Appendix-C16.3-6

Hydrological and Morphological Analysis

D Hydrological and Morphological Analysis

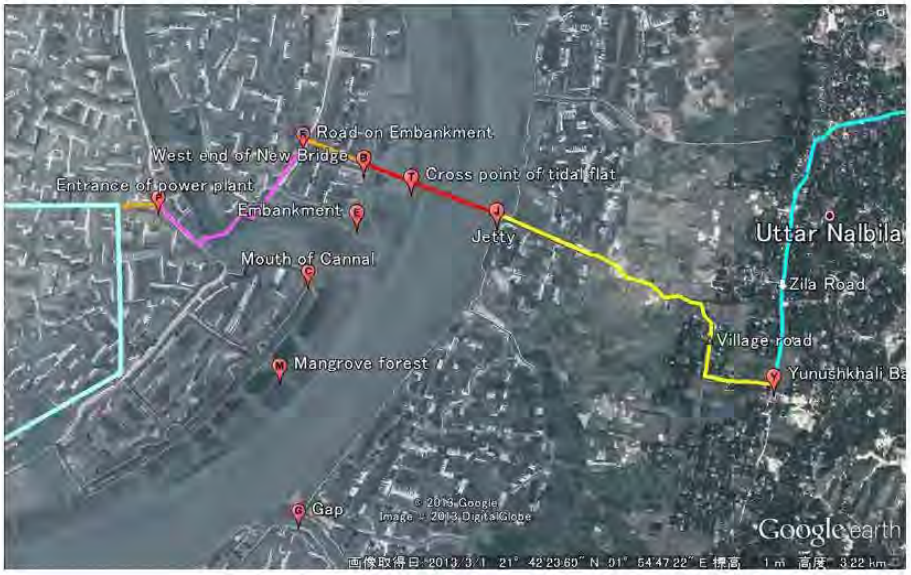
Hydrological and Morphological Analyses for Construction of Bridge over the Kohelia River on the 'Access Road' to the 'Chittagong Area Coal Fired Power Plant'

D1. Introduction

The 'Access Road' of the proposed 'Chittagong Area Coal Fired Power Plant' will need construction of a new bridge over the Kohelia River in Maheshkhali Upazila of Cox's Bazar District. The bridge will be about 640 m long on about 578 m wide river channel. The Kohelia River is referred to as Matarbari Channel in Bangladesh Water Development Board (BWDB) documents. The proposed power plant is going to be located inside BWDB Coastal Flood Protection Polder No – 70; in areas under Matarbari and Dholghata unions of Maheshkhali Upazilla. The Polder 70 is surrounded by the Kohelia River on the northern and the eastern sides where as the Kutubdia Channel and the Bay of Bengal is located on the western side and the southern side respectively. The proposed approach road coming from the eastern side will cross the Kohelia River and then follow the BWDB embankment for a distance, on way to the proposed power plant site inside the Polder 70. The Kohelia River Bridge will start from Nayaghata Jetty site, on the eastern bank of the Kohelia River. The bridge will cover about62 m mud-flat on the west bank after crossing the existing river channel.

General lay-out of the Kohelia River, proposed bridge site, access road alignments and part of power plant site are shown in the figure below:

Figure:General lay-out of the proposed Kohelia River Bridge site

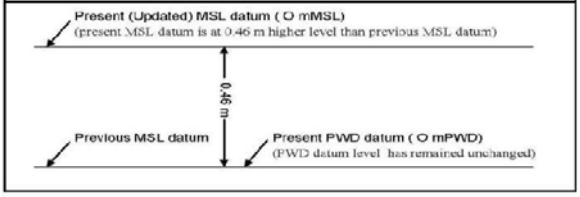


Hydrological and morphological analyses of the Kohelia River, related to the construction of the proposed bridge have been detailed in the following chapters. Considering normal practice all the analyses have been presented in Public Works Department (PWD) datum values. Relationship between Public Works Department (PWD) value and Mean Sea Level (MSL) value has been explained below mathematically and schematically for quick reference.

Relationship between Mean Sea Level (MSL) value and Public Works Department (PWD) value

Public Works Department (PWD) datum value was fixed initially on the basis of the then Mean Sea Level (MSL) datum value. Subsequently MSL datum level has been raised up but PWD datum level has remained unchanged. The schematic relationship is shown in the attached figure. Because of rising of MSL datum level, the new mathematical relationship between MSL and PWD levels is: mPWD =mMSL + 0.46 m

Figure: Schematic representation of relationship between MSL and PWD datum values



D2 Hydrological Analyses For Design Of The Proposed Kohelia River Bridge

Hydrological analyses are done to determine hydraulic design parameters for detailed design of a bridge. The analyses would be kept limited to the Kohelia River Bridge only, for reasons as have been detailed before. The required hydraulic deign parameters are:

(1) Design High Water Level (DHWL);
(2) Design Low Water Level (DLWL);
(3) Design Discharge;
(4) Water Way Opening;
(5) Anticipated Scour Depth; and
(6) Navigation Clearance.

Following data and information have been collected from field reconnaissance, surveys and other sources.

- The Kohelia is an active tidal river. The proposed bridge is going to be about 640 m long; of which about 578 m will be on main channel and about 62 m will be on western side mud flat;
- Average ground level on the eastern side of the bridge is 2.157 mPWD.
- Average ground level on the western side mud-flat is 2.587 mPWD.
- RL of the river banks at bank-full stage is 2.157mPWD
- Cross section area of the river at bank-full level is 1050 m^2
- Observed highest water level at a BWDB water level gauge station (Shaflapur of Maheshkhali) in close proximity of the bridge site is 4.36 mPWD.
- Observed lowest water level at the gauge station mentioned above is (-) 2.17 mPWD
- Observed lowest bed level of the river at the time of bathymetries survey was (-) 3.87 mPWD.
- Mean High Water Spring (MHWS) at nearby Cox's Bazar as per BIWTA Tide Table - 2013 is:
  3.785 mCD = 3.785-(4.836-3.931) mPWD = 2.88 mPWD.
- Mean Low Water Spring (MLWS) at nearby Cox's Bazar as per BIWTA Tide Table – 2013 is:
  0.205 mCD = 0.205-(4.836-3.931) mPWD = (-) 0.700 mPWD.
- Highest flood level considered in construction of BWDB Polder - 70 embankment in 1962-65 was 3.96 mPWD (source: Halcrow et. al; BWDB Systems Rehabilitation Project, Feasibility Report, Polder – 70 Sub-project; June 1994).
- A BWDB design of protective work for Polder – 70 in 30 June 2009 has considered HWL to be 4.00 mPWD.
- Anticipated navigation clearance above design high water level is 8 m.
- Horizontal clearance is 30.48m

1 Design High Water Level (DHWL)

Roads & Highways Department of Bangladesh made an overall hydraulic analysis for the Bangladesh region in 1992 for bridge design purpose under Road Master Plan Project (RMPP). The RMPP Study Report (in Vol-V; Hydrology) recommended 50 years flood frequency analyses for construction of road bridges on stretches of land exposed to direct over-spill from large rivers. The study also recommended use of normal high tide level for design purpose in case of roads located within active tidal zone. Fixations of Design High Water Level (DHWL) considering different criteria are detailed below.The criteria considered are:

- Tide level;
- Long-term highest water level;
- Frequency analyses;
- HFL considered by BWDB, (a) in construction of Polder – 70; and (b) in construction of protective works for Polder – 70
- Cyclone storm surge levels; and
- Sea level rise.

1.1 Tide level

The Kohelia River is in active tidal zone being connected to Bay of Bengal directly at one end and through Kutubdia Channel at the other end. Tides in Bangladesh coast originate in the Indian Ocean and then enter the Bay of Bengal through 2 submarine canyons, namely the 'Swatch of No Ground' and the 'Burma Trench'. The tides in the Bay of Bengal are predominantly semi-diurnal having a tidal period of 12 hours 25 minutes. Normal high tide level in Bay of Bengal is the Mean High Water Spring (MHWS). MHWS is the highest level to which spring tide reaches on the average over a period of time (often 19 years). The level is generally considered to be the high water mark. MHWS is expressed in meter above or below Chart Datum (CD). CD is the plane of vertical reference to which all charted depths are related. It is a plane so low that the water levels seldom fall below it.

MHWS value of nearby Bangladesh Inland Water Transport Authority (BIWTA) measuring station Cox's Bazar is 3.785m CD (BIWTA Tide Table-2013). It may be mentioned here that BIWTA Bench Mark (BM) height at Cox's Bazar is 4.836 m and 3.931 m in CD value and PWD value respectively.

Therefore, MHWS value is3.785 - (4.836 - 3.931) mPWD = 2.880 mPWD

1.2 Long term highest water level

Nearest available water level station is BWDB water level measuring station at Shaflapur of Maheshkhali Upazila. Particulars of the gauge station are:

Station Name: Shaflapur, Maheshkhali BWDB Gauge Station
Station ID: SW 200
Station Location: Latitude 21.6479, Longitude 91.98

Data of the gauge station mentioned above was procured for the period of 1971 to 2012 from BWDB archive being maintained by Hydrology Directorate of BWDB. Yearly maximum and minimum water levels were extracted. It may be mentioned here that missing data as well as confusing data were not considered in preparation of the list. Observed yearly maximum and minimum water levels of Shaflapur, Moheshklali is given in the table below:

Table: Yearly maximum and minimum water levels of Shaflapur, Maheshkhali BWDB Gauge StationPeriod:1971to2012(Source: Hydrology Directorate, BWDB)

Serial	Year	Yearly maximum WL(mPWD)	Maximum recorded WL during the period (mPWD)	Yearly minimum WL(mPWD)	Minimum recorded WL during the period(mPWD)
1	1971	3.23		(-) 1.68	

Serial	Year	Yearly maximum WL(mPWD)	Maximum recorded WL during the period (mPWD)	Yearly minimum WL(mPWD)	Minimum recorded WL during the period(mPWD)
2	1972	3.05		(-) 1.77	
3	1973	3.17		(-) 1.80	
4	1974	3.75		(-) 1.74	
5	1975	2.74		(-) 1.68	
6	1976	3.16		(-) 0.39	
7	1977	3.35		(-) 1.67	
8	1978	2.59		(-) 1.68	
9	1983	4.21		(-) 1.91	
10	1984	3.65		(-) 1.55	
11	1985	4.36	**4.36**	(-) 1.20	
12	1986	3.60		(-) 1.20	
13	1987	4.20		(-) 1.50	
14	1988	4.20		(-) 1.50	
15	1989	4.20		(-) 1.86	
16	1990	3.76		(-) 1.86	
17	1991	3.13		(-) 2.17	**(-) 2.17**
18	1992	3.33		(-) 2.10	
19	1993	3.56		(-) 1.88	
20	1994	3.16		(-) 1.64	
21	1995	3.74		(-) 1.55	
22	1996	3.88		(-) 1.35	
23	1997	3.75		(-) 1.40	
24	1998	3.20		(-) 1.30	
25	2004	3.45		(-) 1.60	
27	2005	3.70		(-) 1.80	
28	2006	2.80		(-) 1.70	
29	2007	*		(-) 1.80	
30	2008	3.84		*	
31	2009	3.98		*	
32	2010	3.95		*	
33	2011	3.88		*	
34	2012	3.97		*	

Note:*indicates confusing data

Highest recorded water level at the gauge station SW 200 during the period 1971 – 2012 is 4.36 mPWD

1.3 Frequency analyses of highest flood levels

Frequency analysis of highest flood levels on the basis of available BWDB Shaflapur, Maheshkhali data was done using Gumbels EV-1 method. The peak water levels are:

1: 10 year: 4.29 mPWD
1: 20 year: 4.59 mPWD
1: 25 year: 4.68 mPWD
1: 50 year: 4.98 mPWD

Halcrowet.al, did frequency analysis with BWDB data of Bakkhali River near Cox's Bazar during feasibility study preparation for Polder-70 sub-project under BWDB Systems Rehabilitation Project (June 1994). They calculated peak water levels as:

1:20 year: 3.63 mPWD
1:50 year: 3.74 mPWD

Halcrow et.al in their report mentioned above, also quoted frequency analysis of Cyclone Protection Project-II for the region as:

1:20 year: 4.24 mPWD
1:50 year: 4.60 mPWD

1.4 HFL considered by BWDB, (a) in construction of Polder – 70; and (b) in construction of protective works for Polder – 70

(a) Highest flood level considered in construction of BWDB Polder - 70 embankment

Polder - 70 was constructed by BWDB during the period of 1962-1965, under 'Coastal Embankment Project (CEP-1)'. The polder had 25.76 km of sea dyke and 8.04 km of interior dyke. Design crest levels of the sea dyke and the interior dyke were 5.49 mPWD [3.96 m (HFL) +1.53 m (free board)] and 4.88 mPWD [3.96m (HFL)+0.92m (Free board)] respectively. The dykes have withstood the onslaught of tides and storm surges without any over topping since then.

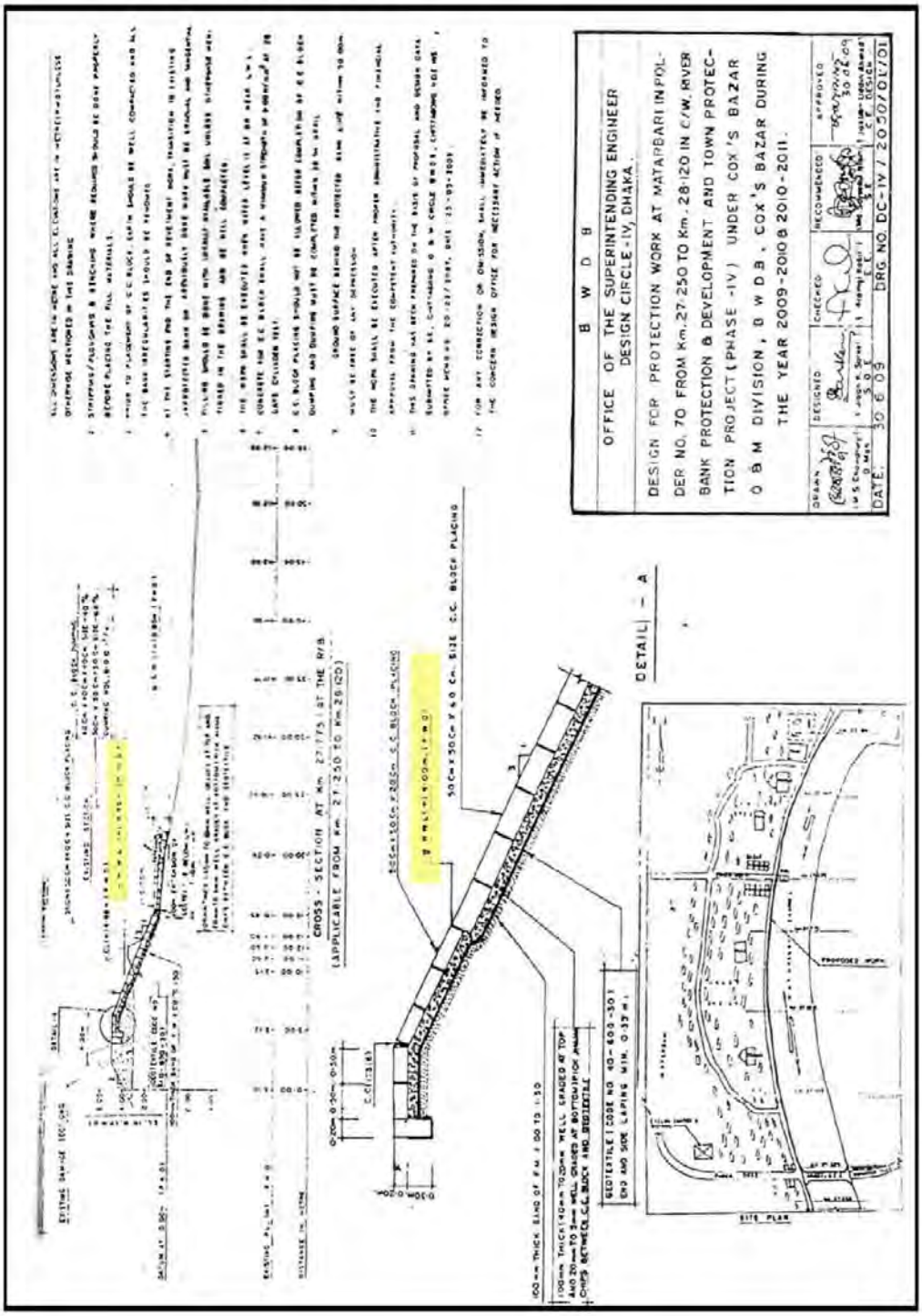
Design flood level considered for construction of the dykes was 3.96 mPWD. (Reference: Halcrow et. al; BWDB Systems Rehabilitation Project; Feasibility Report, Polder-70 Sub-project; June 1994).

(b) Highest water level considered by BWDB (in 30 June 2009) in design of protective worksof Matarbari in BWDB Polder - 70 embankment

BWDB Design Circle – IV, Dhaka designed protective works for Matarbari, Km 27.250 to Km 28.120 of Polder – 70 embankments in connection with Riverbank Protection & Development and Town Protection Project (Phase – IV) under Cox's Bazar O&M Division, BWDB, Cox's Bazar during the year 2009 – 2010 & 2010 – 2011. Highest water level for the design of the protective works has been taken as 4.00 mPWD. Photocopy of a drawing sheet showing the considered Highest Water Level (HWL) of 4.00 mPWD is given in the following page.

Considering the aspects mentioned above it may be considered that BWDB constructions of Polders – 70 embankments and protective works have been designed considering Highest Water Level (HWL) of 4.00 mPWD.

Figure: BWDB drawing for protective works of Matarbari, Polder – 70 showing considered HWL of 4 mPWD



1.5 Cyclone storm surge levels

Cyclone storm surges are caused due to combined effect of different weather/environmental parameters. The parameters have too many variables and each of which is very sensitive in nature. Weather forecasting, using world's most powerful computers, is yet to be brought to a credible stage. Because of presence of so many variables in parameter, cyclone and/or cyclonic storm surge predication to an acceptable degree is yet to materialize.

Storm surge heights resulting from cyclones along Bangladesh coast have been collected from Bangladesh Meteorological Department (BMD) for the period 1960 to to-date. Since there has been no major cyclone in Bangladesh coast in recent time, the BMD has put the period 1960-2011 in the statement. In fact the statement contains cyclone AILA on 25-02-2009 as the last entry. The BMD list is given below.

Table: Major Cyclonic Storms in Bangladesh from 1960 to 2011 with Storm Surge Heights
(Source:Bangladesh Meteorological Department)

Date of landfall	Landfall area	Max. wind speed (Kph)	Surge height
11.10.1960	Chittagong	160	6.0 m
31.10.1960	Chittagong	193	6.6 m
09.05.1961	Chittagong	160	5.0 m
30.05.1961	Chittagong (Near Feni)	160	2.0 - 4.55 m
28.05.1963	Chittagong- Cox's Bazar	200	6.0 m
11.05.1965	Chittagong-Barisal Coast	160	3.7 m
05. 1l. l965	Chittagong	160	6-7.62 m
15.12.1965	Cox's Bazar	210	2.4 - 3.6 m
23.09.1966	Noakhali coast	139	6 - 6.67 m
1.11.1966	Chittagong		6-6.7 m
07.12.1966	Cox's Bazar	81	-
08.11.1967	Khulna (Sundarban)	111	-
23.10.1967	Cox's Bazar	107	
23.10.1970	Bangladesh- WestBengal coast	163	4.7 m
12.11.1970	Chittagong	224	3 - 10 m
8.05.1971	Chittagong	81	2.4 - 4.24 m
29.09.1971	Sundarban coast	97 - 113	0.61 m
6.11.1971	Chittagong- Noakhali coast	--	-
18.1l.l973	Chittagong	102	-
30.05.1974	Patuakhali	74 - 83	-
28.11.1974	Chittagong -Cox's Bazar coast	163	3.0 - 5.1 m
10.12.1981	Khulna	120	2.12-4.55 m
15.10.1983	Chittagong	93	-
09.11.1983	Chittagong -Cox's Bazar coast	136	1.5 m
24.05.1985	Chittagong	154	4.55 m
29.11.1988	Khulna coast	160	4.4 m
18.12.1990	Cox's Bazar coast	115	2.13 m
29.04.1991	Chittagong	225	6 - 7.6 m
31.05.1991	Noakhali coast	83	2.5 m
02.05.1994	Cox's Bazar-Teknaf Coast	200 - 250	3.64 - 4.85 m
25.11.1995	South of Cox's Bazar	55	3.05 m
26.10.1996	Sundarban coast	70	1.5 - 2.0 m
19.05.1997	Sitakundu	232	4.55 m
27.09.1997	Sitakundu	150	3.03-4.55 m
20.05.1998	Chittagong coast near Sitakundu	173	0.911m
28.10.2000	Sundarban coast	50-60	1.22 m
12.11.2002	Sundarban coast near Raimangal River	65-85	2.13 m
19.05.2004	Cox's Bazar &Akyab coast	65-90	1.223 m

Date of landfall	Landfall area	Max. wind speed (Kph)	Surge height
15.05.2007(**AKASH**)	Ctg-Cox's Bazar coast near ctg	83	-
15.11.2007(**SIDR**)	Khulna-Barisal coast near Patharghata	223	6.10 m
26.10.2008(**Rashmi**)	Khulna-Barisal coast near Patharghata		2.13 m
17.04.2009(**BIJLI**)	Ctg-Cox's Bazar coast near Chittagong	90	-
25.05.2009(**AILA**)	West Bengal-Khulna (Bangladesh) coast near Sagar Island of India	92	2.44m

The highest recorded storm surge of the list is the storm surge of 12 November 1970, which has been recorded as 3 m – 10 m. Wide variation in the recorded stage of 3 m to 10 m, itself, expresses the guess/ estimation factor. The list contains the next highest storm surge to be of height 6 m – 7.62 m of the year 1965. There is again the presence of estimation factor. More or less same hold true for other data also.

There have been several exercises on predicting storm surge heights on the basis of frequency analysis. It may be mentioned here that methods of frequency analyses are empirical in nature based on statistical analyses. These have been postulated to predict long term impact of water level or discharge. Variation of water level or discharge has some limited variables. As has been mentioned before, storm surge heights are the effect of many variables. It is not comprehensible, how analysis of storm surge heights can be analogous to that of water level or discharge.However, for academic interest, some of the findings of related frequency analysis of storm surges on Bangladesh coast are presented below.

— **Frequency analysis on the basis of BMD data using Gumbel' EV-1 method**

Rearranging the yearly extreme values gives the following Table:

Year	Extreme Surge Height (m)
1960	6.6
1961	5.0
1963	6.0
I965	7.62
1966	6.7
1970	10
1971	4.24
1974	5.1
1981	4.55
1983	1.5
1985	4.55
1988	4.4
1990	2.13
1991	7.6
1994	4.85
1995	3.05
1996	2.0
1997	4.55
1998	0.911
2000	1.22
2002	2.13
2004	1.223
2007	6.10
2008	2.13
2009	2.44

Gumbel'sEV-1 method gives the following surge heights for recurrence intervals mentioned against them:

Frequency Analyses of Bangladesh Coast Cyclone Storm Surges									
Recurrence interval in years	1:2	1:5	1:10	1:20	1:25	1:50	1:100	1:200	1:1000
Water level in mPWD	3.91	6.38	8.01	9.58	10.08	11.62	13.14	14.65	18.17

— **Cyclone Protection Project (CPP)- II's frequency analysis**

Cyclone Protection Project–II presented the following cyclonic storm surge levels as per frequency analysis in their Final Project Preparation Report; Appendix – C (reference: Halcrow et. al; BWDB Systems Rehabilitation Project; Feasibility Report – Polder 70Sub-project; June 1994).

Peak water levels (mPwd) on frequency analyses of storm surges for Polder - 70						
Frequency in years	1:5	1:10	1:20	1:40	1:50	1:100
Water levels in m(PWD)	4.31	4.92	5.53	6.03	6.23	6.75

— **Institute of Water Modeling (IWM)'s analysis**

Institute of Water Modeling (IWM), in connection with a study for Pacific Consultants International of Japan reported the 100 year surge level to be around 5.5m MSL (5.96m PWD) near Sonadia Island of Cox's Bazar (IWM: Coastal and Hydraulic Study for Deep Sea Port, Final Report; November 2008).

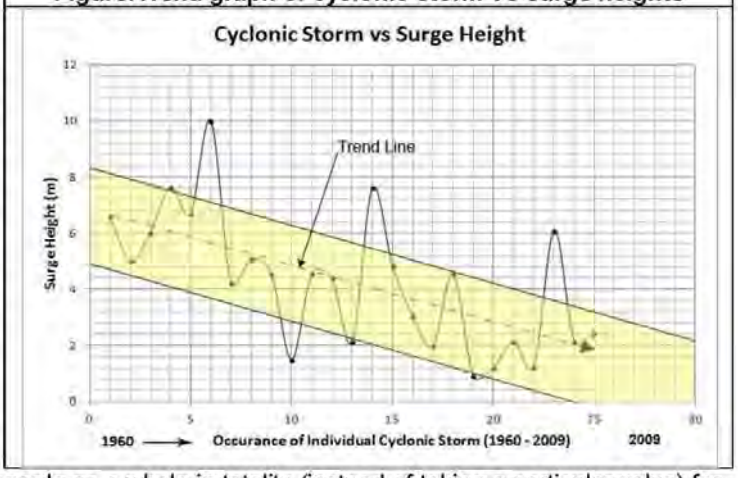
Comparison of Different Analyses Mentioned Above

It could be seen that the results are not even close to one another. For 1:100 years frequency, the storm heights are 13.14 m, 6.75 m and 5.96 m from BMD's data, CPP – II's data and IWM data respectively.

The BMD's storm surge heights (taking the higher of the stated values for each entry) were arranged in descending order to have an idea about a median cluster. But ready identification of a median cluster was not possible from the data set. The data so arranged were: 10m; 7.62 m; 7.6 m; 6.7 m; 6.6 m; 6.1 m; 6.00 m; 5.1 m; 5.0 m; 4.85 m; 4.55 m; 4.55 m; 4.55 m; 4.4 m; 4.24 m; 3.05 m; 2.44 m; 2.13 m; 2.13 m; 2.13 m; 2.00 m; 1.5 m; 1.223 m; 1.22 m and 0.911 m.

The storm surge heights were plotted against individual storms over the period; to find out trend, if any. The graph is attached herewith. It can be seen in the graph that the storm surge heights (with the exception of a few data) fit nicely in an envelope; and the envelop shows a downward movement trend. This is contrary to generally held conception that with global warming the storm surge heights are likely to increase.

Figure:Trend graph of cyclonic storm Vs surge heights



Analyzing all the above mentioned facts, evaluation of past cyclone storm surge height records as a whole in totality (instead of taking a particular value) for fixation of design high water is recommended

1.6 Sea level rise due to climate change

It is now an accepted fact that the major impact of climate change due to global warming will be the 'Sea Level Rise (SLR)'. Many papers are there in qualitative or broad based terms as to possible impact of global warming on water sector of Bangladesh. Research papers mentioning impacts of SRL in definite or quantitative terms are few and far.

The Water Resources Planning Organization (WARPO) of Bangladesh has made a detailed assessment of Impacts of SLR in the coastal zone of Bangladesh based on the recommendations of the Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC) and NAPA (National Adaptation Program of Action) scenarios (WARPO: Impact Assessment of Climate Zone of Bangladesh, 2005).The potential effects of climate change were studied for different sea level rise i. e. 14 cm, 32 cm and 88 cm for the project years 2030, 2050 and 2100.

World Bank in its report "Bangladesh: Climate Change and Sustainable Development Report No. 21140 BD, Dhaka; in the year 2000; predicated sea level rise of 10 cm, 25 cm and 1 m for Bangladesh coasts by the year 2030, 2050 and 2100 respectively. The above mentioned values are in a sense pessimistic in type, when compared to IPCC's global predicted range of 18 cm to 59 cm SLR for the year 2100.

Considering all the aspects 32 cm as considered by WARPO for the year 2050 seems to be a reasonable value for SLR consideration for construction of the road bridge.

1.7Water Way Opening

Any bridge design has to have sufficient water way, so that no afflux is created even under condition of maximum flooding. Presence of afflux has the risk of outflanking of the bridge or creation of higher velocity which may cause unanticipated scouring. In either case stability of bridge structure is endangered.

Required net water way according to Lacey's Formula is $W_s = 4.75 \sqrt{Q}$; where W_s is the required water way opening in meter and Q is the design discharge in m^3/sec. Putting the design discharge value of 7289 m^3/sec, the required net water way comes to:

$W_s = 4.75\sqrt{Q} = 4.75\sqrt{3745}$ m =290.68 m

Present water way width of the river is 578 m and the proposed bridge width including viaduct is 640 m. So the proposed bridge width is safe from water way opening consideration.

2 Design Low Water Level (DLWL)

Design low water level can be fixed from the following 2 considerations:
i) Tidal Mean Low Water Spring (MLWS)
ii) Lowest observed water level

3 Mean Low Water Spring (MLWS)

Tidal Mean Low Water Spring (MLWS) is the lowest level to which spring tide reaches on the average over a period of time (often 19 years). This is generally considered to be the low water mark. MLWS value of nearby measuring station Cox's Bazar is 0.205 m CD (BIWTA Tide Table 2013)Therefore MLWS Value in mPWD is 0.205 - (4.836-3.931) m PWD=(-) 0.700 m PWD

4 Lowest observed water level

Referring to table mentioned above the lowest water level of Shaflapur, Maheshkhali BWDB Gauge SW 200 is (-) 2.17 m PWD.

5 Recommended "Design High Water Level"

The findings of discussions made above can be summed up as:

i) Tidal Mean High Water Spring (MHWS): 2.880 mPWD
ii) Observed highest water level: 4.36 mPWD
iii) Highest flood level considered for Polder 70: 4.00 m PWD
iv). Frequency analysis of highest flood level

Analysis	1:20 year flood frequency	1:50 year flood frequency
Analysis of Shaflapur BWDB data	4.59 mPWD	4.98 mPWD
Halcrow's analysis using Cox's Bazar BWDB data	3.63 mPWD	3.74 mPWD
CPP-II's analysis	4.24 m PWD	4.60 m PWD

v) Sea Level Rise Effect: 32 cm in the year 2050
vi) Navigation Clearance: 5 m above Design High Water Level

Considering all the above mentioned facts, the recommended "Design High Water Level (DHWL)" for design of Kohelia Bridge is 4 mPWD. The recommended water level of 4.00 mPWD along with additional 5 m navigation clearance will be sufficient to take care of impacts of anticipated 32 cm sea level rise in 2050 as well as cyclone storm surge heights normally observed in the past.

6 Recommended "Design Low Water Level (DLWL)"

Recommended "Design Low Water Level (DLWL)" for design of Kohelia Bridge is (-) 0.700 m PWD.

7 Design Discharge

No historical data or information as to the discharge of Kohelia River was available. The formula Q = A v gives the discharge; where Q = Discharge in m^3/sec; A = Cross section area in m^2; and v = Velocity in m/sec. Information on cross section area and velocity are required for the purpose. Discharge can also be obtained using indirect methods, namely; (i) the Rational Equation for ill defined channels or (ii) Slope Area Method for defined channels. The Rational Equation Q = ciA gives the peak discharge from drainage basin runoff; where Q = Peak discharge,c = Rational method runoff coefficient,i = Rainfall intensity andA = Drainage area. The Slope Area Method uses Manning's Formula for calculation of velocity. The Manning's Formula is $v = \frac{1}{n} R^{2/3} S^{1/2}$; where, v = Flow velocity; n = Roughness coefficient; R = Hydraulic radius andS =River slope. Accurate catchment area demarcation for rivers in southern region of Bangladesh is difficult, as the rivers often flow parallel to each other and at the same time are inter-connected by cross channels. And, as such, the Slope Area Method is the preferred choice in case of determination of discharge using indirect method.

