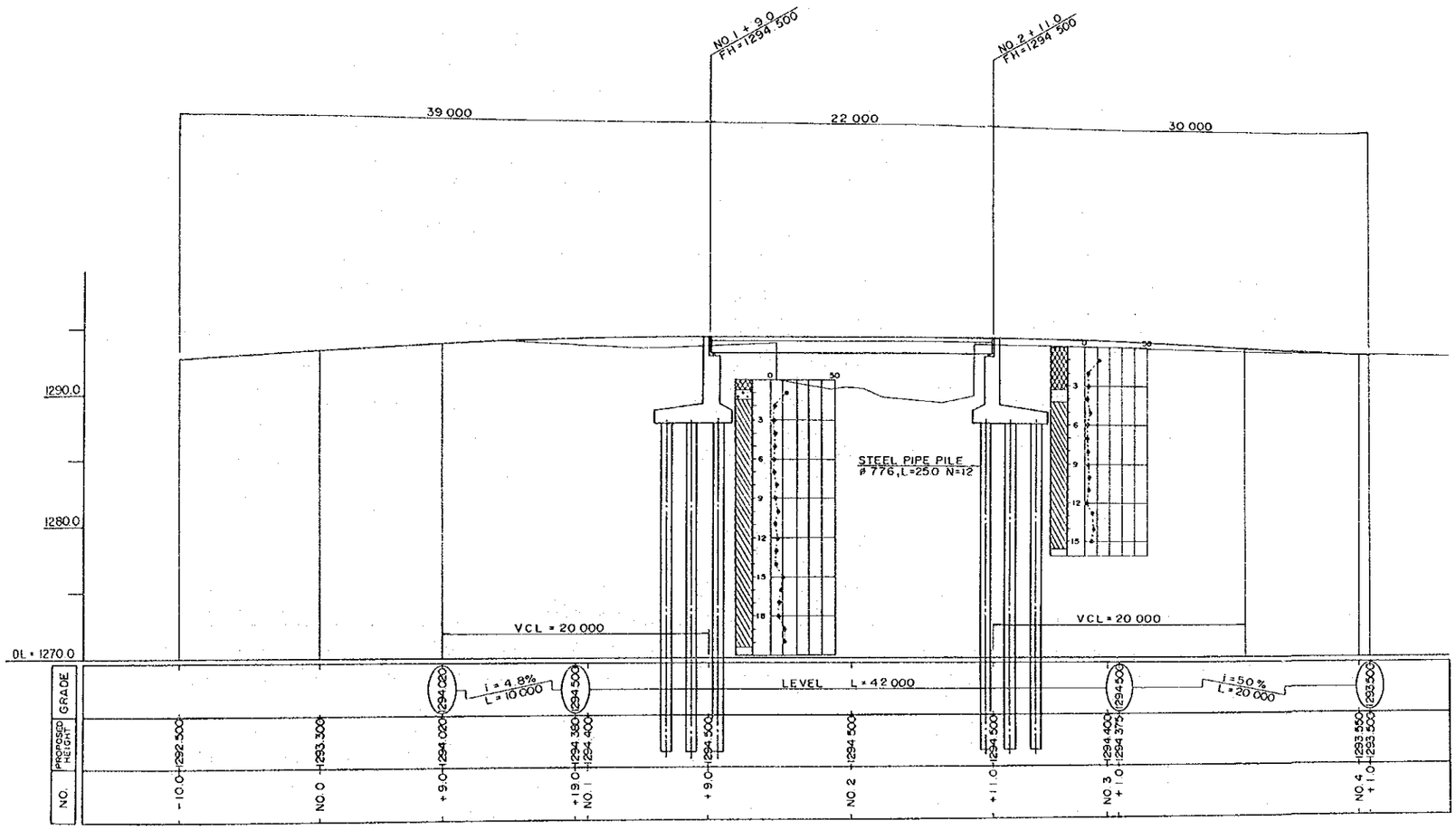
PIER S=1:60



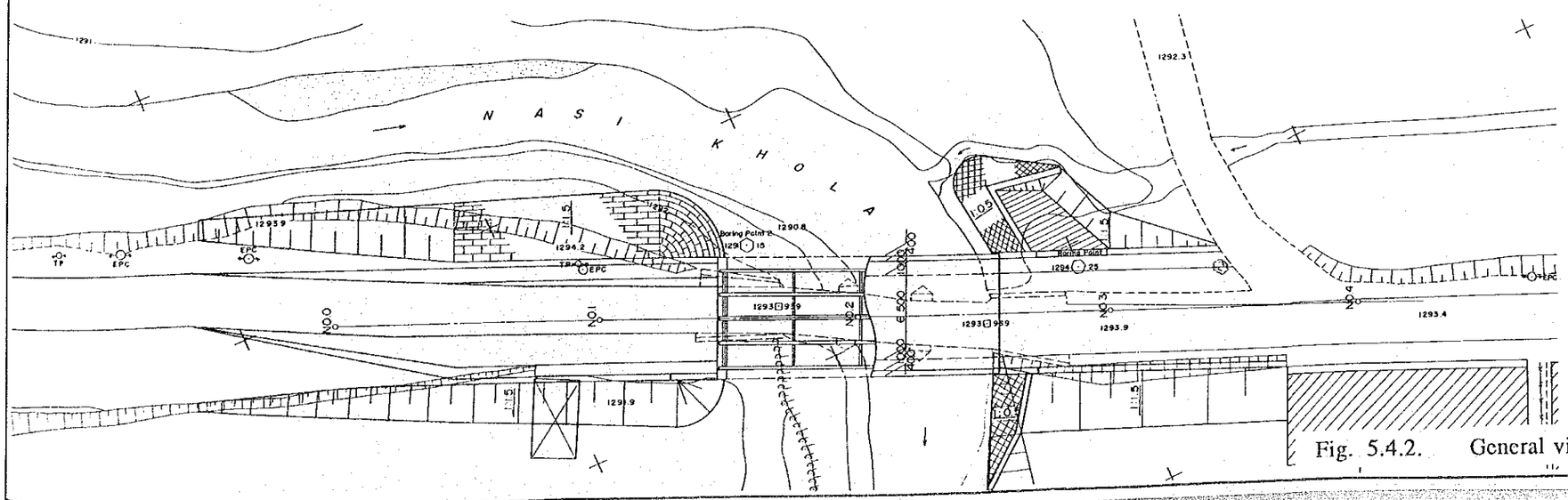
ABUTMENT S=1:60

Fig. 5.4.1. General view of NO. 12 BAGMATI Br.

GENERAL ELEVATION S=1:200



GENERAL PLAN S=1:200



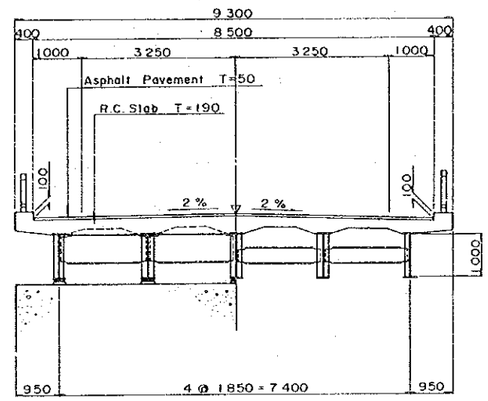
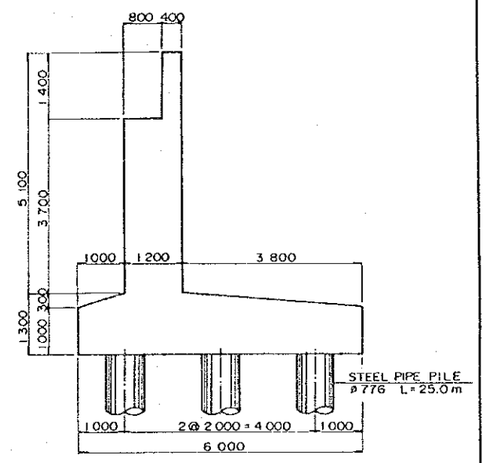


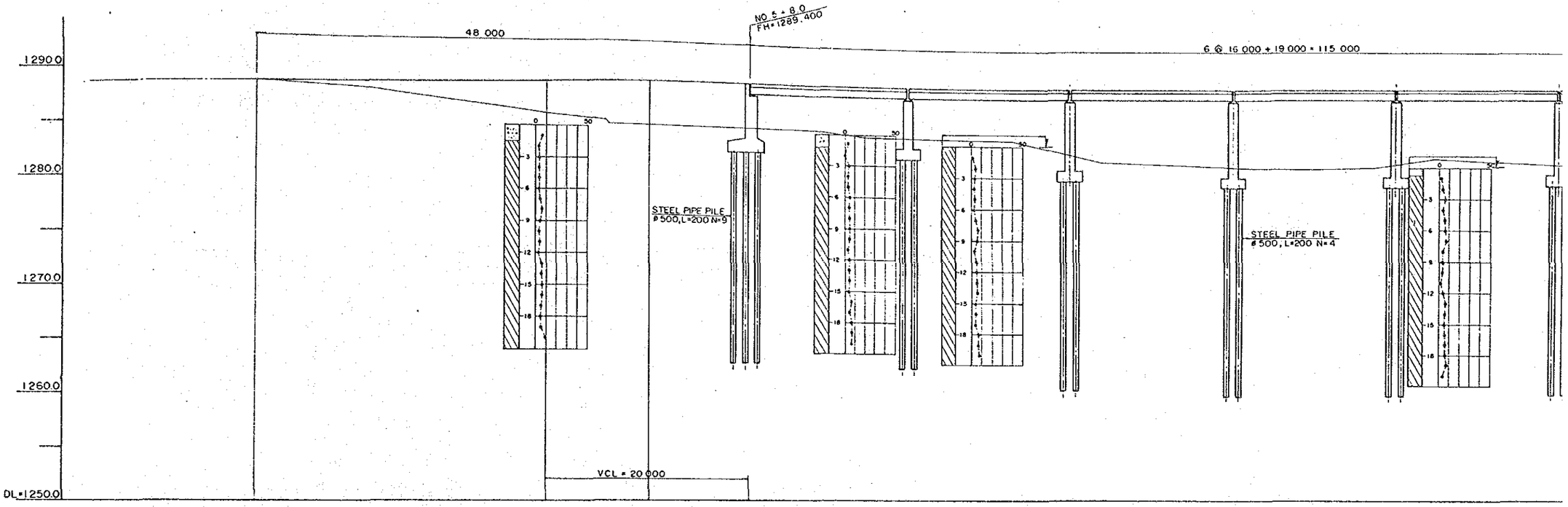
PLATE GIRDER S=1:60



ABUTMENT S=1:60

Fig. 5.4.2. General view of NO. 13 KODKU KHOLA Br.

GENERAL ELEVATION S = 1:200

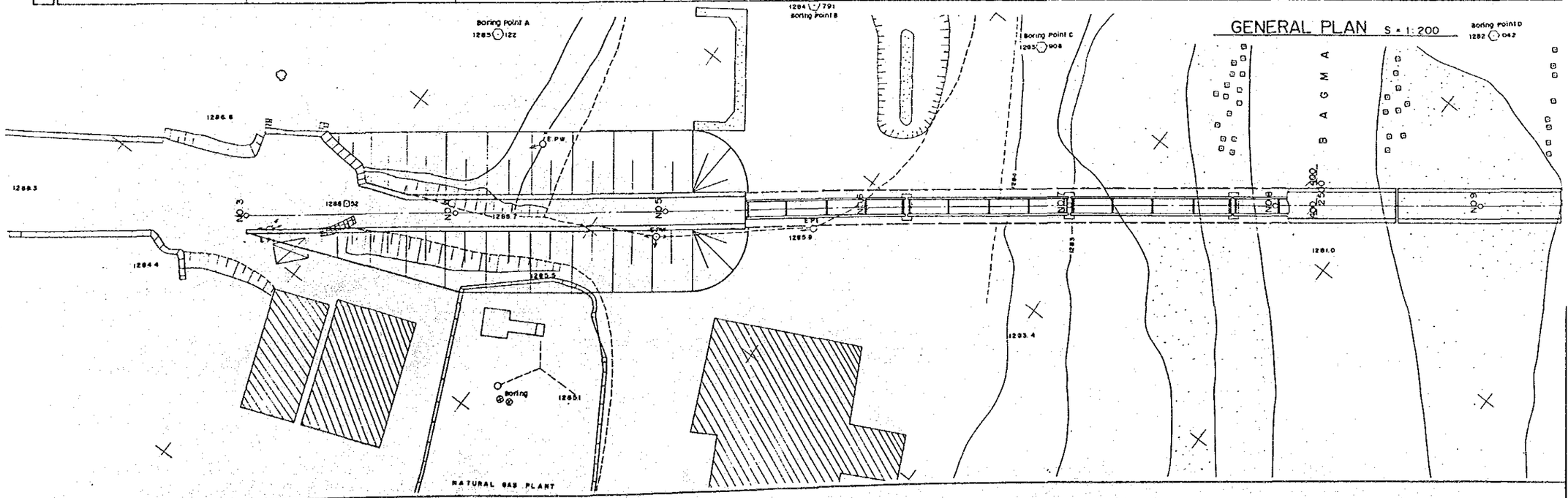


NO		NO. 3	NO 4	+ 16.0	NO. 5	+ 8.0	NO. 6	NO. 7	NO. 8	NO 9
PROPOSED HEIGHT		1289.910	1289.168	1289.368	1289.353	1289.400	1289.400	1289.400	1289.400	1289.400
GRADE		(289.910)		(289.400)						

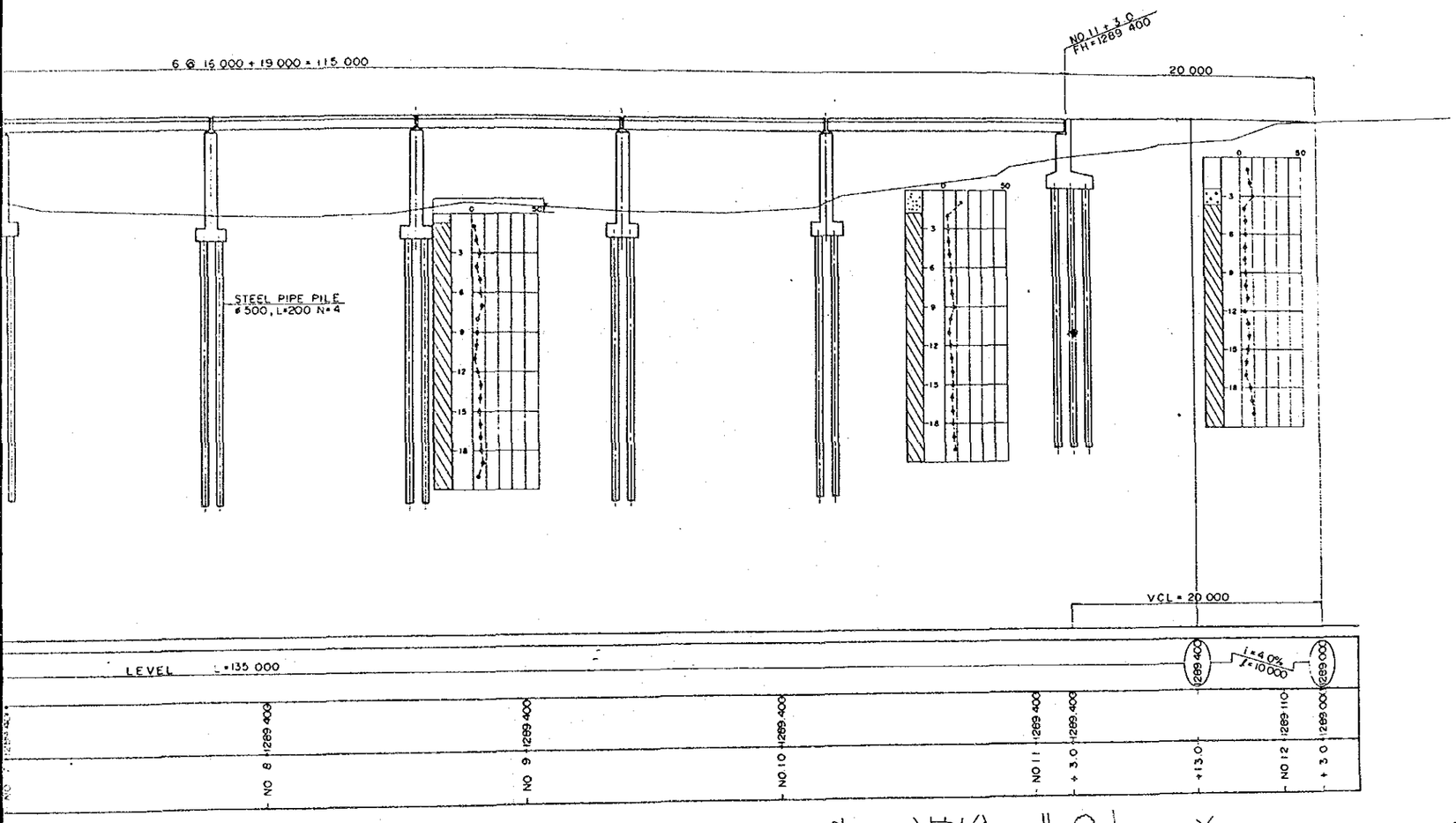
i = 1.29% / = 36.000

LEVEL = 135.000

GENERAL PLAN S = 1:200



GENERAL ELEVATION S = 1:200



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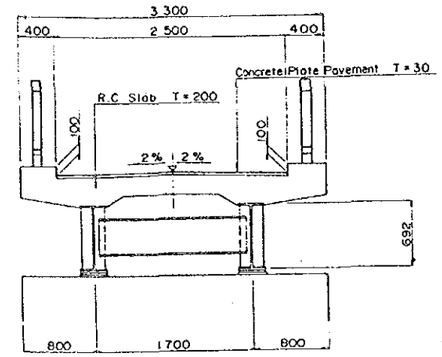

