

## SUBERNREKHA HYDEL PROJECT: AN OUTLINE

The Eastern Region at present has predominantly thermal grid with comparatively small hydel installation. With an ambitious programme of thermal power development in this region during the Fourth & Fifth five Year Plans, it was considered very necessary to back up these installations with a suitable hydel base for taking daily peak loads so as to allow the thermal units to run at highest possible load-factor at which they are most economical. The Subernrekha Project was originally planned to meet this necessity only i.e. to supply peaking power in predominantly thermal grid.

Later, with the establishment of Heavy Engineering Corporation, National Coal Development Corporation, Hindustan Steels etc. round about Ranchi, the scarcity of water began to be felt. With the population growing by leaps and bounds, and with an eye on the inevitable growth of small and medium industries in an around Ranchi, it was felt that the existing water supply sources, including Hatia Dam will be quite inadequate to meet the fast growing demand of water. In the absence of any other dependable source nearby, it was decided to meet this demand of water estimated at 75 cusecs from the Subernrekha Dam.

The Project envisaged the construction of a 116 ft. high earthen dam on River Subernrekha at Getaldud. Out of 350 cusecs of firm water draft available from the reservoir, 75 cusecs have been earmarked for water supply to Ranchi town and the industrial network in and around Ranchi; the rest i.e. 275 cusecs will be utilized in generating hydel power in a series of two power houses, each utilizing a head of about 450 ft. and having an installed capacity of about 65 each (i.e. a total of 130 MW). The power stations are designed at a load factor of 14%. The regulated discharge of 275 cusecs, which will be released back into River Subernrekha, will again be utilized lower down for supplying water to the industrial complex at Jamshedpur, Adityapur etc. Power House No.-I is scheduled to be commissioned in June 1975 & Power House No. II by March 1976. The scope of the Project in a nutshell is therefore.

- (a) To supply 75 cusecs of water to Ranchi town and Ranchi Industrial network.
- (b) To utilize 275 cusecs in generating about 144 million kwh of energy per year in two power houses, each having an installed capacity of 65 MW at 14% L.F. and operating under a " head " of about 450 ft.
- (c) To provide benefits to the industrial complex at Jamshedpur with regulated water discharge from the tail-race of the power house.

#### OUTLINES OF THE PROJECT.

The Project will have a 116" high earthen dam with masonry spillway near Getalsud at lat. 23° 27½ N and Log 85 ° 33½ E. The catchment area of the river at the dam site is about 300sq. miles. From which a firm yield of 350 cusecs can be had. The reservoir will have a live storage capacity of 1.67 lakh acre ft. The total length of dam will be 7,000 ft. plus a 15,000 ft. long low dyks will the height varying from 25 to 10 ft. The spillway, designed to pass a peak flood of 2.5 lakh cusecs, will have 7 bays, each 40' x 36', controlled by tainter gates. The total cost of the dam will be about Rs. 7 crores. The intake for drawing water for Ranchi is being located on the backshore of the reservoir, from where the water will be pumped up to a height of about 300 ft. in storage tanks to be built on Bariatu hills near Ranchi. The cost of water supply project is estimated at about Rs. 6 crores.

For Hydel power, the water will be drawn from an intake in the left flank of the earthen dam, and will be carried in a 5 miles long concrete lined channel before utilizing it in a power house (no. I ) near village Sikidiri, where a natural fall of 450 ft. will be taken advantage of. The power house will have an installed capacity of 65 MW. The tail water will again be carried through a water conductor system consisting of about 4 miles of open concrete lined channels, and two numbers of lined tunnels totaling about 5200 ft. before dropping it through another " fall " of 450 ft. in the power house II on the left bank of River Subernrekha , a little down-stream of Hundru-fall.

The total cost of the water conductor system and the power houses including the mechanical and electrical works will be about Rs. 19:50 crores.

SALIENT FEATURES OF THE PROJECT

A. Dam:

i.	Catchment area	....	300 sq. miles.
ii.	Maximum height	....	116 ft.
iii.	Total length including dyke	....	22,000 ft.
iv.	Live storage capacity	....	1.87 lakh acre ft.
v.	Firm draft available	....	350 cusecs.
vi.	Designed spillway capacity	....	2.5 lakh cusecs.
vii.	Spilway	....	7 Nos. 40' x 36'

Tainter gates.