In this particular case, measured velocity of nearby Kutubdia Channel is available from an IWM study. IWM found maximum average velocity of 1.7 m/sec in the channel at the time of their measurement. (IWM; Hydraulic Modeling Study for Rehabilitation of Affected Seven High Risk Coastal Polders; Final Report; November 2004). In accordance with IWM measurement, v of 1.7 m/sec will be used for subsequent calculations.=

Figure:Bridge alignment vis'-a-vis' location of main channel and mud-flat

The Design flood level is 4.00 m PWD and average low bank level is 2.157 mPWD, so for any rise of water level above 2.157 mPWD, there will be spilling over of water overland on western side mud-flat. It is assumed that cumulative width of the over land flow will be 62 m. The attached figure shows the bridge alignment along with location of main channel and the mud-flat.

Discharges for the main channel, over-land flow and design discharge are shown in the following Table using discharge equation, measured cross section areas and observed velocity.

	Level (mPWD)	Area (m^2)	v(m/sec)	Q=A*v(m^3/sec)
Main channel flow	4.00	2115.25	1.7	3596
Over-land flow	4.00	87.61	1.7	149
Design Discharge				3745

The design discharge is 3745 m^3/sec

8 Anticipated Scour Depth

Bridge and associated protective works are designed in such a way that scouring of river bank or river beds is well taken care of, as not to destabilize the structure. Scouring can be bank scour and/or bed scour. Scour depths are estimated using empirical formula along with mathematical & physical modelling (if available).

Bank scours are erosion of river bank, which can be localized or spread over a length of river and is caused by eddy or local turbulence. Bank scours are closely associated with general alignment of the channel and are also dependent on the nature of materials forming the bank. Constriction of water way can cause bank scour because of sudden increase in velocity (constriction scour). The proposed bridge is going to have via-duct from environmental consideration and for accommodation of clear navigation height requirement. The bank material contains a considerable percentage of clay materials. The bridge alignment is going to be perpendicular to channel alignment and there is no constriction of water way. As such no bank scour is anticipated.

Bed scour can be general deepening of river bed and/or local scour. General deepening of river bed may take place due to long term hydrologic and morphologic changes in the river where as local bed scour takes place due to obstruction in flow passage. The 3 components of bed scours are:

(i) General scour;
(ii) Constriction scour. In this particular case there is no risk of constriction scour (as has already been explained before): and
(iii) Local scour.

8.1 Scour in the main channel

General Scour

General scour in main channel will be calculated using Lacey's Formula for normal scour (d) which is;

$d=0.473\ (Q/f_s)^{1/3}$, where;
d =Normal depth of scour in meter below DHWL
Q =Discharge in cumec; and
f_s = Silt factor = 1.76 √grain size mean dia in mm (D_{50}) = 1.76 √0.08 = 0.5

d=0.473(3596/0.5)⅓ =9.13 m below design flood level

Constriction Scour

Since there is no constriction of water way, occurrence of constriction sour is not anticipated.

Local Scour

General formula for calculation of local scour below pile is:
i) 2.25 x pile dia; when flow depth is 5 m or more ; and
ii) 1.5 x pile dia; when flow depth is less than 5 m

There are other empirical formulae and methods for calculation of local scour. The formulae and methods have been developed from empirical consideration and are site specific. These are also dependent on depth of flow, velocity of flow; angle of attack etc. beside pier size and configuration. The result varies from formula to formula as well as method to method.

Considering empirical nature of different local scour formula, Indian Road Congress (1998, 2000) has recommended doubling the normal depth of scour to determine maximum bed scour (general scour + local scour).

$d_{max} = 2\ d$

T. R. Jagadeesh and M. A. Jayaram in their book" Design of Bridge Structure (Prentice Hall, India) has suggested use of 1.5 d for calculation of depth of scour under abutment and 2d for calculation of depth of scour under pier.

As such anticipated depth of scour in main channel:

i) Below piers in main channel
=2 d below design flood level = 2 x 9.13 m= 18.26 m

ii) Below eastern side abutment (i.e. bridge abutment on Nayaghata Jetty side)
= 1.5 d below design in flood level = 1.5 x 9.13 m= 13.70 m

8.2 Scour in flood plain

General Scour

General scour in flood plain will be calculated using Lacey's Formula for normal scour (d) which is;

$d_{fp}=0.473\ (Q_{fp}/f_s)^{1/3}$, where;
d_{fp}=Normal depth of scour in meter below DHWL
Q_{fp} =Discharge in flood plain in cumec; and
f_s = Silt factor = 1.76 √grain size mean dia in mm (D_{50}) = 1.76 √0.08 = 0.5

d_{fp} =0.473(149/0.5)⅓ =3.16 m below design flood level

Local Scour

General formula for calculation of local scour below pile is:
— 2.25 x pile dia; when flow depth is 5 m or more ; and
— 1.5 x pile dia; when flow depth is less than 5 m

As maximum depth of flow in flood plain will be less than 5 m, local scour below pile in flood plain will be
= 1.5 X 1.2 (assuming pile dia to be 1.2 m)=1.80 m
As such anticipated depth of scour in flood plain:

i) Below piers in flood plain
(a) Considering 2 d_{fp}= 2X 3.16 = 6.32mbelow design flood level
(b) Considering d_{fp}+local scour of pile= 3.16 +2.25 = 5.41mbelow design flood level
(c) Recommended depth of scour below pier in flood plain as per above mentioned criterion (a) is 6.32 m below design flood level

ii) Below western side abutment (i.e. bridge abutment on western side mud-flat)
= 1.5 d_{fp} below design in flood level = 1.5 x 3.16 m = 4.74 m

8.3 Anticipated scour depth & level

i) Below pier in main channel = 18.26 m below design high water level i.e. up to (-)14.26 mPWD
ii) Below eastern abutment (main channel) = 13.70 m below design high water level i.e. up to (-) 9.70 mPWD
iii) Below pier in flood plan = 6.32 m below design high water level i.e. up to(-)2.32 mPWD
iv) Below western abutment (flood plain) = 4.74 m below design high water level i.e. up to (-) 0.74mPWD

9 Navigation Clearance

Mandatory navigation height as per Bangladesh Inland Water Transport Authority (BIWTA) regulation (source: Bridge Design standards for Roads and Highways Department; Government of the People's Republic of Bangladesh, Ministry of Communications, Roads and Railways Division; January 2004) is given below:

Sl.	Classification of waterways	Minimum vertical clearance (m)	Minimum horizontal clearance (m)
I	Class-I	18.30	76.22
2	Class-II	12.20	76.22
3	Class-III	7.62	30.48
4	Class-IV	5.00	20.00

The design manual of Roads and Highways Department; Government of the People's Republic of Bangladesh clarifies that for waterways which have not been classified by BIWTA; consideration shall be given to the local requirement for passage of fishing vessel, boats, trawlers, burgs etc. At least one span must be kept wide enough to accommodate intended river traffic. The absolute minimum vertical clearance should be 1.50 m above standard high water level, where boat traffic exists.

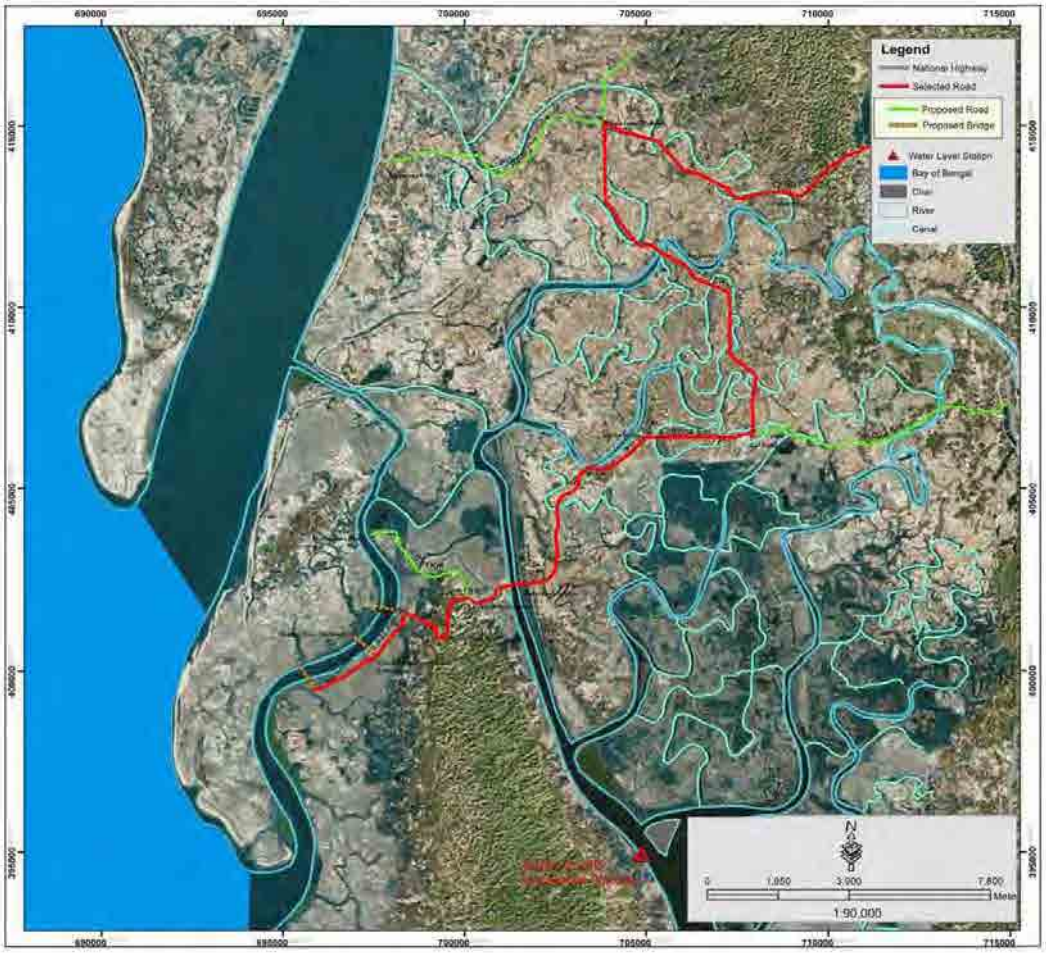
Since the proposed bridge, is on a non-classified route; the absolute minimum vertical clearance has to be more than I.5m above design high water level. It is to be noted that just upstream (about 2 km north) of the proposed bridge is the location of LGED's Matarbari Bridge, which has clear span width of less than/ close to 20 m.The soffit level of the existing bridge is at 12.48 mPWD. As such navigation clearance of the bridge from our Design High Water Level is 8.12 m (12.48 mPWD – 4.36 mPWD). Presence of Matarbari Bridge in a close proximity of the proposed bridge logically creates a boundary condition with its clear span width and navigation height.

On the basis of evaluation of ground realities and consideration of future generated traffic due to power station establishment and approach road construction; it is being recommended that at least 1 span of the bridge should have minimum 20 m horizontal clearance and minimum 5 m vertical clearance.

D3 MORPHOLOGY AND BANK LINE SHIFTING OF THE KOHELIA RIVER

The Kohelia River is a tidal one, in Maheshkhali Upazilla of Cox's Bazar district. In BWDB documents it is often referred to as Matarbari Channel. It is connected to Bay of Bengal on the northern end via Kutubdia Channel. On the southern end it is directly connected to Bay of Bengal. Main portion of the river has north-south alignment. On the northern side it turns west-ward and meets the Kutubdia Channel. On the northern side of the river; the Ujantia Khal meets the river from north and the Koriardia Khal meets the river coming from north-eastern side. From inside Polder-70, the 1.76 km long Donarghona Khal drains into the Kohelia River on the north coming from south side. The 1.86 km long Morakhali Khal, the 8.29 km long Rangakhali Khal and the 4.06 km long Tiakhali Khal drains into the river from west side. It may be mentioned here that the Polder 70 is surrounded by the Kohelia River on the northern and the eastern sides where as the Kutubdia Channel and the Bay of Bengal is located on the western side and the southern side respectively. The 1.84 km long Kankadi Khal drains into the Kutubdia Channel. The figure below shows the geo-morphological setting of the Kohelia River.

Figure:Geo-morphological setting of the Kohelia River

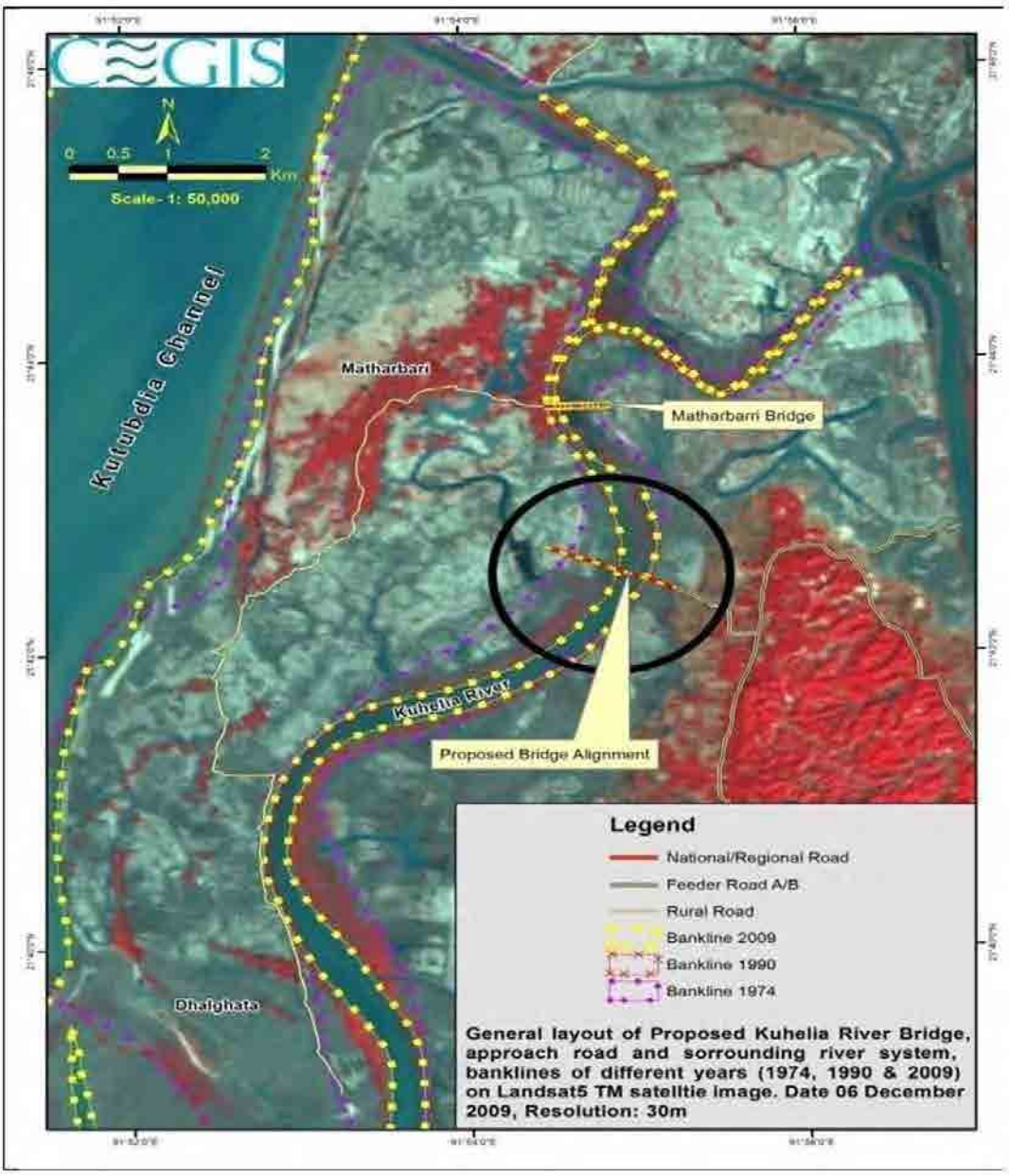


The width of the river at the proposed bridge site at 'Nayaghata Jetty' is about 365 m. LGED's 220.25 m wide Matarbari Bridge is located at about 2 km distance (on the north) from the proposed bridge location.

1 Bank Line Shifting Analyses

Long-time bank line shifting analyses of the Kohelia River was done with satellite images from archive of Center for Environment and Geographic Information Services (CEGIS). Processing of images and analyses of bank line shifting was done with support and cooperation of CEGIS. 1974 image was selected as it was one of the early clear images of the river in CEGIS archive. Image of 2009 shows the present position of the river. 1990 image was randomly selected as an intermediate one. The following image shows the bank lines of the river in different years along the proposed bridge alignment. The image also shows the location of the Matarbari LGED Bridge.

Figure:Long-time bank line shifting of the Kohelia River



Details of the images used in the analyses are as follows:

Name	Path	Row	Acquisition Date	Image Type	Remarks
Landsat5 TM	136	45	06 December 2009	Multispectral 30 m resolution	
Landsat5 TM	136	45	31 December 1990	Multispectral 30 m resolution	
Landsat5 MSS	146	45	10 January 1974	Multispectral 80 m resolution	

The images were first geo-referenced using Ground Control Points (GCP) and projected to the Bangladesh Transverse Mercator (BTM) co-ordinate system. The images were also co-registered. The images were re-sampled to 30 m x 30 m pixel size. Bank lines were identified and extracted. The bank lines of the river from 1974 and 1990 images were superimposed on 2009 image.

The alignment of the proposed bridge was easily identifiable from the view of the 'Nayaghata Jetty' on the image. The bridge alignment was also verified using the following previously recorded co-ordinates:

1) Nayaghata Jetty Side: Latitude: 21^0 42', 33·28" N ;Longitude:91^0 54', 53·77" E
2) Western End Mud Flat:Latitude: 21^0 42', 41·80" N ;Longitude:91^0 54', 31·23" E

The position of the bank lines during different years along the bridge alignment have been found to be:

Eastern Bank

Image	X- Coordinate	Y- Coordinate	Observations on bank line shifting
Image of 1974	698350.574	401572.049	No appreciable movement of bank lines
Image of 1990	698350.574	401572.049	
Image of 2009	698350.574	401572.049	

Western Bank

Image	X- Coordinate	Y- Coordinate	Observations on bank line shifting
Image of 1974	697556.240	401874.296	Bank line has been found to move eastward for a distance of about 500 m by accretion during the period 1974 – 1990; and after that no appreciable movement of bank lines could be seen for the period 1990 - 2009
Image of 1990	698065.813	401684.455	
Image of 2009	698065.813	401684.455	

From hydro-morphological evaluation and bank line shifting it is observed that:

a) The eastern bank has remained stable during the observed period of more than last 25 years (1974-2009); and
b) Accretion of about 500 m took place on the western bank during 1974-1990 (may be due to mangrove afforestation). Than there has been no further accretion or erosion during the observed period of last 19 years i.e. from 1990 to 2009.

On the basis of above mentioned facts and analyses, it is apparent that both the banks of the Kohelia River at the bridge site are presently passing through a stable phase and the present stable phase can be expected to continue in the coming yearsin future; if there is no other external intervention (s).

D4 CONCLUSIONS AND RECOMMENDATIONS FOR DESIGN OF THE KOHELIA RIVER BRIDGE

Review and analyses of the prevailing hydrological and morphological environment of the proposed Kohelia Bridge area leads to the following conclusions and recommendations:

- Design High Water Level:4.00 mPWD
- Design Low Water Level: (-) 0.700 mPWD
- Regime Width of the Kohelia River at Bridge Site:578 m
- Bridge Soffit Level over Navigable Portion of the Channel: Higher than 9.00 mPWD
- Minimum Bridge Span Openings on Navigable Portion of the Channel:20 m
- Anticipated Scour Levels:
  - Observed lowest bed level of the river was at(-) 3.87mPWD.
  - Anticipated maximum scour level at bridge piers in main channel is upto (-) 14.26 mPWD;
  - Anticipated maximum scour level at bridge piers in flood plain is upto (-) 2.32 mPWD;
  - Anticipated maximum scour level at eastern side bridge abutment on main channel bank is upto (-) 9.70 mPWD.
  - Anticipated maximum scour level at western side bridge abutment on flood plain is upto (-) 0.74 mPWD.

Bank lines of the river at the proposed bridge site are in a hydro-morphological stable state; as such occurrence of any major erosion or accretion is not anticipated. Nominal river training and bank protection works are recommended to take care of the normal wave erosions as well as anticipated erosions resulting from interventions in river flow due to construction of the bri.

Appendix-C16.3-7

Drawings

People's Republic of Bangladesh
Ministry of Power, Energy and Mineral Resources

Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh

Access Road
【DESIGN DRAWINGS】

September 2013

Japan International Cooperation Agency

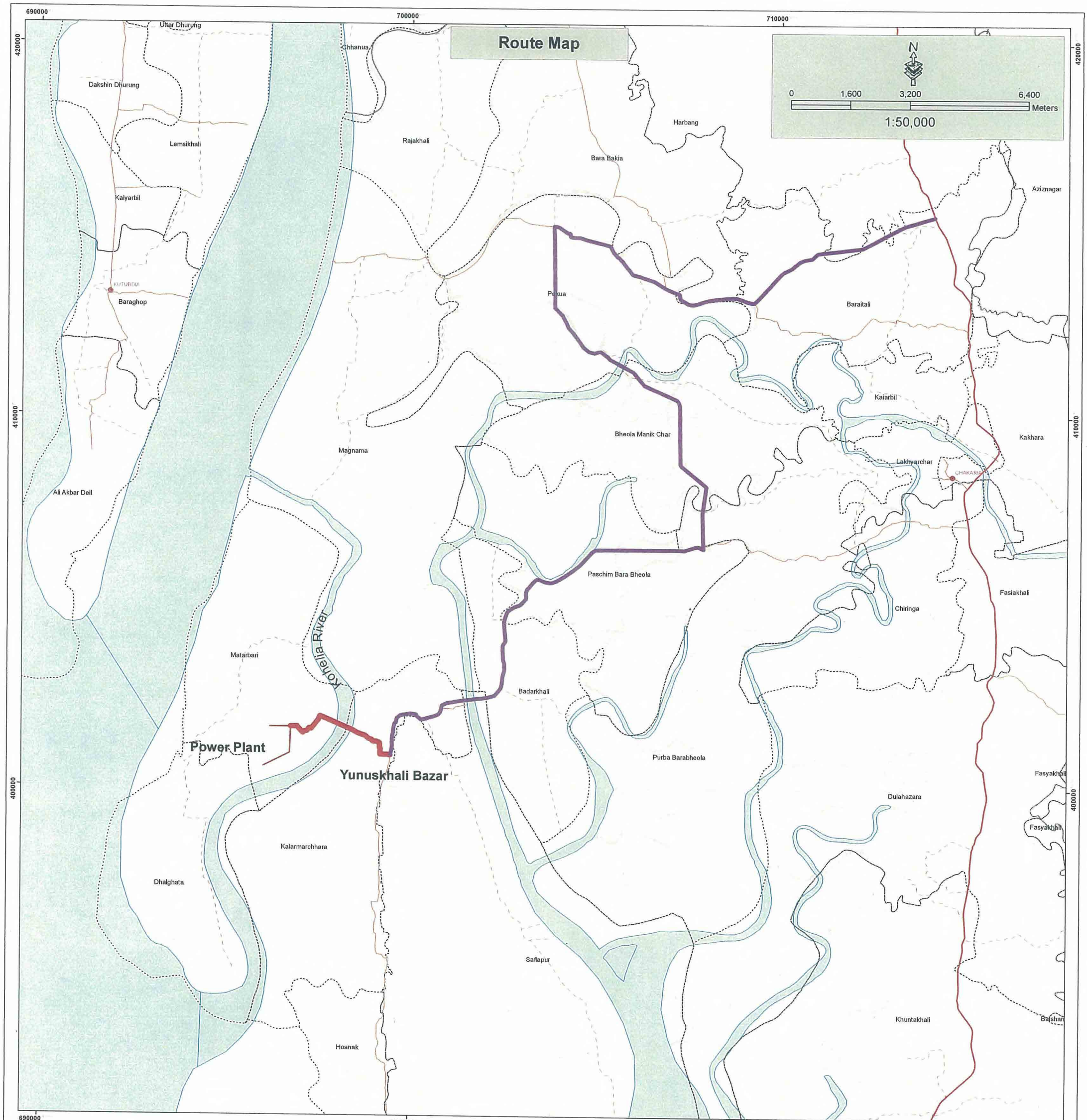
Tokyo Electric Power Services Co., LTD
Tokyo Electric Power Co., LTD

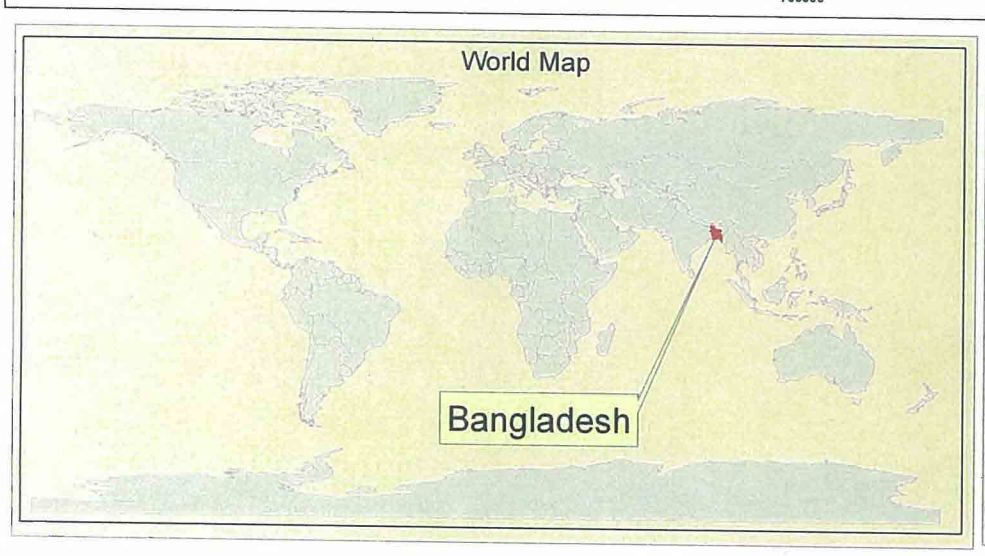
Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh
Access Road
DESIGN DRAWINGS
September 2013

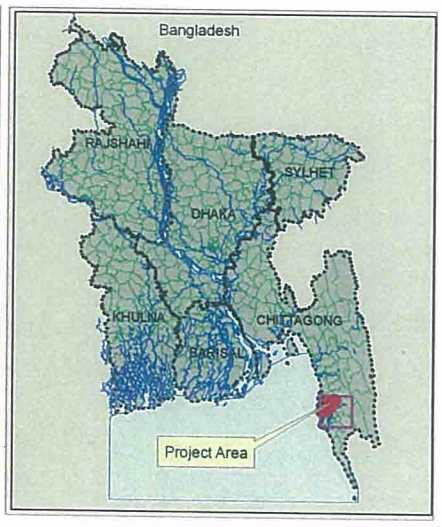
No	ITEM	DWG NO.
	List of Drawings	
1	Route Map (Existing Road)	RM-1
	Route Map (New Road)	RM-1
2	Road Plan (New Road)	PLAN/DWG-01 of 10
3	Road Plan (Existing Road)	PLAN/DWG-01 of 04
4	New Bridge	BRDG/GEN/DWG-01-02, BRDG/S_LP/DWG-03, BRDG/D-40/DWG-04-05, JICA/BRDG/D40/DWG-06, JICA/BRDG/G40/DWG-07, JICA/BRDG/CAB/DWG-08, JICA/BRDG/END/DWG-09, JICA/BRDG/REINF./DWG-10, JICA/BRDG/X_GIR/DWG-11, JICA/BRDG/PIER/DWG-12-13, JICA/BRDG/PILE/DWG-14, JICA/BRDG/ABUT/DWG-15-17, JICA/BRDG/B.PAD/DWG-18, JICA/BRDG/E.JOINT/DWG-19-20, JICA/BRDG/PROT./DWG-21
5	Road Longitudinal Profile	PS/CFPP/S2K-003, 01 of 19
6	Cross Section Index Map	PLAN-DWG-01 of 07
7	Design Cross Section	CS/DWG-01 of 54
8	Culvert and Road Ancillary Structures	CULV-01/DWG-01 of 06, C.WAY/DWG-01, IRRI-DR/DWG-01, SG/DWG-01 of 02, SDR/DWG-01 of 04, BRDG/GEN/DWG-01, BRDG/S_LP/DWG-02, BRDG/P_ELV/DWG-03, BRDG/DECK/DWG-04-05, BRDG/G1/DWG-06-08, BRDG/P1/DWG-09, BRDG/P2/DWG-10, BRDG/P3/DWG-11-12
9	Drainage Route Map	PLAN/DWG-01 of 21
10	Typical Cross Section	RDS/DWG-01 of 09, RS/DWG-01 of 01

ROUTE MAPS

Route Map







Legend

- District HQ
- Thana HQ
- Boundary Wall
- Existing RHD Road
- New Road
- National Highway
- Regoinal Road
- Feeder Road A
- Feeder Road B
- Rural Road
- unionbd91
- Division Boundary
- District Boundary
- char
- River
- River

Roads and Highways Department (RHD) Ministry of Communications	NAME OF THE PROJECT : Preparatory Survey on chittagong Area Coal Fared Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)	DRAWING TITLE : ROUTE MAP	SCALE : 1:50,000	DATE : AUGUST, 2013	DRAWING NO. RM-1