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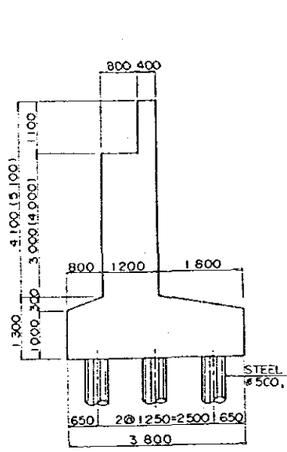
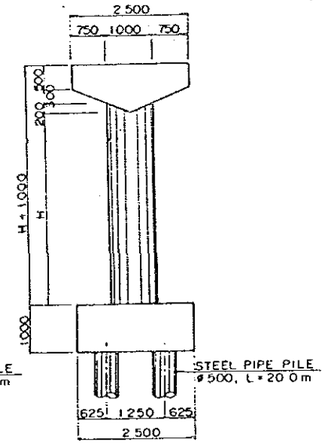


PIER S = 1:60



GENERAL PLAN S = 1:200

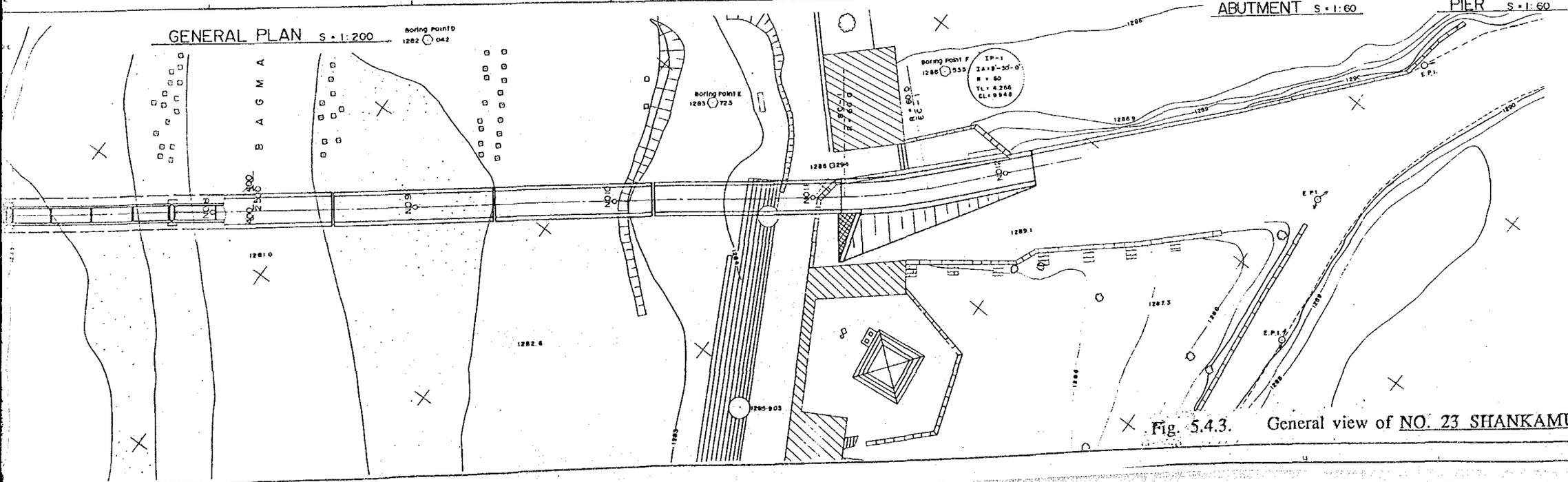
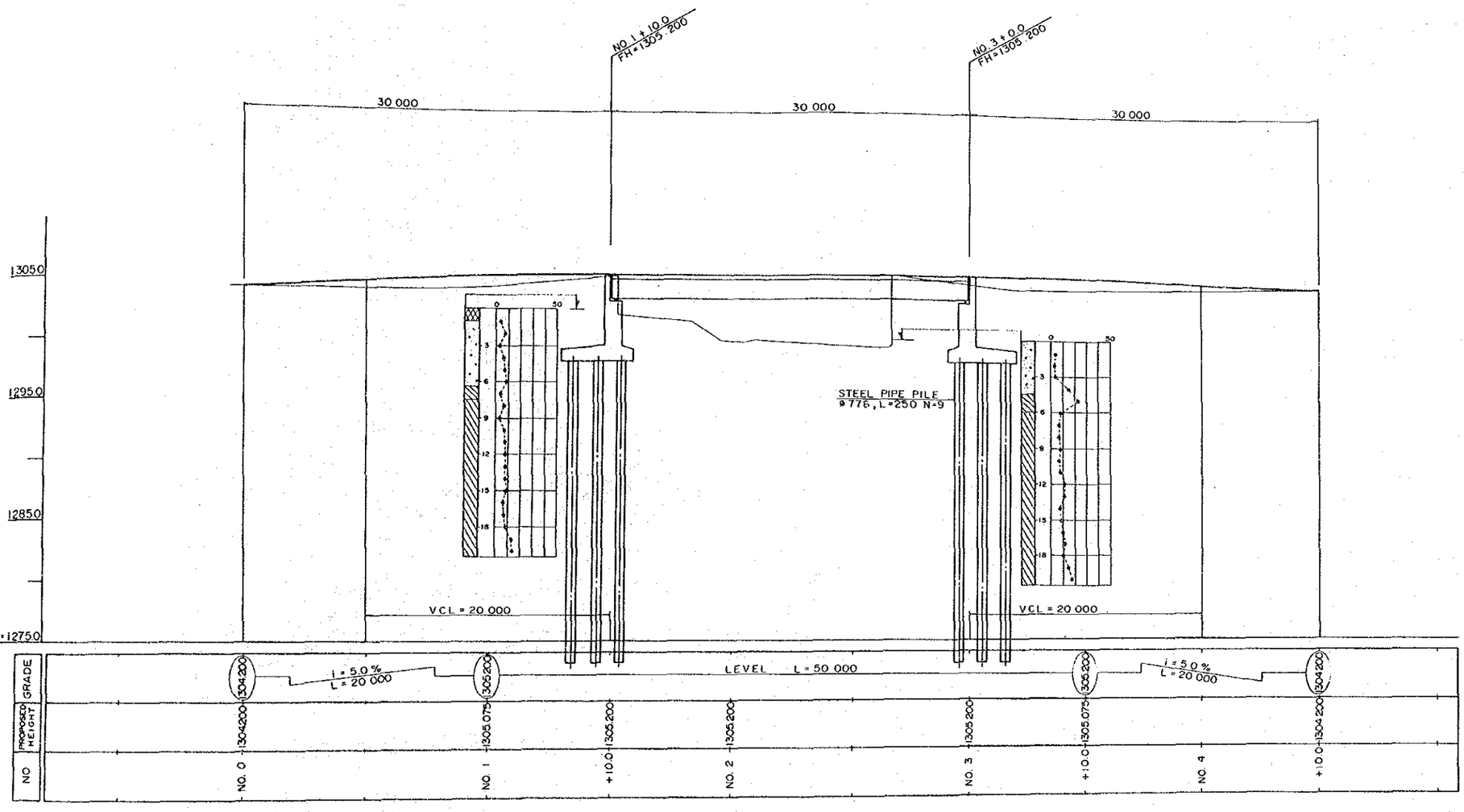


Fig. 5.4.3. General view of NO. 23 SHANKAMUL Br.

GENERAL ELEVETION S=1:200



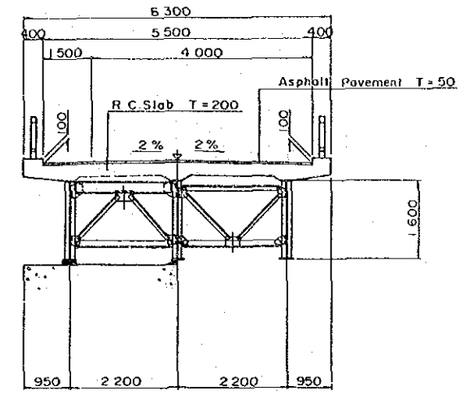
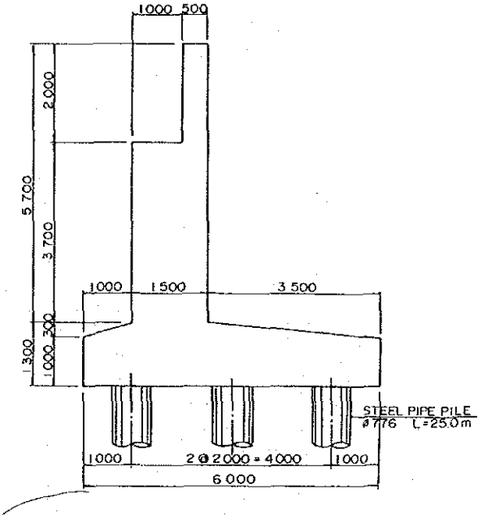


PLATE GIRDER S=1:60



ABUTMENT S=1:60

GENERAL PLAN S=1:200

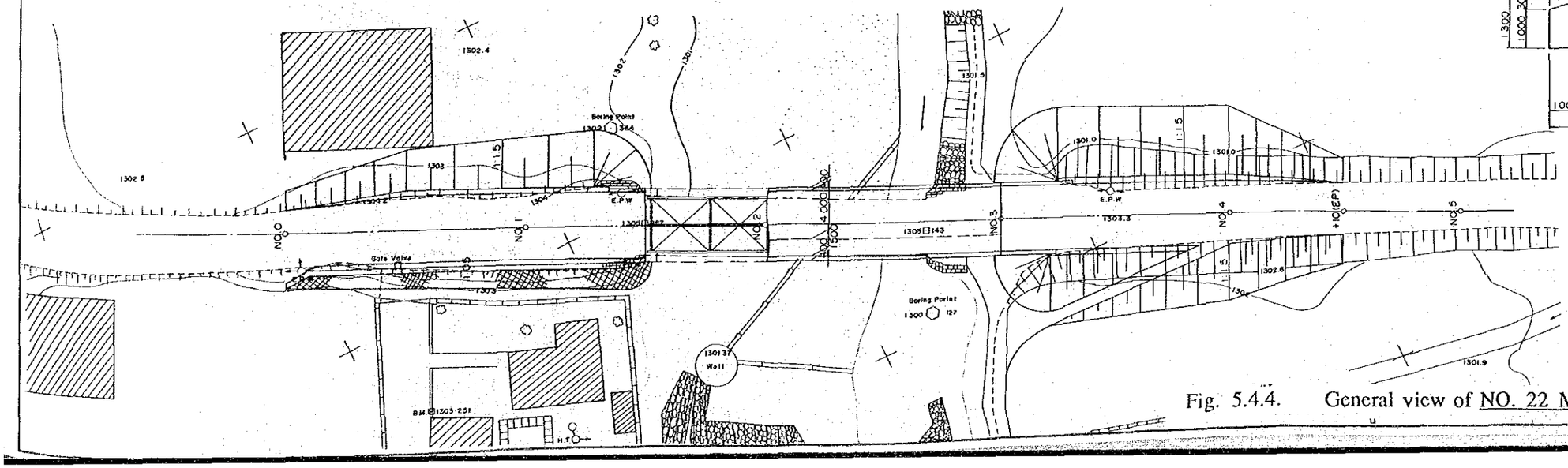
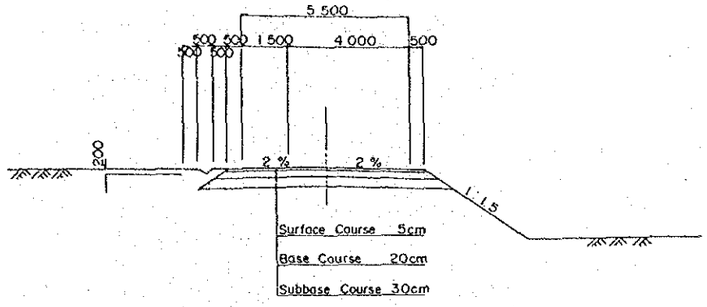


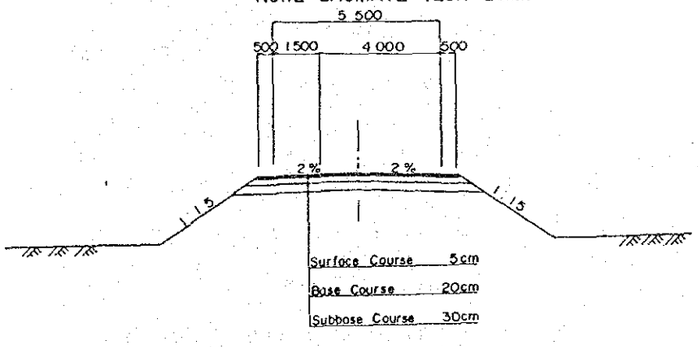
Fig. 5.4.4. General view of NO. 22 MAHADEV KHOLA Br. 5 - 26

TYPICAL CROSS SECTIONS S=1:100

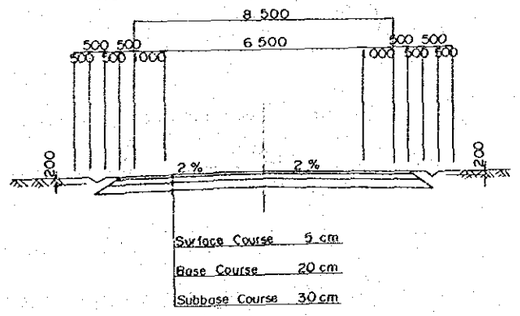
NO.12 BAGMTE (Right Bank)



NO.12 BAGMATE (Left Bank)



NO.13 KODKU KHODA (Right Bank)



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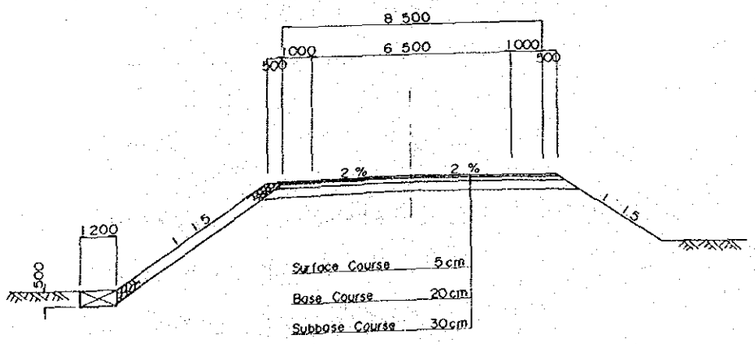
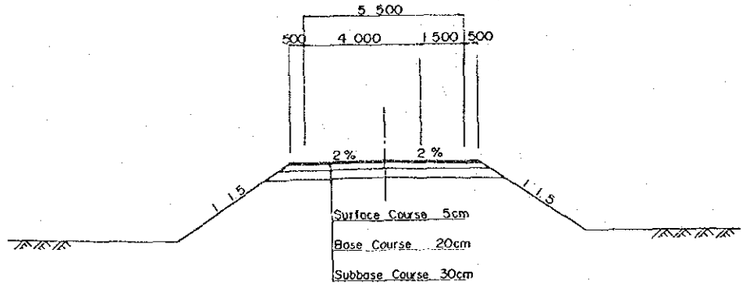
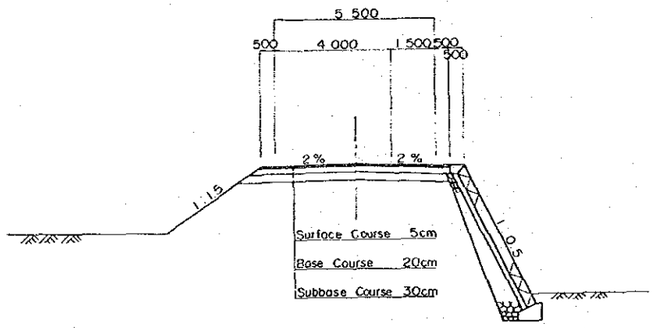


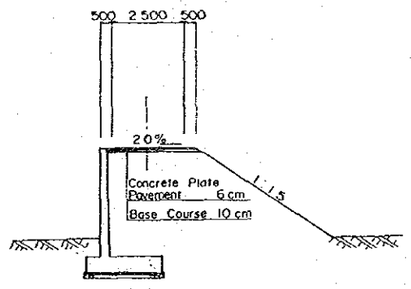
NO.22 MAHADEV (Right Bank)



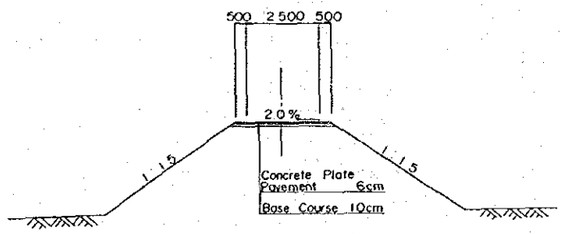
NO.22 MAHADEV (Left Bank)



NO.23 SHNKAMAL (Right Bank)



NO.23 SHNKAMAL (Left Bank)



- Bridge surface area : 1,365.5 m^2
- Number of abutments : 8 Nos
- Number of piers : 10 Nos
- Total quantity of steel : 217.6 ton
- Total quantity of concrete : 1,657 m^3
- Total quantity of reinforcement : 181.5 ton
- Total quantity of steel piles : 2,840 m

5.6 Implementation Plan

5.6.1 Construction Policy

Among the four bridges of the Project, the existing Bagmati and Shankamul bridges play a very important role as pedestrian crossings linking Kathmandu and Patan cities, and these bridges cross over the Bagmati River which is the widest river in the Kathmandu valley. The number of pedestrians utilizing these two bridges are about 4,000 - 5,000 persons in a day.

The Kodku Khola Bridge is utilized by 1,500 cars in a day, and it is also important for vehicular traffic among the other three bridges.

Although the Mahadev Khola Bridge is located in suburban area, it is utilized by 5,000 pedestrians and 5,000 bicycles in a day.

It is necessary to consider the present conditions mentioned above to establish the construction plan for each bridge.

(1) Bagmati Bridge

The traffic volume of motorcycles, bicycles and pedestrians, except cars is very heavy, therefore it is necessary to ensure the safety of passengers during the construction period. The traffic control

persons should be at the site, all day, during the construction period of the approach road and for mobilization of heavy equipment to the site.