B. Power System:

LF.	i.	Installed capacity	....	2 x 65 MW at 14%
	ii.	Total length of power channels	....	9 miles.
	iii.	Capacity of power channels	....	2,000 cusecs (Peak discharge)
	iv.	Total length of tunnels	....	4,805 ft.
	v.	Total length of penstocks	....	3,300 ft.
	vi.	Dia of penstocks	....	13 ft.
	vii.	Total weight of penstocks	....	2,300 tons.
	viii.	Total head utilized	....	900 ft.

C. COST:

i.	Power portion civil	....	Rs. 8.49 crores.
ii.	Power portion Elecl. Mech. Works	....	Rs. 8.55 crores.
iii.	Share of the cost of the dam	....	<u>Rs. 2.50</u>

crores.

Total cost of Project : Rs. 19.54 crores.  
Say Rs. 19: 50 crores.

POWER CHANNEL I, II & III.

1. PRODUCTION:-

Power Channel – I:- Power Channel-I takes off from Getalsud Dam and terminates at the Intake-Structure of Penstock no. I. The total length of this channel is 241 chains (24100 feet). The capacity of the canal is 2,000 cusecs and will feed power-house no. I.

Power Channel- II:- Power channel- II starts from Power House-I and terminates at inlet of Tunnel-I with a total length of 122.5 chains.

Power Channel-III:- Power Channel-III starts from the outlet face of Tunnel-I and ends in the fore bay-pond and thus forms a part of the water conductor system of power house-II

2. ENGINEERING:-

Power Channel-I:- It is a lined canal with a bed width of 15 feet and side slopes of 2:1 (2 horizontal & one vertical ). The full supply depth from 0 Ch. To 160 chains is 11 ft. with a free board of 3 ft. From Ch. 160 to 241, the free board does on increasing and finally at the out fall point, it is 8.74 ft.

The section of Power Channel-I has been fixed after taking into consideration the sudden upsurge and draw-down conditions and also the surcharge pressure caused on the back of the lining due to saturated condition of the back-fill behind the lining. The free-board has been fixed after making computer-studies by C.W. & P.C.

The lining is of 4½" thick cement concrete of grade M – 100. Flap-valves and pressure-release-valves have been provided at suitable intervals to provide for proper exit of the surcharged back-fill pressure where-ever rocky strata is met with, concrete lining is to rest directly over rock. In portions where soil is met with, concrete sleepers have been provided over which the lining rests. Longitudinal and cross-filter-drains have been provided for leading the sub-soil water to the exit point where flap-valves and pressure-release-valves have been provided.

The design and drawing of 12 nos. of C.D. works (L.D. Syphons) have been done by the design wing of the Bihar State Electricity Board in consultation with R.V.P. Department.

Power Channel – II :- The alignment of Power Channel-II huges the slope of hill, and runs almost parallel to hill slope. Efforts have been made to keep entire prism of the channel section in cutting to minimize chances of failure or breaches in the channel section.

The capacity of Power-Channel-II is 2,000 cusecs, bed width 8' with side slope of 1:1.5 ( 1 vertical & 1½ horizontal ), F.S.D. 14', free board 3' & bed slope 1 in 5100. It will be a concrete-lined canal with 4½" thick P.C.C. (1:3:6) . Filters will be provided in the side slopes and bed of the canal to release the sub-soil pressure.

There is altogether 25 nos. of cross-drainage-works, out of which the first one at Ch. 1.20 is an aqueduct, and is being designed in Central water and Power Commission (MW), New Delhi. The remaining 24 nos. are R.C.C. pipe syphons & their drawing & design etc. are being finalised here in consultation with the C.W. & P.C.

Power Channel-III: - It is 25 chains in length, discharging capacity is 2,000 cusecs, and is concrete-lined. Canal section is trapezoidal. Side slope is 1:5:1, free board is 3' and full supply depth is 14' – 0". Bed width is 8'-0" and the bed-slope is 1 in 5100.