Route Map

N

0 320 640 1,280 Meters

1:10,000

696000 697000 698000 699000 700000

404000 403000 402000 401000 400000 399000

Magnama

Matarbari

Kohelia River

Power Plant

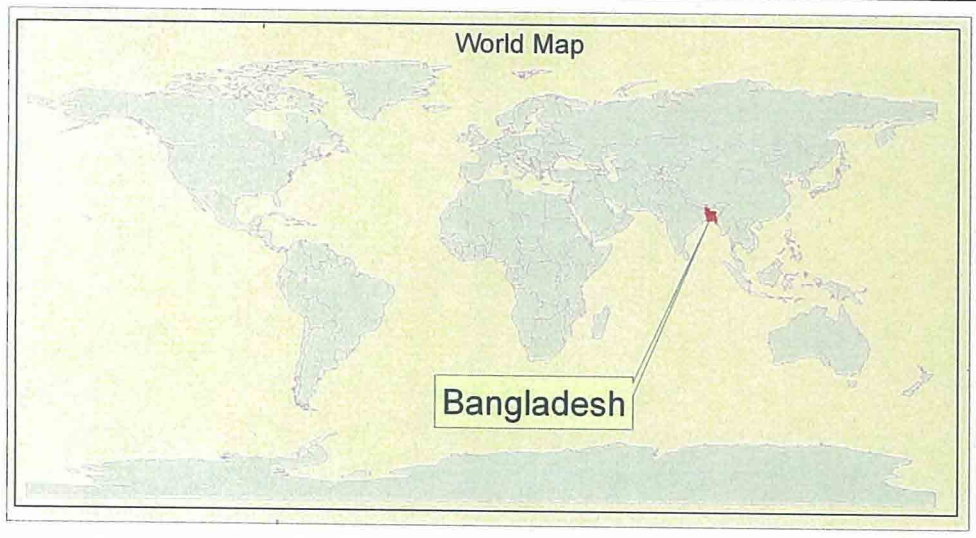
Yunuskhali Bazar

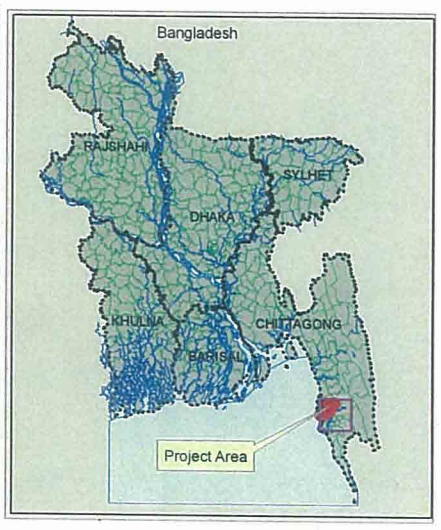
Kalarmarchhara

Saflapur

Dhalghata

World Map





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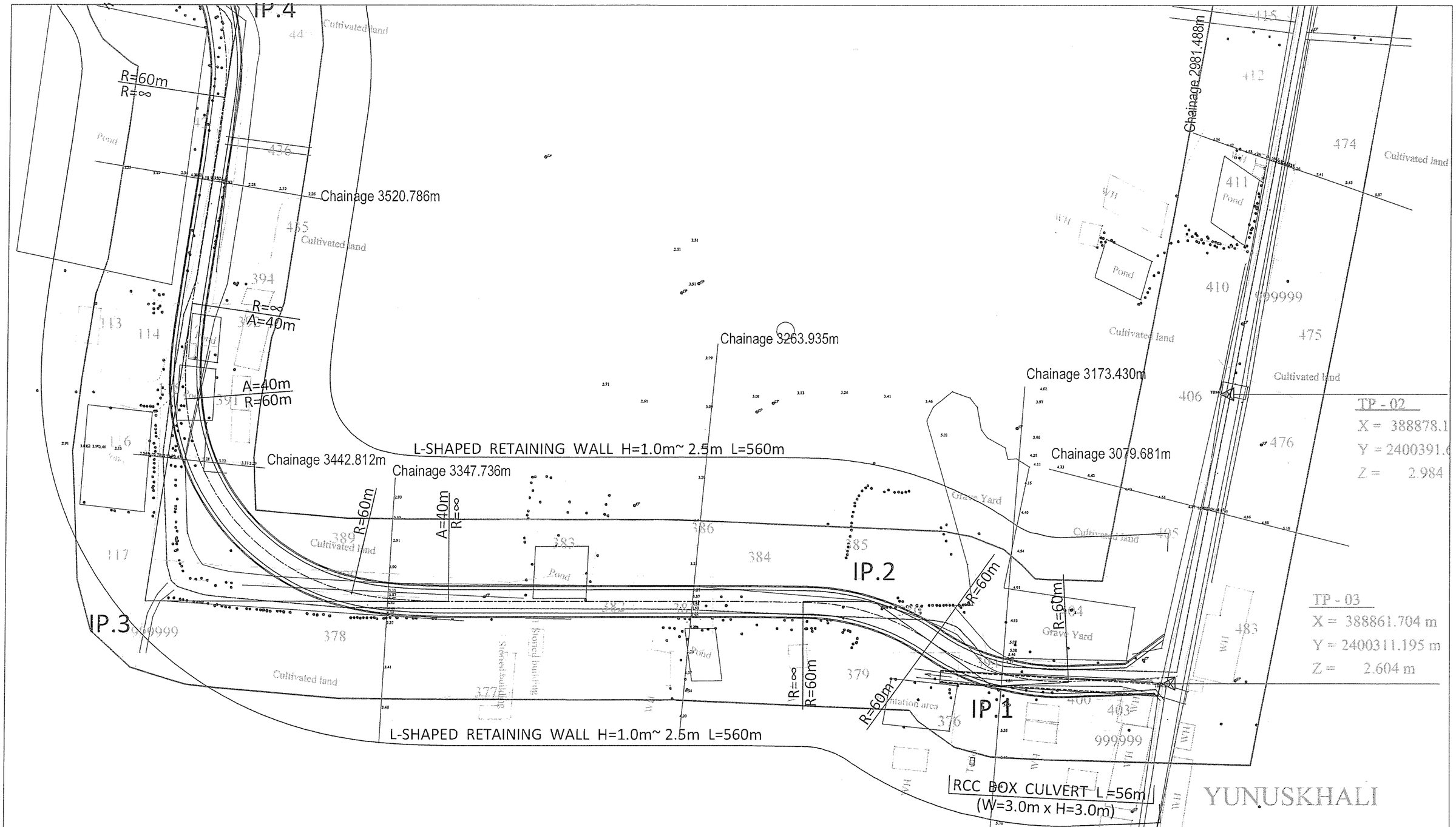
ROAD PLAN (NEW ROAD)



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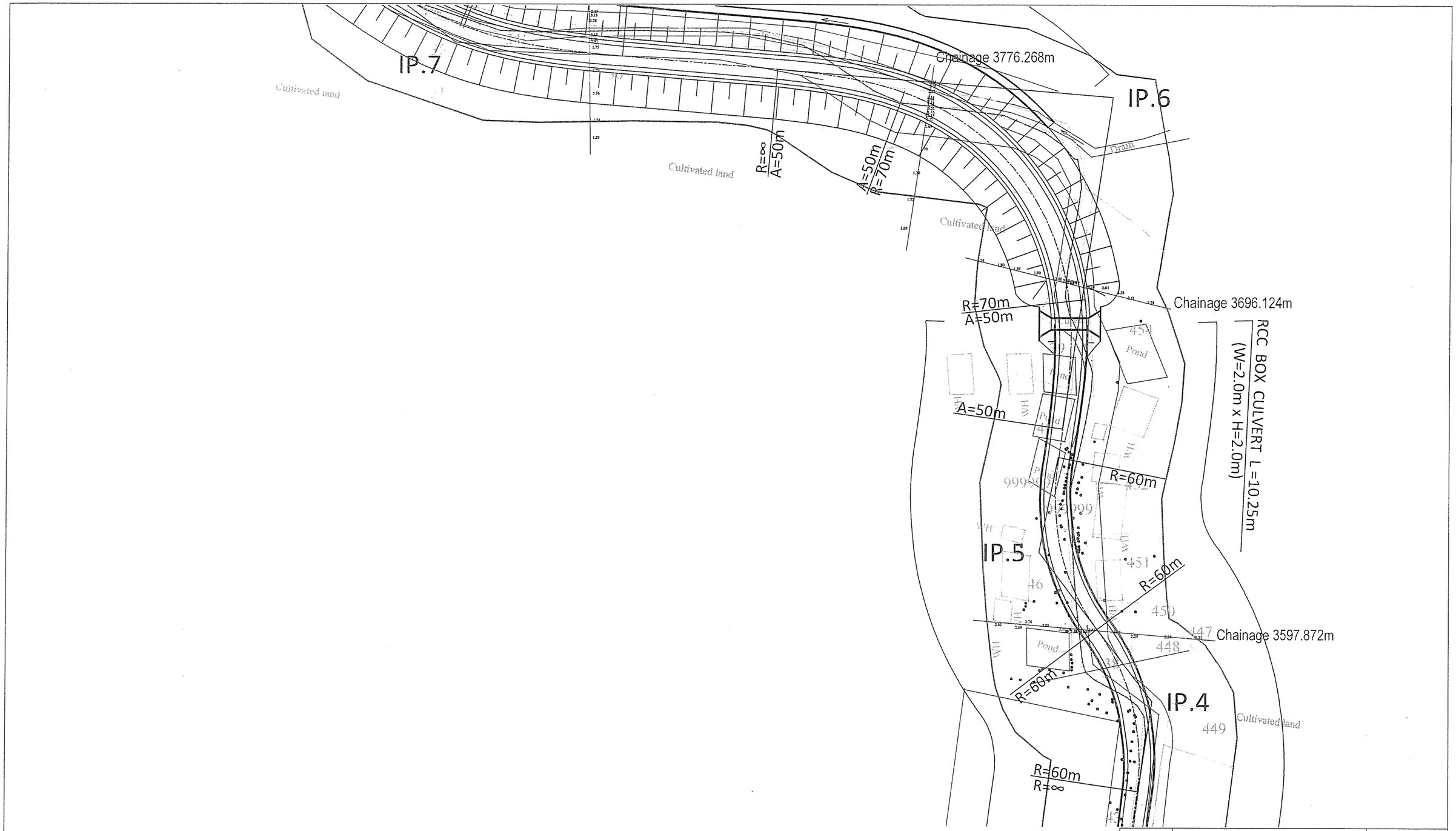

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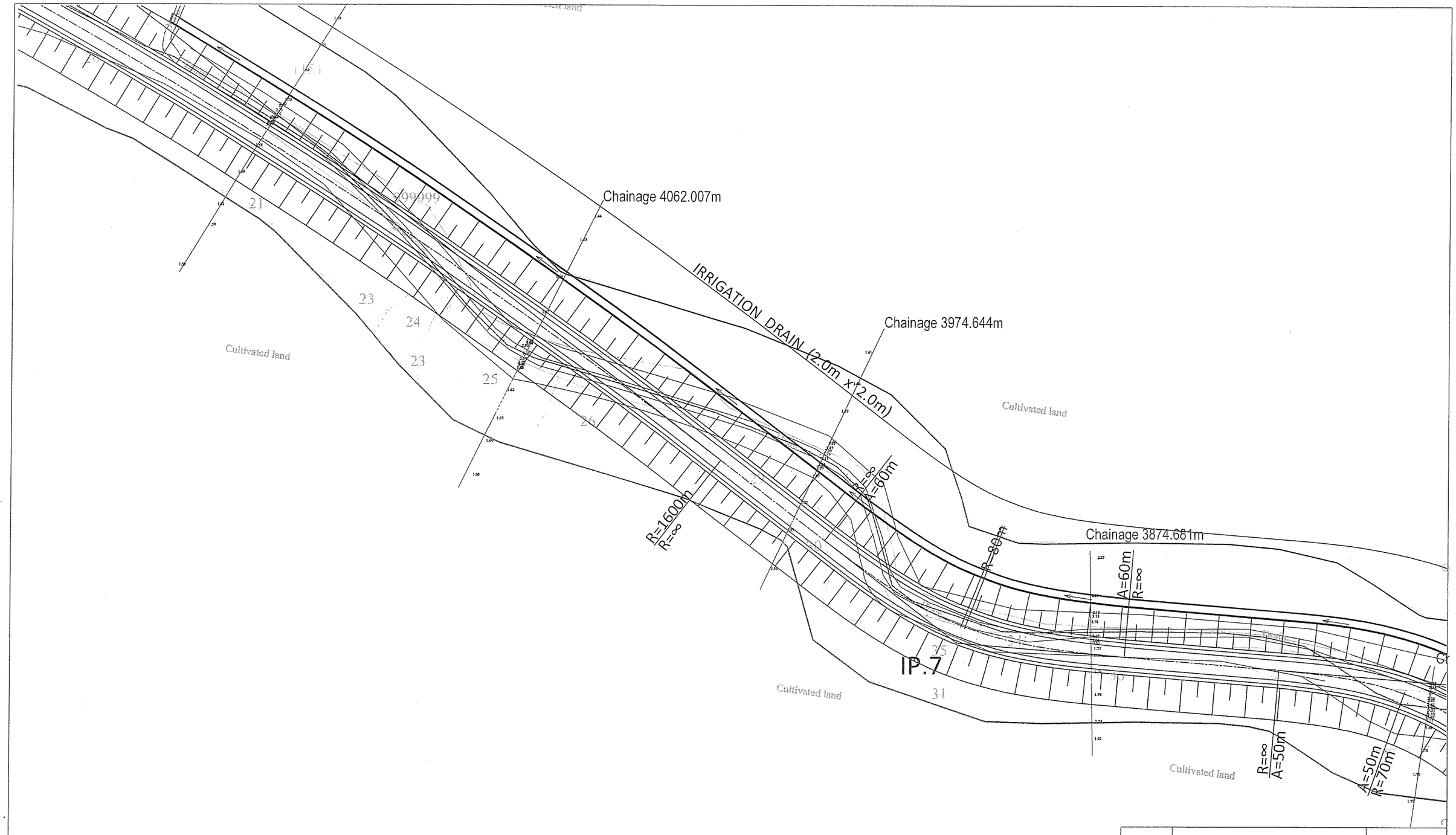

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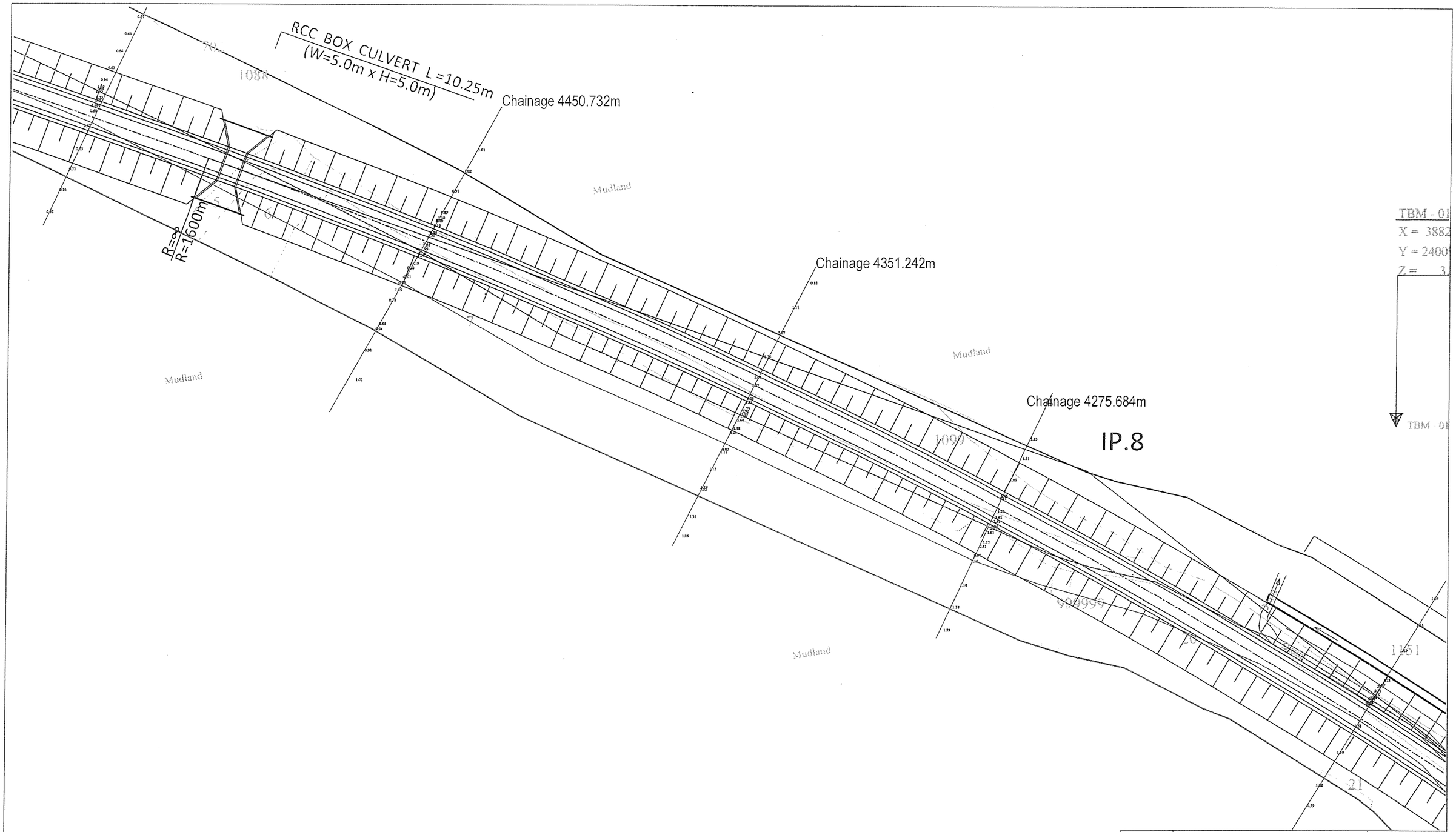

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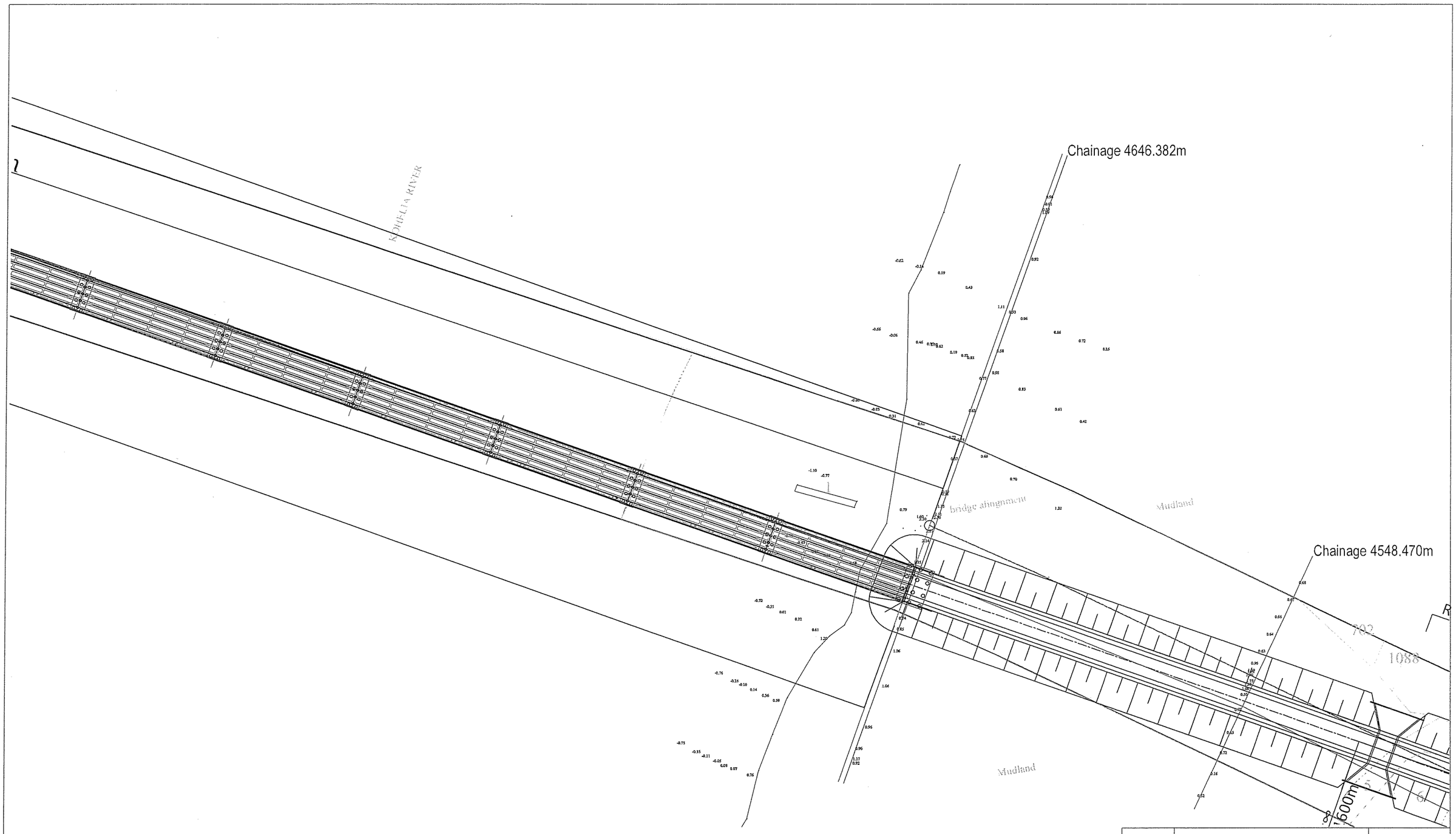

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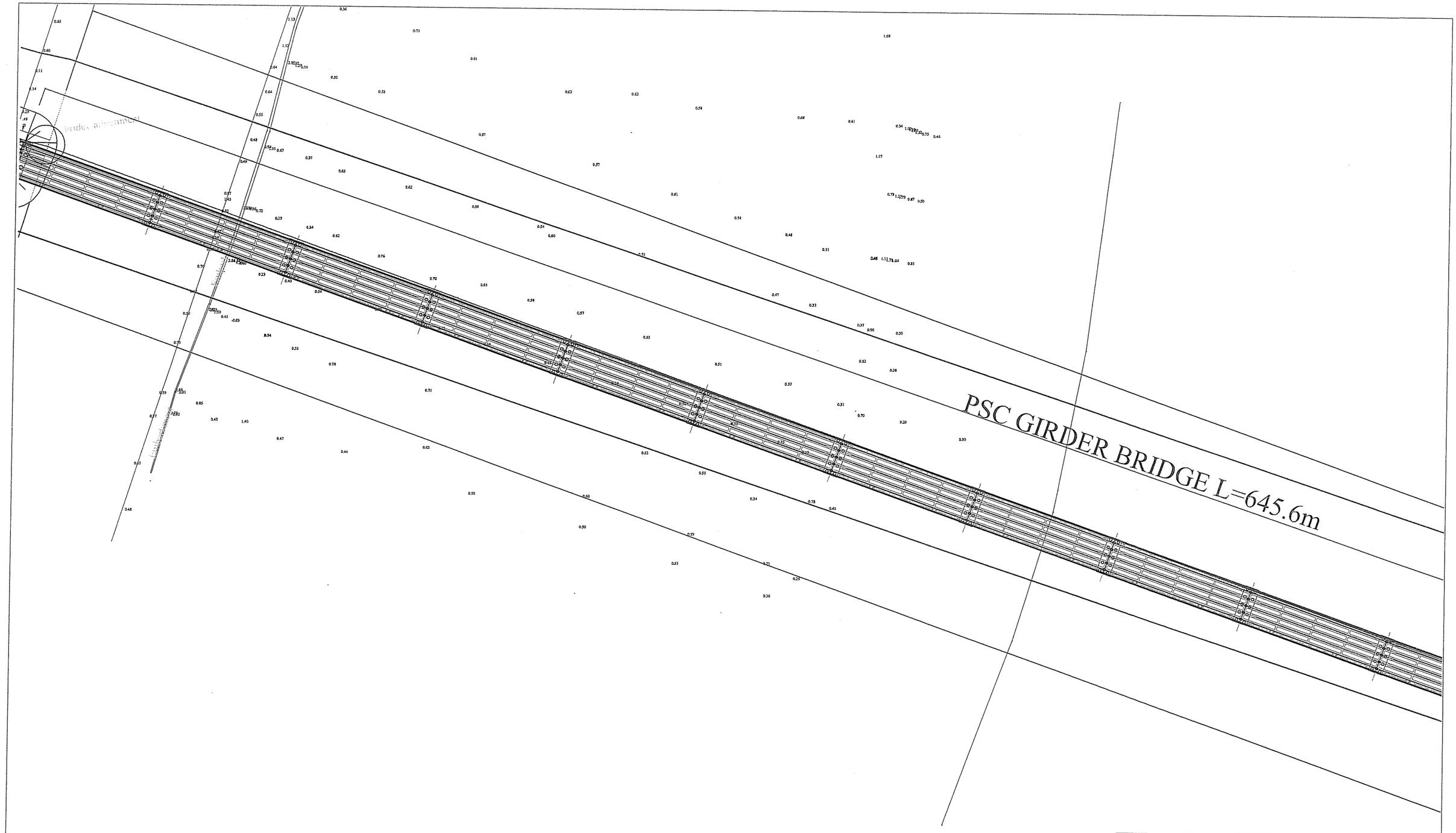

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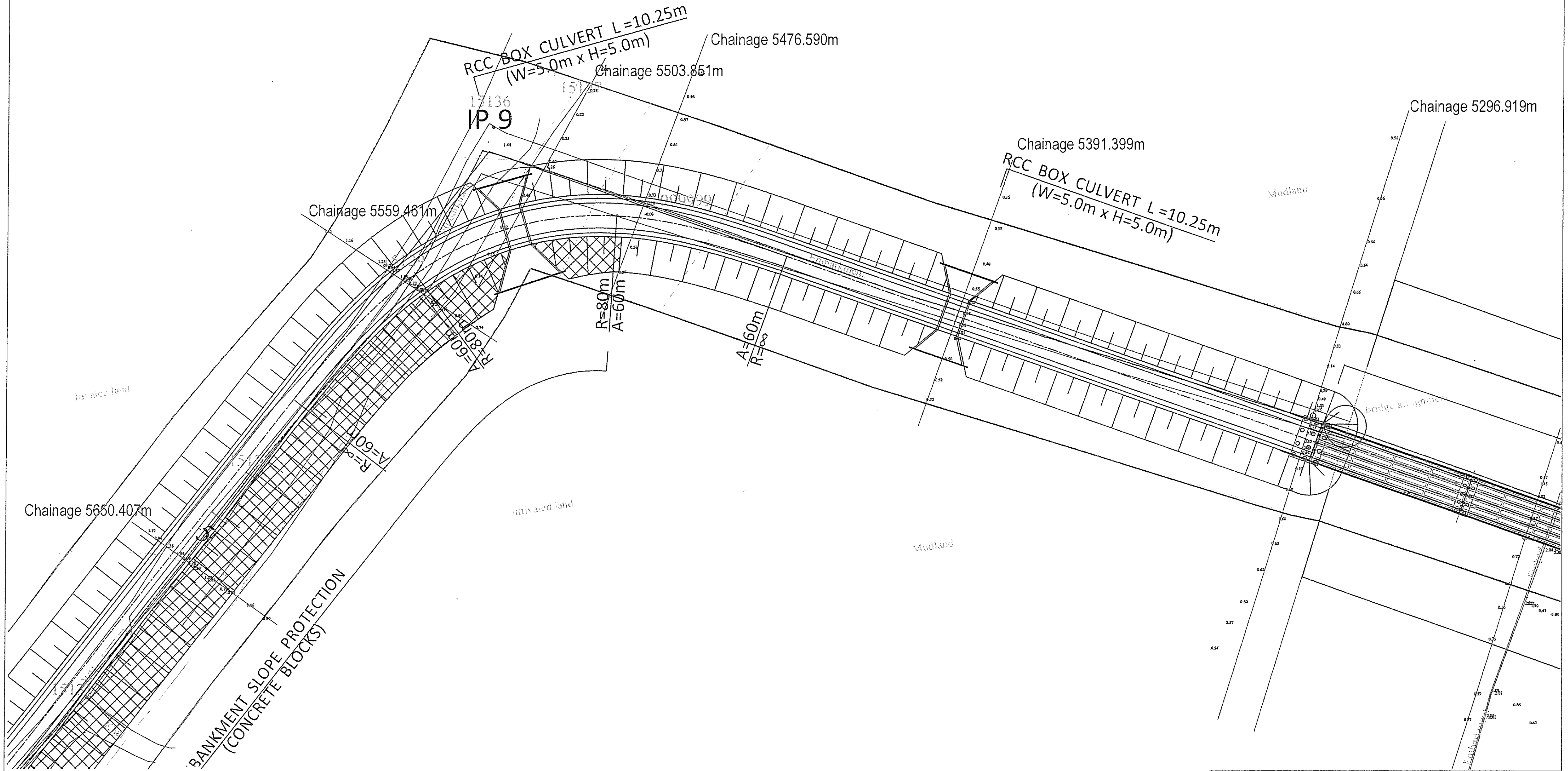

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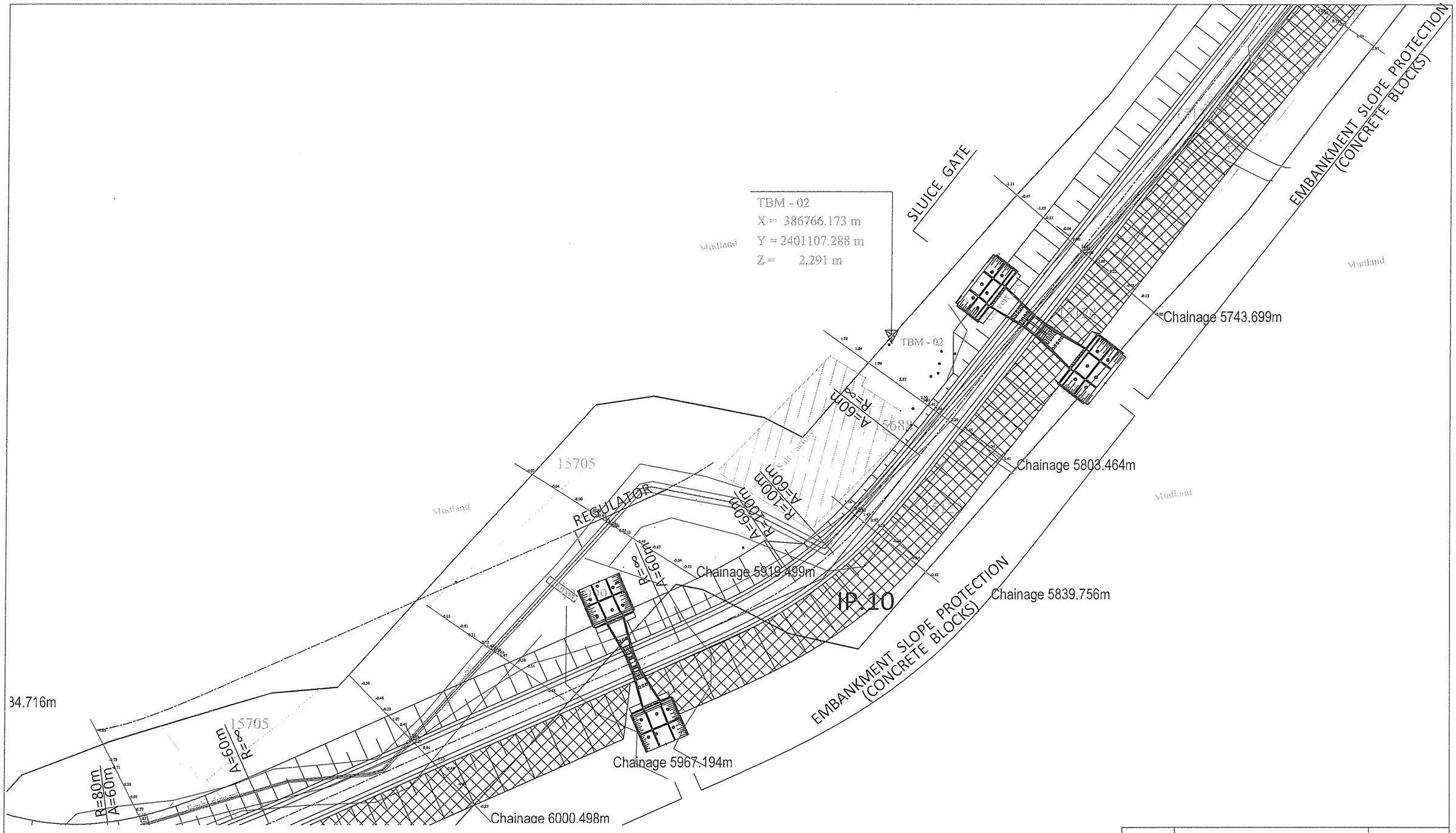