Near the approach road on the Kathmandu side, there is a depot of the DOR for construction equipment. The traffic control in the area should be managed in cooperation with the DOR.

There is a small private religious facility nearby the abutment of the new bridge on the Patan side. The superstructure is required to cross over this facility. As this facility is likely to be always in use, it is necessary to take some measures to ensure safety, by protecting it as well as the people who visit there, from falling materials whilst the construction of the superstructure is in progress.

At the time of construction of the substructures and the temporary erection of the superstructure girders for the river bed, care should be exercised of flood waters during the rainy season. Construction activities in the four months form June to September should be avoided as far as practicable.

(2) Kodku Khola Bridge

This bridge, which is required to be replaced, has the largest vehicular traffic volume of the four bridges. The traffic comprises a mixture motor cycles, private cars, buses, trucks, bicycles, and pedestrians, particularly the traffic volume of buses and trucks shows as many as 1,550 units per day. With respect to a temporary bridge to be provided when the construction of this project bridge is underway, it would be necessary to set up some guide signs and to furnish station competent flagmen to control the traffic. The temporary bridge itself should be large enough to accommodate the dense traffic. It will also

be necessary to provide some simple illumination facilities to the temporary bridge, in view of the dense traffic early in the morning and at night. The temporary bridge on the detour should be provided with an adequate running water cross-section, taking into due consideration the running water volume at the time of flood.

(3) Shankamul Bridge

Although pedestrians only are using the existing bridge, their route to the existing approach road and the existing bridge will intersect with the new project bridge. Because of this, it will be necessary to secure a separate pedestrian route so as to avoid the construction area. Particularly, it would be necessary to secure this route, at the Patan city side, by means of borrowing a piece of land temporarily from a private land-owner. At the time of the construction of substructures and of superstructures on the river bed, care shall be exercised of flood water during the rainy season. The construction activities in the four months from June to September should be avoided as far as practicable.

(4) Mahadev Khola Bridge

As the bridge is used by a large number of pedestrians and cars, and a school is located on the left bank of the downstream river, due consideration should be paid to ensure safety whilst the construction work is in progress.

Since the existing approach road is narrow at the bridge construction site, it is difficult to secure a storage space for construction equipment. Therefore enough space for equipment should be prepared prior to construction, and traffic guardmen should be

provided whilst the work is in progress. It is also necessary to pay due consideration to possible vibration and noise which might take place, in connection with the construction work, for the surrounding area, especially the school. It would be necessary to refrain from construction activities at sometime in the morning, as circumstances warrant. The construction schedule should be prepared so as to have spare time to cope with such unexpected events.

As a general principle, the local labour forces will be utilised to the maximum possible extent, nonetheless, a consideration will also be paid to the use of some heavy construction equipment in order to shorten the construction period. To meet this requirement, some Japanese mechanical operators will be assigned immediately upon the delivery of the equipment and some local technicians will be employed as assistants to the operators.

With reference to steel pipe piles, it is understood that local fabricators can be made available and it is advantageous to do so in view of the costs. Because of this, the steel materials only will be imported from Japan and they will be fabricated in Kathmandu City. As a large quantity of the steel pipe pile is produced at one time, a Japanese engineer will be assigned in the first month for the purpose of quality control.

In addition, a Japanese engineer will be despatched to the site to be in charge of the welding inspection during processing.

5.6.2 Situation of Construction and Considerations for Construction Activities

(1) Situations of Construction

a) Construction Equipment

Heavy construction equipment, except trucks and pick-up cars can not be procured in Nepal. Most of the construction projects in the Kingdom of Nepal are based on aid rendered by the international organizations and no contractor has his own construction equipment.

Rehabilitation and maintenance works of roads and highways in Nepal are implemented by DOR directly. DOR has its own heavy construction equipment such as cranes, trailers, crawler cranes, diesel hammers, etc. due to aid rendered by foreign countries. It is difficult to use this equipment for this project, as the DOR has its own construction schedule and cannot afford to provide them.

b) Materials Locally Available

Cement:

"Hetauda Cement" is the only national cement company, and its production quantity amounts to 260 thousand tons annually. It is said that this corresponds to about 30% of the nationwide consumption, therefore, the material needs to be secured as planned for the project. In this respect, it will be necessary to seek the cooperation of the DOR in advance. The quality and strength of the cement are not generally good. Reportedly, more than $350kg/m^3$ of cement would be needed to acquire the strength of $210kg/cm^2$, nevertheless, this quality is deemed

adequate for the construction of abutments and/or bridge piers.

Reinforcing bar:

Reinforcing bar is produced from iron ingot imported, an electric furnace is used in the production. Depending on the schedule of imported ingot, the amount of bars in the market can sometimes become scarce.

c) Labour

The labour working time, in general, is set at 7 hours from 10:00 a.m to 17:00 p.m. However, at construction sites where it is necessary for the work to be performed within a limited period of time, a working time of 8:00 a.m to 17:00 p.m is employed. In the light of this, the labour cost including an over-time allowance, needs to be prepared accordingly. In addition, the use of a labour supplier is necessary in order to recruit a large labour force. It is also necessary to estimate a provision for overhead costs such as for traffic expenses, accommodation costs, insurance, tools, etc.

d) Delivery of Overseas Procurement Products.

Materials from Japan to Calcutta, India are transported by sea, after which they are transported to Kathmandu through the inland transportation system. Depending on the road situations up to Kathmandu, the dimensions of the materials which are transportable by truck trailer are limited to a maximum of 12 metres. This limit will allow the delivery of materials all way through to the bridge construction sites.

(2) Considerations for Construction Activities

Taking into consideration not only the situations of construction as referred to above, but also the construction schedule in the rainy season, the work needs to proceed by paying attention to the matters as summarized in the following:

a) The Bagmati river, the largest in Kathmandu city, shows a high water level in the four months from June to September. Any construction activities on the river bed are considered dangerous during this particular period of time. Therefore, contractors should refrain from the construction of substructures and superstructures during this time.

b) It is necessary to pay attention to the high water level and to concentrate the work at a higher elevation.

c) The delivery of materials in the rainy season should take into account the road conditions (the roads will be closed to traffic sometimes) so as to be flexible enough to meet the circumstances.

d) The work will be concentrated in the dry season, therefore, the materials, equipment, labour, etc. should be arranged accordingly.

e) The temporary bridge required during construction of the Kodku Khola bridge needs to take into consideration the traffic volume as well as safety. The preparation should be in coordination with the DOR pertaining to the timing of the demolition of the existing bridge which will be done by the Nepal side.

f) Demolition of the existing Mahadev bridge is going to be carried out by the Japanese side, nevertheless, the demolition plan should be explained to the Nepal side in advance and the demolition should be carried out to ensure the satisfactory transfer of technical know-how.

g) The Abutments of the proposed bridges which are to be located close to the existing Bagmati and Shankamul bridges, will require a study into the possible nuisance of vibration which might take place at the time of piling.

5.6.3 Construction Supervision Plan

(1) Basic Policy of Detailed Design and Supervision

a) Detailed Design

It would be most appropriate for the same Consultant to proceed with the detailed design as undertook the basic design study. This will contribute to the cost saving, as the work is required to be done in a short period of time and yet they fully understand the design policy. A local consulting engineering firm will be employed, from the view points of cost saving and transfer of technical know-how, through the preparation of design for the bridge, hand-rail, approach road, etc. and reflect the local features.

b) Construction Supervision

As described above, it would be most appropriate that the construction supervision is to be carried out by the Consultant which performed the detailed design. A local consultant's staff will be requested to participate in the supervision services.

(2) Organization of Implementing the Detailed Design

In the preparation of the detailed design, including the tender documents after the consulting contract was entered into, a Japanese staff containing of the following expertise will be needed:

a) General tasks
b) Bridge superstructures
c) Bridge substructures
d) Foundation piling
e) Approach road
f) Construction cost estimate

Incidentally, for the field survey and the design preparation for incidental works, some local staff will be employed.

(3) Organization of Implementing the Supervision

The tender evaluation will be performed by the Japanese staff. With reference to the supervision organization during the construction period, a Japanese resident engineer as well as some supervisory engineers for major portions of works as outlined below will be required. In addition, some local consultant's staff will be employed as auxiliary staff.

a) Resident engineer

b) Foundation piling

c) Bridge substructures

d) Bridge superstructures

5.6.4 Procurement Plan for Materials

(1) Materials Procurement

The materials needed for construction, in principle, will be procured locally, in so far as they are available.

a) Materials to be procured locally

The materials mentioned below can be made available within the city of Kathmandu with adequate quantity and quality:

① Coarse aggregate for concrete work

② Fine aggregate for concrete work

③ Cement

④ Concrete precast products

⑤ Steel reinforcing bar

⑥ Concrete forms

⑦ Asphalt for pavement

b) Materials to be procured in Japan

① Steel girder for bridge

All the steel plates which can be found in the city of Kathmandu are imported products, and it is hardly possible to secure both the quality and quantity, furthermore, there is no facility to fabricate the steel girders. From the view

point of maintenance, an anti-corrosion type of steel will be used, the import of which is absolutely necessary.

② Steel plate for steel pipe pile

As stated earlier, it is difficult to secure both the quality and quantity.

③ Rubber shoe

All of the shoes to be used for bridges are imported products and the procurement of this type of material in the city is impossible.

c) Procurement other than from Japan

Principal materials will be procured from Japan and from Nepal, therefore, no procurement other than from Japan can be considered.

(2) Procurement of Construction Equipment

There is no company to hire out construction equipment within the city of Kathmandu. Because of this, all the major construction equipment is to be transported from Japan and returned to Japan after completion. Procurement from India which is a neighboring country is possible. However, according to the information gained from the DOR, such equipment is out of date and may be unreliable resulting in poor work efficiency. The proposed main construction equipment to be brought from Japan is tabulated in Table 5.6.1 below.

Table 5-6-1 : List of proposed principal construction equipment to be brought from Japan.

Type of equipment	Specifications	Unit	Application
Bulldozer	15t	2	Road work (earth work)
Backhoe	0.6m^3	2	Road work (earth work), substructural work (excavation)
Truck mounted crane	4t load, 2t suspension	1	For common temporary structures (hauling between sites)
Crawler crane	100t suspension	1	For common temporary structures (hauling between sites)
Truck crane	15~16t suspension	1	Road Work (revetment work), Incidental works (Temp. bridge, etc)
Vibratory hammer	120 kv	1	Substructural work (piling work)
Concrete breaker	30 kg	1	Superstructural work (bridge deck), Incidental works (Demolition of existing bridges)
Motor grader	3.1m width	1	Road work (pavement work)
Macadam roller	10~12t	1	Road work (pavement work) Superstructural work (bridge deck)
Tire roller	8~20t	1	Road work (pavement work) Superstructural work (bridge deck)
Asphalt finisher	Wheel type (1.6~2.8m width)	1	Road Work (pavement work)
Water sprinkler (water tank & 11t truck)	5,500~6,500 litres	2	Road work (pavement) common temporary facilities (hauling between sites and water supply)
Concrete mixer	0.3m^3	6	For entire works (Concrete work)

5.6.5 Implementation Schedule

After the Exchange of Notes, the preparation of the detailed design, tendering and the preparation of the design drawings will take about 4.5 months.

The construction period is estimated at 17 months. These activities are presented in the form of a bar chart as seen in Table 5-6-2.

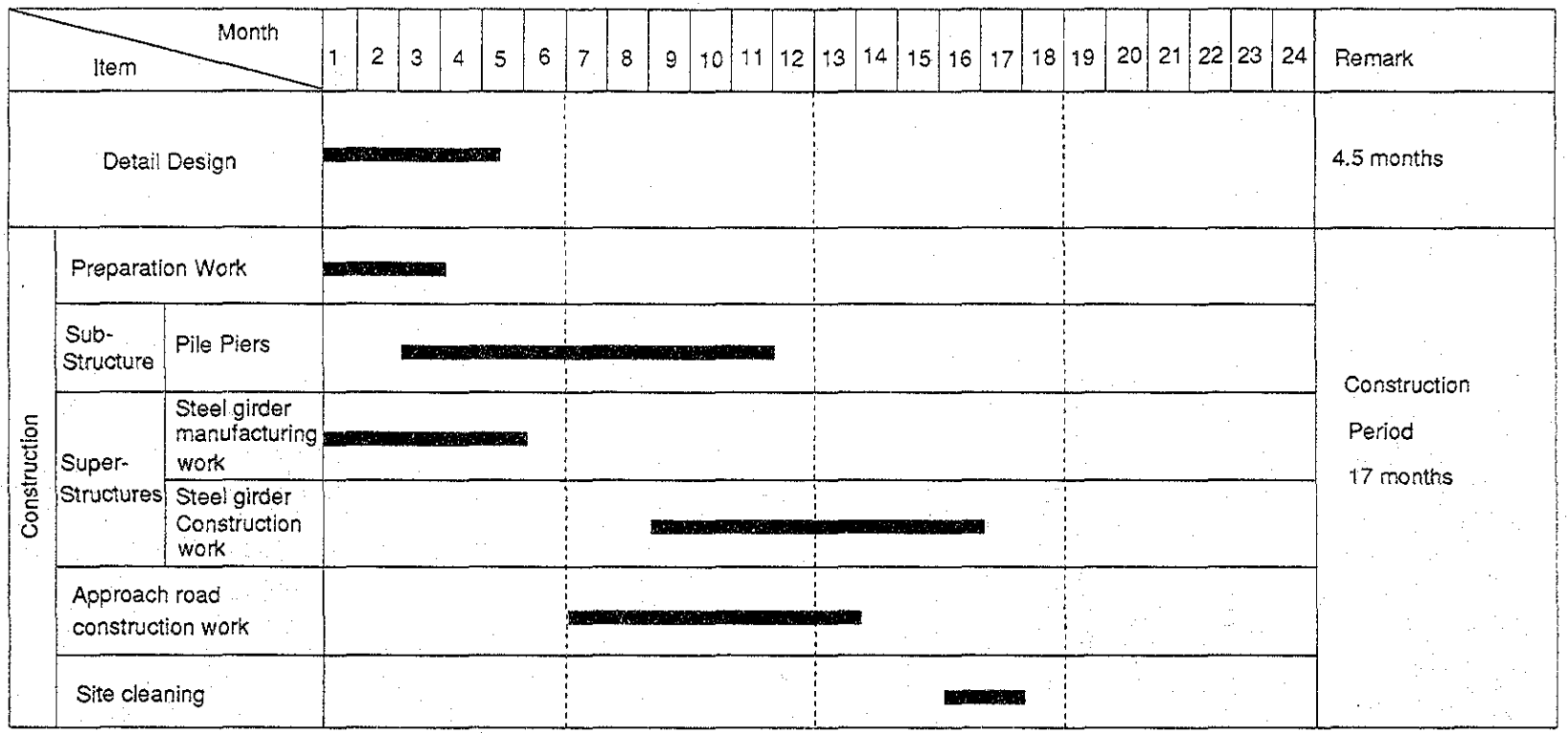
(1) Detailed Design

The work will primarily comprise the preparation of the design drawings and the tender documents, all of which are necessary to enter into the consultant's contract and the commencement of the construction works.

(2) Tender and Contract

The Consultant will carry out the tendering and the contract works on behalf of the executing agency of the Nepal Government.

Table 5-6-2 Implementation Schedule for the Project



(3) Construction Work

The construction comprises a variety of works such as, mobilization, preparatory works, delivery of materials, foundations substructures, superstructures, bridge decks, approach roads and some incidental works related thereto. It is mandatory to prepare a realistic construction plan taking into account a possible high water level which will take place during the wet season at each river.

5.6.6 Approximate Project Cost

(1) The division of works to be shared by both countries, with respect to the execution of this project scheme, is summarized in the following:

a) Works to be undertaken by the Japanese side

- Construction of the bridge foundations, piers, and abutments;
- Construction of approach roads and revetments;
- Construction of bridge superstructures, bridge decks, shoes, bridge deck pavements, expansion joints, bridge hand-rail and pavement lane marking;
- Installation of water drainage facilities over the bridge deck;
- Construction of temporary bridges for detour roads during the course of the construction work and their removal; after completion
- Demolition of the existing Mahadev Khola Bridge;

- Expenses for using water, electric power and telephone which are necessary in performing the construction works referred to above; and

- Costs of the Consultants required in the implementation of the construction works.

b) Works to be undertaken by the Nepal side

- Removal of the existing Kodku Khola Bridge;

- Removal of the water supply main attached to the existing bridge and the installation of this utility to a new bridge;

- Land acquisition for the access roads and the temporary detour road during the course of the construction works;

- Traffic control during the course of the construction works;

- Others such as,

  ① To provide tax exemption privilege in Nepal for materials to be delivered and to ensure smooth customs clearance and convenience of inland transportation

  ② To ensure that Japanese nationals will be exempt from any taxes, duties, fees, levies and other impositions imposed under the laws and regulations in effect in the Kingdom of Nepal for the performance of their services and the products furnished under the authenticated contract.

③ To ensure appropriate maintenance and use of the bridges and roads constructed under the Japanese Grant Aid; and

④ To bear all of the expenses, other than those related to the Japanese Grant Aid, which are necessary to deliver the materials and construct the bridges and roads.

(2) The Nepal Government will be responsible for the work items described in the above section. The cost of these works is estimated at

N.Rp. 9.23 million

5.6.7 Maintenance Operation Plan

(1) The present condition of maintenance operation for bridges

The maintenance operation of bridges within and around the city of Kathmandu is not carried out satisfactorily. For this reason, the durability of the bridges might be shortened. Particularly, it is necessary to set up some measures expeditiously to protect the bridge foundations from scouring caused by a lowered river bed. This is likely to develop in to a serious problem in the future.

(2) Establishment of maintenance organization

The Kathmandu Regional Office of the DOR will be in charge of the bridges under this project. The budget allocation is not separately divided into construction and maintenance, therefore, no adequate administrative control can be expected. In view of this, the understanding of the importance of the maintenance operation will be emphasized through the construction activities. Furthermore, it is

necessary to prepare the maintenance manual for the use by the maintenance agency of D.O.R.