Major portion of the channel is in cutting. Only small portion (nearly 5 chains in length) is in partial filling.

NAME AND FOREBAY DYKE OF PENSTOCK I & II.

1. INTRODUCTION:

Penstock – I :- Intake at Penstock-I is a gated-structure to pass water from Power Channel-I to Penstock-I. It has a masonry forebay-dyke around it. There is another gated structure for head-regulator in the surplus-escape-channel connecting Power Channel-I to Power Channel-II, and by passing Power House-I.

Penstock – II :- The construction drawings of the Penstock-II are being finalised in the C.W. & P.C.

2. ENGINEERING :

a) Intake Structure:

The water from Power channel-I will have a bell-mouth entry through this Intake structure with arrangement of trash-rack fixed in the concrete piers at the entrance. The size of rectangular opening at the bell-mouth-entrance is 5000 mm x 5897 mm. The transition from this rectangular shape to circular shape of the penstock pipe of 3912 mm diameter takes place in a distance of 4000 mm.

b) Fore bay dyke :

It is a rubble-masonry-structure with 450 mm thick coarsed rubble masonry (1:3) at the upstream face, and random-rubble-masonry (1:5) in the remaining portion of the section. It has vertical face on the upstream, and a slope of 0:65H:1-V on the downstream face. Crest width is 2,500 mm. the maximum water level is at EL 577.291 M. The crest-level of the dyke is at EL 579.12 M. Curtain-grouting has been done from the crest-level after the completion of the masonry work. Key-trench has been provided through out the forebay-dyke. The size of the quick-acting gate is 11.943 M. x 4.322 M. There will be electrical as well as mechanical hoisting arrangement.

c) Head regulator of surplus escape:

The crest level is at 573.024 M and the size of the gate is 4.576 M x 6.50 M.

## ANCHOR BLOCKS IN PENSTOCK – I & II.

### 1. INTRODUCTION:

Penstock – I:- Penstock – I forms a part of the water-conductor system from reservoir to Power House- I. Anchor blocks have been provided at every change of slope of penstock.

Penstock – II:- Penstock –II starts from the end of open cut from Tunnel-II. Anchor-blocks have been provided at every change of slope of penstock.

The estimated value of the work of both penstocks of anchor blocks, supports, and the excavation of penstock trench profile is Rs. 19.00 lakhs only.

### 2. ENGINEERING:

Penstock-I :- Penstock-I has four numbers of Anchor-blocks.

Anchor-I is at a horizontal distance of 156.67 M. from the axis of the intake of Penstock-I. From intake to anchor-I, there is a drop of 23.16M. There are eleven numbers of supports in this reach and the inclination of centre line of penstock with horizontal is  $8^{\circ} - 24' - 25.34''$ .

Anchor -2 is at a horizontal distance of 160.02 M from anchor-I and there is a further drop of 31.55 M. There are twelve numbers of supports in this reach and the inclination of the centre line of penstock with horizontal is  $11^{\circ} - 49' - 12.57''$ .

Anchor – 3 is at horizontal distance of 100.420 M from anchor-2, and there is a further drop of 41.33 M. There are 9 nos. of supports in this reach, and the inclination of the penstock line with the horizontal is  $28^{\circ} - 12'$ .

Anchor – 4 is at a distance of 20.120 M from anchor-3, and there is a further drop of 23.84 M. The inclination of centre line of penstock with horizontal is  $49^{\circ} - 15' - 16.3''$ .

Penstock- II:- Penstock- II has three numbers of anchor-blocks.

Anchor-I is at a horizontal distance of 105.269 M from the axis of the intake of Penstock-II. From intake to anchor-I, there is a drop of 58.018 M. There are 8 supports in this reach, and the inclination of centre line of penstock with horizontal is  $28^{\circ} - 52'$ .

Anchor – 2 is at a horizontal distance of 87.254 M from anchor-I and there is a further drop of 35.980 M. there are 7 supports I this reach and the inclination of centre line of Penstock with horizontal is  $22^{\circ} - 24' - 4''$ .