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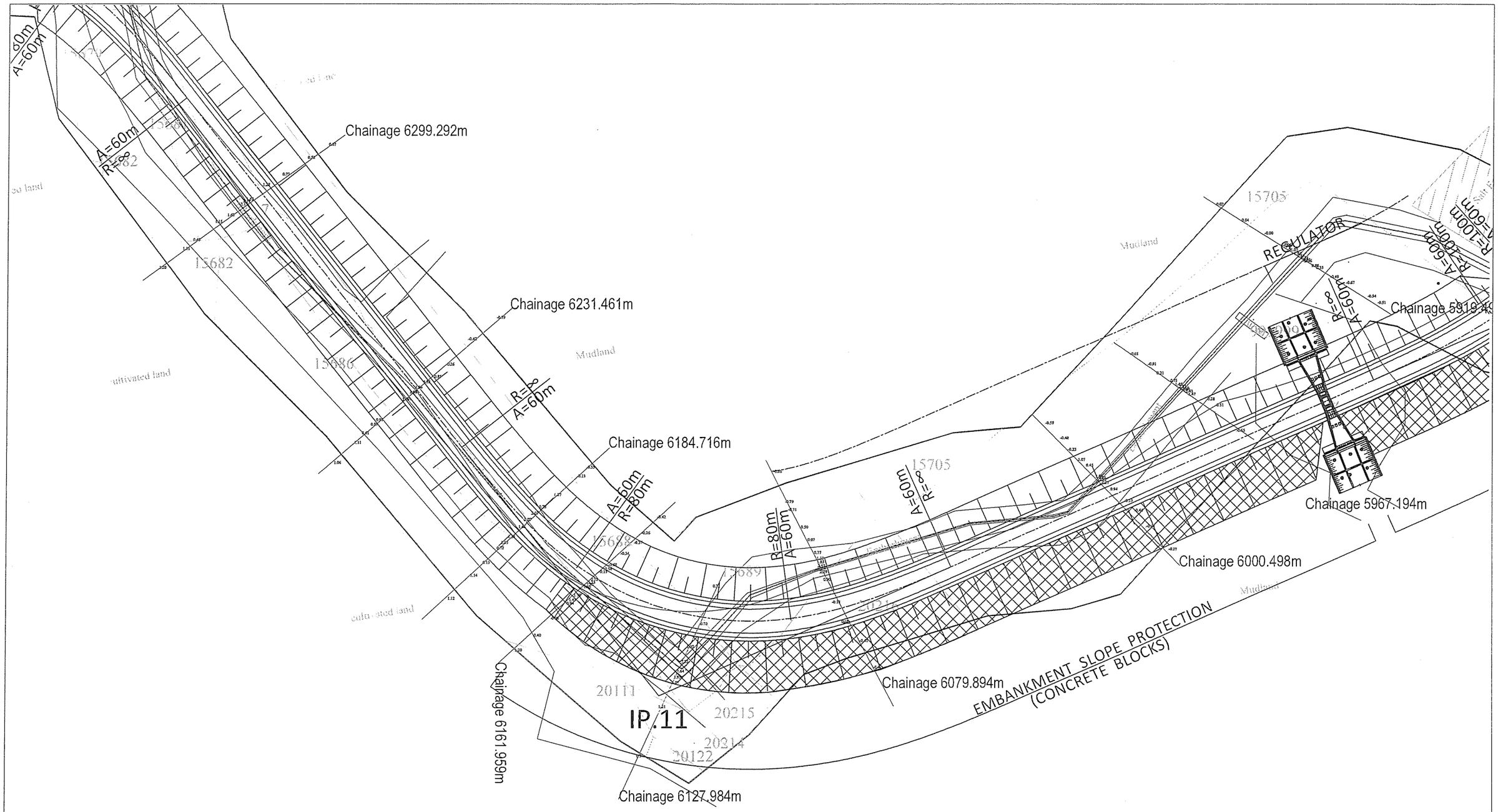

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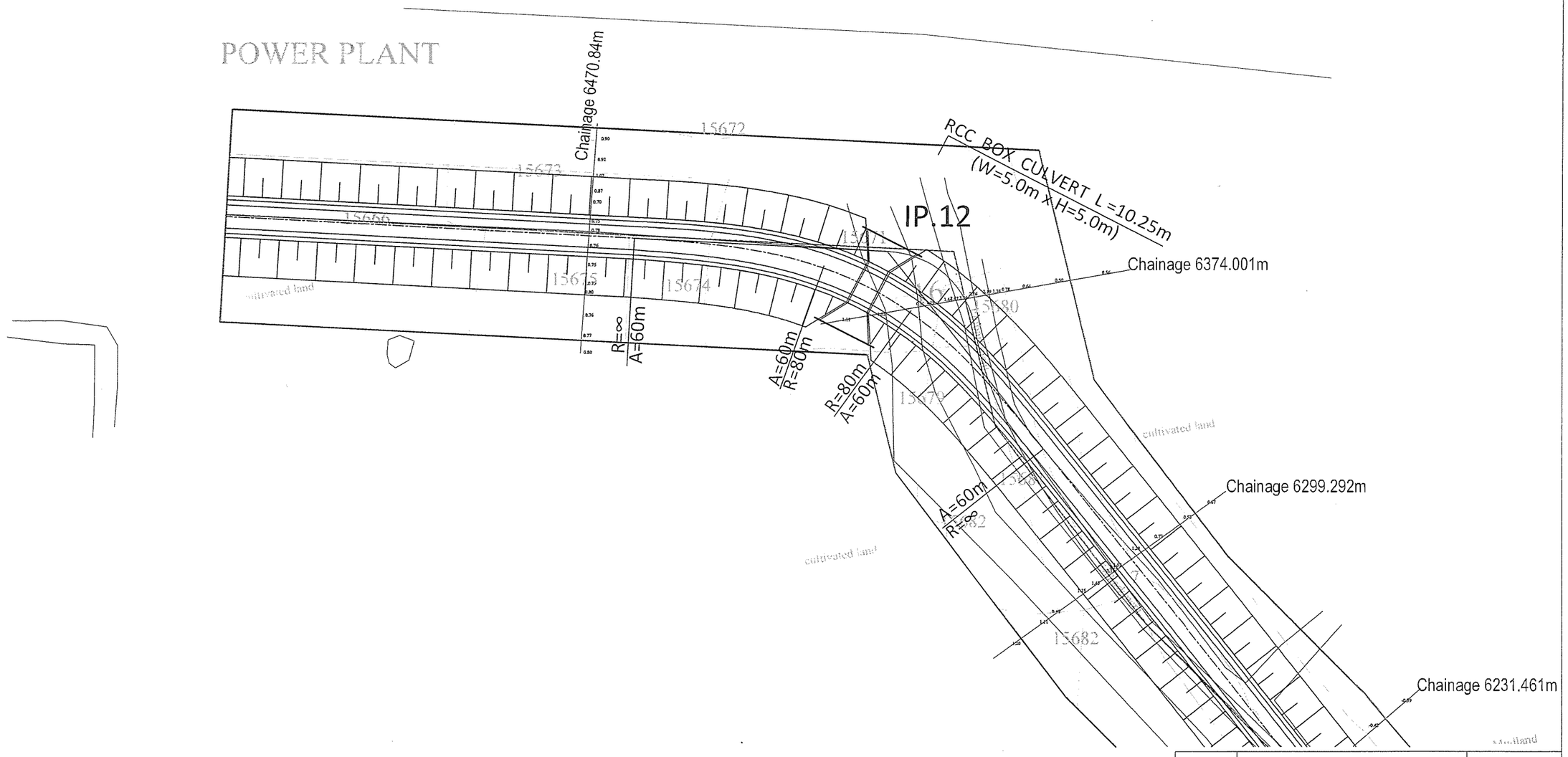
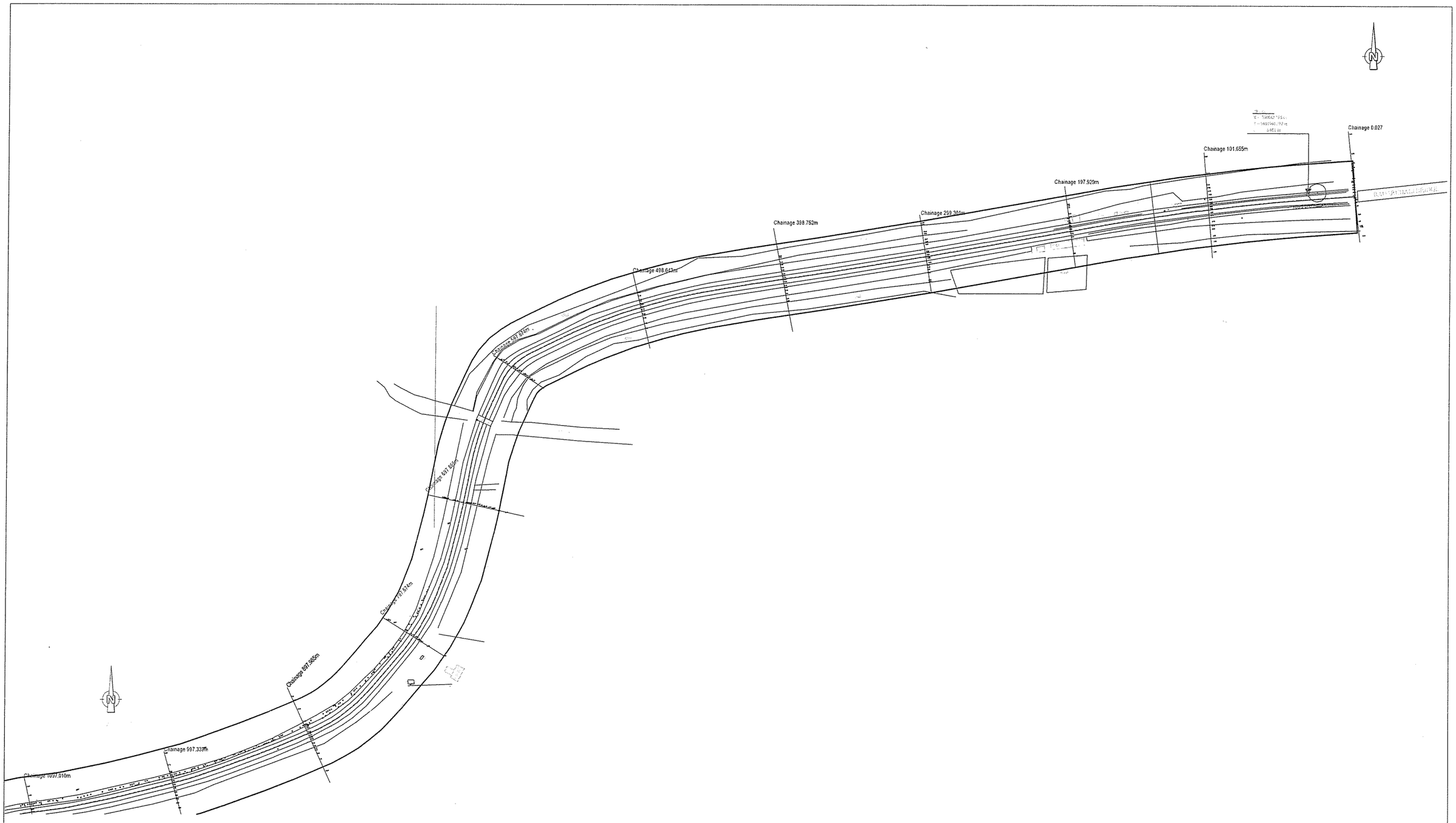


REV.	DESCRIPTION	DATE

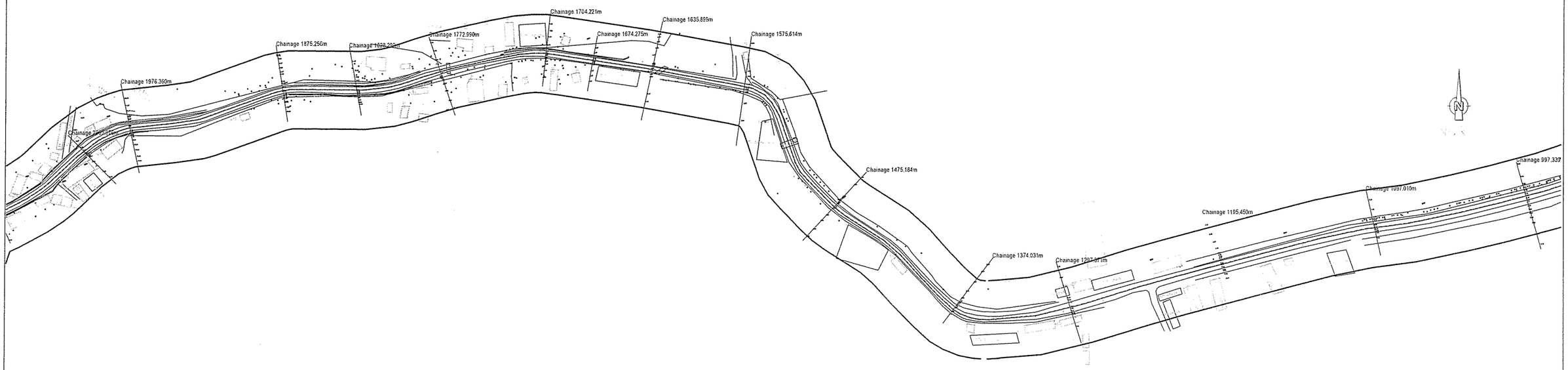
Roads and Highways Department (RHD) Ministry of Communications	NAME OF THE PROJECT : Preparatory Survey on chittagong Area Coal Fared Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)	DRAWING TITLE : ROAD PLAN VIEW BADARKHALI TO POWER PLANT SITE	SCALE : SCALE : 1:1000	DATE : AUGUST, 2013	DRAWING NO. PLAN/DWG- 09 of 10

ROAD PLAN (EXISTING ROAD)



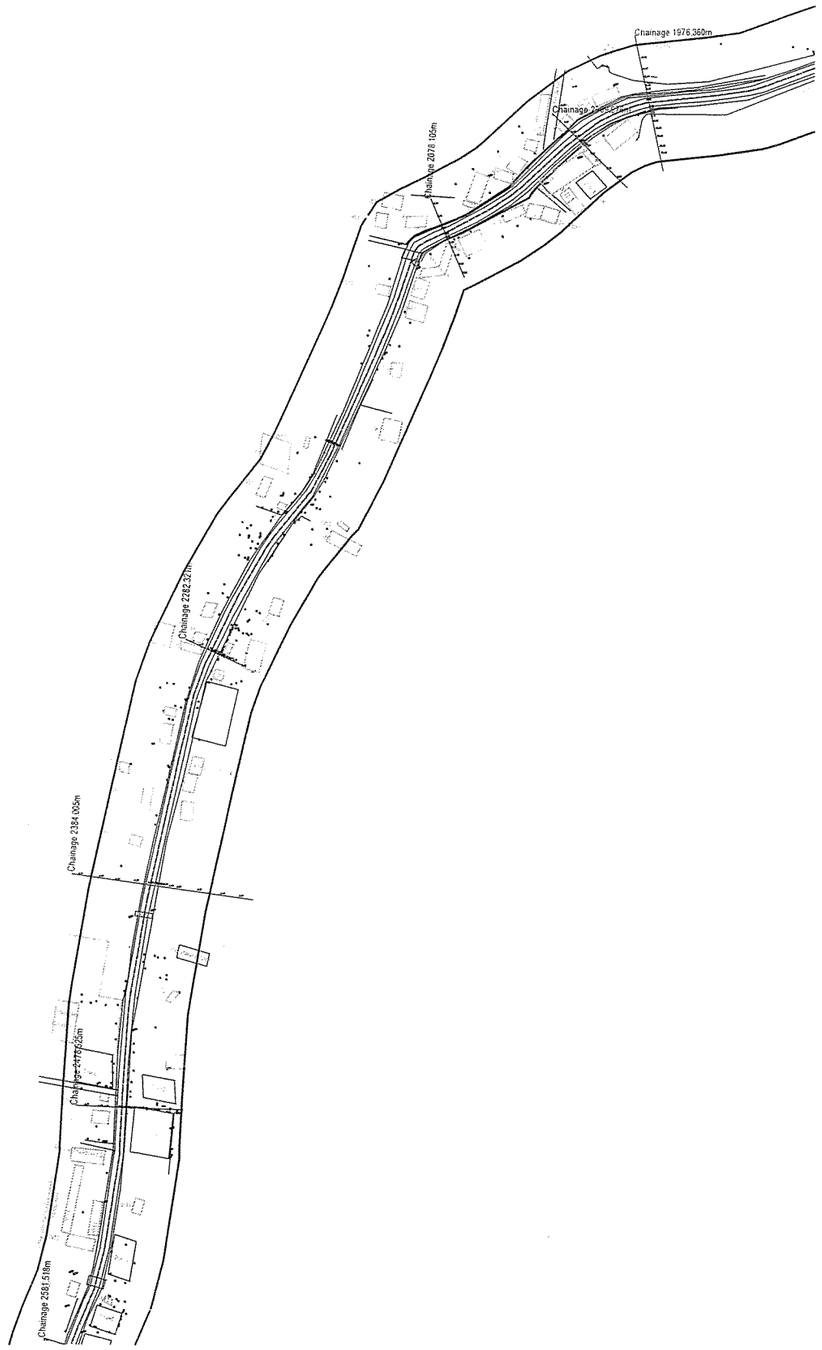
REV.	DESCRIPTION	DATE

Roads and Highways Department (RHD) Ministry of Communications	NAME OF THE PROJECT : Preparatory Survey on chittagong Area Coal Fared Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)	DRAWING TITLE : ROAD PLAN VIEW BADARKHALI TO POWER PLANT SITE	SCALE : SCALE : 1:2500	DATE : AUGUST, 2013	DRAWING NO. PLAN/DWG- 01 of 04



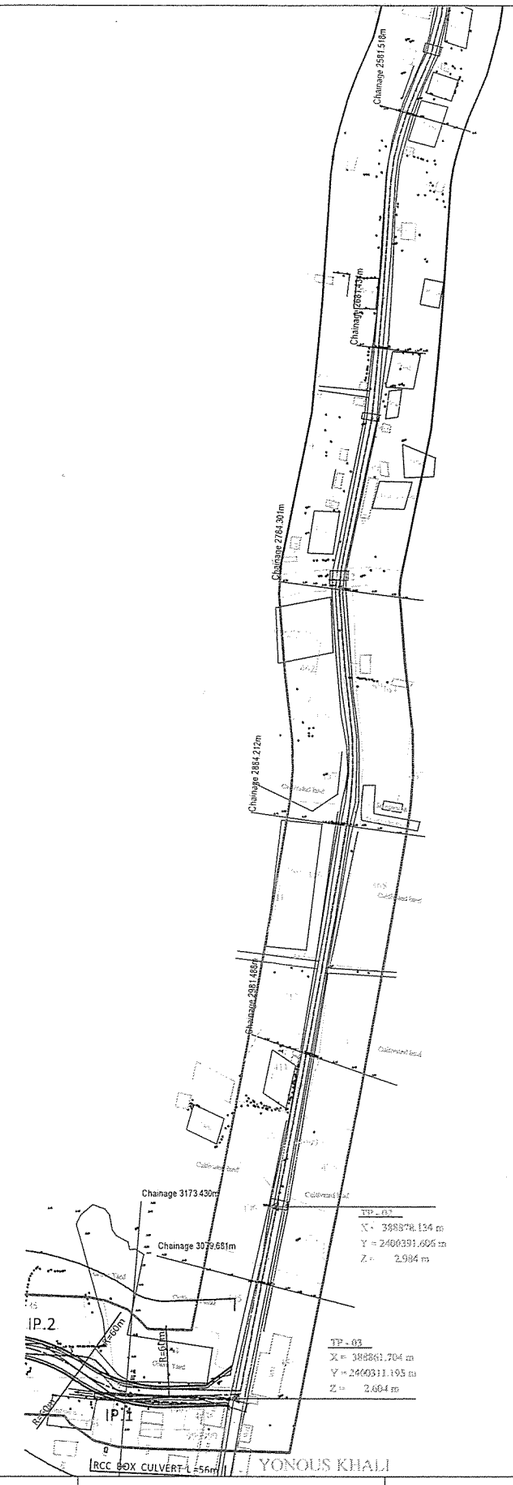
REV.	DESCRIPTION	DATE

Roads and Highways Department (RHD) Ministry of Communications	NAME OF THE PROJECT : Preparatory Survey on chittagong Area Coal Fared Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)	DRAWING TITLE : ROAD PLAN VIEW BADARKHALI TO POWER PLANT SITE	SCALE : SCALE : 1:2500	DATE : AUGUST, 2013	DRAWING NO. PLAN/DWG- 02 of 04



REV.	DESCRIPTION	DATE

Roads and Highways Department (RHD) Ministry of Communications	NAME OF THE PROJECT : Preparatory Survey on chittagong Area Coal Fared Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)	DRAWING TITLE : ROAD PLAN VIEW BADARKHALI TO POWER PLANT SITE	SCALE : SCALE : 1:2500	DATE : AUGUST, 2013	DRAWING NO. PLAN/DWG- 03 of 04



REV.	DESCRIPTION	DATE

Roads and Highways Department (RHD) Ministry of Communications	NAME OF THE PROJECT : Preparatory Survey on chittagong Area Coal Fared Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY(JICA)	DRAWING TITLE : ROAD PLAN VIEW BADARKHALI TO POWER PLANT SITE	SCALE : SCALE : 1:2500	DATE : AUGUST, 2013	DRAWING NO. PLAN/DWG- 04 of 04

NEW BRIDGE

GENERAL NOTES FOR RC CONSTRUCTION

1. CONCRETE

a) FOR PILE CAP, ABUTMENT, APPROACH SLAB, WING WALL, RETURN WALL , CULVERTS BASE SLAB, TOP SLAB, VERTICAL WALLS AND APRONS ETC.
- −28 DAYS STANDARD CYLINDER CRUSHING STRENGTH : fc'=30 N/mm²
- −CONCRETE MIX PROPORTION SHALL BE DECIDED BY MIX DESIGN IN ACCORDANCE WITH SPECIFICATION.

b) FOR DIAPHRAGM, PIER COLUMN, PIER CAP ETC.
- −28 DAYS STANDARD CYLINDER CRUSHING STRENGTH : fc'=30 N/mm²
- −CONCRETE MIX PROPORTION SHALL BE DECIDED BY MIX DESIGN IN ACCORDANCE WITH SPECIFICATION.

c) FOR DECK SLAB, KERBS, RAILINGS, FOOTPATH & BEARING PEDSTALS
- −28 DAYS STANDARD CYLINDER CRUSHING STRENGTH : fc'=35 N/mm²

d) FOR BORED PILES
- −28 DAYS STANDARD CYLINDER CRUSHING STRENGTH : fc'=30 N/mm²

2. REINFORCEMENT

a) TYPE:
DEFORMED BILLET MILD STEEL BARS IN ACCORDANCE WITH ASTM DESIGNATION : A615M−87 OR EQUIVALENT.

b) STRENGTH :
MINIMUM YIELD STRENGTH 415 N/mm² (60000 psi) FOR HYS DEFORMED BAR (Y)

c) SPLICES IN REINFORCEMENT :
- −SPLICES IN REINFORCEMENT IF NECESSARY SHALL BE MADE ONLY AS AUTHORISED BY THE ENGINEER.
- −SPLICES IN REINFORCEMENT AT POINT OF MAXIMUM STRESS IN SLABS, BEAMS, GIRDERS SHALL NOT BE PERMITTED.
- −LAP LENGTH FOR HYS DEFORMED BAR UNLESS OTHERWISE SHOWN WILL BE:

FOR TENSION BAR : − 40 x DIAMETER OF BAR
FOR COMPRESSION BAR: − 30 x DIAMETER OF BAR

d) LAPS SHALL BE STAGGERED AND NOT MORE THAN 50% OF THE HYS DEFORMED BARS AND 25% OF PLAIN BARS SHALL BE LAPPED AT ANY SECTION.

e) TYPE OF REINFORCEMENT IN RC BRIDGE AND PSC BRIDGE SHALL BE PROVIDED AS SHOWN IN DRAWING AND DETAILS.

f) BAR BENDING SCHEDULE GIVEN HEREWITH ARE PROVISIONAL AND CONTRACTOR SHALL PREPARE ACTUAL BAR BENDING SCHEDULE APROVED BY THE ENGINEER BEFOR BAR CUTTING.

3. CLEAR COVER TO MAIN REINFORCEMENT

a)
RAIL POST	= 25mm ALL FACES
RAIL BAR	= 20mm ALL FACES
KERB, POST BASE	= 25mm ALL FACES

b) DECK SLAB

TOP BARS	= 50mm
BOTTOM BARS	= 40mm
EDGES	= 40mm

c) GIRDERS AND DIAPHRAGMS

TOP BARS	= 50mm
BOTTOM BARS	= 50mm
SIDES	= 40mm

d) PIER COLUMN = 75mm (ALL FACES)

e) PIER CAP = 50mm (ALL FACES)

f) ABUTMENT AND WING WALLS = 75mm (ALL FACES)

g) PILE AND PILE CAP = 75mm (ALL FACES)

4. CONSTRUCTION JOINTS IN ADDITION TO THE PLACES SHOWN IN THE DRAWING IF REQUIRED SHALL BE PROVIDED AS PER DIRECTION OF THE ENGINEER−IN−CHARGE

5. GUIDE TO REINFORCEMENT ABBREVIATIONS:

EXAMPLE 1 : A1−Y20−100 INDICATES AS FOLLOWS:
- A1 : BAR MARK '1' IN ABUTMENT
- Y20 : GRADE−60 DEFORMED BAR 20mm DIA
- 100 : C/C BAR SPACING IN mm

EXAMPLE 2 : A3−10−Y20 INDICATES AS FOLLOWS:
- A3 : BAR MARK '3' IN ABUTMENT
- 10 : NO. OF BARS=10
- Y20: GRADE−60 DEFORMED BAR 20mm DIA

6. BEFORE CONSTRUCTION OF FOUNDATION A DETAILED SUBSOIL INVESTIGATION MUST BE CARRIED OUT IN ORDER TO VERIFY THE LENGTH OF PILE AND ITS GEOTECHNICAL CAPACITY AGAINST THE SERVICE LOAD SHOWN ON THE GENERAL ARRANGEMENT DRAWING.

7. EXPANSION JOINTS SHALL HAVE TO CATER FOR A TOTAL MOVEMENT AS INDICATED IN RESPECTIVE DRAWING IT MUST BE PROVIDED OVER THE FULL WIDTH OF DECK AND FOLLOW THE PROFILE INCLUDING KERB AND FOOTPATH.

8. CONCRETE WEARING COORSE OF 50mm THICKNESS SHALL BE PROVIDED AS PER SPECIFICATIONS.

9. FILTER MATERIAL SHALL BE BRICK AGGREGATES AS PER TECHNICAL SPECIFICATIONS AND SHALL BE WELL PACKED TO A THICKNESS NOT LESS THAN 450mm WITH SMALLER SIZE TOWARDS THE SOIL AND BIGGER SIZE TOWARDS THE WALL AND PROVIDED OVER THE ENTIRE SURFACE BEHIND ABUTMENT, WING OR RETURN WALLS TO THE FULL HEIGHT.

10. BACK FILL MATERIAL BEHIND ABUTMENT AND WINGWALLS SHALL BE OF SUITABLE GRANULAR SOIL AS PER TECHNICAL SPECIFICATIONS. MATERIAL FOR BACK FILL SHALL BE APPROVED BY THE ENGINEER IN CHARGE.

11. ABUTMENT DIRT WALL OF PSC BRIDGES SHALL BE CAST ONLY AFTER THE COMPLETION OF ALL PRESTRESSING OPERATIONS

REV.	DESCRIPTION	DATE

ROADS AND HIGHWAYS DEPARTMENT (RHD) Ministry of Communications	NAME OF THE PROJECT : Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	DRAWING TITLE :	SCALE :	DATE : / DRAWING NO.
			GENERAL NOTES OF RCC WORK	Scale : N.T.S.	02 July' 2013 / BRDG/GEN/DWG−01

GENERAL REQUIREMENTS FOR PSC GIRDER

A. MATERIAL STRENGTH

01. CONCRETE SHALL HAVE SPECIFIED CHARACTERISTIC COMPRESSIVE STRENGTH OF STANDARD CYLINDER OR CUBE 15 cm) AT 28 DAYS, ARE AS FOLLOWS:
    a) STANDARAD CYLINDER CRUSHING STRENGTH, f'c = 40 N/mm^2
    b) STANDARD CUBE CRUSHING STRENGTH, fcu = 46 N/mm^2
02. REINFORCING STEEL SHALL CONFORM TO ASTM A615–87 GRADE 60 DEFORMED BARS (MARKED 'Y') HAVING MINIMUM YEILD STRENGTH Fy = 415 N/mm^2.
03. PRESTRESSING STEEL SHALL BE OF 15.24mm DIA. 7 PLY UNCOATED LOW RELAXATION STRAND CONFORMING TO AASHTO–M203 OR EQUIVALENT HAVING THE FOLLOWING STRENGTH:
    (a) MINIMUM ULTIMATE TENSILE STRENGTH (UTS) f's = 1861 N/mm^2
    (b) MINIMUM YIELD STRENGTH f'y =1581 N/mm^2

03. PRESTRESSING CABLE SHALL BE CONSISTS OF 19 NOS.15.24mm DIA. STRAND (19T13) IN A SHEATHING/DUCT

B. PRESTRESSING ACCESSORIES

01. THE DETAILS OF ANCHORAGES, DUCTS, CABLE SPACINGS AND END BLOCK REINFORCEMENT SHOWN ON THE DRAWINGS ARE BASED ON FREYSSINET 19T13 MULTI–STRAND ANCHORAGE SYSTEM.
02. THE SHEATHING/DUCTS FOR THE 19T13 PRESTRESSING CABLES SHALL BE FORMED FROM 95mm INTERNAL DIA. (ID) CORRUGATED STEEL SHEATHS OF BRIGHT METAL STRIP HAVING MINIMUM THICKNESS 0.40mm. THE OUTSIDE DIA. (OD) OF THE SHEATH SHOULD BE ABOUT 6mm LARGER THAN THE ID. THE CONNECTING SLEEVES FOR SHEATH SHOULD HAVE A DIAMETER ABOUT 3.1mm GREATER.
03. FOLLOWING PROPERTIES HAVE BEEN CONSIDERED IN THE DESIGN
    AREA OF STRAND = 98.7 mm^2
    AREA OF CABLE = 1875 mm^2
    MODULLES OF ELASTICITY OF STRAND = $2x10^5$ (N/mm^2)
    AVERAGE SLIP = 6mm
    JACKING FORCE IN EACH CABLE = 2615 KN.

C. WORKMANSHIP DETAILING

01. AFTER SATISFACTORY COMPLETION OF TENSIONING THE CABLES SHALL GROUTED AS PER STANDARED SPECIFICATION. BESIDES THE GROUT HOLES AT STRESSING END ONE GROUT VENT MAY ALSO BE PROVIDED AT LOWEST POINT OF EACH CABLE, IF REQUIRED BY THE ENGINEER.
02. EXTRA LENGTH OF CABLE REQUIRED FOR FIXING FREYSSINET JACK IS 750mm. HOWEVER FOR OTHER ANCHORAGE SYSTEM GRIP LENGTH SHALL BE VERIFIED AT SITE.
03. THE CABLE MUST BE PLACED STRAIGHT AND CO–AXIAL WITH THE ANCHORAGE FOR A DISTANCE OF AT LEAST 400mm.
04. THE PROFILE OF LONGITUDINAL PRESTRESSING DUCTS SHALL BE MAINTAINED BY PROVIDING 10mm DIA. U–SHAPED MS WELDED SADDLES ATTACHED TO ONE BRANCH OF THE STIRRUPS @ 1000mm C/C APPROX.
05. NON–PRESTRESSED REINFORCEMENT IS TO BE ADJUSTED TO THE SATISFACTION OF THE EINGINNER, IF OBSTRUCTON TO CABLE DUCT OCCURS.