(3) Major points of maintenance

Some of the major items of maintenance with respect to the completed bridges will be as follows:

a) Damages to the bridge hand-rail and pavement caused by collision of vehicles;

b) Corrosion of the steel girders and bearing shoes caused by rain water and/or dust;

c) Localized scouring around piers caused by flood, lowered river bed, etc; and

d) Damages to the approach road for bridges due to deterioration as traffic volume increases.

CHAPTER 6. PROJECT EVALUATION AND CONCLUSION

CHAPTER 6 : PROJECT EVALUATION AND CONCLUSION

The Major significance and socioeconomic effects of the bridge reconstructions in this project are as summarized in the following.

The primary significance of bridge reconstruction is to provide adequate means of river crossing compatible with current traffic demands in place of the existing substandard facilities at the sites of the respective project bridges. This involves replacement of three existing bridges, namely Bagmati Bridge (No.12), Kodku Khola Bridge (No.13), and Mahadev Khola Bridge (No. 22), which are either physically inadequate to cope with current demands or are in danger of collapsing, and reconstruction of another, i.e. Shankamul Bridge (No. 23), which has already collapsed and is currently substituted by a temporary timber structure.

By installing bridges with adequate widths commensurate with traffic volumes, it will solve the traffic problems at project bridge sites, which have been bottlenecks of urban transportation in Kathmandu, thereby contributing to the promotion of regional transportation and economic development within the area of project influence.

Apart from such direct effects, the completion of this project is expected to bring about remarkable positive impacts on the socioeconomic developments in the Kathmandu capital region as a whole.

The central area of Kathmandu today is confronted with a host of urban environmental problems, in such respects as housing, transportation, air and water pollution, public sanitary, etc. In pursuit of their alleviation, urban development and road improvement within the metropolitan region of Kathmandu are being programmed by relevant authorities of HMG/N.

Principal orientations of future development identified in the Urban Development Program are, (1) to extend beyond the ring road which encompasses the over-congested city centre further outward into the outskirt of the city to its northwest and southeast, and (2) to develop the green area along the Bagmati river between Kathmandu and Patan, and integrate these two urban areas across the River (Figures 4-2-1).

The main issues of development identified in the Road Improvement Program are, construction and/or expansion of (1) the riverside road along the left bank of the Bagmati River, and (2) the two existing river crossing structures (i.e. Bagmati and Shankamul Bridges in this Project), and their approach roads (Figure 2-3).

Kodku Khola Bridge (No. 13) and Mahadev Khola Bridge (No.22) locate at strategic positions for future urban development in the outskirt of Kathmandu to its northwest and southeast, as stated above.

The two major cities in Kathmandu Metropolitan Region, namely Kathmandu and Patan, are separated by Bagmati River which is about 120-150 m wide. Three bridges connect these cities across the river at present. Two of these locate on the ring road 5.5 km apart from each other, away from the city centre where traffic demand is small. Under this situation, traffic between the two cities inevitably concentrateS at the third bridge which locates within the central area encompassed by the ring road, causing traffic congestion in its vicinity throughout the day.

For road networks in urban areas, spacing of neighbouring routes at about 0.5 to 1.0 km intervals is generally considered appropriate. From this point of view, a minimum of two bridges would be required along the sector of Bagmati River between the two intersection points with the ring road.

From this point of view, it is obvious that functioning of Bagmati Bridge (No.12) and Shankamul Bridge (No.23) are prerequisites for sound urban and roads development within Kathmandu Metropolitan Region, and are therefore strategically important in such planning.

Based on the above considerations, implementation of this Phase 2 project, as grant assistance, is considered very meaningful and therefore strongly recommended that it should be materialized, as requested by GON, as early as possible

Regarding the construction scheme of Shankamul Bridge, it should be noted that the bridge proposed herein for the exclusive use of pedestrians and bicycles is only a provisional means to meet the immediate traffic demand for the time being. This is because the location and timing for construction of the riverside road along the left bank of the Bagmati river, which will eventually serve as the approach road to the bridge, is yet unknown, and that it would only be reasonable to construct the permanent bridge after the nature and details of its approach road is determined. In view of the foreseeable advantages of having a vehicular bridge at this location, it is strongly recommended that early actions be taken to render necessary contextual settings ready for the construction of such a road bridge.

Some of the existing bridges located within the city of Kathmandu are deemed to have serious problems from the viewpoint of stability as their pier foundations are exposed above the river bed. The principal cause of this exposure is attributable to the lowering of the river of the river bed, caused by the collecting of fine aggregate. Especially, as construction work increases within the Kathmandu area, the demands for fine aggregate in construction activities is significantly augmented and

consequently, the lowering of the river beds are accelerating. Should such a tendency be left unabated, many of them will collapse before long.

It is of paramount importance to take prompt preventive action to avoid lowering the river beds in order to secure the stability not only of the existing bridges but also those to be newly constructed.

APPENDIX

[APPENDIX]

1. MEMBERS OF THE JAPANESE BASIC DESIGN TEAM

i) Field Survey

Assignment	Name	Position
Team Leader	Mamoru YAMAGATA	Project Manager Honshu-Shikoku Bridge Authority
Project Coordinator	Kunihiro YAMAUCH	First Project Management Division, Grant Aid Project Management Department, JICA
Bridge Planner	Takeshi NAKAYAMA	Pacific Consultants International
Bridge Designer	Yoshihiko WAKABAYASHI	Japan Bridge Structure Institute.
Highway Engineer	Yoshimichi NOGUCHI	Pacific Consultants International
Construction Management/Cost Estimator	Hiroyuki ENDO	Pacific Consultants International
Geotechnical Eng'r/Surveyor	Osamu NOGOSHI	Pacific Consultants International

ii) Explanation and discussion of draft final report

Assignment	Name	Position
Team Leader	Mamoru YAMAGATA	Project Manager Honshu-Shikoku Bridge Authority
Project Coordinator	Koji NOGUCH	Grant Aid division Bureau of Economic cooperation Ministry of Foreign Affairs
Bridge Planner	Takeshi NAKAYAMA	Pacific Consultants International
Construction Management/Cost Estimator	Hiroyuki ENDO	Pacific Consultants International

2. ITINERARY FOR FIELD SURVEY

Cumulative Days	Date	Place	Activities
1	April 9 (Tue)	Tokyo - Bangkok	
2	10 (Wed)	Bangkok-Kathmandu	Site reconnaissance
3	11(Thu)	Japanese Embassy	Courtesy Call
		JICA	
		Department of Roads	
		(D.O.R)	
4	12 (Fri)	D.O.R	Presentation and
		JICA	explanation of Inception
			Report
5	13 (Sat)	Field	Site reconnaissance
6	14 (San)		Team meeting.
7	15 (Man)	D.O.R	Discussion on Project Plan
8	16 (Tue)	D.O.R	Minutes of Discussion,
			Signing
9	17 (Wed)	Japanese Embassy	Explanation of the Minutes
10	18 (Thu)	Kathmandu-Bangkok	Team Leader/Coordinator
			leaving for Tokyo
		D.O.R	Discussion on Traffic
			Survey
11	19 (Fri)	D.O.R	Discussion on Traffic
			Survey
12	20 (Sat)		Holiday
13	21 (San)	Field	Site reconnaissance, Team
			Meeting
14	22 (Mon)	D.O.R	Discussion on Traffic
			Survey

Cumulative Days	Date	Place	Activities
15	23 (Tue)	Field	Traffic Survey
16	24 (Wed)	Field	Traffic Survey
17	25 (Thu)	D.O.R	Data collection
			Discussion on Project Plan
		Field	Site reconnaissance
18	26 (Fri)	D.O.R	Data collection
			Discussion on Project Plan
		Field	Site reconnaissance
19	27 (Sat)	Field	Site reconnaissance
			Sorting out the data
20	28 (San)	Field	Site reconnaissance
			Data collection
			Team meeting
21	29 (Man)	Field	Site reconnaissance
			Data collection
22	30 (Tue)	Field	Site reconnaissance
23	May 1 (Wed)	D.O.R	Data collection
			Discussion on Project Plan
		Field	Site reconnaissance
24	2 (Thu)	Field	Site reconnaissance
			Data collection
25	3 (Fri)	Field	Site reconnaissance
		D.O.R	Data collection
			Discussion on Project Plan
26	4 (Sat)		Holiday
27	5 (San)	D.O.R	Data collection
			Discussion on Project Plan

Cumulative Days	Date	Place	Activities
28	6 (Mon)	JICA	Discussion on Project Plan
		Japanese Embassy	
29	7 (Tue)	Field	Site reconnaissance
30	8 (Wed)	D.O.R	Discussion on Project Plan
31	9 (Thu)	D.O.R	Discussion on Project Plan
			Data collection
32	10 (Fri)	JICA	Discussion on Project Plan
		D.O.R	
33	11 (Sat)		Holiday
34	12 (San)		Sorting out the data
35	13 (Mon)	JICA	Discussion on Project Plan
		D.O.R	
36	14 (Tue)	JICA	Explanation of survey
		D.O.R	results
		Japanese Embassy	
37	15 (Wed)	Field	Site reconnaissance
		JICA	Discussion on Project Plan
38	16 (Thu)	Kathmandu-Bangkok	Leaving for Tokyo
39	17 (Fri)	Bangkok-Tokyo	

Itinerary for explanation and discussion of draft final report

Cumulative Days	Date	Place	Activities
1	Aug 28 (Wed)	Tokyo-Bangkok	
2	29 (Thu)	Bangkok-Katumandu	
3	30 (Fri)	MOWT	Joint meeting at MOWT
4	31 (Sat)		Holiday Internal meeting
5	Sep 1 (San)		Holiday Internal meeting
6	2 (Mon)		Discussion with DOR
7	3 (Tue)		Signing on minutes
8	4 (Wed)	Katumandu-Bangkok	
9	5 (Thu)	Bankok-Tokyo	

3. LIST OF MEMBERS CONCERNED

Embassy of Japan in Nepal	Ambassador	Mr. Chuichi Ito
		Mr. Mikio Ishiwatari
JICA, Nepal Office	Resident Representative	Mr. Hidekazu Kumano
	Asst. Resident Representative	Mr. Masatoshi Nagatomo.
		Mr. Masahito Oyama

Ministry of Works and Transport

	Mr. M. M. Amatya	Acting Secretary
	Mr. R. B. Sharma	Director General, DOR
*	Mr. Narayan D. Sharma	Former Director General, DOR
	Mr. D. B. Basnet	Central Regional Director, DOR
*	Mr. Sudhir P. Upadhyay	Former Central Regional Director, DOR
	Mr. C. K. LAL	Assistant Engineer
		Central Regional Director, DOR
*	Mr. Situla	Former Assistant Engineer
		Central Regional Director, DOR
*	Mr. Shrestha	Former Assistant Engineer
		Central Regional Director, DOR

Ministry of Housing & Physical Planning

Mr. Gauri N. Rimal
Acting Secretary

Mr. B. Sharma
Deputy Regional Director

Ministry of Education & Culture

Mr. Shaphayal Amatya
Acting D. G., Department of Archeology

Ministry of Finance

Mrs. S. Rajbhandari
Under Secretary

Mr. Tulasi Neopane
Under Secretary

National Planning Commission

Mr. S. L. Shrestha
Under Secretary

* These members were transferred to new appointments during the study period.

4. MINUTES OF DISCUSSION

MINUTES OF DISCUSSIONS
ON
THE BASIC DESIGN STUDY
ON
THE PROJECT FOR RECONSTRUCTION OF BRIDGES (PHASE 2)
IN KATHMANDU
IN
THE KINGDOM OF NEPAL

In response to the request of His Majesty's Government of Nepal (hereinafter referred to as HMG/N) for Grant Aid for the Project for Reconstruction of bridges (Phase 2) in Kathmandu (hereinafter referred to as "the Project"), the Government of Japan decided to conduct a basic design study on the Project and entrusted the study to the Japan International Cooperation Agency (JICA). JICA sent to the Kingdom of Nepal the study team headed by Mr. Mamoru YAMAGATA, Project Manager, Honshu-shikoku Bridge Authority, from April 9 to May 17,1991.

The team had a series of discussions on the Project with the officials concerned of HMG/N and conducted a field survey in Kathmandu.

As a result of the study and discussions, both parties agreed to recommend to their respective Goverinments that the major points of understanding reached between them, attached herewith, should be examined towards the realization of the Project.

Kathmandu, April 16, 1991

Mr. Mamoru YAMAGATA
Team Leader
Basic Design Study Team
JICA

Mr. Narayandatt SHARMA
Director General
Department of Roads
Ministry of Works and Transport
HMG/N,

ATTACHMENT

1. TITLE OF THE PROJECT

The title of the Project is " The Project for Reconstruction of Bridges (Phase 2) in Kathmandu".

2. OBJECTIVES OF THE PROJECT

The objective of the Project is to reconstruct superannuated bridges in Kathmandu in order to smoothen and improve the safety of the traffic flow.

3. EXECUTING ORGANIZATION

The executing agency for the implementation of the Project is The Department of Roads, The Ministry of Works and Transport.

4. LOCATION OF THE PROJECT

The location of the bridges subjected to the Project are shown in Annex-I.

5. REQUEST BY HMG/N

The outline of the bridges which are requested by HMG/N to reconstruct under the Japanese Grant Aid are shown in Annex - II. The Japanese study team will convey to the Government of Japan the intention of HMG/N that the former takes the necessary measures to cooperate in implementing the project within scope of the Japanese economic cooperation in grant aid.

6. JAPANESE GRANT AID PROGRAM

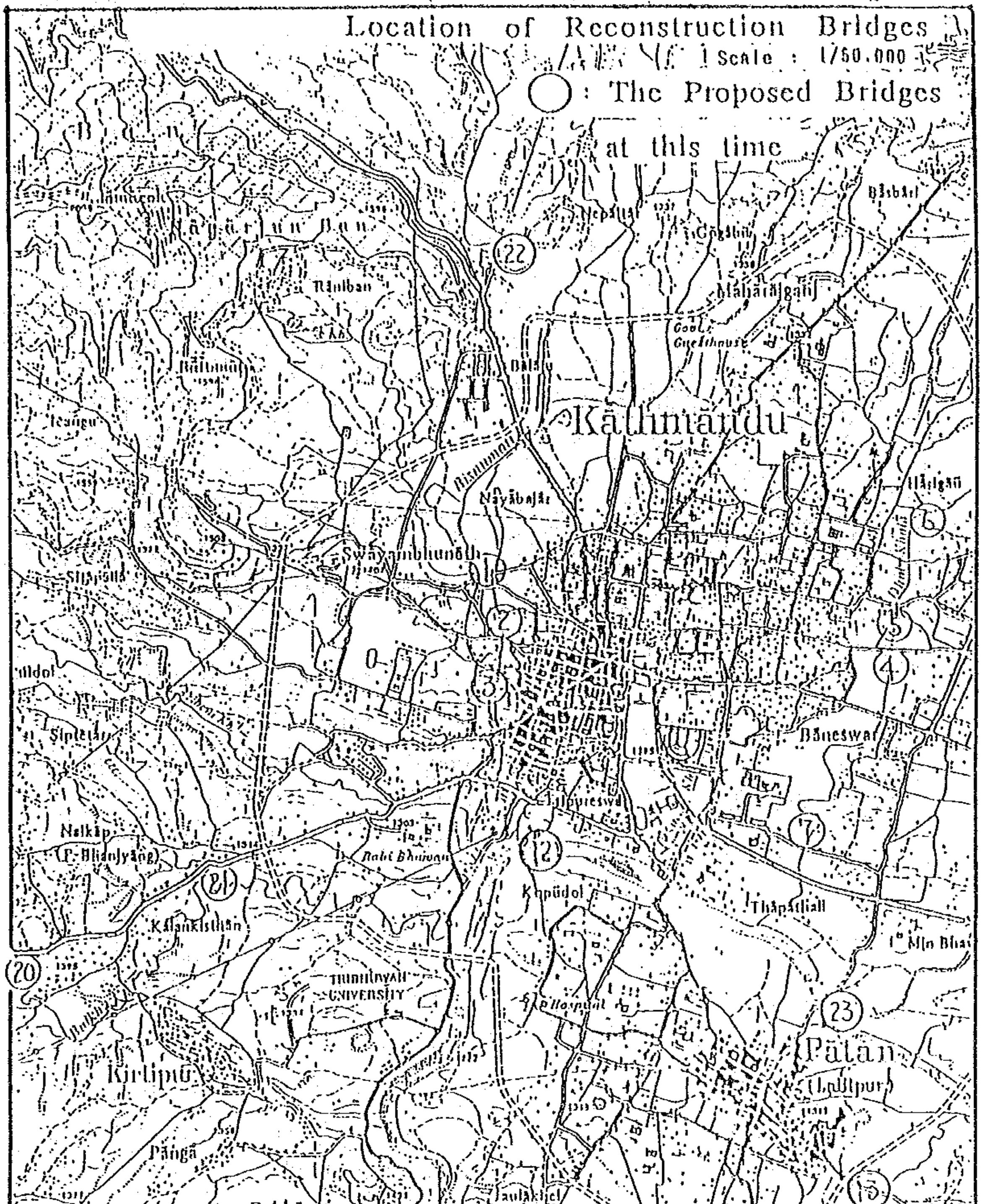
The Nepal side has understood the system of the Japanese Grant Aid Program explained by the Team which includes a principle for use of a Japanese consultant firm and Japanese contractors for the implementation of the Project.

7. NECESSARY MEASURES TAKEN BY NEPAL

HMG/N would take the necessary measures for realization of the Project as shown in the Annex-III on condition that the Japanese Grant Aid is extended to the Project.

8. REMOVAL OF THE EXISTING BRIDGES

The Nepal side ensured that the existing bridges except Bridge No. 22 would be removed, if necessary, prior to the construction of new bridges on condition that the Grant Aid Program is extended to the Project.


Location of Reconstruction Bridges
Scale : 1/50,000
○ : The Proposed Bridges at this time
Kathmandu
Swayambhunath
Nayabajar
Baneswar
Thapathali
Kirtipur
Patan (Lalitpur)
TRIBHUVAN UNIVERSITY
Cobhar
Thaiba
Okhaldhunga
Khumaltar
Sanokhokna
Naikap
Kalanki
22
2
3
4
5
6
7
11
12
13
20
21
23

ANNEX- II

OUTLINE OF THE PROJECT

The outline of the Project proposed by HMG/N to the Government of Japan under its Grant Aid Program is to reconstruct the following four bridges, which are inadequate functioning and dilapidated conditions.