Anchor – 3 is at a horizontal distance of 57.044 M from anchor – 2. There are 5 supports in this reach.

POWER HOUSE – I & II

1. INTRODUCTION:

Power House –I :- Power House-I has an installed capacity of 65MW at 13.75% L.F. 2000 cusecs of water will be drawn for about 4 hours daily during peak hours from the reservoir at Getalsud Dam through a 7500 meter long concrete lined power channel-I to Power House-I through a 3912 mm dia penstock-pipe.

Power House –II :- Power House-II have one set of 65MW capacity. 2000 cusecs of water would be drawn for about 4 hours daily during peak hours from the reservoir of Getalsud Dam to Power House-I through 7500 M long Power Channel-I and then through 3912 mm dia penstock-pipe, water from Power House-I will reach Power House-II through a water conductor system consisting of Power Channel –II, Tunnel-I, Power Channel-III, Tunnel-II, open-cut channel, and penstock-pipe.

Power House-II is located on the left bank of Subernrekha River, and is on the downstream of Hundru fall. It is approachable by 84 chain long Hill-Road No. II. During shut-down of Power House-I for maintenance etc. , the water will be diverted through the surplusihg-escape connecting Power Channel-I to Power Channel –II, and in case of maintenance & shut-down of Power House-II, the water will be released into the Subernrekha river through an escape structure provided in the open-cut channel connecting Tunnel-II & Penstock-II.

2. ENGINEERING:

Power House –I:- The Power House is designed as one unit structure. The foundation level of hydro-generator is at 422.50 M. The penstock meets the scroll-case of the unit at EL 431.84 M.

The level of the machine-hall is 437.239 M. The crane-beam elevation is 451.25 M, and the roof-level is 459.525 M. The size of the draft-tube at entrance is 9000 x 1925 mm, and at exit there are 2 nos. of openings of 3750 x 4112 mm each. The head over the turbine is 141.273 meters.

The EOT to be installed will be of 250/130 tons capacity. Order for manufacturing 2 nos. EOT crane has been placed with M/s. Hindustan Motors Ltd.

The tail-race-water from the Power House-I discharges into power channel-II which forms part of water-conductor system of Power House-II.

Power House –II :- The Power House is designed as one unit structure. The foundation level of the hydro-generator is at elevation 286.874 M. The penstock meets the scroll-case of the unit at elevation 296.204 M. Level of the machine-hall is at E.L. 308.318 M. Crane-beam elevation is at 322.18 M, and the roof level is at 329.45 M. The size of the draft tube at entrance is 9000 x 1925 mm.

The tail-race-water of Power House-II discharges into river Subernrekha in a regulated manner to be utilized at various places on the downstream of the river.

## TUNNEL - I & II

### 1. INTRODUCTION:

The tail-water from Power House-I is led upto Tunnel-I-inlet by means of a concrete lined 122.5 chains long Power Channel-II which hugs the foot of the hill which lies in the Damodar Valley basin. Tunnel-I brings back the Subernrekha water from the Damodar valley into the Subernrekha valley. Water from the outlet of the tunnel-I is led upto the Fore bay-pond through 26 chains long concrete-lined Power Channel-II from where it is diverted into Tunnel-II. Water from the outlet of Tunnel-II is led upto Penstock-II of Power House-II through a 300' long open-cut channel.

### 2. ENGINEERING:

These two tunnels are non-pressure D-shaped, and concrete –lined. The length of tunnel-I is 1145 M, and that of tunnel-II is 320 M. the thickness of concrete lining is 225 mm, and the bed-slope is 1 in 2000. The discharging capacity of the tunnels is 2000 cusecs. The invert level of tunnel-I at inlet-portal is 430.443, and that of outlet-portal is 429.870 M.

The invert-levels of tunnel-II at inlet and out-let-portals are 429.64 and 429.48 M respectively.

FORE BAY DAM

1. INTRODUCTION:

2000 cusecs of water from Power channel-III is led into the valley which is being closed by forebay dam so that the water does not escape down, and also the full supply level in tunnel-II is maintained after the creation of the pond.

It is zoned earthen embankment. There is no provision of any sluice or escape structure in the dam.