D. CLEAR COVER TO PRESTRESSING AND REINFORCING STEEL

01. MINIMUM CLEAR COVER TO REINFORCING STEEL SHALL BE 40mm.

E. PRESTRESSING AND GROUTING OPERATION

01. THE PRESTRESSING FORCE IN EACH CABLE AT ANCHORAGE DURING STRESSING PRIOR TO LOCK OFF (JACKING FORCE) SHALL BE 2615KN.
02. EACH CABLE SHALL BE SIMULTENOUSLY STRESSED FROM BOTH END OF PC GIRDER BY USING FREYSSINET/OR EUIVALENT MULTISTRAND JACK.
03. NO. OF STAGES, STRESSING SEQUENCE OF THE CABLES AND CONCRETE STRENGTH f'ci AT DIFFERENT STAGE OF STRESSING SHALL BE AS SHOWN ON RESPECTIVE SHEET OF THE DRAWING SERIES OF THE PC GIRDER.
04. THE APPLIED PRESTRESSING FORCES ON THE CABLES SHALL BE MEASURED ON THE RECENTLY JACKS ACCOMPANIED BY ELONGATION MEASUREMENT IN PRESENCE OF THE ENGINEER OR HIS DESIGNATED REPRESENTATIVE. PROPER RECORDS OF THE ABOVE SHALL BE MAINTAINED.
05. ALL DUCTS SHALL BE GROUTED FOLLOWING STRANDARD SPECIFICATION AFTER SATISFACTORY COMPLETION OF THE STRESSING OPERATIONS AND APPROVAL OF THE ENGINEER.
06. FOR ALL STRESSING AND GROUTING OPERATIONS, THE PROCEDURE GIVEN IN THE GUIDE FOR FREYSSINET OR EQUIVALENT METHODS SHALL BE USED.

F. INSTALLATION DETAILS

01. THE PC GIRDERS SHALL BE MOVED AT LEAST AFTER COMPLETION OF THE 1ST STAGE STRESSING OF THE CABLES AND GROUTING OF THE CABLE DUCTS ONLY.
02. THE PC GIRDERS SHALL BE LIFTED BY PROIVIDING SUPPORTS IN THE VICINITY OF THE CENTER LINE OF BEARINGS ONLY.
03. LATERAL SUPPORTS TO THE PRECAST PC GIRDER SHALL BE PROVIDED DURING MOVEMENT OPERATION OF THE SAME AND CONCRETING OF THE CAST–IN–SITU DECK.
04. TIME DIFFERENCE BETWEEN GIRDER CONCRETE & DECK CONCRETE SHALL NOT BE MORE THAN 2 MONTHS.

G. MISCELLANEOUS

01. THE SURFACE OF THE TOP FLANGE OF THE PC GIRDER SHALL BE INTENTIONALLY ROUGHENED EXPOSING ABOUT 6mm OR 1/4TH HEIGHT OF THE COARSE AGGREGATE BREAKING THEM TO DEVELOP COMPOSITE ACTION BETWEEN THE PC GIRDER CAST–IN–SITU DECK CONCRETE.
02. PRECAMBER TO THE GIRDER SHALL BE PROVIDED AT THE GIRDER SOFFIT BEFORE CASTING OF GIRDER
03. ALL LAP LENGTHS SHALL BE PROVIDED AT LEAST 40 x BAR DIA. AND SHALL BE STAGGERED BY +/– 50% UNLESS OTHERWISE SHOWN.

H. SPECIAL NOTE FOR PRESTRESSING

01. (i) IF THE CALCULATED ELONGATION IS REACHED BEFORE THE CALCULATED GUAGE PRESSURE IS OBTAINED, CONTINUE TENTIONING TILL ATTAINING THE CALCULATED GAUGE PRESSURE,PROVIDED THE ELONGATION DOES NOT EXCEED 1.05 TIMES THE CALCULATED ELONGATION. IF THIS ELONGATION IS ACHIEVED BEFORE THE CALCULATED GUAGE PRESSURE IS ATTAINED, STOP STRESSING AND INFORM THE ENGINEER.

(ii) IF THE CALCULATED ELONGATION HAS NOT BEEN REACHED CONTINUE TENSIONING BY INTERVALS OF 5 Kg/Sq.CM UNTIL THE CALCULATED ELONGATION IS REACHED PROVIDED THE GAUGE PRESSURE DOES NOT EXCEED 1.05 TIMES THE CALCULATED GUAGE PRESSURE.

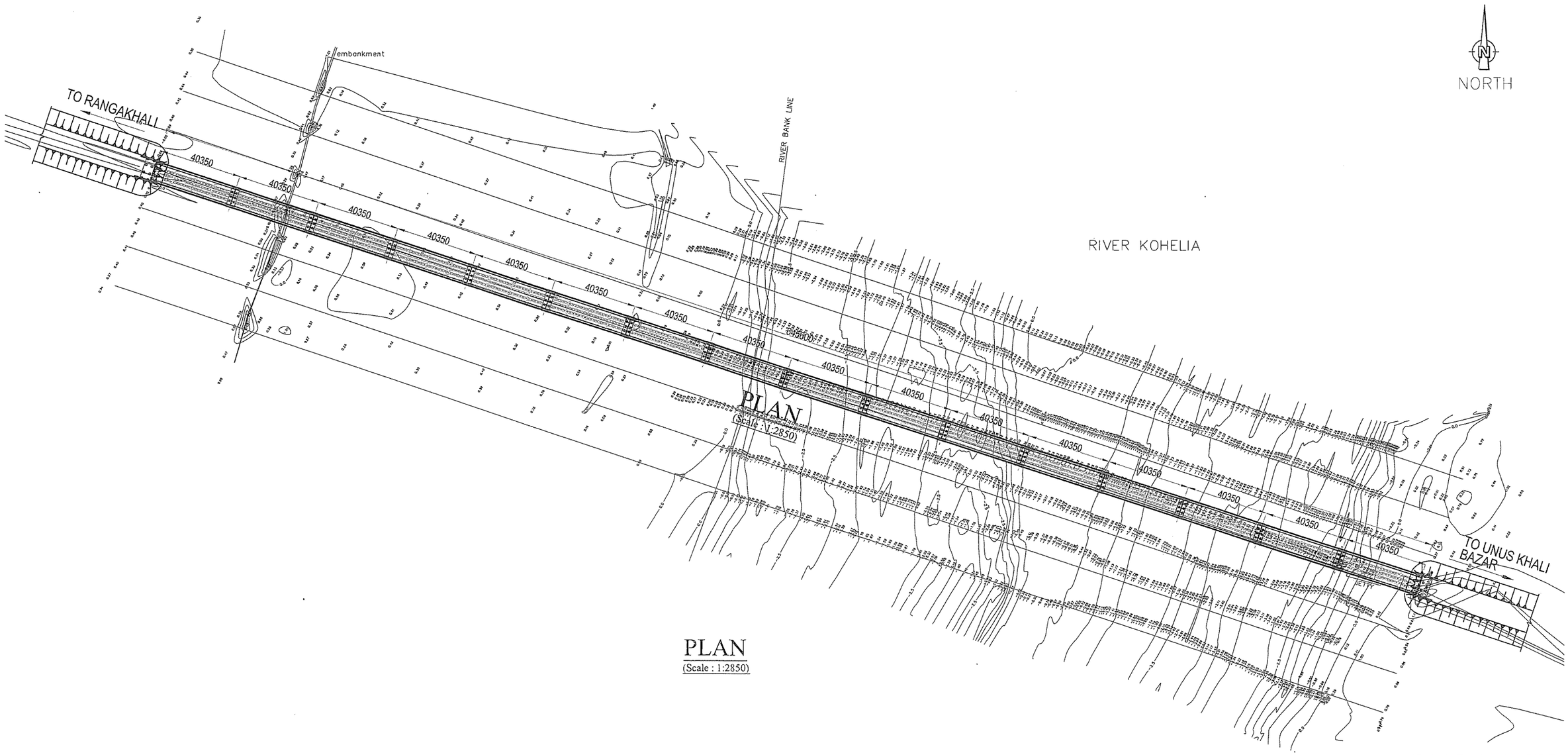
(iii) IF THE ELONGATION AT 1.05 TIMES THE CALCULATED GAUGE PRESSURE IS LESS THAN 0.95 TIMES THE CALCULATED ELONGATION, THE FOLLOWING MEASURES MUST BE TAKEN, IN SUCCESSION,TO DEFINE THE CAUSE OF THIS LACK OF ELONGATION.

- RECALIBRATE THE PRESSURE GUAGE
- CHECK THE CORRECT FUNCTIONING OF THE JACK. PUMP AND LEADS.
- DE–TENSION THE CABLE, SLIDE IT IN ITS DUCT TO CHECK THAT IT IS NOT BLOCKED BY MORTAR WHICH HAS ENTERED THROUGH HOLES IN THE SHEATH. RE–TENSION THE CABLE IF FREE. IF THE REQUIRED ELONGATION IS NOT OBTAINED. FURTHER FINISHING OPERATIONS SUCH AS CUTTING OR SEALING SHOULD NOT BE UNDERTAKEN WITHOUT THE APPROVAL OF THE ENGINEER.

02. ELONGATION SHOWN IN THE DRAWINGS SHALL BE CORRECTED FOR THR ACTUAL 'A' AND 'E' VALUE OF WIRES OBTAINED FROM THE MANUFACTURER .
    CORRECTED ELONGATION = ELONGATION SHOWN IN THE DRAWINGS x A.E/A1.E1
    A, E ARE THE DESIGN AREA AND MODULUS OF ELASTICITY OF WIRES.
    A1,E1 ARE ACTUAL AREA AND MODULUS OF ELASTICITY OF WIRES.

REV.	DESCRIPTION	DATE

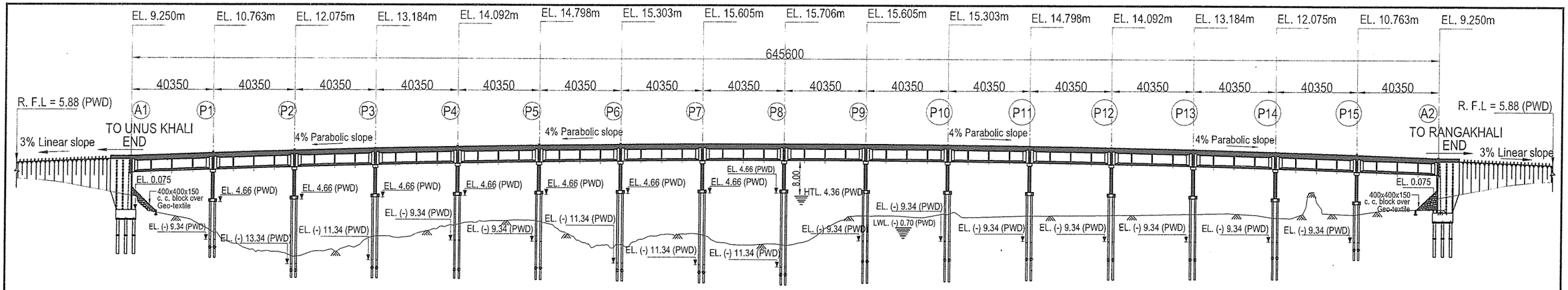
ROADS AND HIGHWAYS DEPARTMENT (RHD)	NAME OF THE PROJECT :		DRAWING TITLE :	SCALE :	DATE :	DRAWING NO.
Ministry of Communications	Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	GENERAL NOTES FOR PSC WORK	Scale : N.T.S.	02 July' 2013	BRDG/GEN/DWG–02



PLAN
(Scale : 1:2850)

REV.	DESCRIPTION	DATE

ROADS AND HIGHWAYS DEPARTMENT (RHD) Ministry of Communications	NAME OF THE PROJECT : Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	DRAWING TITLE : LAYOUT PLAN OF 640.0m LONG PSC GIRDER BRIDGE OVER KOHELIA RIVER, COX'S BAZAR.	SCALE : Scale : As above	DATE : 02 July' 2013	DRAWING NO. BRDG/S_LP/DWG-03

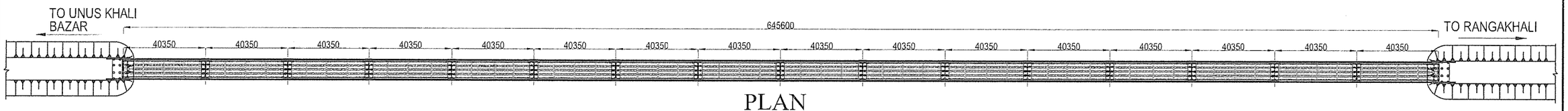


GENERAL ELEVATION

(Scale : 1:2000)

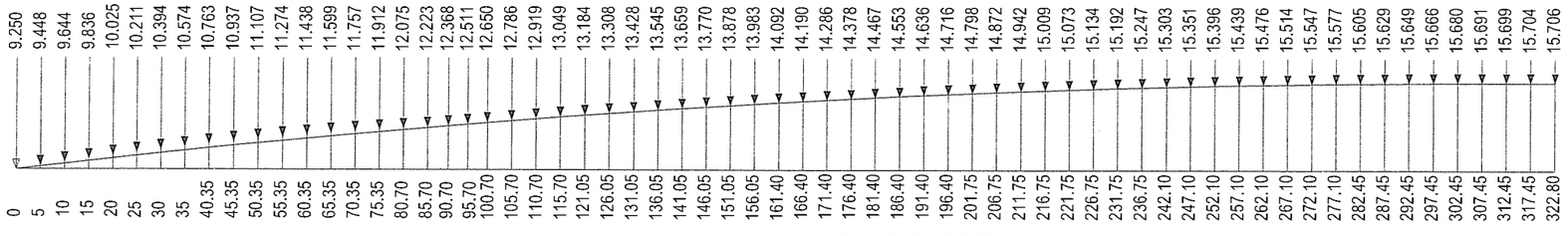
EXIST. RL (m)	2.150 1.250 0.570 0.380 0.190 0.000 -0.270 -0.830 -1.380 -2.130 -2.550 -2.900 -3.170 -3.360 -3.400 -3.500 -3.870 -3.710 -3.370 -3.320 -3.170 -3.030 -2.900 -2.390 -1.880 -1.830 -1.920 -1.910 -1.690 -1.370 -1.090 -0.890 -0.710 -0.470 -0.460 -0.350 -0.230 -0.270 -0.220 -0.230 -0.250 -0.480 -0.940 -1.450 -2.070 -2.470 -2.770 -2.680 -2.640 -2.860 -2.300 -1.910 -1.760 -1.590 -1.640 -1.550 -1.540 -1.790 -2.370 -2.490 -2.650 -2.640 -2.570 -2.510 -2.560 -2.640 -2.420 -2.210 -1.510 -0.790 -0.270 0.230 0.290 0.270 0.290 0.270 0.170 0.110 0.230 0.420 0.550 0.100 0.130 0.150 0.190 0.230 0.260 0.300 0.310 0.310 0.320 0.320 0.330 0.340 0.350 0.360 0.380 0.390 0.390 0.400 0.420 0.450 0.460 0.480 0.500 0.510 0.540 0.560 0.530 0.470 0.420 0.260 0.140 0.110 0.270 1.200 1.750 0.560 0.540 0.490 0.500 0.640 0.790 0.940 0.970 0.980 0.980 0.980 0.980 1.000
DISTANCE (m)	0.00 5.00 10.00 15.00 20.00 25.00 30.00 35.00 40.00 45.00 50.00 55.00 60.00 65.00 70.00 75.00 80.00 85.00 90.00 95.00 100.00 105.00 110.00 115.00 120.00 125.00 130.00 135.00 140.00 145.00 150.00 155.00 160.00 165.00 170.00 175.00 180.00 185.00 190.00 195.00 200.00 205.00 210.00 215.00 220.00 225.00 230.00 235.00 240.00 245.00 250.00 255.00 260.00 265.00 270.00 275.00 280.00 285.00 290.00 295.00 300.00 305.00 310.00 315.00 320.00 325.00 330.00 335.00 340.00 345.00 350.00 355.00 360.00 365.00 370.00 375.00 380.00 385.00 390.00 395.00 400.00 405.00 410.00 415.00 420.00 425.00 430.00 435.00 440.00 445.00 450.00 455.00 460.00 465.00 470.00 475.00 480.00 485.00 490.00 495.00 500.00 505.00 510.00 515.00 520.00 525.00 530.00 535.00 540.00 545.00 550.00 555.00 560.00 565.00 570.00 575.00 580.00 585.00 590.00 595.00 600.00 605.00 610.00 615.00 620.00 625.00 630.00 635.00 640.00 645.00

SECTION AT BRIDGE CENTER LINE



PLAN

(Scale : 1:2850)



DECK FINISHED LEVEL

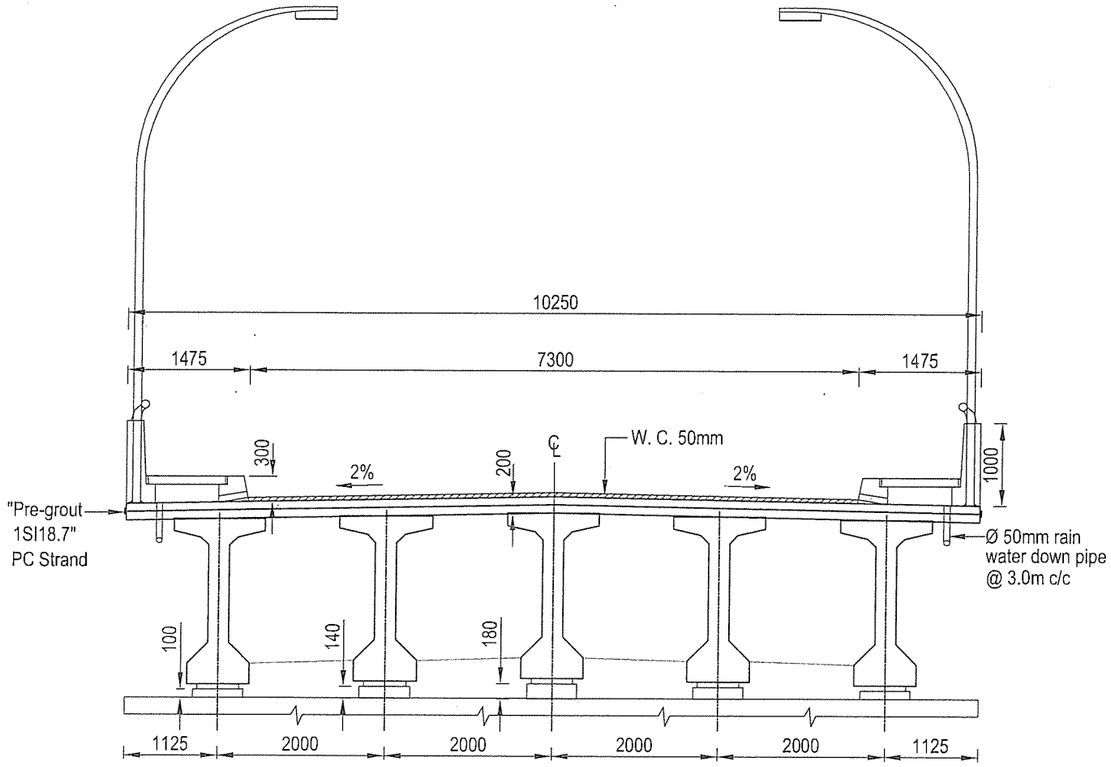
(Scale : 1:500)

Note :

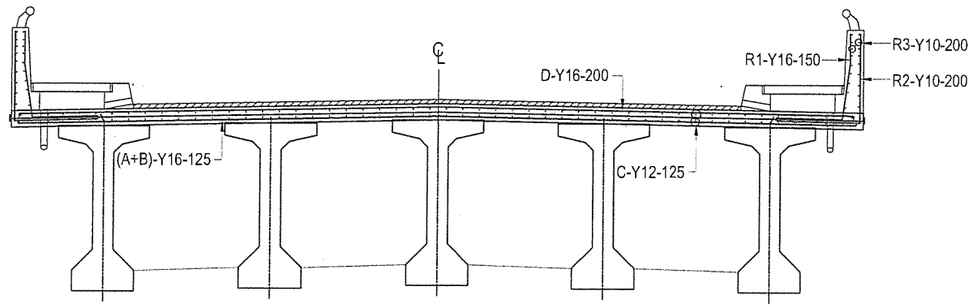
1. All dimensions are in mm unless otherwise specified.
2. In the Bridge 4% Parabolic Slope and in the Approach 3% Linear slope is used.

REV.	DESCRIPTION	DATE

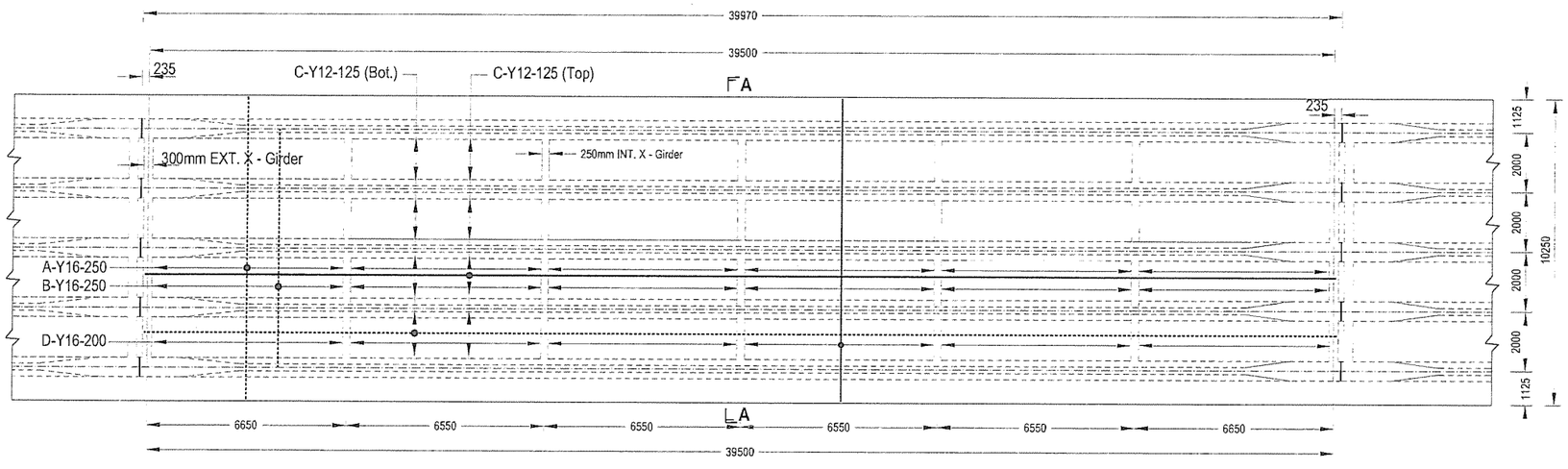
ROADS AND HIGHWAYS DEPARTMENT (RHD)	NAME OF THE PROJECT :		DRAWING TITLE :	SCALE :	DATE :	DRAWING NO.
Ministry of Communications	Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	PLAN AND SECTIONAL ELEVATION OF 640.0m LONG PSC CONCRETE GIRDER BRIDGE OVER KOHELIA RIVER	Scale : As above	02 July' 2013	BRDG/D-40/DWG-04



DECK SECTION (CONCRETE)



DECK SECTION (REINFORCEMENT)



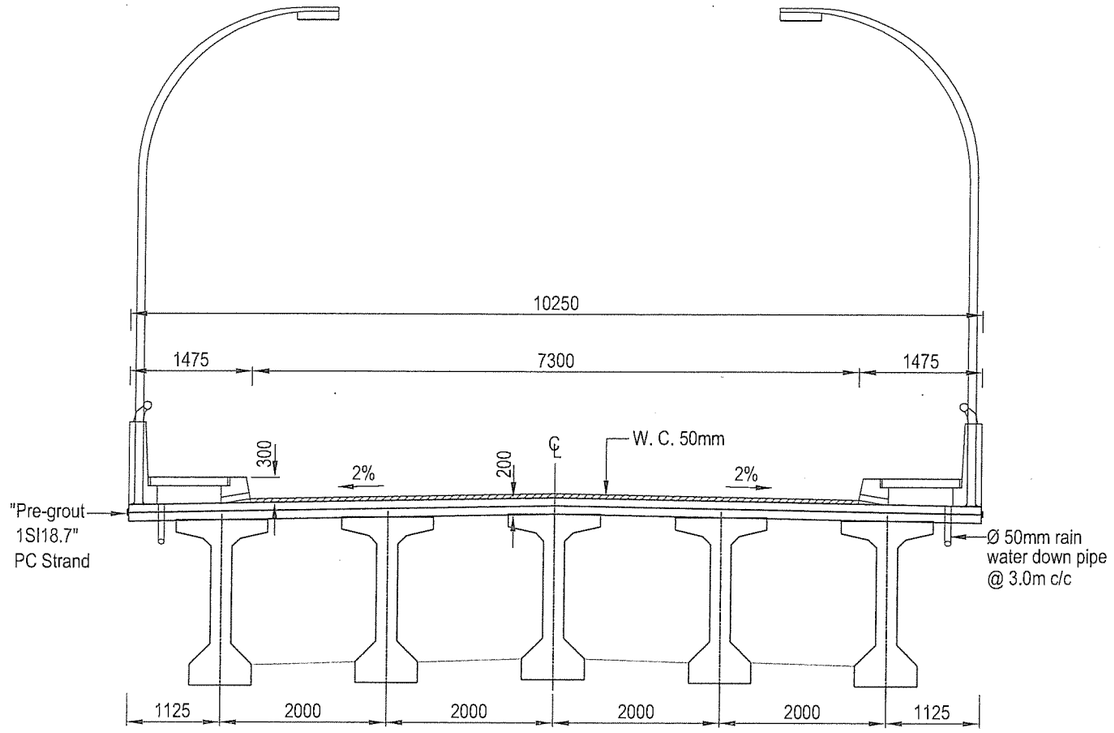
PLAN OF DECK SECTION (REINF.)
(Scale : 1:150)

Note :

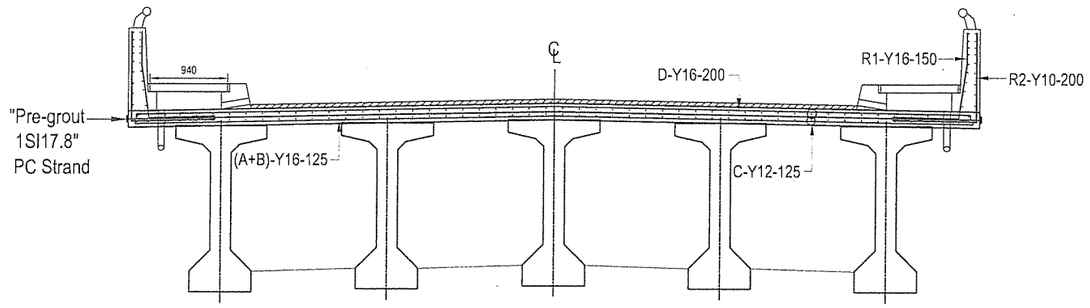
1. Expansion joint in slab to be provided at every three span interval.
2. Tranverse Pre-stressing Strand ("pre-grout 1SI18.70") to be provided at 500mm c/c along the deck slab.