(1)	No. 12	Bagmati Bridge	Bagmati River
(2)	No. 13	Kodku Khola Bridge	Kodku River
(3)	No. 23	Shankamul Bridge	Bagmati River
(4)	No. 22	Mahadev Khola Bridge	Lambagar River

ANNEX-III

NECESSARY MEASURES TAKEN BY HMG/N

1. To secure land necessary for the execution of the Project and provide enough space for such construction as temporary offices, working area, stockyard and others.
2. To ensure that river area necessary for the construction of the facilities be freely accessible.
3. To clear, level and reclaim the project sites.
4. To ensure prompt unloading, tax exemption and custom clearance at ports of disembarkation in the Kingdom of Nepal and facilitate prompt internal transportation therein of the products purchased under the Grant.
5. To secure, with respect to the supply of the products and services under verified contracts that Japanese nationals shall not be subject to any custom duties, internal taxes and other fiscal levies which may be imposed in the Kingdom of Nepal.
6. To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry to the Kingdom of Nepal and stay therein for the performance of their work in accordance with the relevant laws and regulations of the Kingdom of Nepal.
7. To ensure the necessary budget and personnel for the proper and effective operation and maintenance of the bridges provided under the grant aid.
8. To provide necessary permissions, licenses and other authorizations for carrying out the Project.
9. To bear two kinds of commissions to the Japanese foreign exchange bank for the banking services, based upon the "Banking Arrangement," namely, the advising commission of the "Authorization to Pay" and payment commission.
10. To bear all local expenses, other than those to be borne by the grant aid.

M.Y

MINUTES OF DISCUSSIONS ON THE PROJECT FOR RECONSTRUCTION OF BRIDGES (PHASE 2) IN KATHMANDU IN THE KINGDOM OF NEPAL

In April 1991, the Japan International Cooperation Agency (JICA) dispatched a Basic Design Study on the Project for the Reconstruction of Bridges (phase 2) in Kathmandu (hereinafter referred to as "the Project") to the Kingdom of Nepal and through discussions, field survey and technical examination of the results in Japan, has prepared the draft report of the study.

In order to explain and to consult with officials of His Majesty's Government (HMG) of Nepal on the components of the draft report, JICA sent to the Kingdom of Nepal a study team, which is headed by Mr. Mamoru YAMAGATA, Manager, Honshu-Shikoku Bridge Authority and is scheduled to stay in the country from 29 August to 4 September.

As a result of discussions both parties confirmed the main items described on the attached sheets.

Kathmandu September 2, 1991.

Mr. Mamoru YAMAGATA
Team Leader
Basic Design Study Team
JICA

R B Sharma

Mr. R.B. Sharma
Director General
Department of Roads
Ministry of Works & Transport

ATTACHMENT

(1) Component of draft report

HMG of Nepal has agreed and accepted in principle the components of the draft report proposed by the Team.

Especially, the location and type of Shankamul bridge recommended by the study team was confirmed and accepted by the Joint Meeting Members at Ministry of Works & Transport, which is composed by the Government Agency concerned (the attendants are shown in Annex - 3).

At the meeting, it was requested by the Government Agencies that the design of Shankamul and Bagmati bridges should be paid attention to its circumstances, for both sites are very close to the historic core.

(2) Japan's Grant Aid system

1. HMG of Nepal has understood the system of Japanese Grant Aid explained by the Team.

2 HMG of Nepal will take the necessary measures described in Annex - 1 and 2 for smooth implementation of the Project on condition that the Grant Aid Assistance by the Government of Japan is extened to the Project.

3. Further schedule

The team will make the final report in accordance with the confirmed items and send it to HMG of Nepal by the end of October.

M.S

RM.

NECESSARY MEASURES TO BE TAKEN BY HMG OF NEPAL IN CASE JAPAN'S GRANT AID IS EXECUTED.

Annex - 1

1. To secure the site for the execution of the Project and provide enough space for the construction such as temporary offices, working area, stockyard and others.

2. To ensure that river area necessary for the construction of the bridges be freely accessible.

3. To ensure prompt unloading, tax exemption and custom clearance at ports of disembarkation in the Kingdom of Nepal and facilitate prompt internal transportation therein of the products purchased under the Grant.

4. To secure, with respect to the supply of the products service under verified contracts that Japanese Nationals shall not be subject to any custom duties, internal taxes and other fiscal levies which may be imposed in the Kingdom of Nepal.

5. To accord Japanese Nationals whose services may be required in connection with the supply of the products and the services under the verified contracts such facilities as may be necessary for their entry to the Kingdom of Nepal and stay therein for the performance of their work.

6. To ensure the necessary budget and personnel for the proper and effective operation and maintenance of the bridges provided under the grant aid.

7. To provide necessary permissions, licenses and other authorizations for carrying out the Project.

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

9. To bear all local expense, other than those to be borne by the grant aid.

UNDERTAKINGS TO BE COVERED BY THE RECIPIENT GOVERNMENT

Annex - 2

Bridge Name/Site	Land Acquisition	Land lease for Temporary Works	Demolishing			Clearing & Grubbing	Public Facilities	
			Wooden/Steel Superstructure	Brick-Abutment	Brick Pier		Electric Cable	Water Pipe
No.12 Bagmati	*	*	-	-	-	-	-	-
No.13 Kodku Khola	*	*	*	*	*	*	*	*
No.23 Shankamul	*	*	-	-	-	-	-	-
No.22 Mahadev Khola	*	*	-	-	-	-	-	*
Stock-Yard (Materials & Equipment)	-	*	-	-	-	-	-	-

Note: *: to be required or transferred.

The above undertakings for land acquisition, lease for temporary works and other preparatory works are to be made by the commencement of the Project. Necessary actions for the undertakings will be started as soon as possible, taking into account the urgent construction works.

Annex - 3

ATTENDANTS OF JOINT MEETING

Aug. 30, 1991.

Ministry of Works & Transport

Mr. M.M. Amatya
Acting Secretary

Mr. R.B. Sharma
Director General, DOR

Mr. D.B. Basnet
Regional Director
Central Regional Directorate, DOR

Ministry of Housing & Physical Planning

Mr. Gauri N. Rimal
Acting Secretary

Mr. B. Sharma
Deputy Regional Director

Ministry of Education & Culture

Mr. Shaphayal Amatya
Acting D.G., Department of Archiology

Ministry of Finance

Mrs. S. Rajbhandari
Under Secretary

Mr. Tulasi Neopane
Under Secretary

National Planning Commission

Mr.S.L. Shrestha
Under Secretary

5. List of Collected data

LIST OF COLLECTED DATA

(1) SOCIO-ECONOMIC

1) Guide to Nepal

2) Statistic Year Book of Nepal 1989

3) Development Atlas of Nepal (Statistical Profile) 1988

4) Nepal Dimension of Development 1989

5) Landlessness and Migration in Nepal

6) Migration Statistics from Demographic Sample Survey
1986 / 1987 1988

7) Population Monograph of Nepal 1987

8) Greater Kathmandu Drainage Master Plan Studies 1989

9) Statistical Pocket Book Nepal 1990
Central Bureau of Statistics.

10) Population Distribution in Kathmandu and Patan 1987,1988
(Greater Kathmandu Drainage Plan Studies, Volume 1)

11) Main Economic Indicator Monthly Report.
Nepal Rastra Bank (Aug, Sep, Oct/1990)

12) Population Census - 1971 Central Bureau of Statistics 1975

13) Population Census - 1981 Central Bureau of Statistics 1984

14) Population Monograph of Nepal Central Bureau of Statistics 1987

15) Economic Survey Fiscal Year 1989 - 90 Ministry of Finance 1990

16) Budget Speech of The Fiscal Year 1990 - 91 Ministry of Finance. 1990

(2) TRANSPORT/TRAFFIC

1) Total Vehicles of Registered in Nepal Upto June 1991.

2) Study of the Road Transport Industry Final Report
Ministry of Works and Transport Department of Roads.

3) NIRMAN - YATAYAT Journal of Works and Transport
Ministry of Works & Transport.

4) Transport Sector Profile Study (ADB)
Road Maintenance Study Final Report January 1988

5) Nepal Road Statistics 1989 Department of Roads.

(3) METEOROLOGICAL

1) Climatological Records of Nepal.
1921 - 1975
1976 - 1980
1981 - 1982
1983 - 1984

(4) GEOLOGY

1) Soil Investigation of SANKHMUL BRIDGE SITE

2) Engineering Geology of Kathmandu, Nepal
Asian Institute of Technology. Bangkok, Thailand April, 1987.

3) Journal of Nepal Geological Society August, 1988, December 1989.

(5) HYDROLOGY

1) Surface Water Records of Nepal (Bagmati River)

2) Hydrological Study of Bagmati
River at Sankhamul Bridge Site Silt Consultants (P) LTD March 1982

3) Road flood rehabilitation project Design and Construction Management of Kathmandu Valley Bridges Volume IV. H.M.G. Department of Roads.

(6) SPECIFICATIONS & STANDARDS

1) Nepal Road Standards (2027)
(First Revision - 2045) Department of Road.

2) Design Manual for Urban Roads 1989,
(Ministry of housing and physical planning)

3) Standard Drawings Urban Roads and Drains.
(Ministry of housing and physical planning)

4) Methods for testing tar & bituminous materials Part 2 - Viscosity test.

5) Methods for testing tar and bituminous materials
Determinations of ductility.

6) Design Manual for River training Works in Nepal.
Ministry of Water Resources. June 1988

(7) MAP

1) Planning Map of Satellite Images,Kathmandu
S = 1 : 250,000. 1986 - Sheet NG 45 - 1

2) Geological Map of Central Nepal S = 1 : 250,000.
Department of mines and geology

3) Nepal Administrative, S = 1 : 2,000,000. H.M.G
Survey Deportment, Topographical Survey Branch, 1987.

4) Bagmachi Administrative

5) Geological Map of Kathmandu Area and central Mahobharat Range
S = 1 : 250,000. H.M.G. Department of mines and geology.

6) City Map NO.1 KATHMANDU S = 1: 10,000

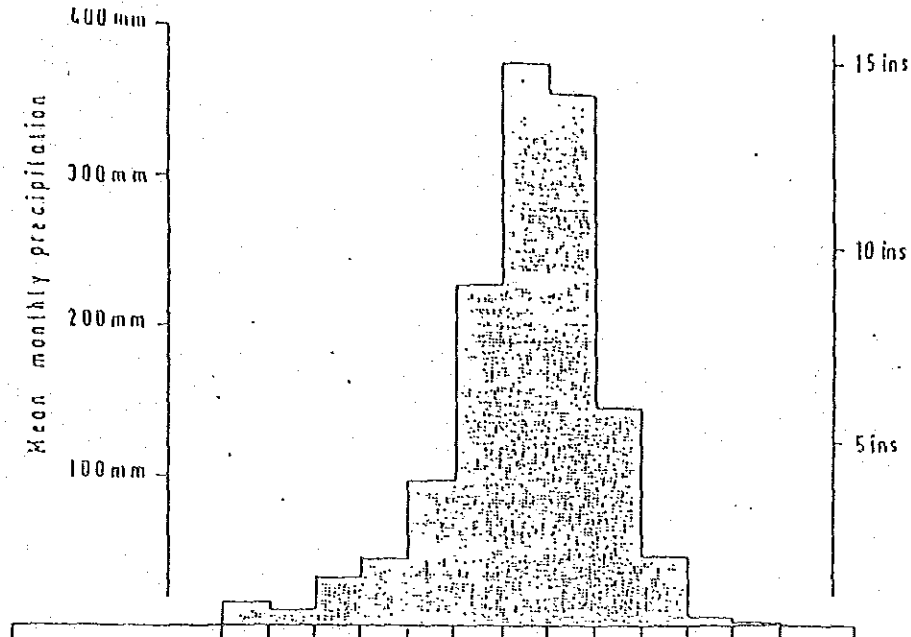
7) City Map NO.2 Central KATHMANDU S = 1: 5,000

8) Land Utilization Map NO.72 $\frac{E}{1}$ NO.72 $\frac{E}{2}$
NO.72 $\frac{E}{6}$ NO.72 $\frac{E}{5}$

9) Aerial Photos for Kathmandu

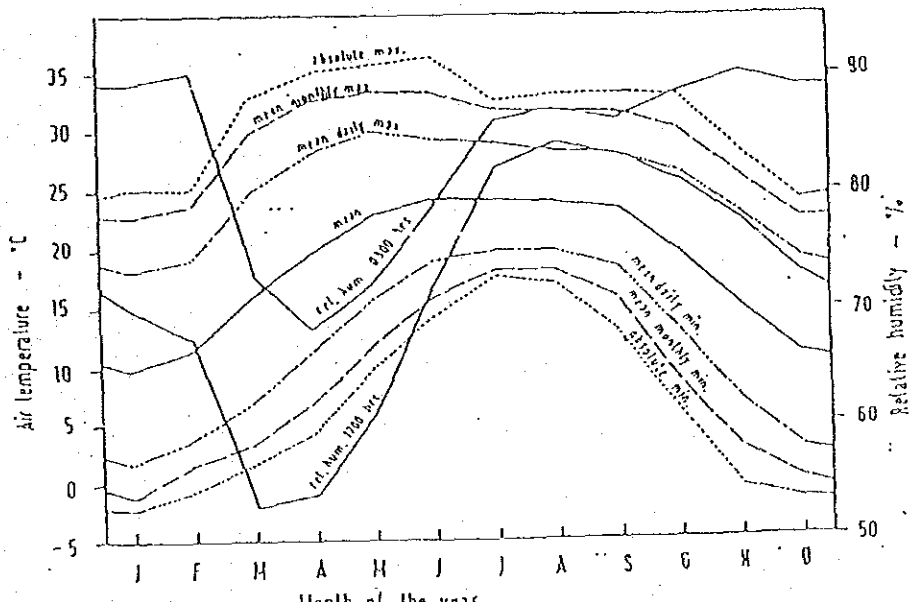
6. TECHNICAL DATA

(1) PRECIPITATION, AIR TEMPERATURE AND HUMIDITY IN KATHMANDU.



Month.	J	F	M	A	M	J	J	A	S	O	N	D	Year
Mean precip.(mm)	17.9	15.7	32.0	45.0	92.2	229.2	378.9	358.0	167.1	47.2	6.9	1.8	1378
Std. deviation (mm)	19.5	19.9	21.2	31.1	53.3	77.2	105.2	64.8	65.5	47.8	11.8	3.5	21.9

Monthly precipitation based on 1948-1970 data



Average monthly air temperature and humidity variation

(2) DISCHARGE AND GAUGE HIGHT

(BAGMACHI RIVER, CHOBAR)

Station name: Chovar　　　　Date: 23 July 1989
River: Bagmati River
Station no.: 550

EXTREME DISCHARGES

MAXIMUM INSTANTANEOUS			MINIMUM INSTANTANEOUS		
Discharge (cumec)	Gauge height (meters)	Date	Discharge (cumec)	Gauge height (meters)	Date
206	6.29	1 Sep. 1963	0.15	1.55	14 June 1963
251	6.76	3 Sep. 1964	0.020	1.40	9 June 1964
395	8.10	9 July 1965	0.040	1.40	13 June 1965
634	11.55	24 Aug. 1966	0.18	1.57	21 Apr. 1966
680	12.25	10 July 1967	0.57	1.56	4 June 1967
497	9.60	4 Oct. 1968	0.24	1.65	28 May 1968
431	8.70	19 Aug. 1969	0.44	1.64	14 June 1969
582	10.22	16 July 1970	0.24	1.40	1 Mar. 1970
617	10.57	12 June 1971	0.36	1.58	21 Mar. 1971
876	13.16	28 July 1972	0.046	1.30	8 June 1972
335	7.66	25 July 1973	0.16	1.42	4 June 1973
350	7.82	30 Aug. 1974	0.15	1.41	20 Mar. 1974
591	10.31	3 Aug. 1975	0.20	1.10	6 June 1975
245	6.66	30 June 1976	0.49	1.27	20 Mar. 1976
299	7.26	20 June 1977	0.28	1.27	26 Mar. 1977
407	8.45	16 July 1978	0.84	1.48	9 Mar. 1978
416	8.55	21 Aug. 1979	0.29	1.28	7 June 1979
254	6.75	31 July 1980	0.31	1.36	18 Apr. 1980