3. ENGINEERING:

It is 23 M high structure of 152.5 M length. The impervious-core having co-efficient of permeability upto ten feet per year will be shrouded with semi-pervious fill material on both up-stream and down-stream sides of the core. The up-stream-slope above dead-storage-level is to be pitched with 750 mm thick boulders over 450 mm thick inverted-filter, and the down-stream slope is to be turfed. Down-stream blanket-filter 100 mm thick and the height of the toe is to be 1/6th of the height of dam. There is provision of positive-cut-off trench. Its depth has been designed as 1/3 of the height of dam, or a higher if impervious strata are met with earlier. The upstream-slope varies from 1 in 2 to 1 in 3.5, and the down-stream slope varies from 1 in 1.25 to 1 in 3. The crest-level of dam is 437.388 M, and the F.R.L. is 434.34 M. At the deepest section there is one 7625 mm wide berm at EL 424.281 M on the upstream slope and on the down-stream slope, there are two berms of 3050 mm and 7625 mm widths respectively at EL 428.224 M and E.L. 420.624. The width at crest-level is 7625 mm.

<u>LOAD</u>	<u>DISCHARGE/REQUIRED.</u>
1 MW	$26+300 = 326$ Cusecs.
5 "	$130+300 = 430$ "
10 "	$260+300 = 560$ "
15 "	$390+300 = 690$ "
20 "	$520+300 = 820$ "
25 "	$650+300 = 950$ "
30 "	$780+300 = 1080$ "
35 "	$910+300 = 1,210$ "
40 "	$1,040+300 = 1,340$ "
45 "	$1,710+300 = 1,470$ "

<u>LOAD</u>	<u>DISCHARGE/REQUIRED.</u>
50 MW	$1,300+300 = 1,600$ Cusecs.
52 "	$1,352+300 = 1,652$ "
55 "	$1,430+300 = 1,730$ "
60 "	$1,562+300 = 1,862$ "
62 "	$1,616+300 = 1,916$ "
65 "	$1,700+300 = 2,000$ "

1. Plant Identification: -2 x 65 MW, Subernrekha Hydel Project, Sikidiri.
2. River system: -Subernrekha H.
3. Down stream plant: -Down
4. Water travel/time: -Dam to forebay –I 25 to 30 minutes. Tail race of Unit-I

5. Minimum Elevation: -1900 1905 In practice
6. Maximum elevation: -1936 1936
7. Minimum Head: -  $\frac{\text{P.H.-I}}{138.903}$        $\frac{\text{P.H.-II}}{132.0}$
8. Maximum Head: - 140.483 M      133.7 M
9. Minimum Discharge: - } 2000 cusecs for 65 MW Load.
10. Maximum Discharge: - }
11. Tandem: - Tandem & cascade.
12. M.W. Discharge when head is maxm. In Tabular for M } Table attached.
13. M.W. Discharge when Head is Minim. in Tabular form }
14. Elevation: -Content Table.
15. DeltaTail water: -Discharge.
16. Unit loading order: -5 to 10 Minutes. From 0 to 65 MW.

FEATURES OF SUBERNREKHA HYDEL PROJECT, POWER HOUSE

POWER HOUSE – I	Commissioned in 17th Oct'. 1977.
POWER HOUSE – II	Commissioned in 18th Oct'. 1980
POWER HOUSE – I	Progressive Hrs. Run - 44096.2
POWER HOUSE – II	Progressive Hrs. Run - 48513.17
POWER HOUSE - I	Generated - 2696308500 Units
POWER HOUSE –II	Generated - 2635080400 Units
POWER HOUSE – I	Head Maxm. – 140M Minum. – 138M
POWER HOUSE – II	Minum Maxm. – 134M Minum. – 132M
POWER HOUSE – I	Capacity 65 MW
POWER HOUSE – II	Capacity 65 MW
TURBINE	Francis (vertical)
Penstock Pipe dia	4.212M
Length of Penstock pipe – I	- 437M
LENGTH OF PENSTOCK PIPE – II	250M
Discharge of water	2,000 Cusecs
Speed of M/c	300 RPM Anti Clock wise.