REV.	DESCRIPTION	DATE

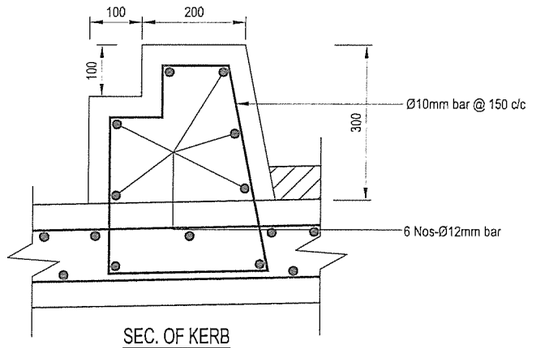
ROADS AND HIGHWAYS DEPARTMENT (RHD) Ministry of Communications	NAME OF THE PROJECT : Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	DRAWING TITLE : TYPICAL SECTION OF DECK SLAB FOR 640.0m LONG PSC GIRDER BRIDGE OVER KOHELIA RIVER SCALE : Scale : As above DATE : 02 July' 2013 DRAWING NO. BRDG/D-40/DWG-05



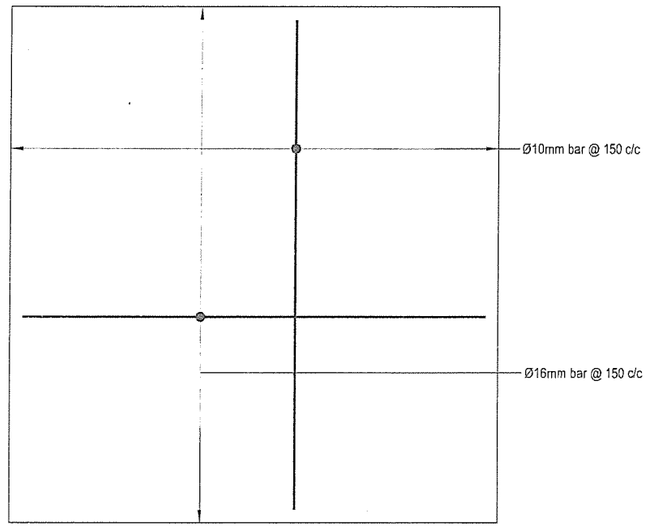
DECK SECTION (CONCRETE)



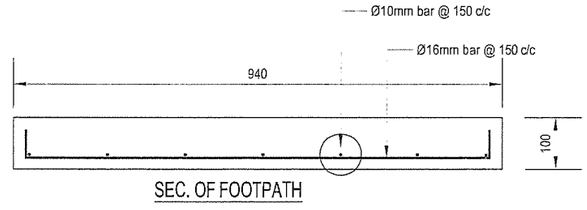
DECK SECTION (REINFORCEMENT)



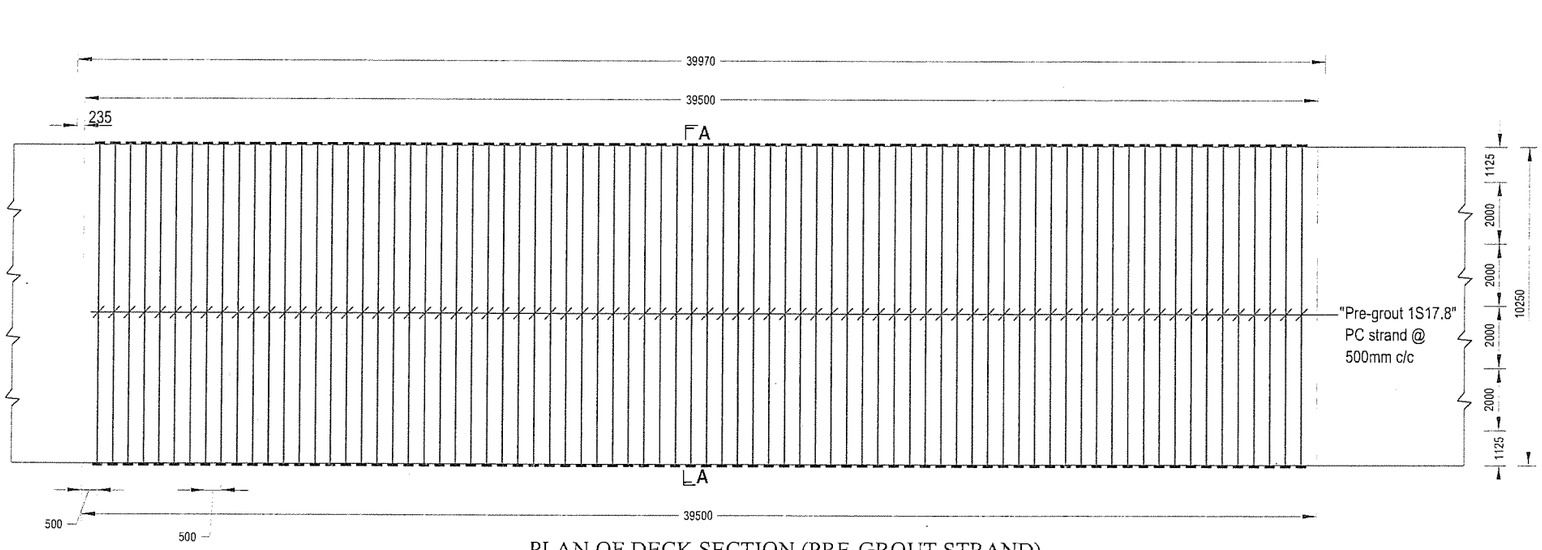
SEC. OF KERB



PLAN OF FOOTPATH



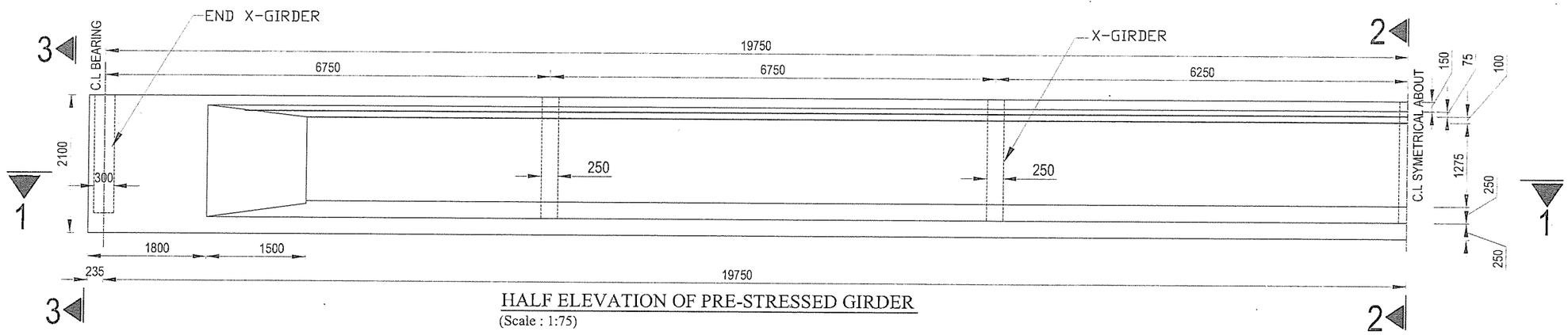
SEC. OF FOOTPATH



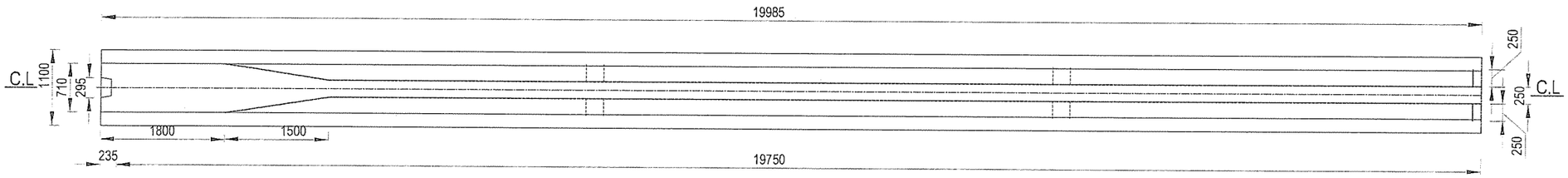
PLAN OF DECK SECTION (PRE-GROUT STRAND)
(Scale : 1:150)

REV.	DESCRIPTION	DATE

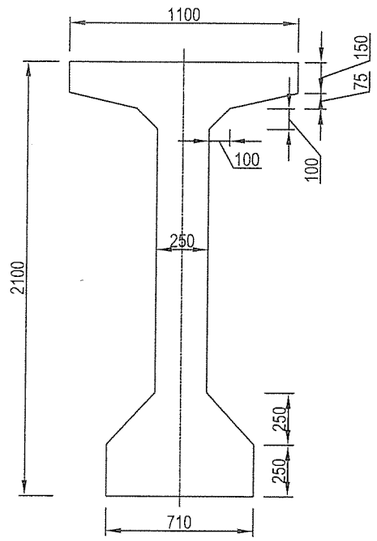
ROADS AND HIGHWAYS DEPARTMENT (RHD)	NAME OF THE PROJECT :		DRAWING TITLE :	SCALE :	DATE :	DRAWING NO.
Ministry of Communications	Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	PLACING OF PRE-GROUT STRAND IN THE DECK SLAB	Scale : As above	02 July' 2013	JICA/BRDG/D40/DWG-06



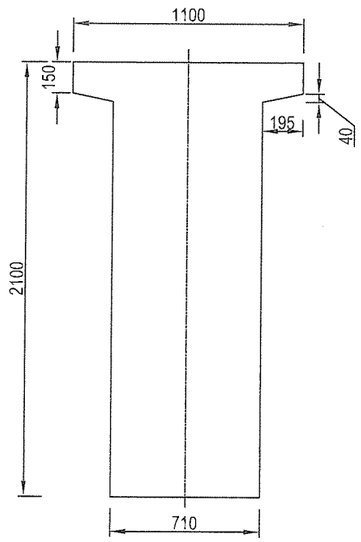
HALF ELEVATION OF PRE-STRESSED GIRDER
(Scale : 1:75)



TOP VIEW OF PRE-STRESSED GIRDER (SEC. 1-1)
(Scale : 1:75)



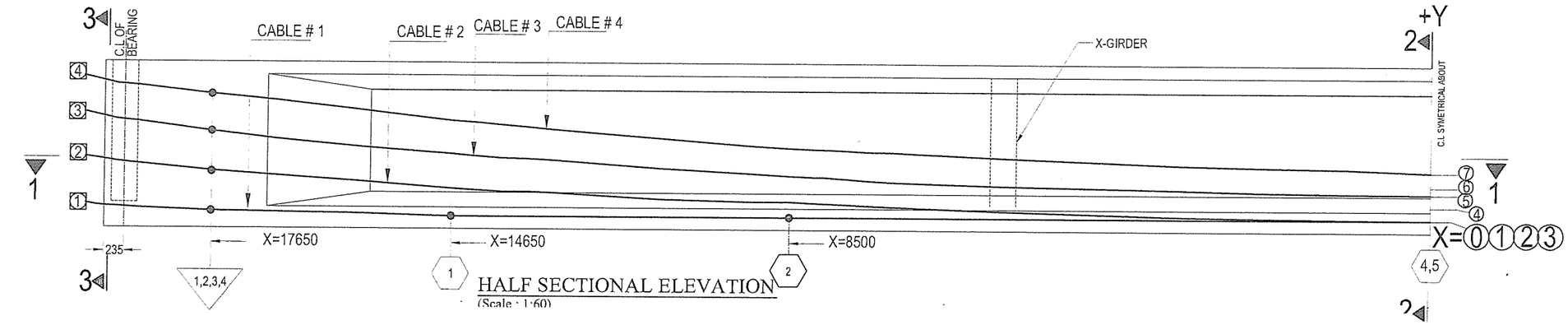
SEC. 2-2



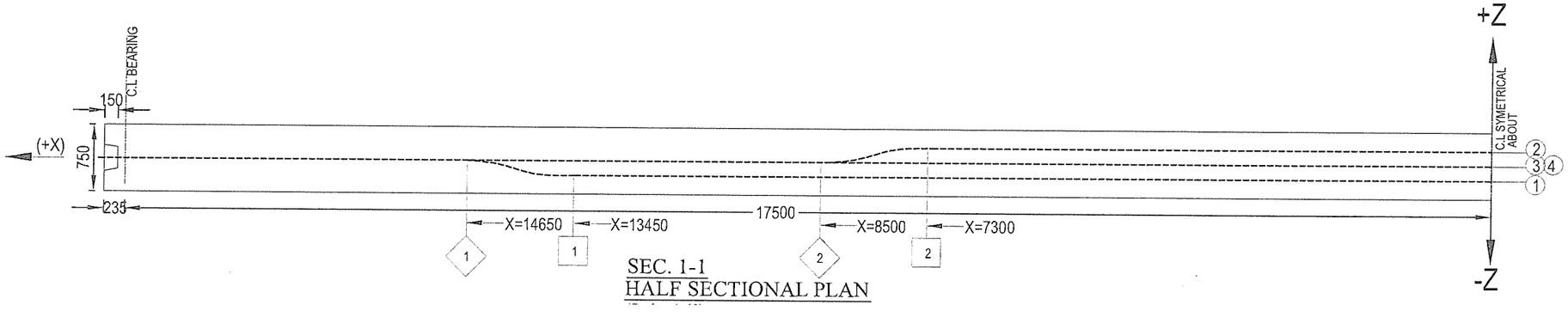
SEC. 3-3
(Scale : 1:30)

REV.	DESCRIPTION	DATE

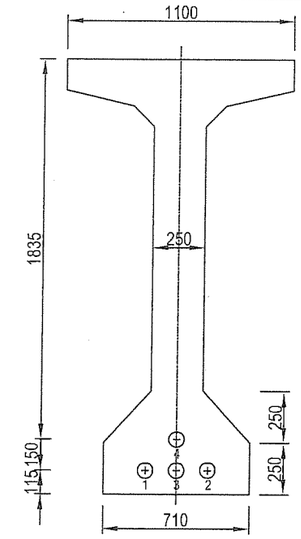
ROADS AND HIGHWAYS DEPARTMENT (RHD)	NAME OF THE PROJECT :		DRAWING TITLE :	SCALE :	DATE :	DRAWING NO.
Ministry of Communications	Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	DETAILS OF 40.32m LONG PSC GIRDER BRIDGE OVER KOHELIA RIVER AT COX'S BAZAR.	Scale : As above	02 July' 2013	JICA/BRDG/G40/DWG-07



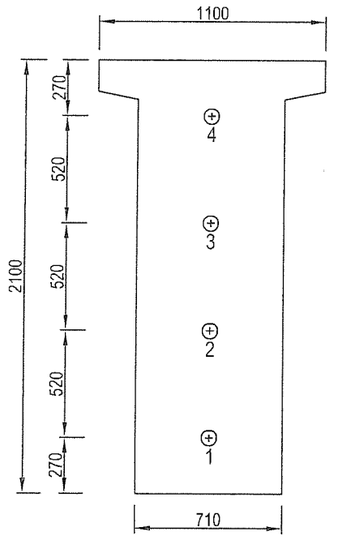
HALF SECTIONAL ELEVATION
(Scale : 1:60)



SEC. 1-1
HALF SECTIONAL PLAN



MID SECTION



END SECTION
(Scale : 1:30)

Cable No.	ORDINATE AT DISTANCE X FROM CENTER																																		Extension at each jacking end	Emergence angle
	20001		18500		17500		16500		15500		14650		13450		12250		10550		10250		9000		8000		6500		7300		6100		6000		5500		5000		3000		2000		1000		0			
	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z		
1	270		220		193		169		150		115		115		115		115		115		115		115		115		115		115		115		115		115		115		115		115		139.60	0.89
2	790		625		526		442		365		308		240		187		136		131		116		116		115		115		115		115		115		115		115		115		115		140.01	3.86
3	1310		1137		1030		928		833		756		655		563		447		429		357		306		331		274		226		223		205		190		142		127		116		115		140.91	6.78
4	1830		1604		1463		1330		1205		1105		973		852		700		676		582		515		546		473		411		406		383		363		300		281		269		255		141.86	8.82
1		0		0		0		0		0		0		-75.0		-150		-150		-150		-150		-150		-150		-150		-150		-150		-150		-150		-150		-150		-150			
2		0		0		0		0		0				0		0		0		0		0		0		0		75		150		150		150		150		150		150		150			

LEGEND

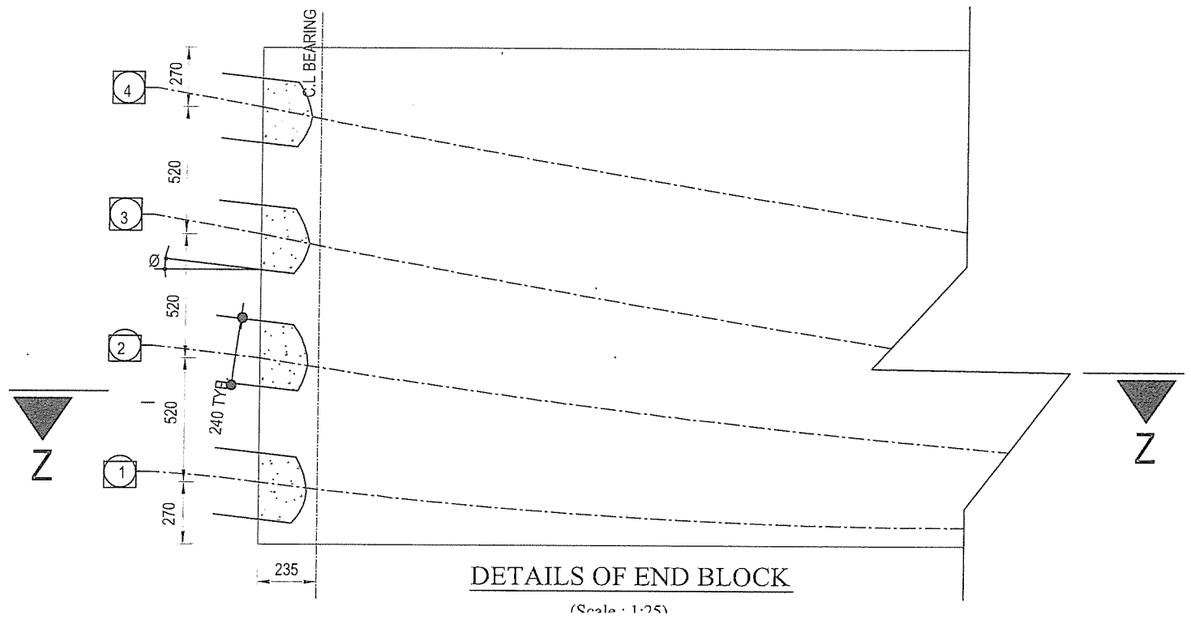
- INDICATES START OF CURVE IN ELEVATION
- INDICATES END OF CURVE IN ELEVATION
- INDICATES START OF CURVE IN PLAN
- INDICATES END OF CURVE IN PLAN
- INDICATES END OF CABLE
- INDICATES CABLE NUMBER

Note :

1. All dimensions are in mm unless otherwise mentioned.
2. Type of girder shall be of Pre-cast Post-tensioned Pre-stressed Concrete.
3. Both Exterior and Interior girder shall be of same type, size & cable pos

REV.	DESCRIPTION	DATE

ROADS AND HIGHWAYS DEPARTMENT (RHD)	NAME OF THE PROJECT :		DRAWING TITLE :	SCALE :	DATE :	DRAWING NO.
Ministry of Communications	Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	DETAILS OF CABLE PROFILE FOR PSC GIRDER	Scale : As above	02 July' 2013	JICA/BRDG/CAB/DWG-08



DETAILS OF END BLOCK

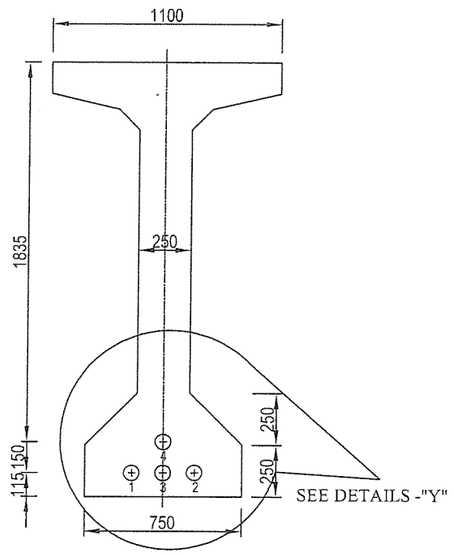
(Scale : 1:25)

NOTES :

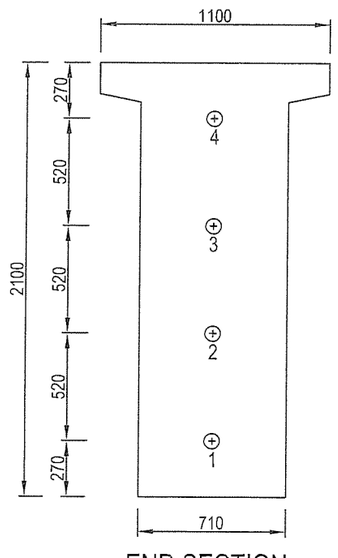
1. EACH CABLE SHALL BE STRESSED SIMULTANEOUSLY FROM BOTH ENDS. THE JACKING FORCE IN EACH CABLE SHALL BE 2615 kN TO BE IMPERTED SIMULTANEOUSLY AT BOTH ENDS.
2. THE SEQUENCE OF STRESSING OF PRESTRESSING CABLES SHALL BE AS FOLLOWS.
   STAGE 1 : 3, 1, 2 & 4
3. STAGE 1 STRESSING OF CABLE SHALL BE DONE AFTER 10 DAYS OR CONCRETE STRENGTH NOT LESS THAN 30N/mm2 WHICHEVER IS LATER.
4. CONSTRUCTION SEQUENCE

DAYS (AFTER CASTING OF GIRDER)	DAYS
10	STRESSING OF STAGE 1 CABLES
AFTER 21	SHIFTING OF FINAL POSITION, CASTING OF DECK SLAB INSTALLATION OF EXPANSION JOINTS CASTING/ LAYING OF FOOTPATH, KERBS, WEARING COURSE AND RAILINGS

   AFTER STAGE 1 STREEING GIRDER CAN BE SHIFTED.
5. FOR ANCHORAGE DERAILS REFER DRG.
6. THE EXTENSION SHOWN IN THE TABLE IS FOR THE PORTION OF CABLES LYING BETWEEN MID SPAN AND GRIPPING POINT OF THE JACK.
   THE GRIPPING POINT IS ASSUMED AT 750mm FROM THE FACE OF THE RECESS.
7. EACH CABLES CONSISTS OF 19 NOS. 12.7mm (19T13) STRANDS.
8. CONTRUCTOR SHALL BE SUBMITTED PROCESS OF STRESSING WITH ELONGATION AND CAMBER OF BEAM DECK TO EACH CABLE STRESSING TO THE ENGINEER IN-CHARGE FOR APPROVAL BEFOR 30 DAYS OF BEAM CASTING.

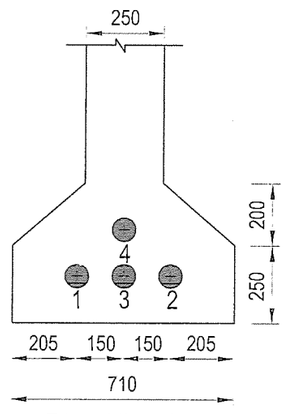


MID SECTION



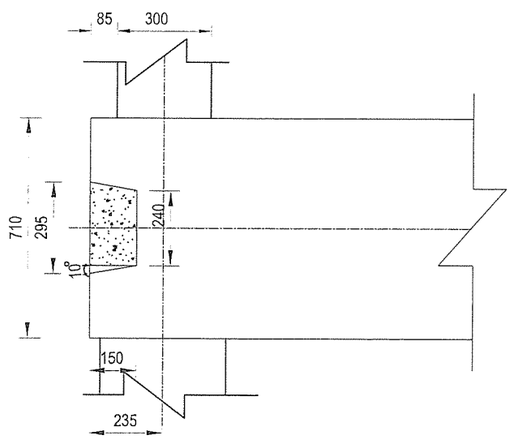
END SECTION

(Scale : 1:30)



DETAIL Y

(Scale : 1:20)

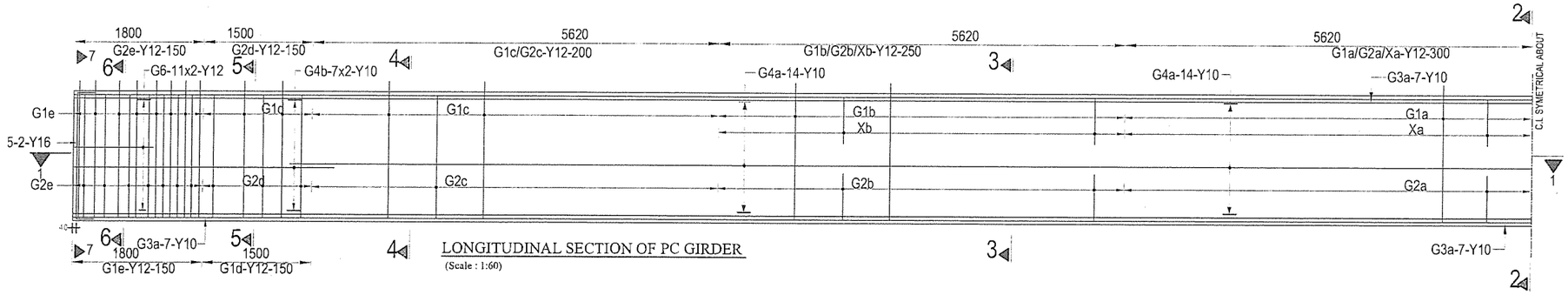


SECTION Z-Z

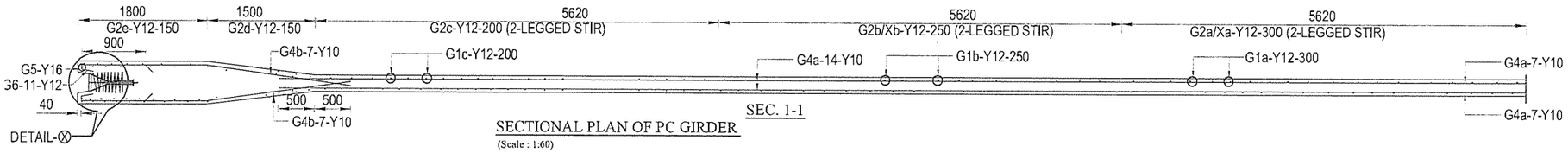
(Scale : 1:20)

REV.	DESCRIPTION	DATE

ROADS AND HIGHWAYS DEPARTMENT (RHD)	NAME OF THE PROJECT :		DRAWING TITLE :	SCALE :	DATE :	DRAWING NO.
Ministry of Communications	Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	DETAILS OF END SECTION OF PSC GIRDER	Scale : As above	02 July' 2013	JICA/BRDG/END/DWG-09

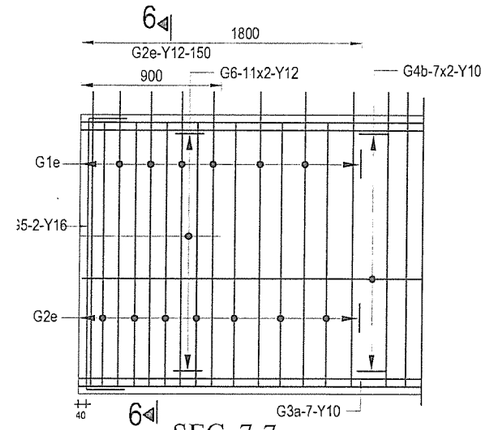


LONGITUDINAL SECTION OF PC GIRDER
(Scale : 1:60)

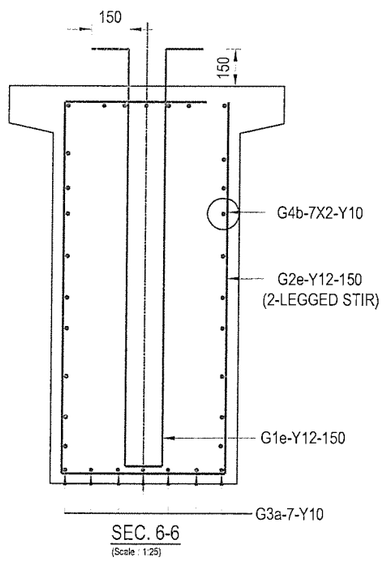


SECTIONAL PLAN OF PC GIRDER
(Scale : 1:60)

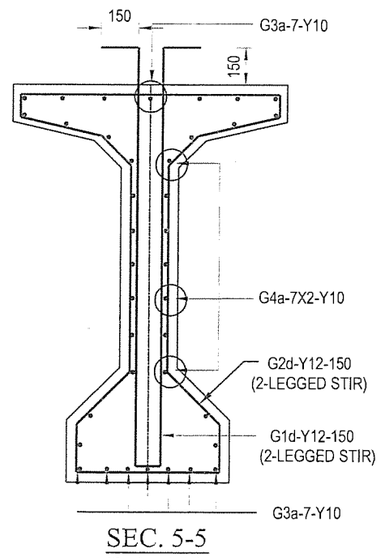
SEC. 1-1



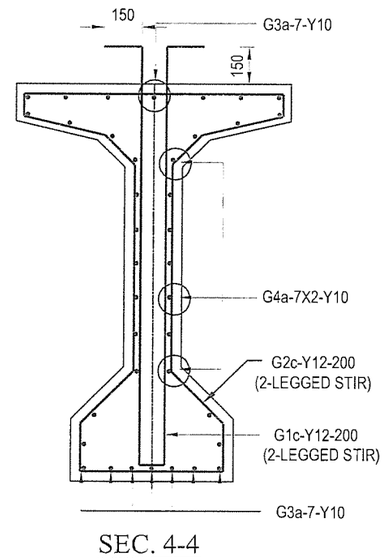
SEC. 7-7



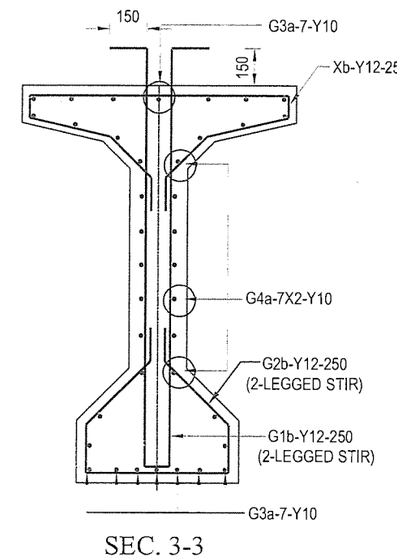
SEC. 6-6
(Scale : 1:25)



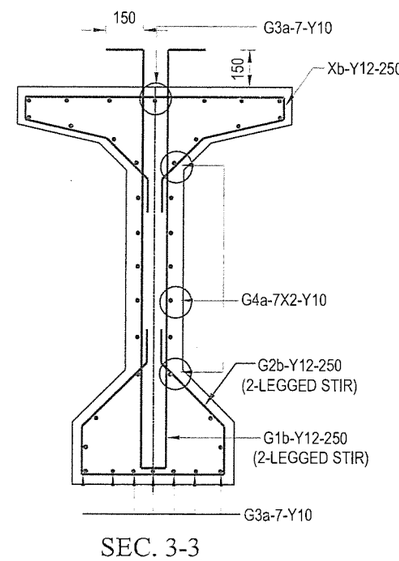
SEC. 5-5
(Scale : 1:25)



SEC. 4-4
(Scale : 1:25)



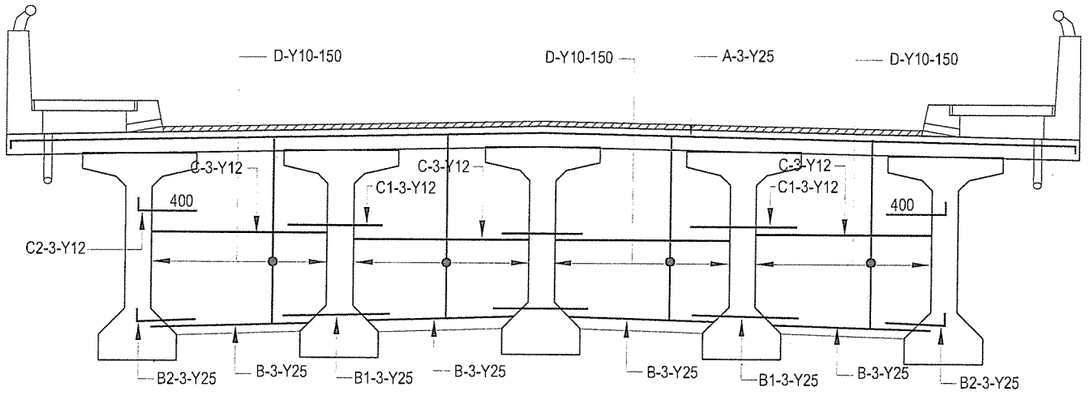
SEC. 3-3
(Scale : 1:25)



SEC. 3-3
(Scale : 1:25)

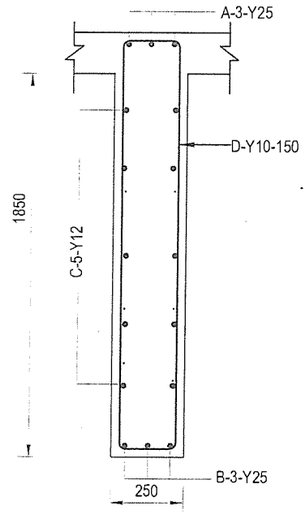
REV.	DESCRIPTION	DATE

ROADS AND HIGHWAYS DEPARTMENT (RHD)	NAME OF THE PROJECT :		DRAWING TITLE :	SCALE :	DATE :	DRAWING NO.
Ministry of Communications	Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	NON-PRESTRESSED REINFORCEMENT DETAILS	Scale : As above	02 July' 2013	JICA/BRDG/REINF./DWG-10

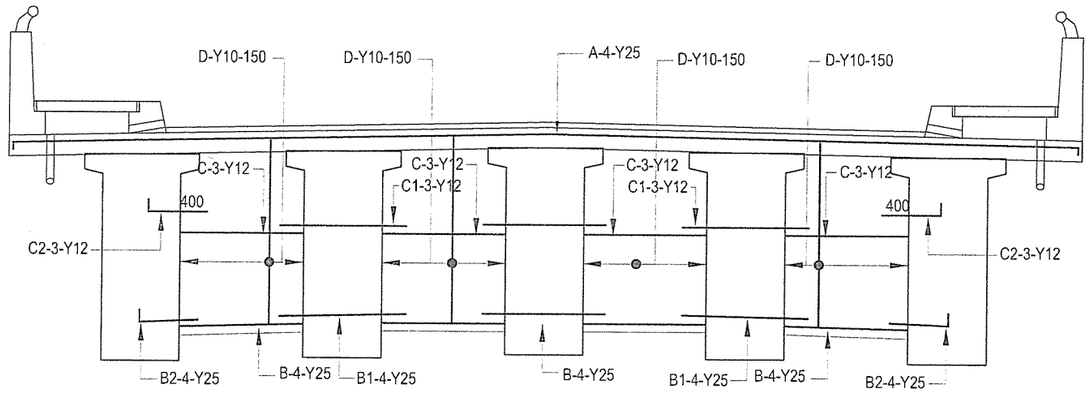


REINF. DETAILS OF MID X-GIRDER

(Scale : 1:60)