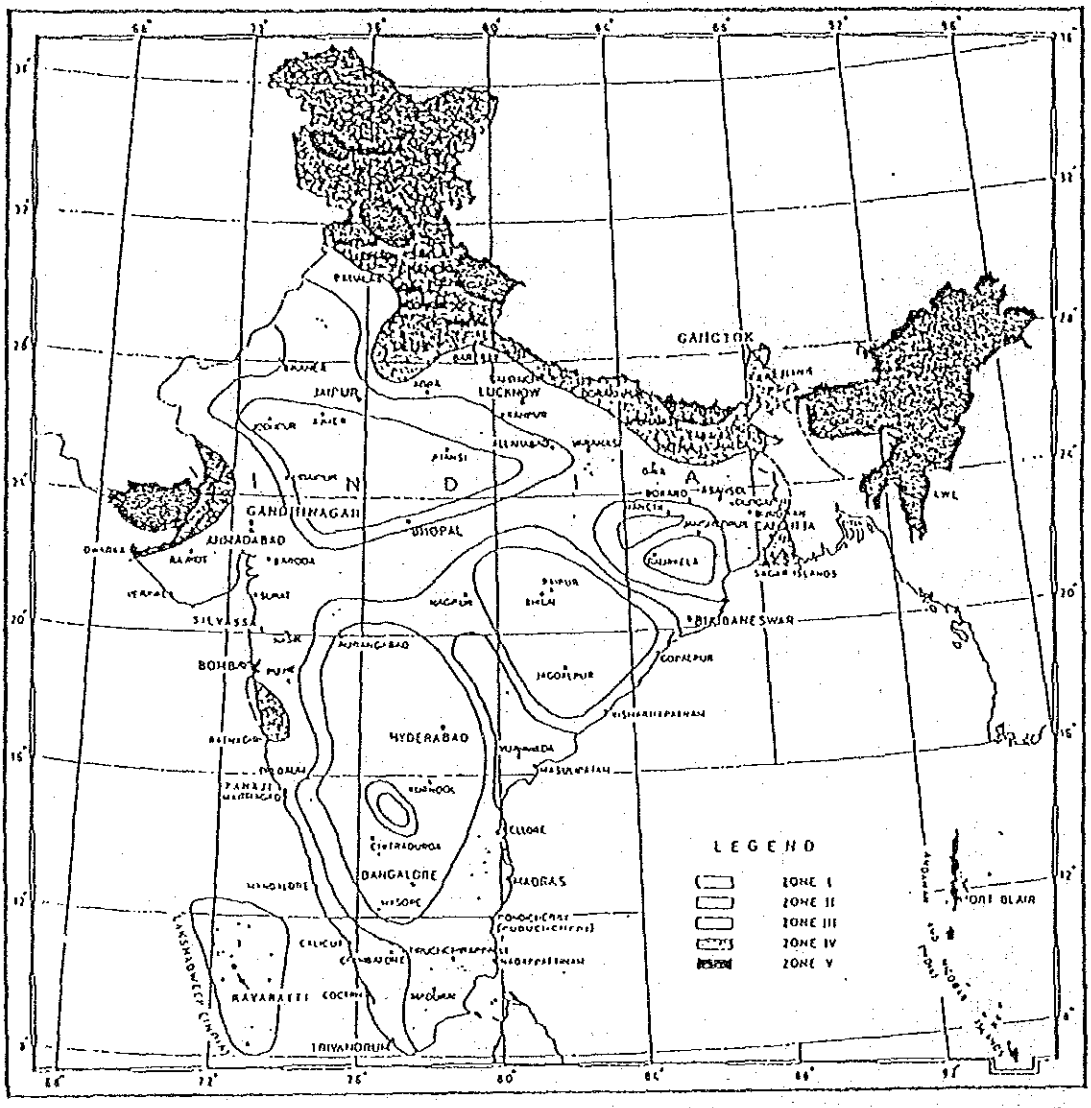
(3) SEISMIC COEFFICIENTS FOR SOME IMPORTANT TOWNS (NBCI)

SEISMIC COEFFICIENTS FOR SOME IMPORTANT TOWNS

Town	Zone	Horizontal Seismic Coefficient α_h	Town	Zone	Horizontal Seismic Coefficient α_h
Agra	III	0·04	Jabalpur	III	0·04
Ahmadabad	III	0·04	Kanpur	III	0·04
Ajmer	I	0·01	Kathmandu	V	0·08
Allahabad	II	0·02	Kohima	V	0·08
Almora	IV	0·05	Kurnool	I	0·01
Ambala	IV	0·05	Lucknow	III	0·04
Amritsar	IV	0·05	Ludhiana	IV	0·05
Asansol	III	0·04	Madras	II	0·02
Aurangabad	I	0·01	Madurai	II	0·02
Bahraich	IV	0·05	Mandi	V	0·08
Bangalore	I	0·01	Mangalore	III	0·04
Barauni	IV	0·05	Monghyr	IV	0·05
Bareilly	III	0·04	Moradabad	IV	0·05
Baroda	III	0·04	Mysore	I	0·01
Bhatinda	III	0·04	Nagpur	II	0·02
Bhilai	I	0·01	Naimital	IV	0·05
Bhopal	II	0·02	Nasik	III	0·04
Bhubaneswar	III	0·04	Nellore	II	0·02
Bhuj	V	0·08	Panjim	III	0·04
Bikaner	III	0·04	Patiala	III	0·04
Bokaro	III	0·04	Patna	IV	0·05
Bombay	III	0·04	Pilibhit	IV	0·05
Burdwan	III	0·04	Pondicherry	II	0·02
Calcutta	III	0·04	Poona	III	0·04
Calicut	III	0·04	Raipur	I	0·01
Chandigarh	IV	0·05	Rajkot	III	0·04
Chitradurga	I	0·01	Ranchi	II	0·02
Coimbatore	III	0·04	Roorkee	IV	0·05
Cuttack	III	0·04	Raurkela	I	0·01
Darbhanga	V	0·08	Sadiya	V	0·08
Darjeeling	IV	0·05	Simla	IV	0·05
Dehra Dun	IV	0·05	Sironj	I	0·01
Delhi	IV	0·05	Srinagar	V	0·08
Durgapur	III	0·04	Surat	III	0·04
Gangtok	IV	0·05	Tezpur	V	0·08
Gauhati	V	0·08	Thanjavur	II	0·02
Gaya	III	0·04	Tiruchchirappalli	II	0·02
Gorakhpur	IV	0·05	Trivandrum	III	0·04
Hyderabad	I	0·01	Udaipur	II	0·02
Imphal	V	0·08	Varanasi	III	0·04
Jaipur	II	0·02	Vijayawada	III	0·04
Jamshedpur	II	0·02	Vishakhapatnam	II	0·02
Jhansi	I	0·01			
Jodhpur	I	0·01			
Jorhat	V	0·08			

NOTE — The coefficients given are according to 5.2.1 and should be suitably modified for important structures according to 5.2.2 and 5.4.

(4) SEISMIC ZONES (NBCI)



The territorial waters of India extend into the sea to a distance of twelve nautical miles measured from the appropriate base line.
Based upon Survey of India map with the permission of the Surveyor General of India. © Government of India copyright 1975

Fig. 13 Map of India Showing Seismic Zones

(5) LIST OF EARTHQUAKES OF MORE THAN 5 MAGNITUDE IN RICHTER SCALE, OCCURRED WITHIN THE NEPAL REGION.

LIST OF EARTHQUAKES OF MORE THAN 5 MAGNITUDE

ON RICHTER SCALE, OCCURED WITHIN THE NEPAL REGION

Y	M D	EPCL AREA	LAT DEG N	LONG DEG E	DEPT KM	INT MM	MAG	REF
1966	1218	WEST NEPAL	29.6	81.0			5.0	USC
1966	1221		29.65	80.79			5.2	ISC
1967	0105		30.0	86.0			5.2	LAO
1967	0814		28.0	80.0			5.0	LAO
1967	1218		29.46	81.71			5.0	ISC
1968	0527	NEPAL	29.7	80.4			5.1	USV
1969	0204		28.3	81.4			5.1	LAO
1969	0211		28.1	82.7			6.2	LAO
1969	0213		27.9	85.4			5.0	LAO
1969	0213		28.0	81.8			5.3	LAO
1969	0224		27.9	85.6			5.2	LAO
1969	0303		30.04	79.84			5.0	ISC
1969	0305		29.2	81.1			5.2	HARI
1970	0212		29.24	81.57			5.3	ISC
1970	0226		27.62	85.7			5.0	ISC
1971	0503	TIBET	30.79	84.33	27		5.3	ISC
1971	1204	NEPAL	27.93	87.95	29		5.2	ISC
1972	0204	TIBET	30.34	84.47	18		5.1	ISC
1972	0315	TIBET	30.425	84.502	33		5.3	NEIS
1972	0428	TIBET	31.34	84.92	32		5.0	ISC
1973	0102	TIBET	31.17	88.08	43		5.1	ISC
1973	0422	TIBET	28.135	86.993	33		5.2	NEIS
1973	1016	NEPAL	28.219	82.945	33		5.2	NEIS
1974	0303	TIBET	30.74	86.32			5.5	ISC
1974	0324	NEPAL	27.66	86.0			5.4	ISC
1974	0927	NEPAL	28.59	85.51	20		5.5	ISC
1974	1223	NEPAL	29.32	81.38	45		5.2	ISC
1975	0131	NEPAL	28.1	84.729	33		5.4	NEIS
1975	0619		26.74	87.5			5.1	NEIS
1975	0906	NEPAL	29.21	81.95	33		5.1	ISC
1975	1126	TIBET	28.15	87.8	33		5.0	ISC
1976	0510	NEPAL	29.284	81.46	33		5.2	NEIS
1976	0914	TIBET	29.795	89.559	82		5.5	NEIS
1976	0929	NEPAL	29.817	81.39	33		5.0	NEIS
1976	1023	TIBET	28.676	86.228	63		5.1	NEIS
1977	0106	TIBET	31.048	88.058	33		5.2	NEIS
1977	0316	TIBET	31.3	89.38	33		5.0	ISC
1977	1118	TIBET	32.693	88.388	33		6.5	NEIS
1978	0210	NEPAL	28.03	84.7			5.3	ISC
1978	0808	TIBET	32.27	83.1			5.1	ISC
1978	1004	NEPAL	27.834	85.963	33		5.2	NEIS
1979	0520	NEPAL INDIA BORDER	30.029	80.31	33		5.9	NEIS

LIST OF EARTHQUAKES OF MORE THAN 5 MAGNITUDE

ON RICHTER SCALE, OCCURED WITHIN THE NEPAL REGION

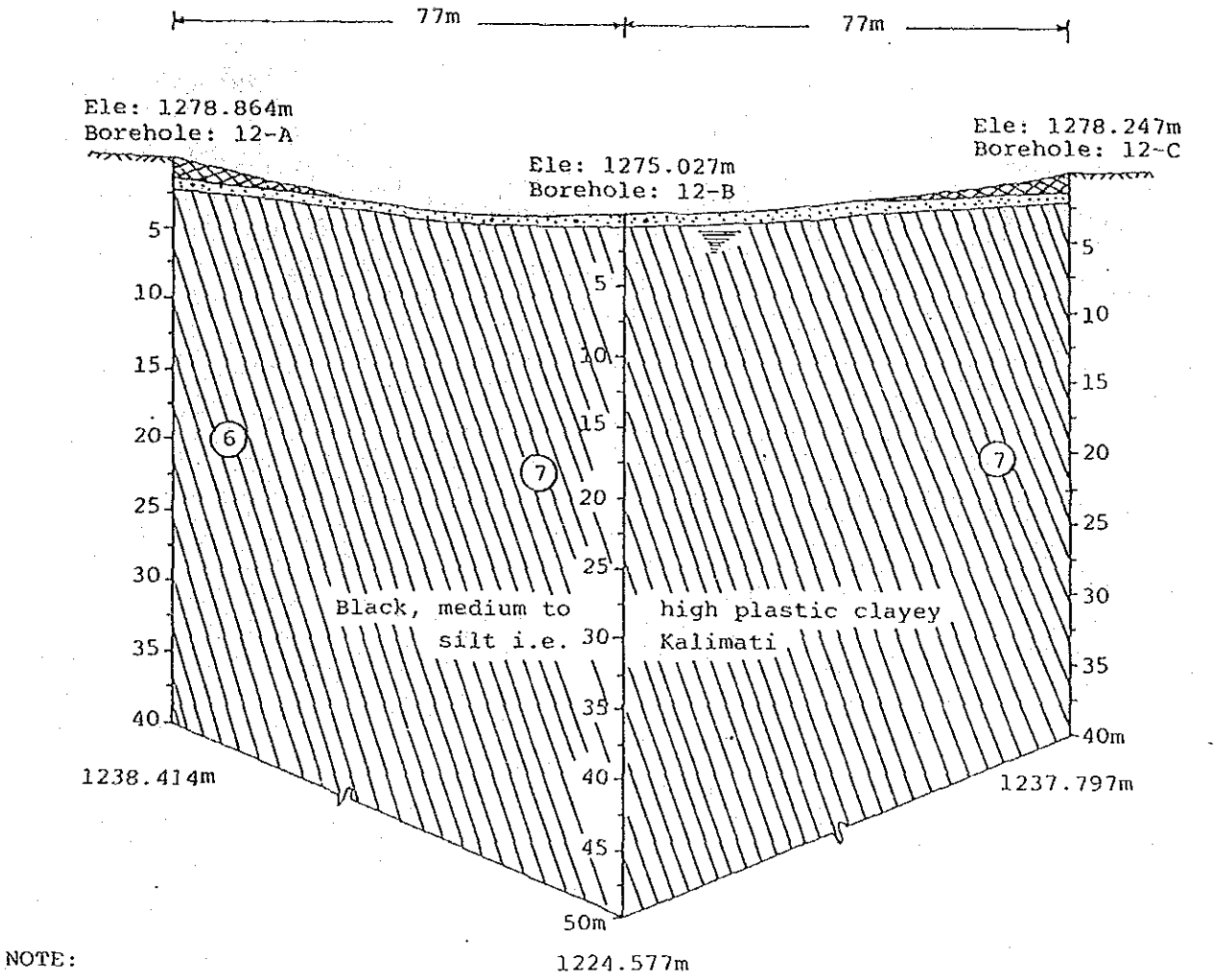
Y	M D	EPCL AREA	LAT DEG N	LONG DEG E	DEPT KM	INT MM	MAG	REF
1979	0619	NEPAL INDIA BORDER	26.74	87.48			5.2	ISC
1980	0222	TIBET	30.55	88.86	14		5.7	ISC
1980	0625	TIBET	30.13	81.76	28		5.1	ISC
1980	0729	NEPAL	29.34	81.21	3		5.7	ISC
1980	0729	NEPAL	29.598	81.092	18		6.1	NEIS
1980	1008	TIBET	31.354	87.666	33		5.0	NEIS
1980	1010	NEPAL	29.17	81.208	33		5.0	NEIS
1980	1118	TIBET	29.55	85.18	24		5.0	ISC
1980	1119	SIKKIM	27.4	88.8			6.0	ISC
1981	0515		29.504	81.942			5.1	
1982	0405		27.496	88.894			5.1	NEIS
1983	0202	INDIA CHINA BORDER	27.032	92.87	33		5.2	NEIS
1983	0301	INDIA CHINA BORDER	28.61	95.982	33		5.0	NEIS
1984	0219	NEPAL INDIA BORDER	29.659	80.55	58		5.0	NEIS
1984	0415	TIBET	31.586	82.262	33		5.0	NEIS
1984	0518	NEPAL	29.606	81.884	33		5.6	NEIS
1984	0521	INDIA BANGLADESH	23.663	91.519	33		5.3	NEIS
1984	1230	INDIA BANGLADESH	24.598	92.839	33		5.6	NEIS

Abbreviation

Y = year
M = month
D = day
EPCL = epicentre location
LAT = latitude
LONG = longitude
DEPT = depth of hypocentre

(6) GEOLOGICAL SOIL PROFILE AT BRIDGE SITE

BAGMATI BRIDGE SITE



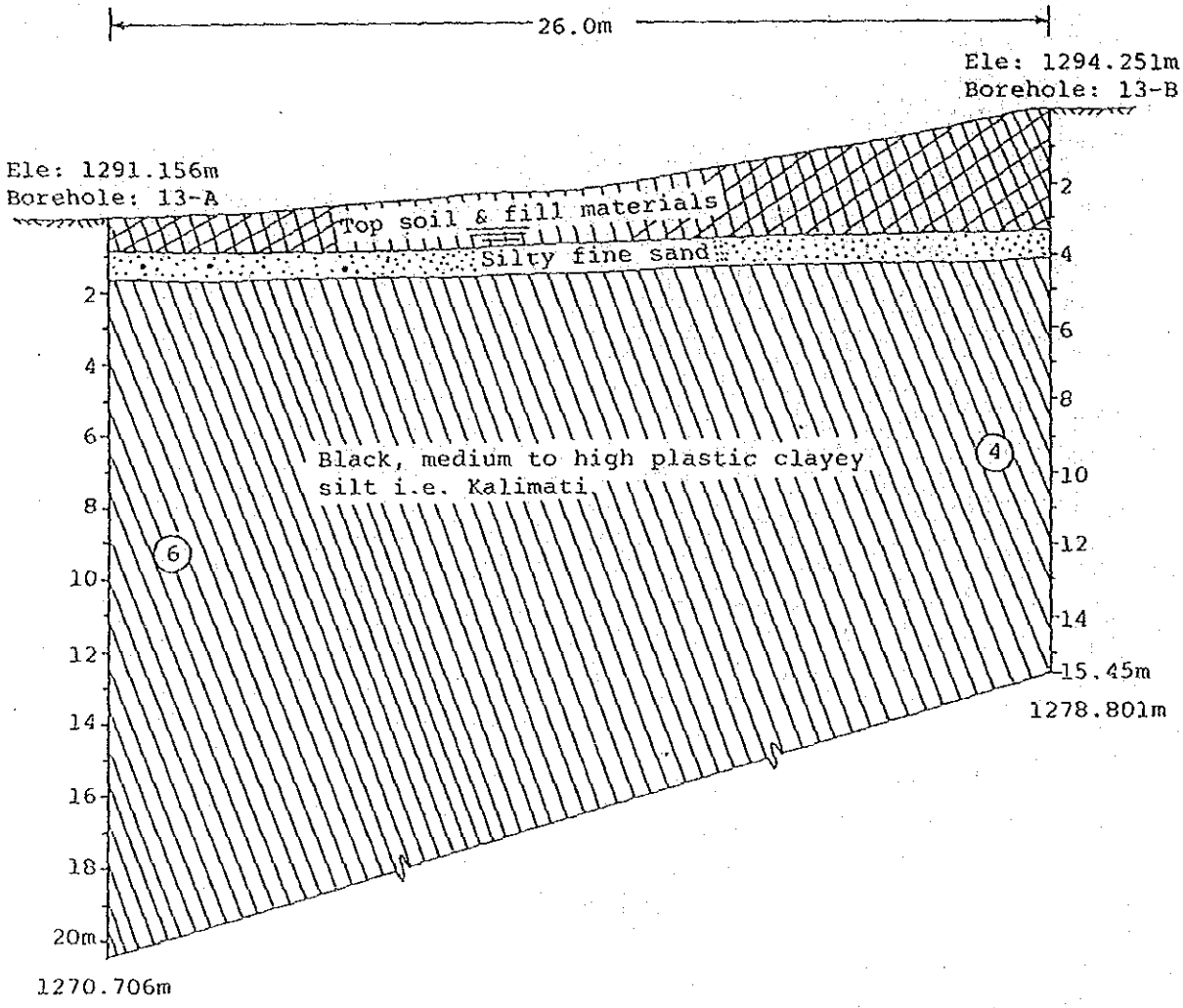
NOTE:

(7) average SPT value for the strata etc.

top soil

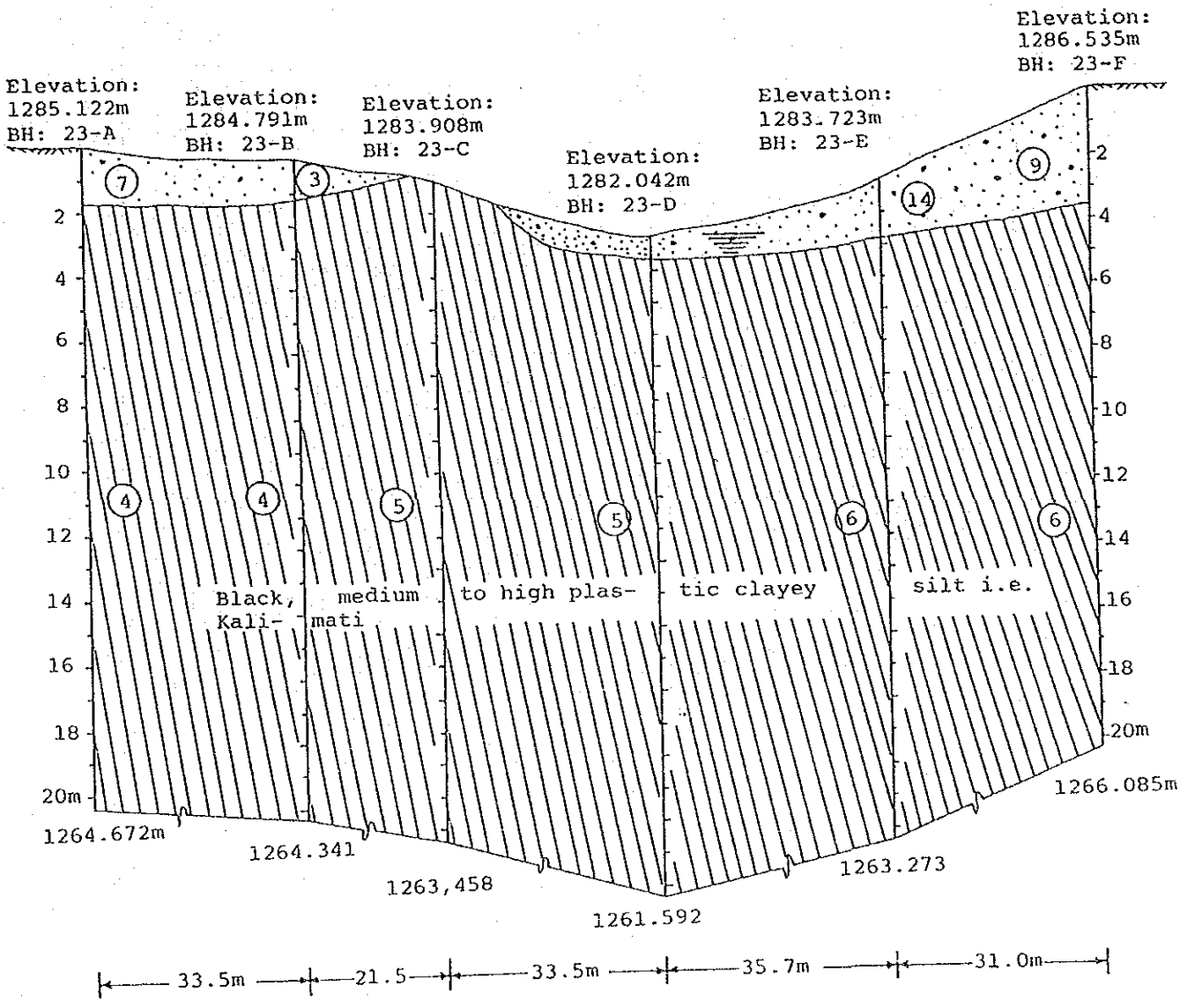
Sand with gravel

KODKU BRIDGE SITE



(6) average SPT value for the strata etc.

SHANKHAMUL BRIDGE SITE

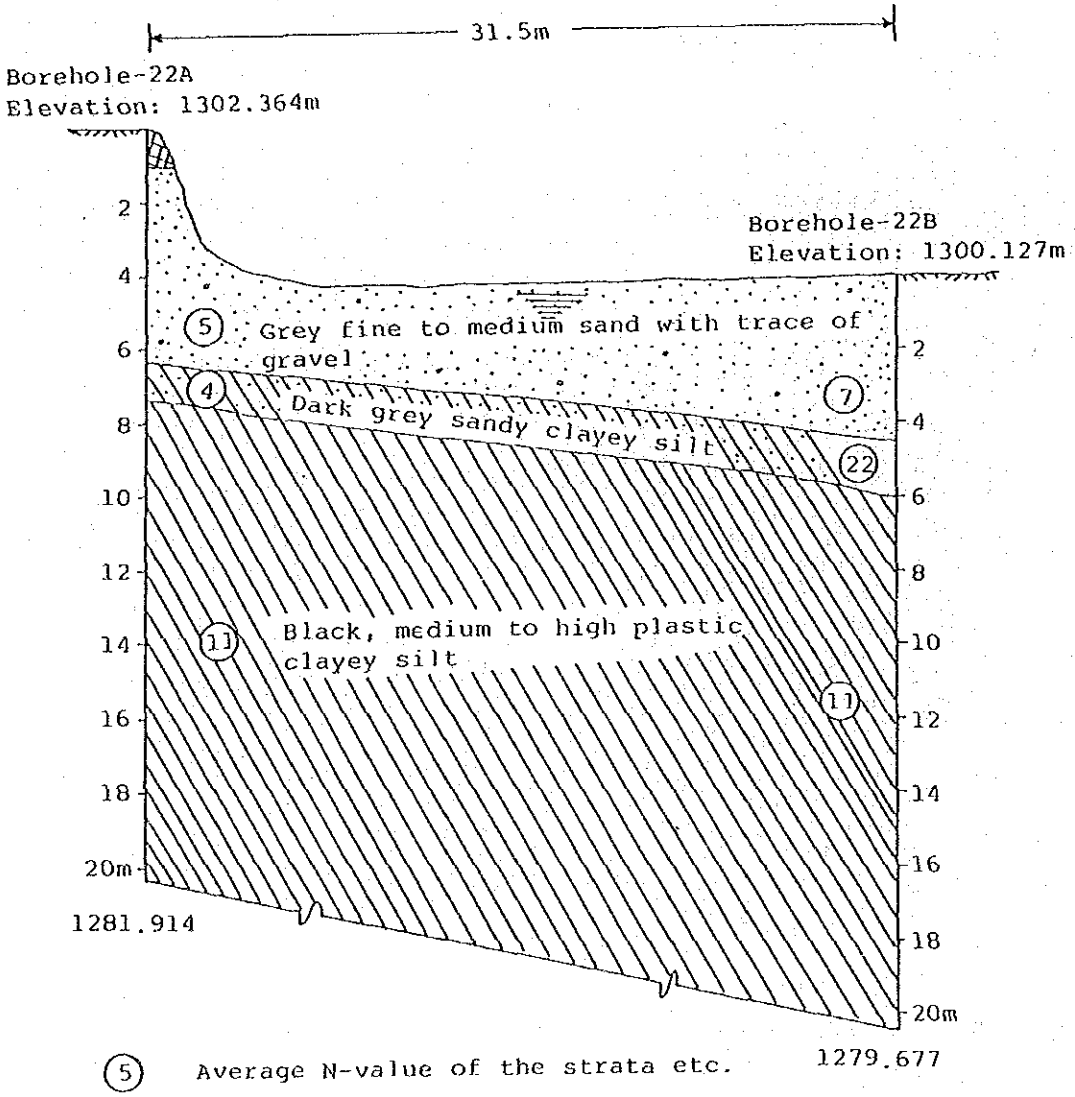


NOTE:

(7) average SPT for the strata etc.

fine to medium sand with trace of gravel

MAHADEV KHOLA BRIDGE SITE



(7) SOIL BORING LOG

Borehole: 12 A

Project : Soil investigation for the basic design study on the project for reconstruction of bridges (Phase-2)

Elevation: 1278.864m

Location: Bagmati river, Teku

Total depth: 40.45m

Date: 23-28.4.1991

Soil Description	Depth, meter	No. of blows 10cm	10cm	10cm	N-Value
Silty sand with brick bats (0-1.0m)		0	1	0	1
Sand with trace of gravel (1.0-2.0m)		0	1	1	2
	3	1	0	1	2
		0	1	1	2
		1	1	1	3
	6	2	2	1	5
		1	1	1	3
		1	1	1	3
	9	0	1	2	3
		0	1	2	3
		1	2	2	5
	12	2	2	2	6
		1	2	2	5
		2	2	2	6
	15	1	2	2	5
		1	2	1	4
		1	2	2	5
	18	2	1	2	5
Black, medium to high plastic clayey silt i.e. Kalimati (2.0-40.45m)		1	2	2	5
		1	2	1	4
	21	1	2	2	5
		2	2	2	6
		2	3	3	8
	24	2	2	3	7
		1	1	2	4
		1	2	2	5
	27	1	2	2	5
		2	2	2	6
		2	2	2	6
	30	2	2	3	7
		2	2	3	7
		2	3	2	7
	33	3	2	2	7
		3	3	1	7
		2	3	2	7
	36	4	5	5	14
		2	6	6	14
		4	5	6	15
	39	4	6	6	16
	40	5	5	7	17

Symbol

Sample/type

Disturbed samples are taken at every 1.0m depth to the entire depth of borehole

Water level

Water level is available at the surface

SPT value-N, No. of blows/30cm penetration

10 30 50 70 90

NOTE:

■ Undisturbed sample

Borehole: 12-B

Project : Soil investigation for the basic design study on the project for reconstruction of bridges (Phase-2)

Elevation: 1275.027

Location: Bagmati river, Teku Total depth: 50.45m

Date: 30.4-5.5.1991

Soil Description	Depth, meter	Sample/type	No. of blows 10cm	10cm	10cm	N-Value	Water level	SPT value-N, No. of blows/30cm penetration
Coarse sand with gravels (0-0.7m)			1	1	1	3		
			1	1	1	3		
			1	1	2	4		
	3		1	1	1	3		
			1	1	1	3		
			1	1	1	3		
	6		1	1	1	3		
			1	1	1	3		
			1	1	1	3		
	9		1	1	1	3		
			1	1	2	4		
			1	1	1	3		
	12		1	1	1	3		
			0	1	1	2		
			1	1	1	3		
	15		0	1	1	2		
			1	1	1	3		
			2	2	2	6		
	18		1	2	2	5		
			2	2	3	7		
Black, medium to high plastic clayey silt i.e. Kalimati (0.7m-50.0m)			2	3	4	9		
	21		2	2	3	7		
			3	3	2	8		
			3	2	3	8		
	24		3	3	3	9		
			3	2	3	8		
			3	3	3	9		
	27		2	3	3	8		
			2	2	3	7		
			2	3	3	8		
	30		3	2	3	8		
			3	3	3	9		
			2	3	3	8		
	33		2	3	3	8		
			2	3	3	8		
			3	3	4	10		
	36		4	4	3	11		
			3	3	4	10		
			3	4	3	10		
	39		2	3	4	9		
			2	3	4	9		
			4	3	3	10		
	43							
NOTE:			3	4	3	10		
Natural gas blowed from 25m depth	46		3	4	4	11		
			3	3	3	9		
	49							
	50		3	3	4	10		

Disturbed samples extracted from each 1.0m depth to the entire depth of borehole

Water level encountered at the surface

Borehole: 12 C

Project : Soil investigation for the basic design study on the project for reconstruction of bridges (Phase-2)

Elevation: 1278.247m

Location: Bagmati river, Teku Total depth: 40.45m

Date: 26-28.4.1991

Soil Description	Depth, meter	No. of blows 10cm	10cm	10cm	N-Value
Top soil i.e. silty sand (0-1.0m)		1	0	0	1
Grey, silty fine sand (1-1.8m)		0	1	1	2
	3	0	1	1	2
		1	0	1	2
		1	1	0	2
	6	1	1	0	2
		1	1	1	3
		1	1	2	4
	9	1	1	2	4
		2	2	2	6
		2	2	2	6
	12	2	2	2	6
		2	2	1	5
		2	2	2	6
	15	2	2	2	6
		1	2	2	5
		2	1	2	5
	18	2	1	3	6
Black, medium to high plastic clayey silt i.e. kalimati (1.8-40.45m)		2	1	3	6
		2	2	2	6
	21	2	2	2	6
		2	3	3	8
		2	3	4	9
	24	4	4	4	12
		4	4	4	12
		4	4	5	13
	27	4	4	4	12
		4	4	5	13
	30	3	4	5	12
		4	4	5	13
	33	4	4	5	13
		4	4	5	13
	36	4	4	5	13
		4	5	5	14
	39	4	5	6	15
	40				

Sample/type: Disturbed samples are taken at every 1.0m depth to the entire depth of borehole

Water level: Water level is available at the surface

SPT value-N, No. of blows/30cm penetration

Borehole: 13-A

Project : Soil investigation for the basic design study on the project for reconstruction of bridges (Phase-2)

Elevation: 1291.156

Location: Kotkhu khola

Total depth: 20.45

Date: 6-7.5.1991

Soil Description	Depth, meter	No. of blows 10cm	10cm	10cm	N-Value
Top soil		4	4	5	13
Sand with gravel & boulder		1	1	2	4
	3	1	1	1	3
		1	1	2	4
		1	1	2	4
	6	1	1	2	4
		2	2	3	7
		1	2	2	5
Black, medium to high plastic clayey silt (2.5m-20.45m)	9	1	1	1	3
		2	2	2	6
		1	1	2	4
	12	2	2	2	6
		2	2	2	6
		2	2	2	6
	15	3	3	4	10
		4	3	3	10
		3	3	3	9
	18	2	3	3	8
		3	4	4	11
		3	4	4	11
	21				
	24				
	27				
	30				

Symbol

Sample/type: Disturbed samples extracted at each 1.0m depth to the entire depth of borehole

Water level: Water level encountered at the surface

SPT value-N, No. of blows/30cm penetration

10 30 50 70 90

Borehole: 13-B

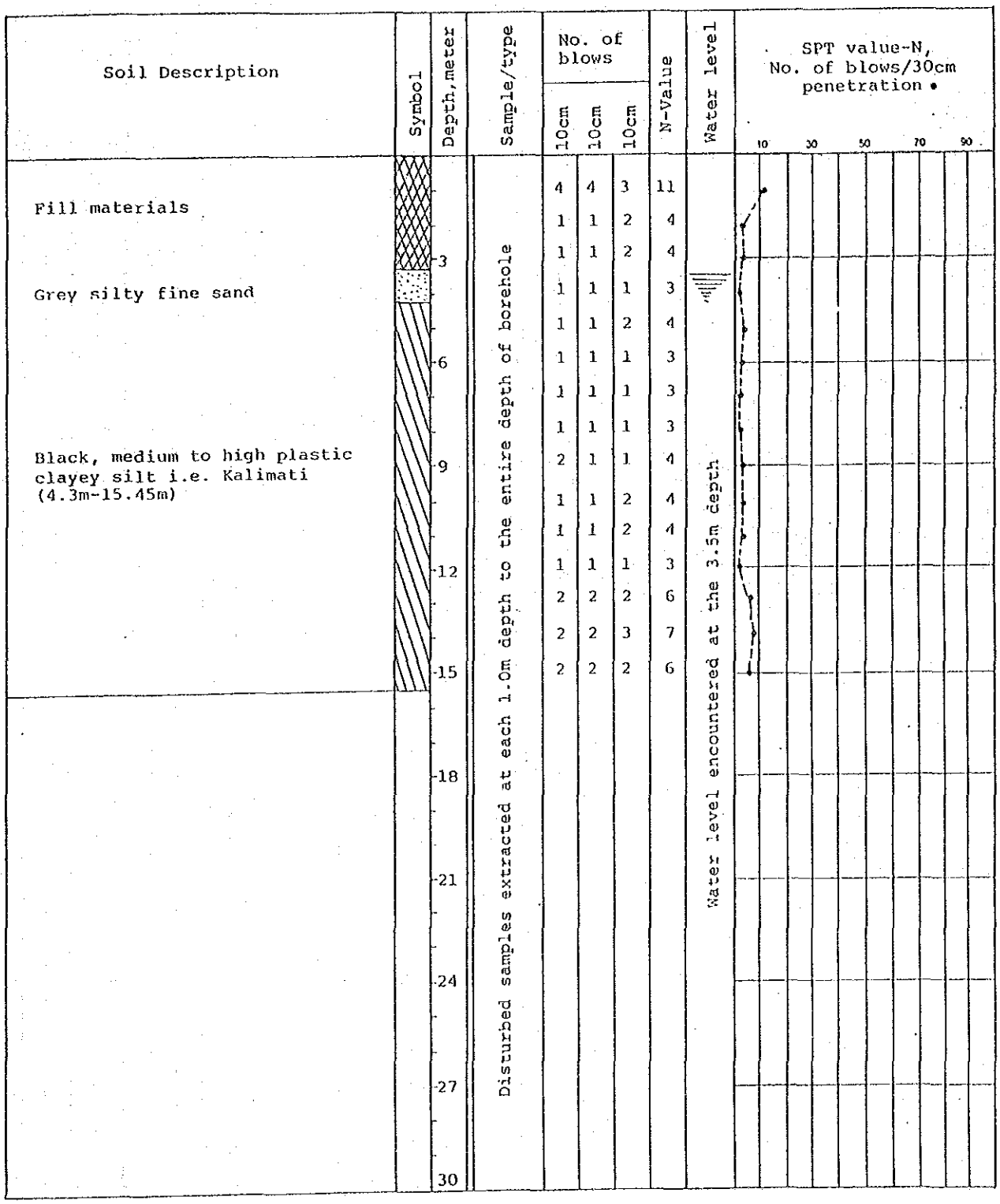
Project : Soil investigation for the basic design study on the project for reconstruction of bridges (Phase-2)