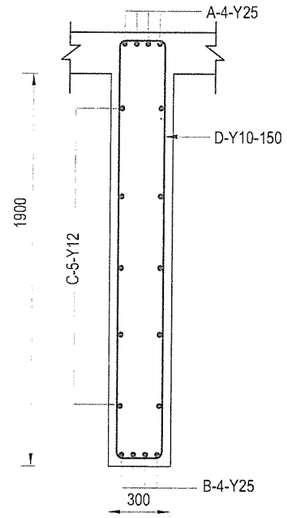


SEC. B-B (INTERIOR X-GIRDER)



REINF. DETAILS OF END X-GIRDER

(Scale : 1:60)



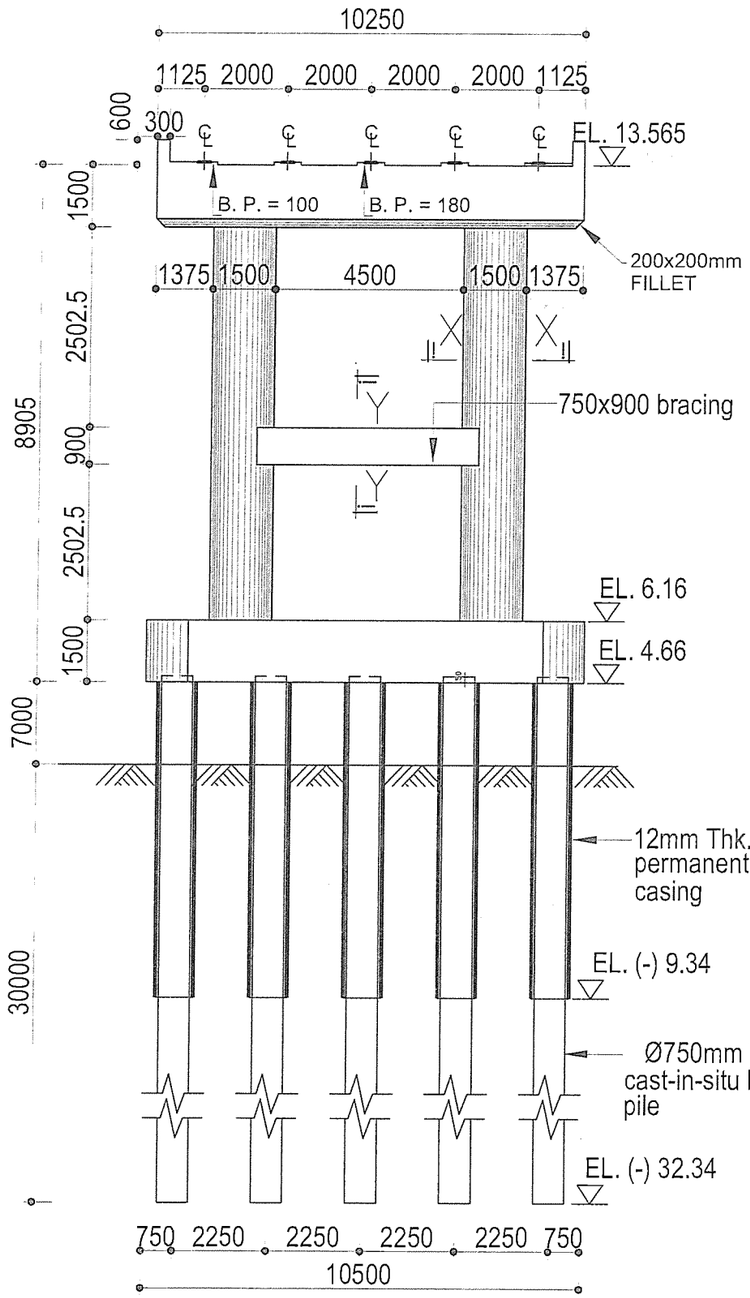
SEC. A-A (END X-GIRDER)

(Scale : 1:30)

SHAPE CODE	01	01A	02	02A	02B	03	04	05	06
SHAPE OF BARS	a	b a	b a	c b a	b a	a b	b a	b c a	a c b

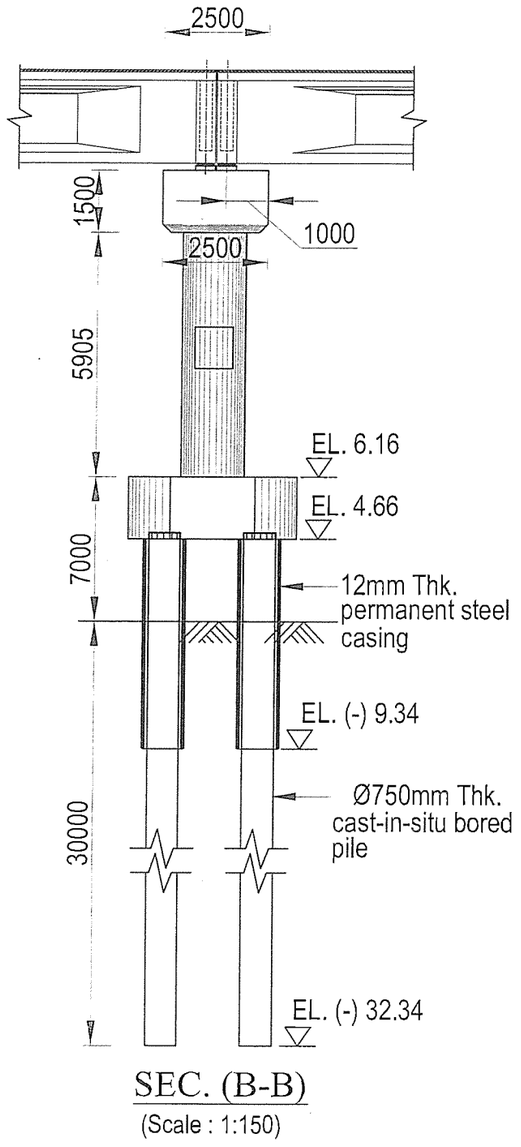
REV.	DESCRIPTION	DATE

ROADS AND HIGHWAYS DEPARTMENT (RHD)	NAME OF THE PROJECT :		DRAWING TITLE :	SCALE :	DATE :	DRAWING NO.
Ministry of Communications	Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	X-GIRDER DETAILS	Scale : As above	02 July' 2013	JICA/BRDG/X_GIR/DWG-11



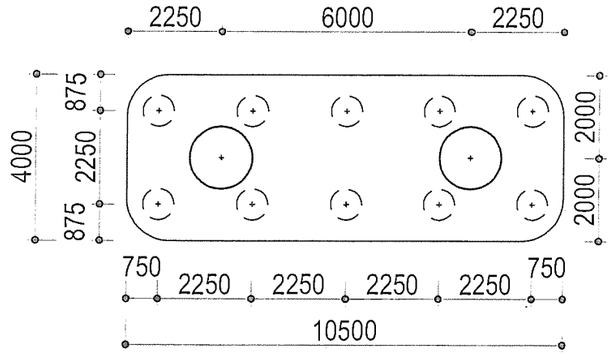
SECTIONAL ELEVATION OF PIER (A-A)

(Scale : 1:150)



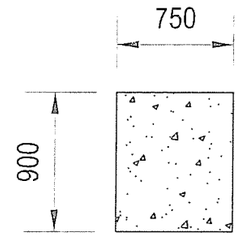
SEC. (B-B)

(Scale : 1:150)



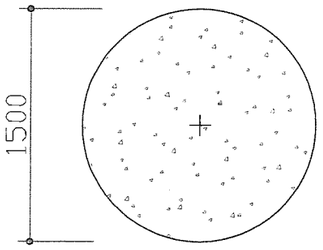
PILE LAYOUT PLAN

(Scale : 1:150)



SEC. Y-Y

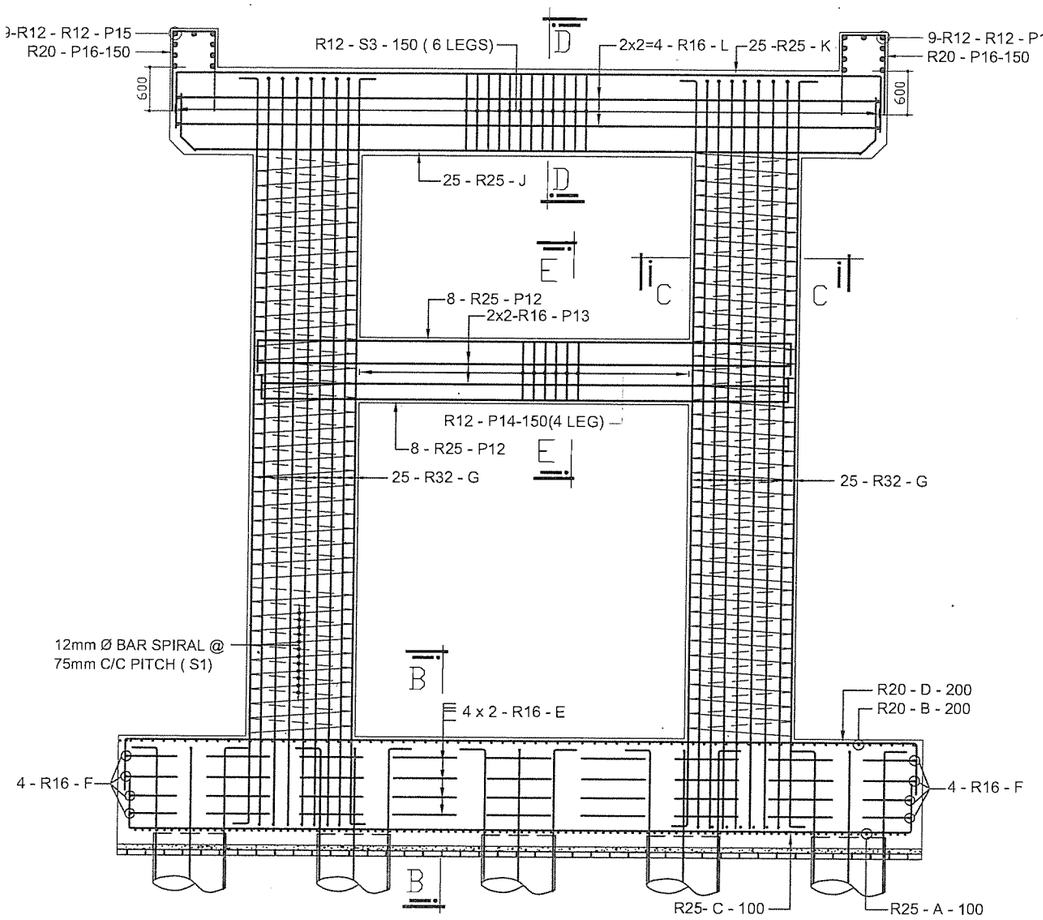
(Scale : 1:40)



SEC. X-X

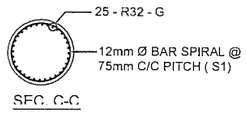
REV.	DESCRIPTION	DATE

ROADS AND HIGHWAYS DEPARTMENT (RHD)	NAME OF THE PROJECT :	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	DRAWING TITLE :	SCALE :	DATE :	DRAWING NO.
Ministry of Communications	Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).		CONCRETE OUTLINE OF PIER-P8 (TYPICAL)	Scale : As above	02 July' 2013	JICA/BRDG/PIER/DWG-12

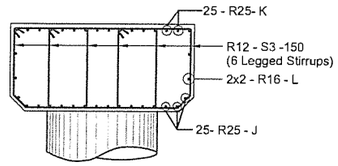


REINFORCEMENT ELEVATION OF PIER

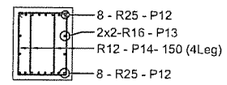
SECTION A - A



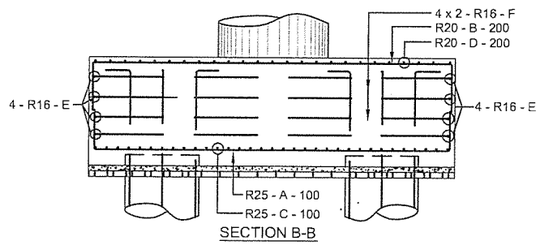
SEC. C-C



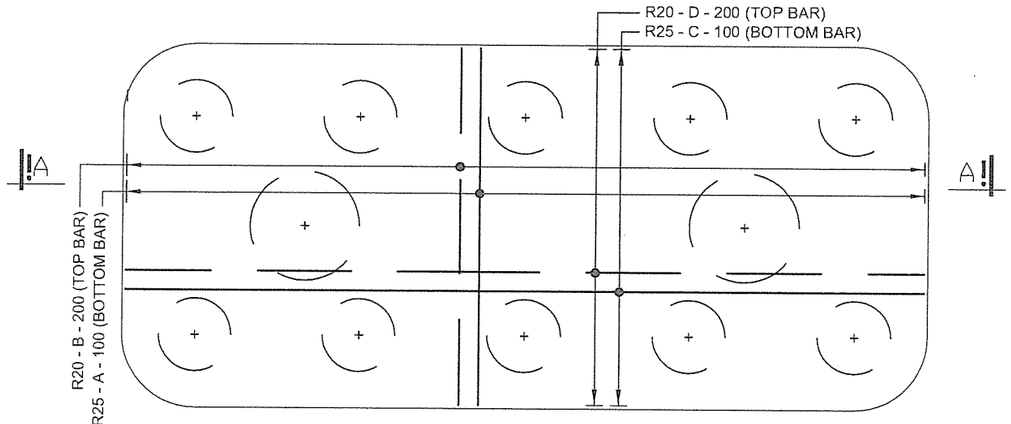
SEC. D-D



SEC. E - E



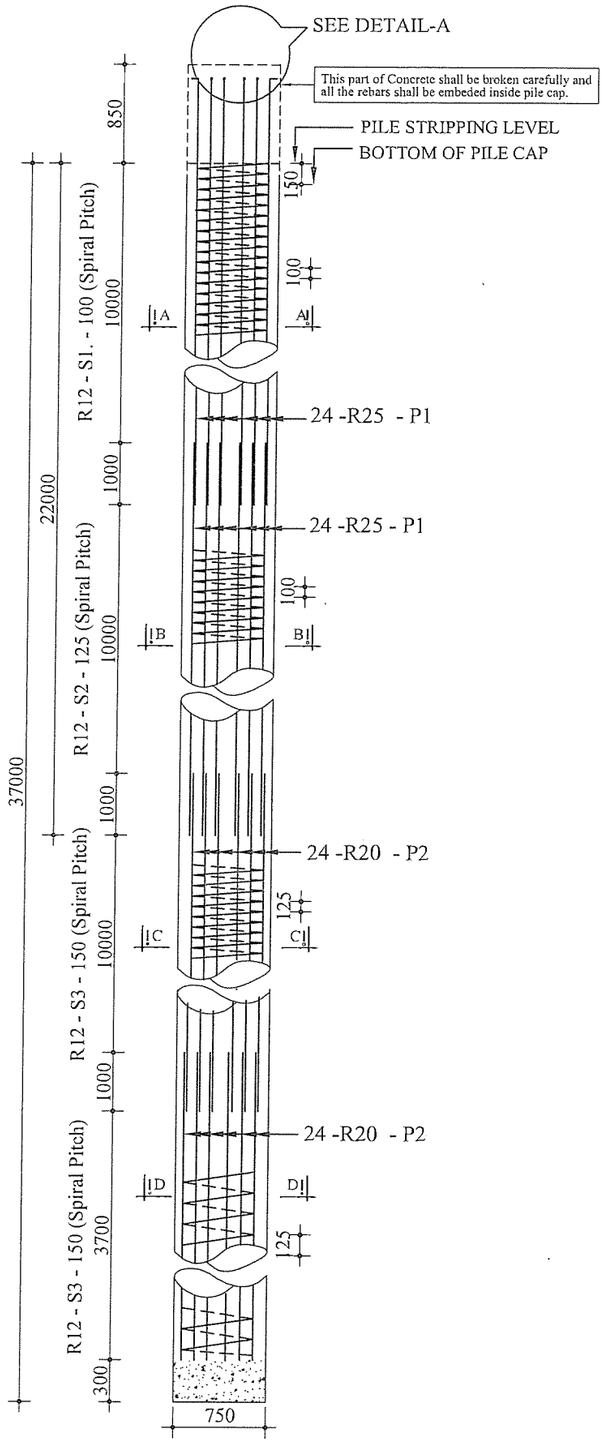
SECTION B-B



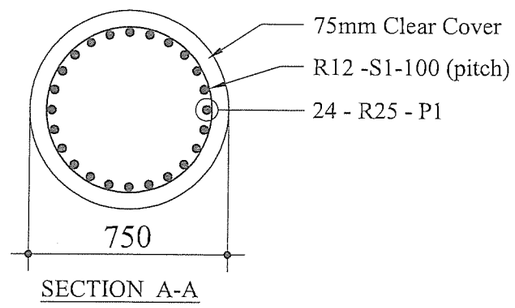
REINFORCEMENT PLAN OF PILE CAP

REV.	DESCRIPTION	DATE

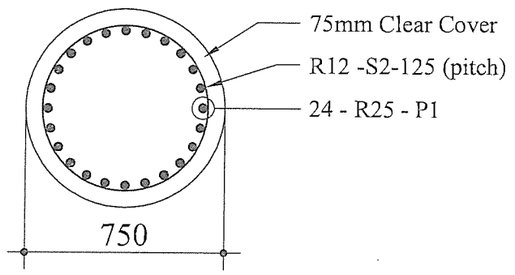
ROADS AND HIGHWAYS DEPARTMENT (RHD)	NAME OF THE PROJECT :	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	DRAWING TITLE :	SCALE :	DATE :	DRAWING NO.
Ministry of Communications	Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).		REINFORCEMENT DETAILS OF PIER (TYPICAL)	Scale : As above	02 July' 2013	JICA/BRDG/PIER/DWG-13



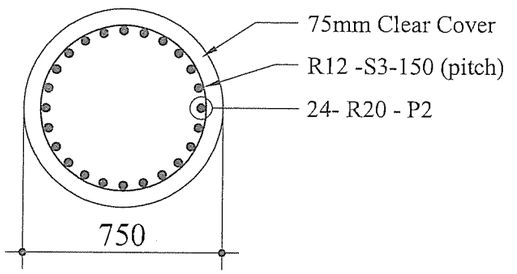
REINF. DETAILS OF PIER PILE
CAST-IN-SITU PILE DETAILS



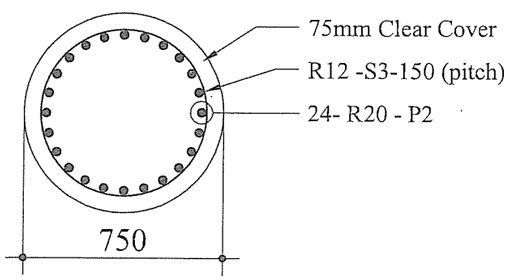
SECTION A-A



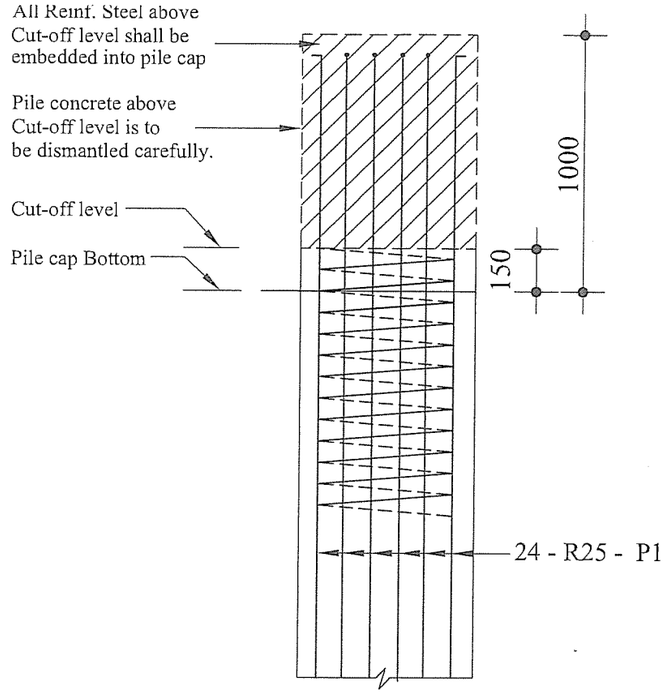
SECTION B-B



SECTION C-C



SECTION D-D



DETAIL-A

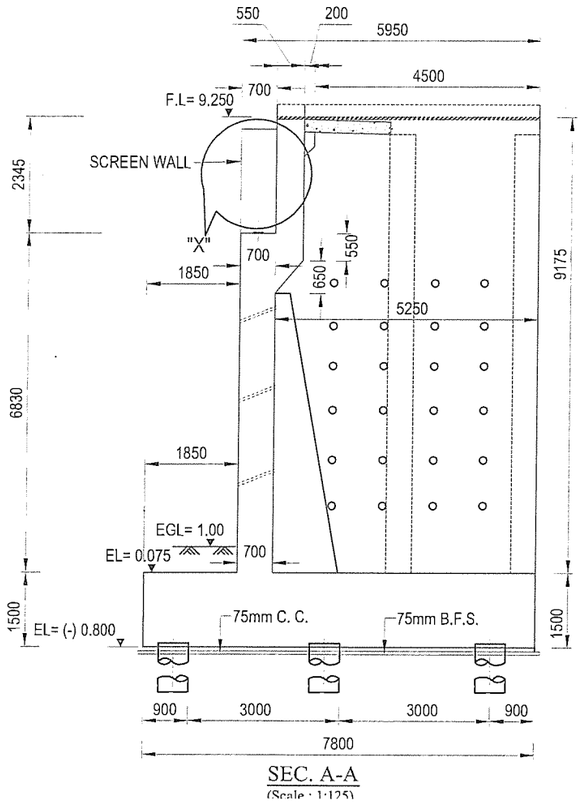
NOTES:

Cast-in-situ Pile:

1. All dimensions are in millimeters unless otherwise mentioned .
2. 28 days cylinder crushing strength of concrete f'c= 25 N/mm^2 (3500 psi)
3. Yield strength of M.S deformed reinforcement bar fy = 413 N/mm^2 (60000 psi)
4. Clear Cover to main reinforcement bar is to be 75mm. unless otherwise mentioned.
5. When concreting at the top of Pile one batch of concrete must be over flown to ensure fresh concrete at Pile head.
6. The spiral reinforcement should preferably be tack welded to the main Reinforceing bars.
7. The lapping portion of main reinforcement shall be joint welded .
8. Design load of Pile under service load condition is 210 M. T for Pier Pile.
9. Test load shall be 420M. T. on service Pile.
10. Pile capacity is to be confirmed by static pile load test.
11. Boring to done by Rotary drilling method.

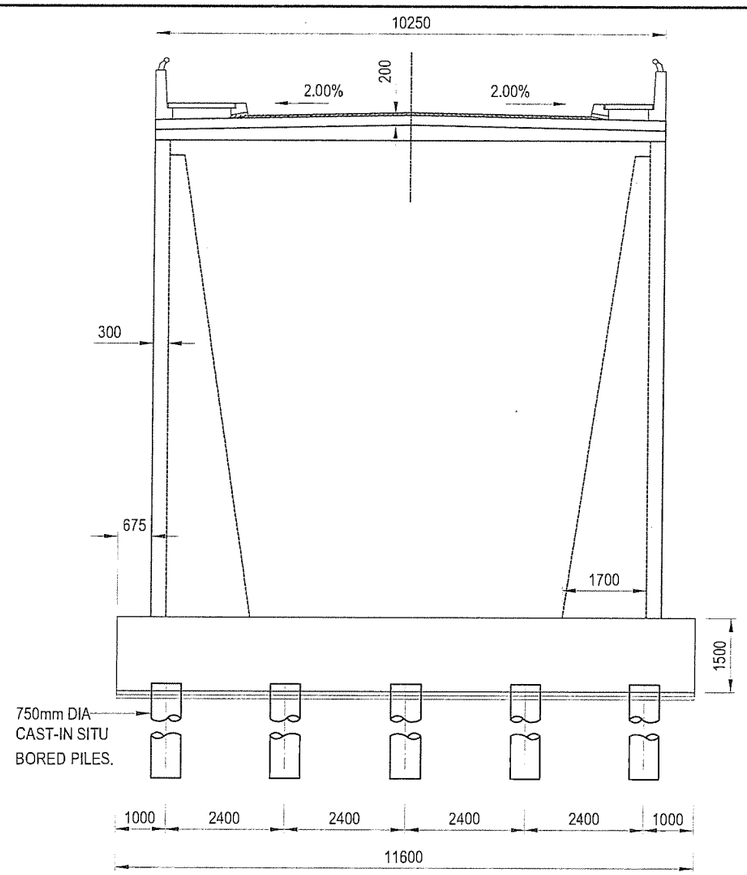
REV.	DESCRIPTION	DATE

ROADS AND HIGHWAYS DEPARTMENT (RHD) Ministry of Communications	NAME OF THE PROJECT : Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	DRAWING TITLE : REINFORCEMENT DETAILS OF PIER PILE (TYPICAL) Scale : As above 02 July' 2013 DRAWING NO. JICA/BRDG/PILE/DWG-14

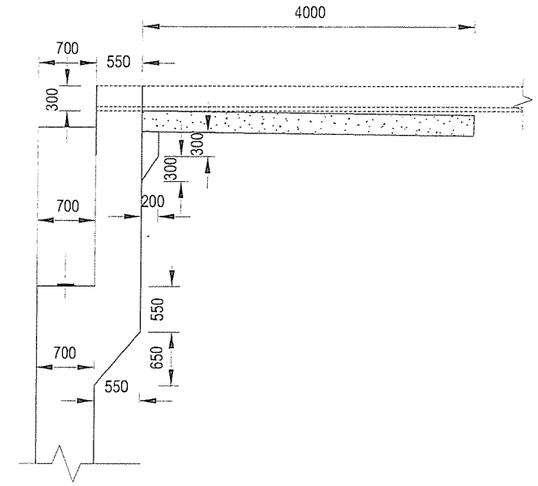


SEC. A-A

(Scale : 1:125)

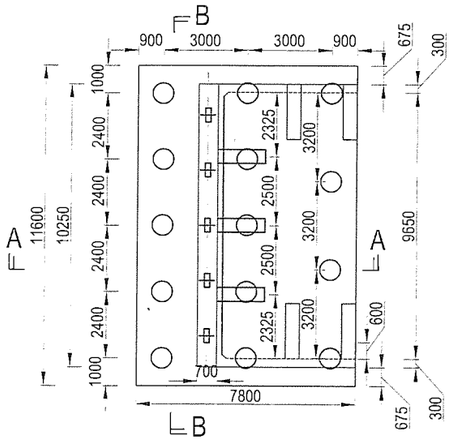


SECTIONAL ELEVATION B-B

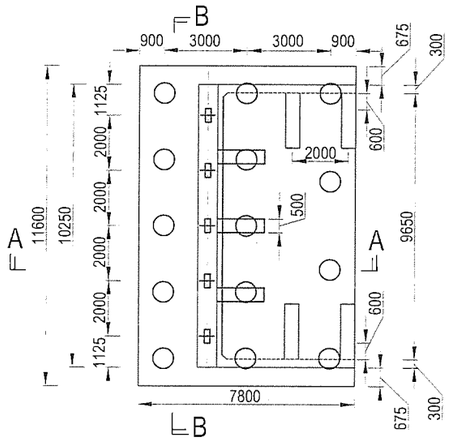


DETAILS "X"

(Scale : 1:75)



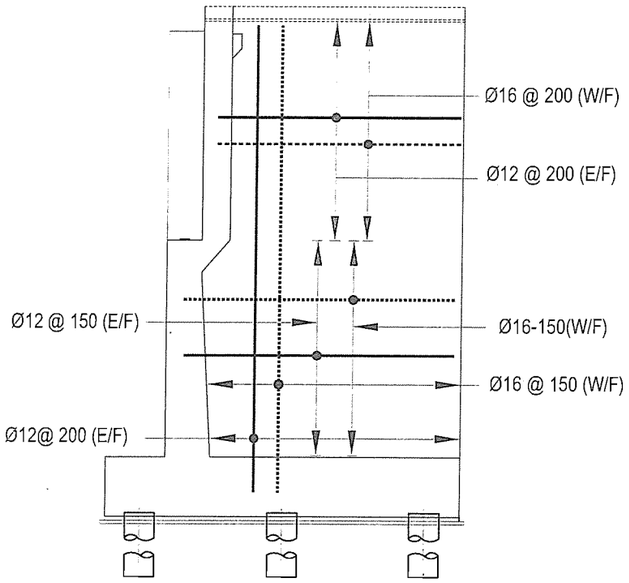
PILE CAP & PILE LAYOUT PLAN



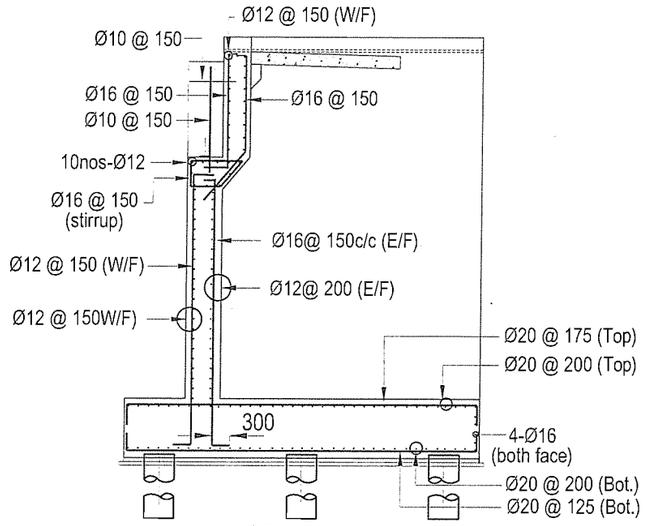
PLAN OF ABUTMENT & BEARING PAD ARRANGEMENT

REV.	DESCRIPTION	DATE

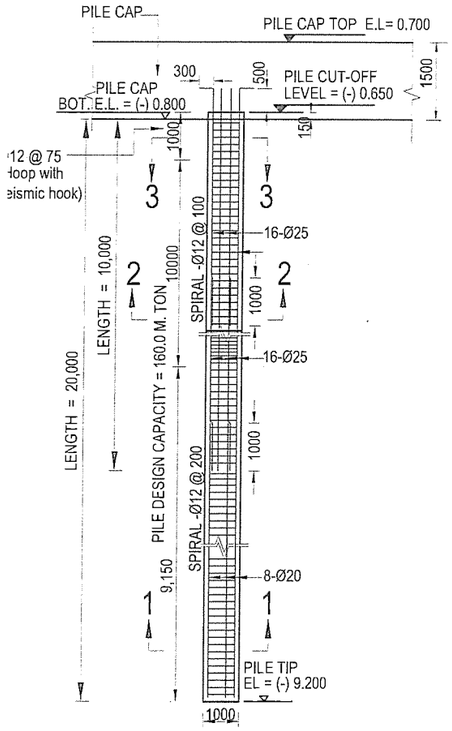
ROADS AND HIGHWAYS DEPARTMENT (RHD) Ministry of Communications	NAME OF THE PROJECT : Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	DRAWING TITLE : CONCRETE OUT LINE OF ABUTMENT (A1 & A2) Scale : As above 02 July' 2013 DRAWING NO. JICA/BRDG/ABUT/DWG-15



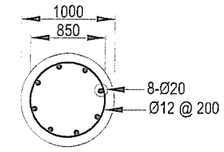
ELEV. SHOWING REINF.
DETAILS OF RETURN WALL
(Scale : N.T.S)



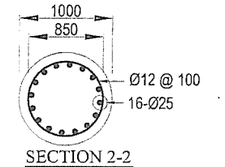
SEC. C-C
(Scale : 1:125)



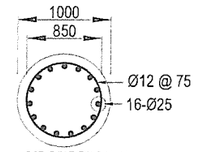
SECTIONAL ELEVATION
OF ABUTMENT PILE
(Scale : 1:130)



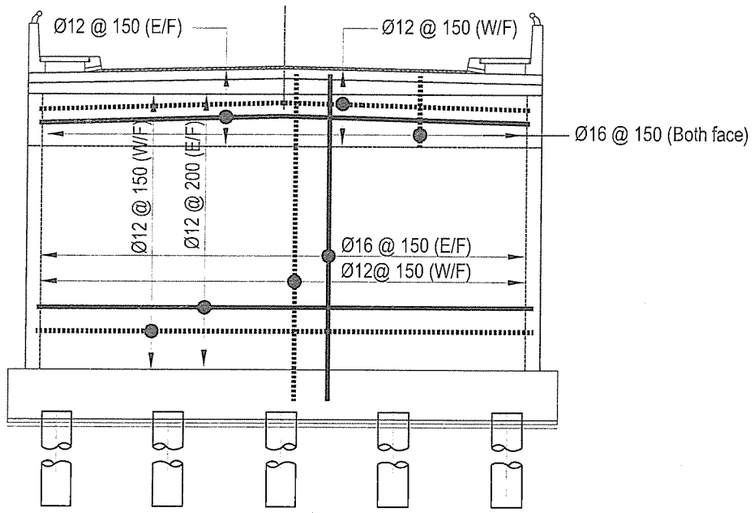
SECTION 1-1
(Scale : 1:50)



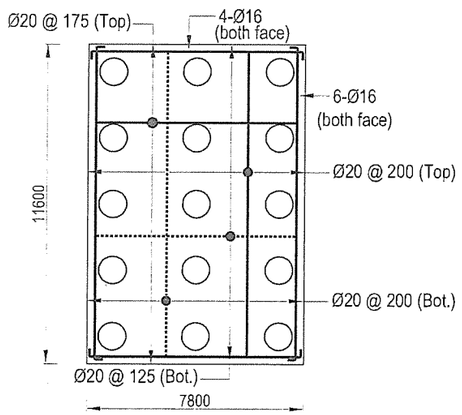
SECTION 2-2
(Scale : 1:50)



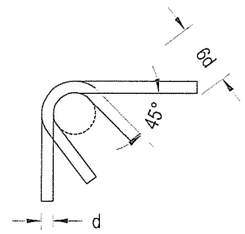
SECTION 3-3
(Scale : 1:50)



SECTIONAL ELEVATION B-B
(Scale : 1:125)



PLAN SHOWING REINF.
DETAILS OF PILE CAP
(Scale : 1:225)



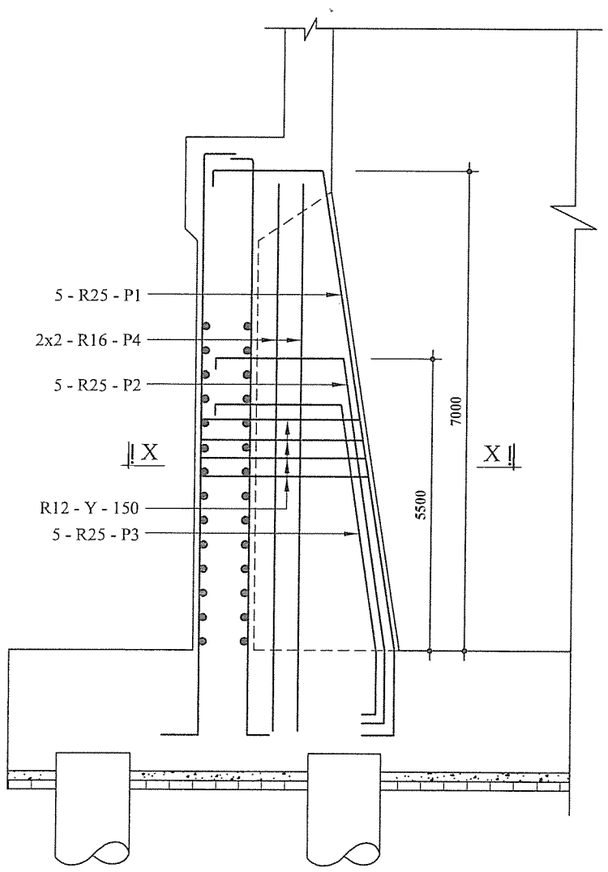
SEISMIC HOOK
(Scale : 1:30)

Legend :

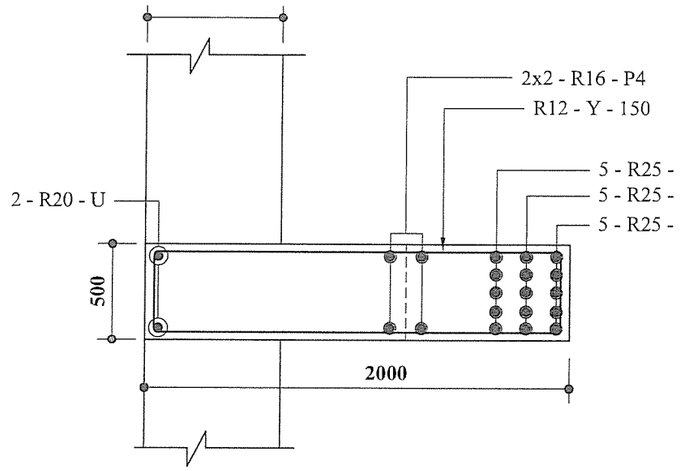
E/F : Earth face
W/F : Water face

REV.	DESCRIPTION	DATE

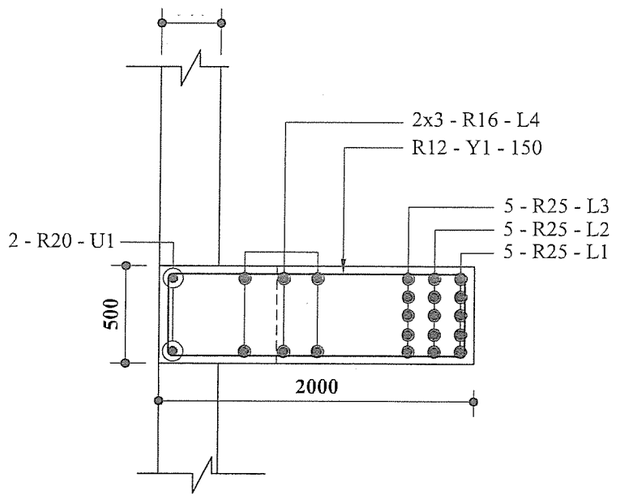
ROADS AND HIGHWAYS DEPARTMENT (RHD) Ministry of Communications	NAME OF THE PROJECT : Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	DRAWING TITLE : REINF. DETAILS OF ABUTMENT (A1 & A2) Scale : As above 02 July' 2013 CONTRACT NO DRAWING NO. JICA/BRDG/ABUT/DWG–16



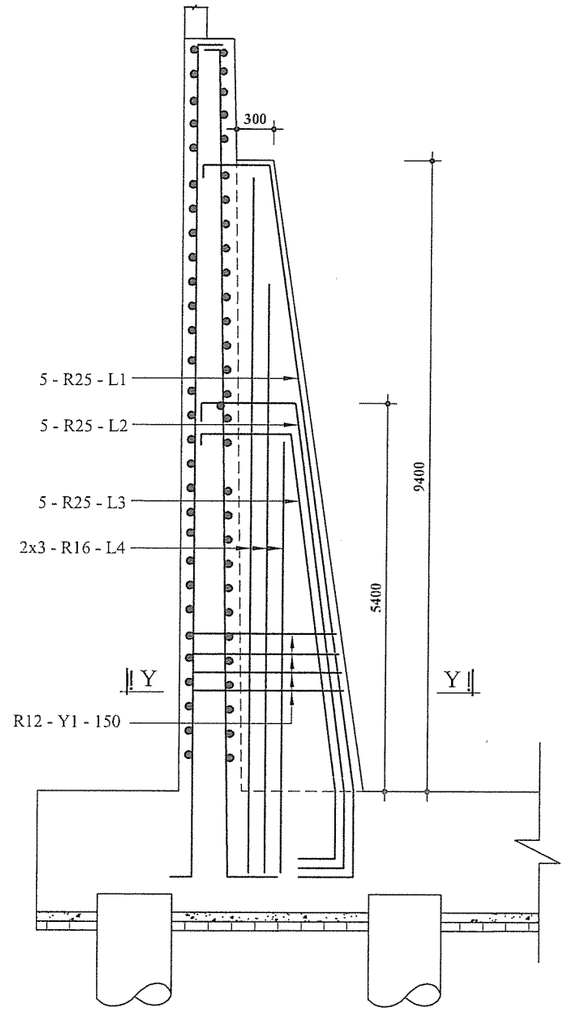
REINF. DETAILS OF ABUTMENT COUNTERFORT (C2)



SECTION X -X (C2)



SECTION Y -Y (C1)



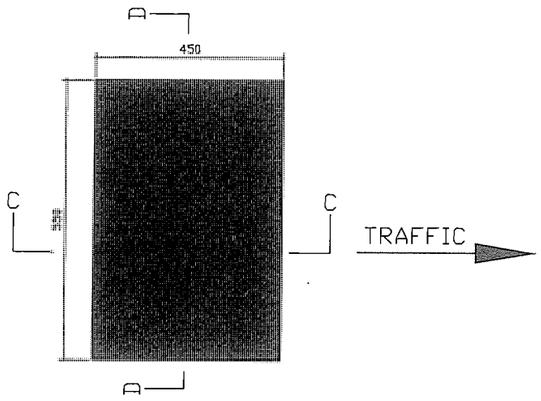
REINF. DETAILS OF WINGWALL COUNTERFORT (C1)

NOTES:

1. Clear cover to main reinforcement bar is to be 50mm. unless otherwise mentioned.
2. 28 days cylinder strength of concrete: f 'c = 25.0N/mm (3600 psi)
3. Yield strength of mild steel deformed bar fy = 413N/mm (60000psi)
4. EF = Earth Face
   WF = Water Face

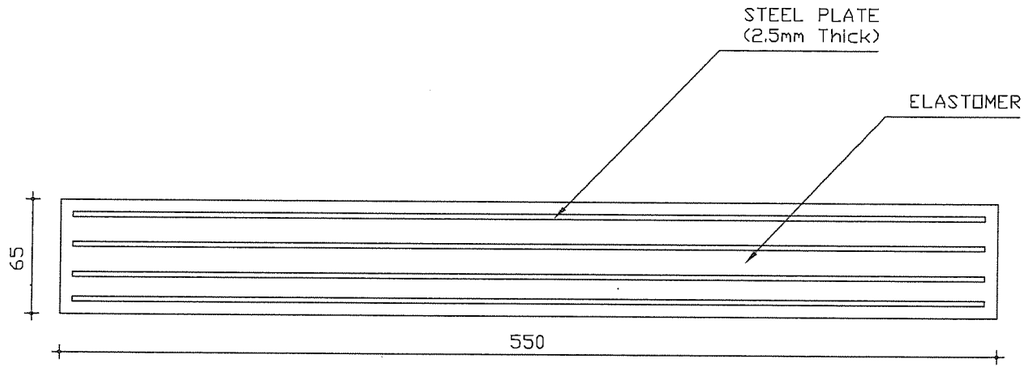
REV.	DESCRIPTION	DATE

ROADS AND HIGHWAYS DEPARTMENT (RHD) Ministry of Communications	NAME OF THE PROJECT : Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	DRAWING TITLE : REINF. DETAILS OF COUNTERFORT (FOR ABUT. A1 & A2)	DRAWING NO. Scale : As above 02 July' 2013 JICA/BRDG/ABUT/DWG-17



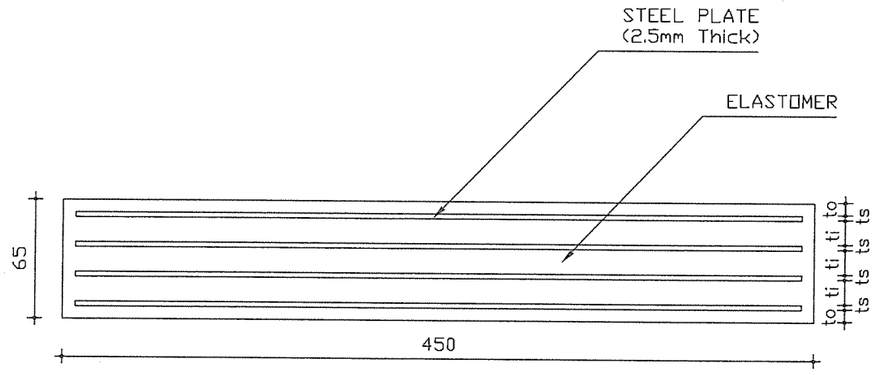
PLAN-BEARING

Scale: 1:20



SECTION D-D

Scale: 1:10



SECTION C-C

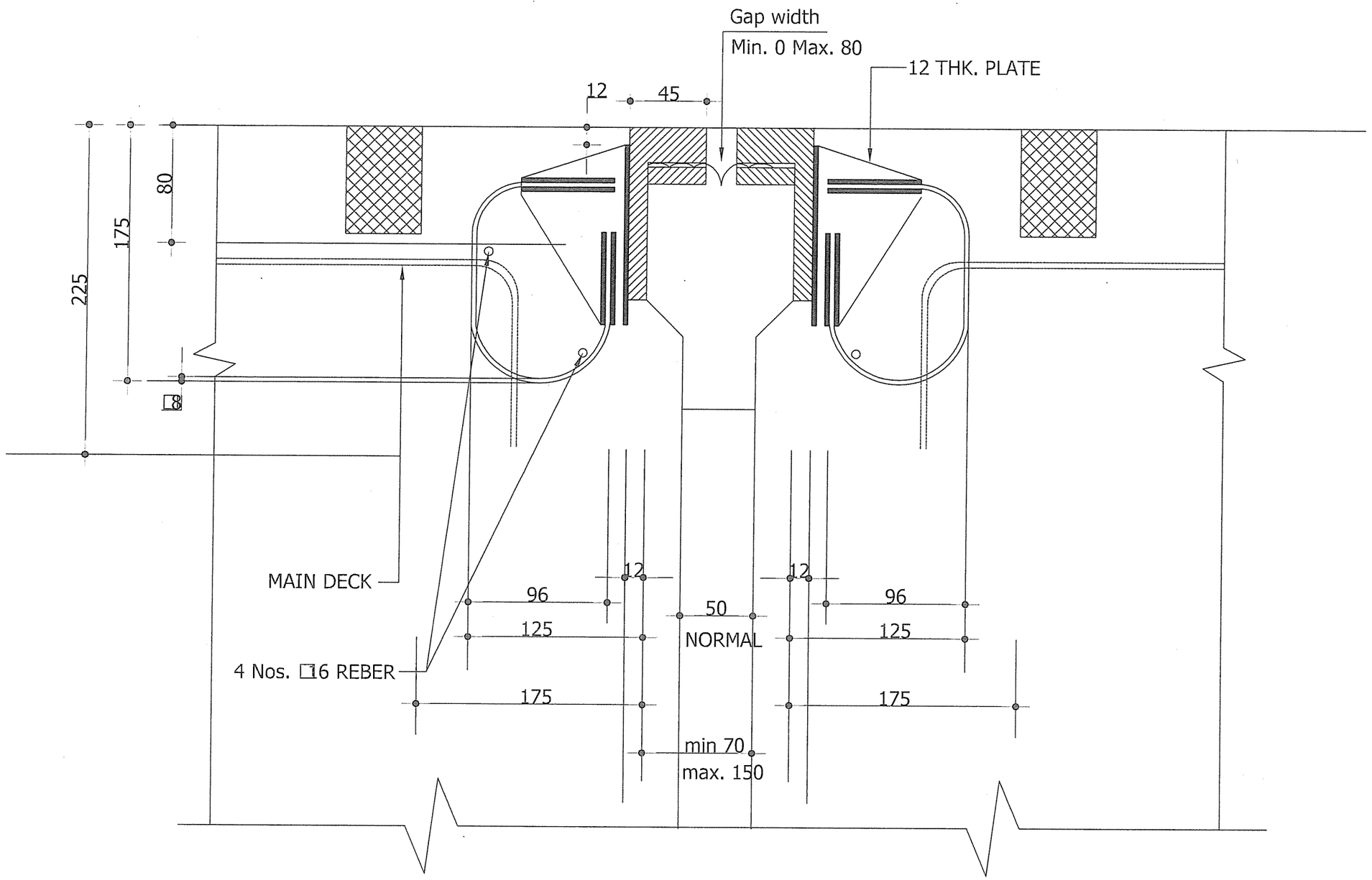
Scale: 1:10

1. EMBEDDED STEEL PLATE SHALL CONFORM TO AASHTO DESIGNATION: M183/M183M-90
   (ASTM DESIGNATION: A 36/A 36M-88d) WITH MINIMUM fy=250 N/mm2.
2. SHORE 'A' HARDNESS OF ELASTOMER SHALL CONFORM TO MINIMUM 60.
3. SHEAR MODULUS OF ELASTOMER AT 73 DEG. F SHALL BE MINIMUM 0.9 N/mm2
4. COMPRESSION SET 35% (MAX)
5. TEST TO BE DONE FOR 115 M. TON LOAD
6. TENSILE STRENGTH 2250 PSI OR 15.5 N/mm2
7. ELONGATION AT BREAK 35%
8. ALL TEST OF BEARING SHALL BE DONE AS PER AASTO M251-92.

1. Thickness of exterior layer of elastomer, t0=6.5mm
2. Thickness of interior layer of elastomer, ti=14mm
3. Thickness of steel plate, ts=2.5mm
4. Total thickness of bearing= 4x2.5+14x3+2x6.5=65mm

REV.	DESCRIPTION	DATE

ROADS AND HIGHWAYS DEPARTMENT (RHD)	NAME OF THE PROJECT :		DRAWING TITLE :			DRAWING NO.
Ministry of Communications	Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	DETAILS OF ELASTOMERIC BEARING PAD	Scale : As above	02 July' 2013	JICA/BRDG/B.PAD/DWG-18

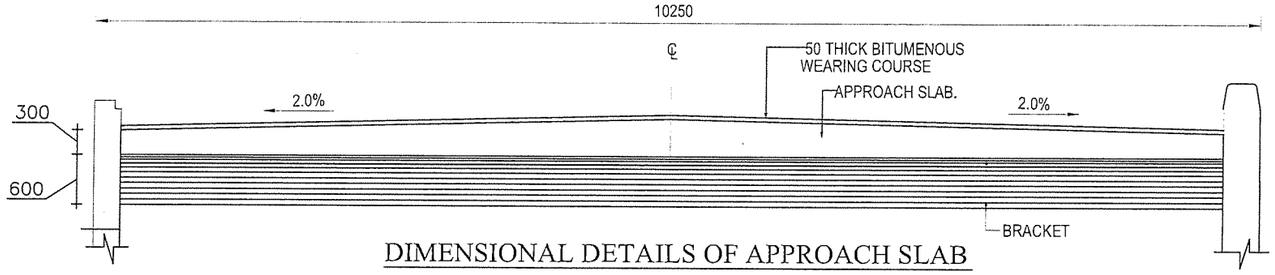


SEC. OF EXPANTION JOINT

(Scale : 1:3)

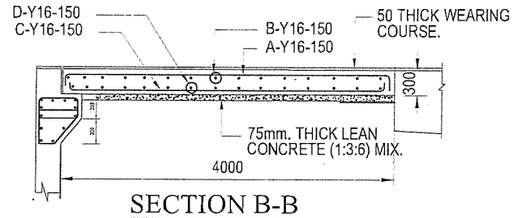
REV.	DESCRIPTION	DATE

ROADS AND HIGHWAYS DEPARTMENT (RHD) Ministry of Communications	NAME OF THE PROJECT : Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	DRAWING TITLE : DETAILS OF EXPANSION JOINT Scale : As above 02 July' 2013 DRAWING NO. JICA/BRDG/E.JOINT/DWG-19



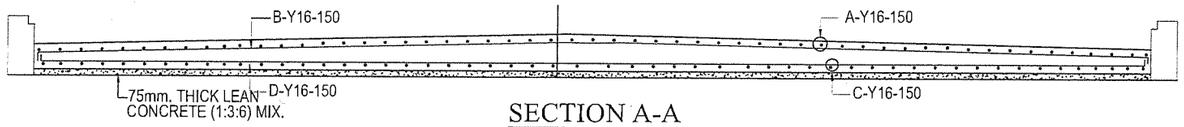
DIMENSIONAL DETAILS OF APPROACH SLAB

(Scale : 1:75)



SECTION B-B

(Scale : 1:75)

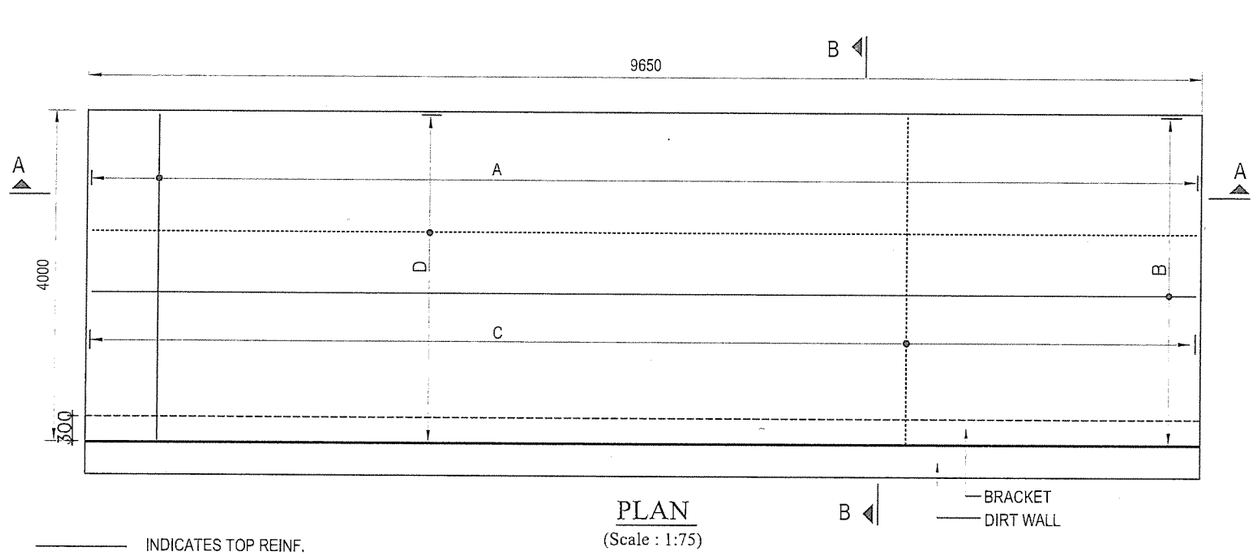


SECTION A-A

(Scale : 1:75)

BAR BENDING SCHEDULE OFAPPROACH SLAB (EACH)

TYPE OF BAR	SYM. OF MARK	DIA OF BAR	SHAPE CODE	SPACE OF BAR	BENDING DIMENSION (mm) a	b	c	d	LENGTH OF BAR	NO OF BAR	TOTAL LENGTH (m)	WT. OF STEEL (Kg)	SHAPE CODE	BAR SHAPE
GRADE-60 DEFORMED BAR	A	16	38	150	3900	75	75		4050	64	259.20	409.18	38	a b c
	B	16	99	150	9550	75	75		9700	27	261.90	413.28		
	C	16	38	150	3900	75	75		4050	64	259.20	409.18	38	a b c
	D	16	38	150	9550	75	75		9700	27	261.90	413.28		
TOTAL = 1644.92														



PLAN

(Scale : 1:75)

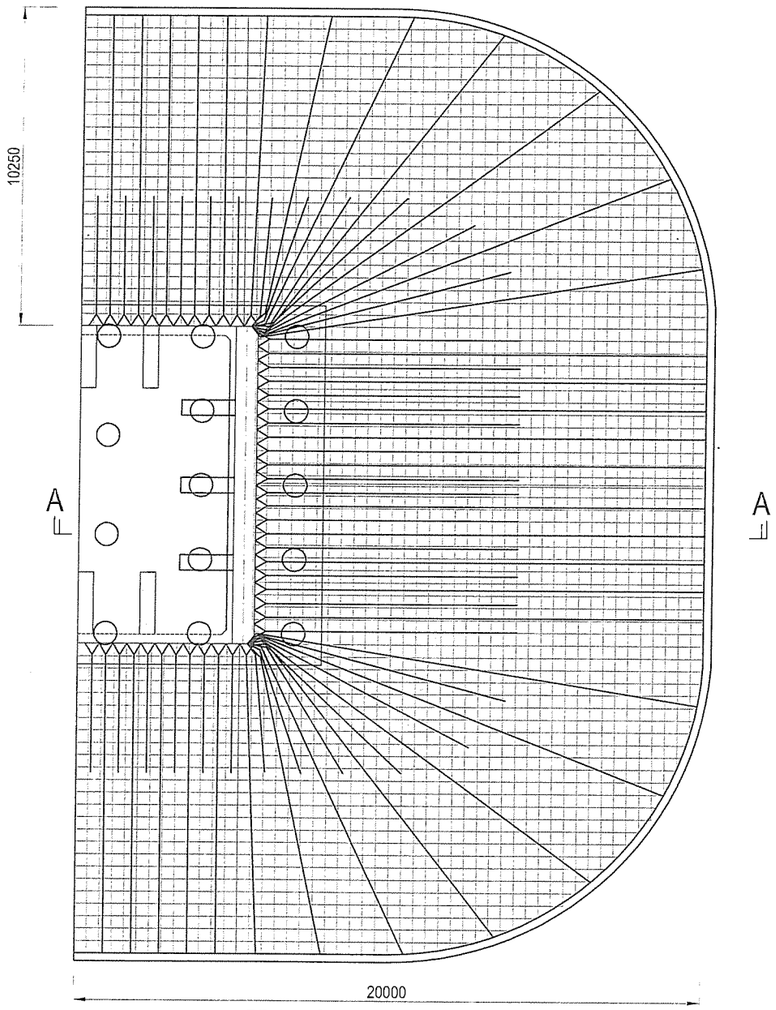
SYMB. OF BAR	SHAPE	SYMB. OF BAR	SHAPE
38	150 a 150	85	286, 72, 200
60	a, b	99	68, 142, c
70	a, b, c, d		

NOTES :

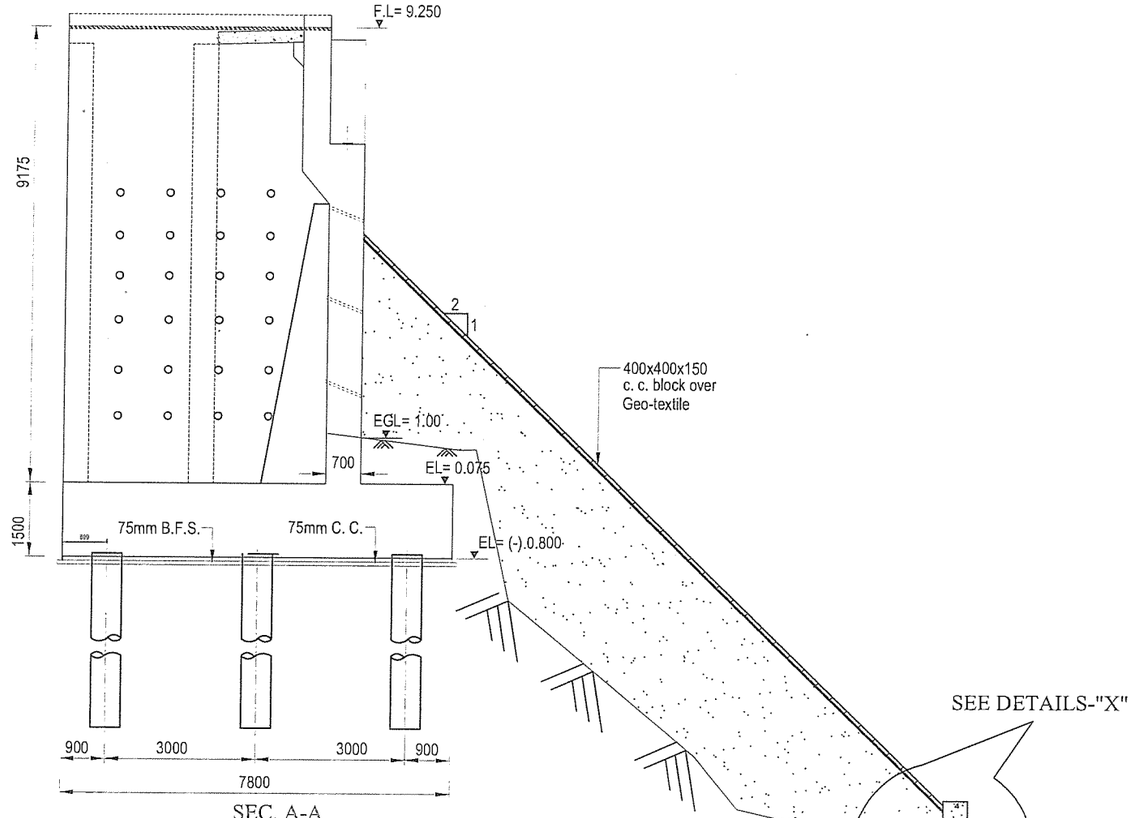
1. ALL DIMENSIONS ARE IN mm UNLESS OTHERWISE SPECIFIED.
2. DIMENSIONS SHOWN IN THE BAR BENDING SCHEDULE SHALL BE VERIFIED AT SITE.
3. CONCRETE COVER FOR APPROACH SLAB & BRACKET = 50mm

REV.	DESCRIPTION	DATE

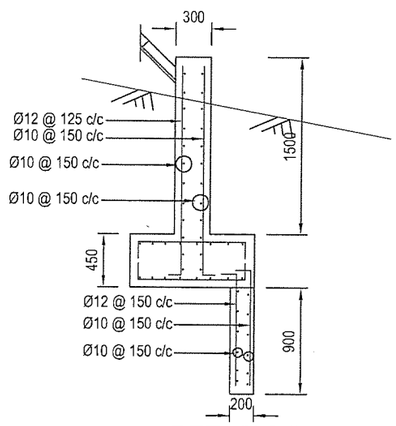
ROADS AND HIGHWAYS DEPARTMENT (RHD) Ministry of Communications	NAME OF THE PROJECT : Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	DRAWING TITLE : DETAILS OF EXPANSION JOINT Scale : As above 02 July' 2013 DRAWING NO. JICA/BRDG/E.JOINT/DWG-20



PLAN OF SLOPE PROTECTION
(Scale : 1:200)



SEC. A-A
(Scale : 1:125)



DETAILS-"X"

REV.	DESCRIPTION	DATE

ROADS AND HIGHWAYS DEPARTMENT (RHD)	NAME OF THE PROJECT :		DRAWING TITLE :	SCALE :	DATE :	DRAWING NO.
Ministry of Communications	Preparatory Survey on Chittagong Area Coal Fired Power Plant Development Project in Bangladesh (JICA Study).	JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)	DETAILS OF PROTECTION WORK ON BOTH ABUTMENT	Scale : As above	02 July' 2013	BRDG/PROT./DWG-21