Elevation:1294.251

Location: Kotkhu khola

Total depth: 15.45m

Date: 6-7.5.1991



Borehole: - 22A

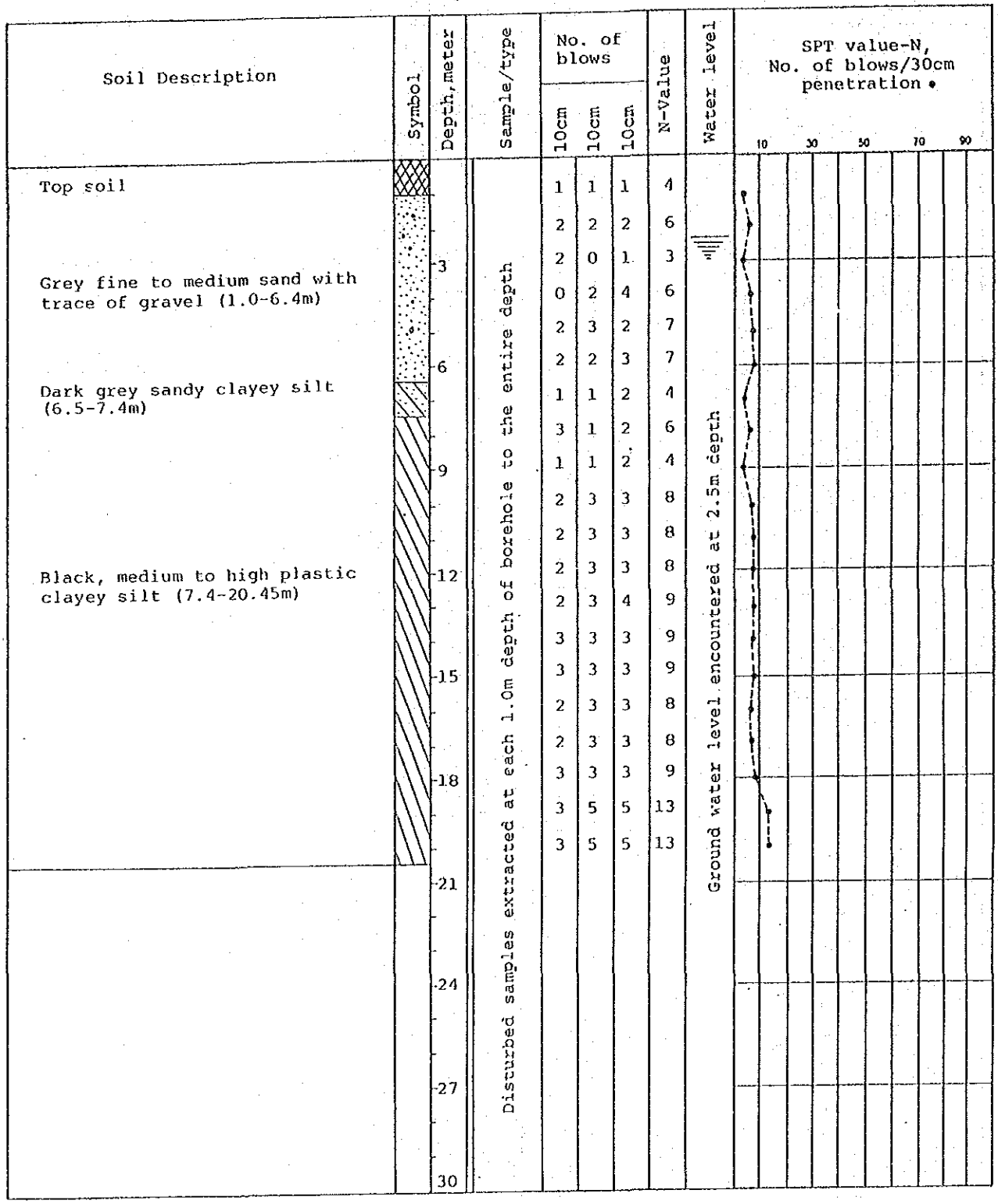
Project : Soil investigation for the basic design study on the project for reconstruction of bridges (Phase-2)

Elevation: 1302.364m

Location: Mahadev Khola

Total depth: 20.45m

Date: 18-21.4.1991



Borehole: - 22B

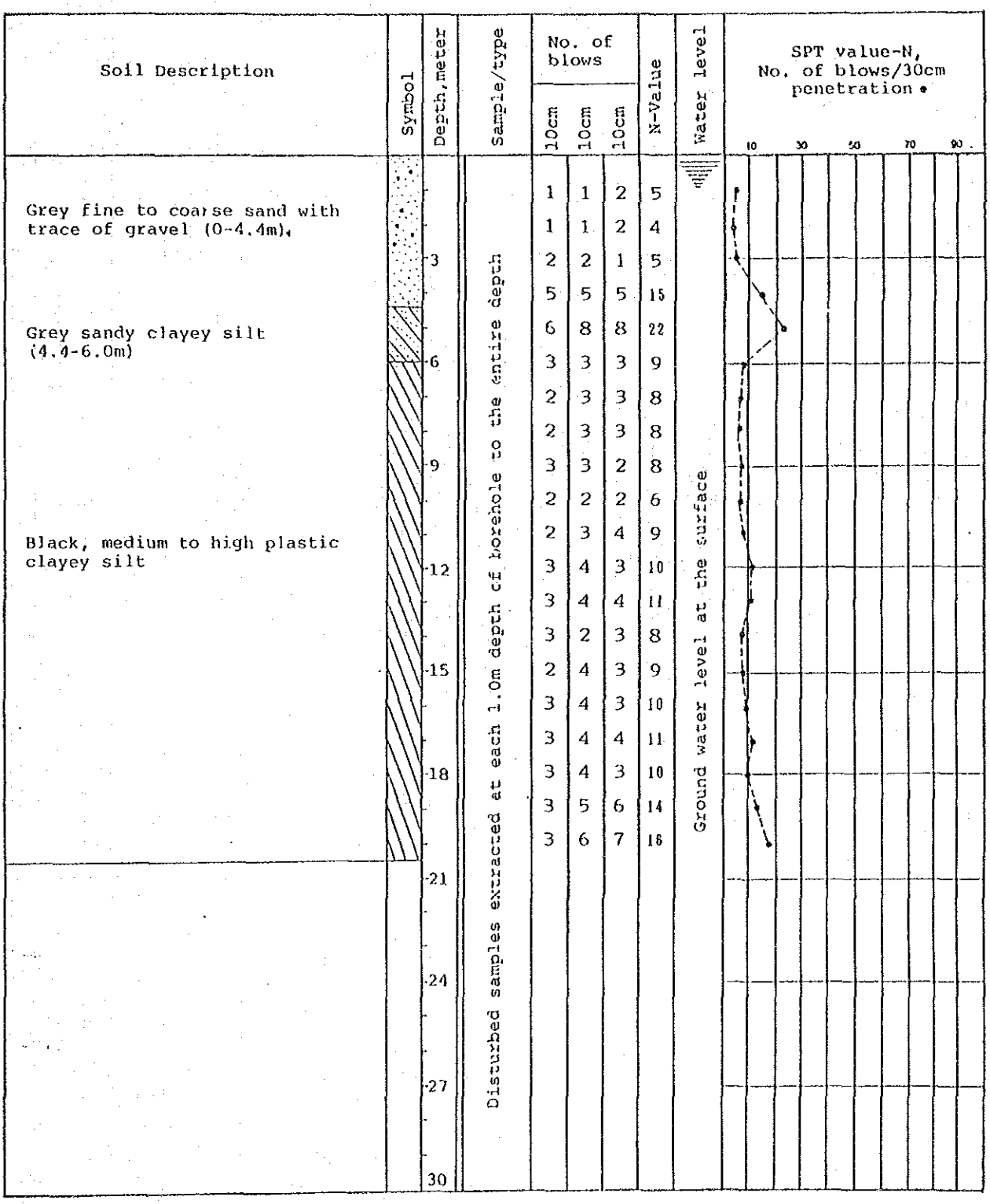
Project : Soil investigation for the basic design study on the project for reconstruction of bridges (Phase-2)

Elevation: 1300.127

Location: Mahadev Khola

Total depth: 20.45m

Date: 18-21.4.1991



Borehole: 23-A

Project : Soil investigation for the basic design study on the project for reconstruction of bridges (Phase-2)

Elevation: 1285.122m

Location: Bagmati river, Sankhamul

Total depth: 20.45m

Date: 3.5.1991

Soil Description	Depth, meter	No. of blows 10cm	10cm	10cm	N-Value
Grey, fine to medium sand with gravel (0-1.8m)	0	3	2	2	7
		1	1	1	3
	3	1	1	1	3
		1	1	1	3
		1	1	1	3
	6	1	1	1	3
		2	1	1	4
		2	2	2	6
Black, brown, medium to high plastic clayey silt i.e. Kalimati (1.8-20.45m)	9	1	1	2	4
		1	1	1	3
		2	1	1	4
	12	1	1	1	3
		2	2	2	6
		1	2	2	5
	15	2	2	2	6
		2	2	2	6
		1	2	2	5
	18	1	2	2	5
		1	2	2	5
		3	3	3	9
	21				
	24				
	27				
	30				

Disturbed samples extracted from each 1.0m depth interval to the entire depth

Water level is encountered at the surface

SPT value-N, No. of blows/30cm penetration •

10 30 50 70 90

Borehole: 23-B

Project : Soil investigation for the basic design study on the project for reconstruction of bridges (Phase-2)

Elevation: 1284.791m

Location: Bagmati river, Sankhamul

Total depth: 20.45m

Date: 30.4.1991

Soil Description	Depth, meter	No. of blows 10cm	10cm	10cm	N-Value
Grey, fine to medium sand (0-1.3m)		1	1	1	3
		0	0	0	0
	3	1	1	1	3
		1	1	1	3
		1	1	1	3
	6	1	2	2	5
		1	2	1	4
		1	2	2	5
Black, medium to high plastic clayey silt (1.3-20.45m)	9	1	2	2	5
		1	2	2	5
		1	1	2	4
	12	1	2	2	5
		1	1	2	4
		1	1	2	4
	15	1	1	2	4
		2	2	3	7
		1	2	2	5
	18	2	2	2	6
		2	2	3	7
		2	2	3	7
	21				
	24				
	27				
	30				

Symbol

Sample/type: Disturbed samples extracted from each 1.0m depth interval to the entire depth

Water level: Water level is encountered at 1m depth

SPT value-N, No. of blows/30cm penetration •

10 30 50 70 90

Borehole: 23-C

Project : Soil investigation for the basic design study on the project for reconstruction of bridges (Phase-2)

Elevation: 1283.908m

Location: Bagmati river, Sankhamul

Total depth: 20.45m

Date: 2.5.1991

Soil Description	Symbol	Depth, meter	Sample/type	No. of blows 10cm	10cm	10cm	N-Value	Water level	SPT value-N, No. of blows/30cm penetration • (10 30 50 70 90)
Black, medium to high plastic clayey silt i.e. Kalimati (0-20.45m)		3	Disturbed samples extracted from each 1.0m depth interval to the entire depth	0	0	1	1	Water level is encountered at the surface	
				1	1	2	4		
				1	2	1	4		
		6		1	1	1	3		
				1	1	2	4		
				1	1	1	3		
		9		2	1	2	5		
				2	2	3	7		
				1	2	3	6		
		12		1	1	1	3		
				1	2	2	5		
				1	2	2	5		
				1	2	2	5		
		15		2	2	2	6		
				1	1	2	4		
				1	1	2	4		
				1	1	2	4		
		18		2	2	3	7		
				2	2	3	7		
				2	3	3	8		
		21							
		24							
		27							
		30							

Borehole: 23-D

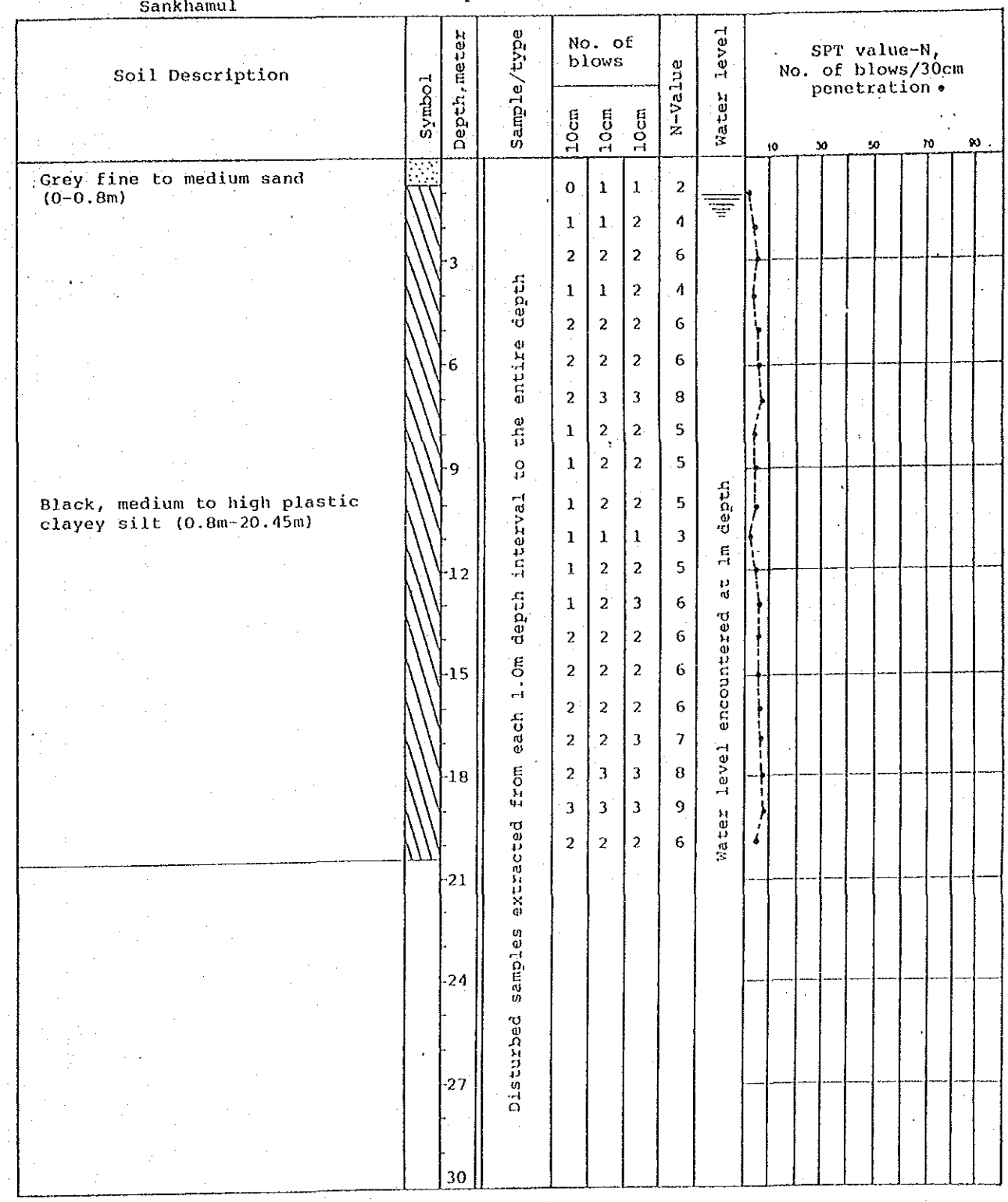
Project : Soil investigation for the basic design study on the project for reconstruction of bridges (Phase-2)

Elevation: 1282.042m

Location: Bagmati river, Sankhamul

Total depth: 20.45m

Date: 3.5.1991



Borehole: 23-E

Project : Soil investigation for the basic design study on the project for reconstruction of bridges (Phase-2)

Elevation: 1283.723m

Location: Bagmati river, Sankhamul

Total depth: 20.45m

Date: 2.5.1991

Soil Description	Depth, meter	No. of blows 10cm	10cm	10cm	N-Value
Grey fine to medium sand with gr gravel (0-1.8m)		4	4	6	14
		1	1	1	3
	3	1	1	2	4
		1	1	2	4
		2	1	2	5
	6	2	2	2	6
		1	2	3	6
		2	2	3	7
	9	3	2	3	8
Black, medium to high plastic clayey silt i.e. Kalimati (1.8m-20.45m)		2	1	2	5
		1	2	1	4
	12	2	1	2	5
		2	2	2	6
		2	3	2	7
	15	2	3	2	7
		2	2	2	6
		2	2	3	7
	18	2	3	2	7
		3	2	3	8
		3	2	4	9
	21				
	24				
	27				
	30				

Sample/type: Disturbed samples extracted from each 1.0m depth interval to the entire depth

Water level: Water level encountered at the surface

SPT value-N, No. of blows/30cm penetration •

10 30 50 70 90

Borehole: 23-F

Project : Soil investigation for the basic design study on the project for reconstruction of bridges (Phase-2)

Elevation:1206.535m

Location: Bagmati river, Sankhamul

Total depth: 20.45m

Date: 30.4.1991

Soil Description	Depth, meter	Sample/type	No. of blows 10cm	10cm	10cm	N-Value	Water level	SPT value-N, No. of blows/30cm penetration •
Grey fine to medium sand (0-1.4m)		Disturbed samples extracted from each 1.0m depth interval to the entire depth	2	2	3	7	Water level encountered at the surface	
			2	3	4	9		
Grey coarse sand with gravel (1.4m-3.7m)	3		3	4	4	11		
			1	1	2	4		
			1	2	2	5		
	6		1	2	2	5		
			2	2	2	6		
			1	2	2	5		
	9		2	2	2	6		
			1	2	2	5		
Black, medium to high plastic clayey silt i.e. kalimati (3.7m-20.45m)			2	2	3	7		
	12		1	1	3	5		
			2	2	2	6		
			2	2	3	7		
	15		2	2	2	6		
			1	2	2	5		
			1	2	2	5		
	18		2	3	3	8		
			3	3	3	9		
			3	3	4	10		
	21							
	24							
	27							
	30							

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