KATHMANDU UNIVERSITY

SCHOOL OF ENGINEERING
DEPARTMENT OF CIVIL ENGINEERING

FINAL DEFENSE
ON

"POTENTIAL STUDY OF SETI KHOLA HYDROPOWER PROJECT"

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Outline of Presentation

1. Introduction
2. Objectives
3. Scope and Limitations
4. Literature Review
5. Methodology
   a. Alternative Analysis
   b. Hydrological Analysis
   c. Hydraulic Design
   d. Financial Analysis
6. Conclusion and Recommendation
7. References

Introduction

- Seti Khola Hydropower Project is a run-of-river (RoR) type hydropower project.

- The project is located in Pokhara Metropolitan City, Kaski District, Gandaki Province of Nepal.

Geographical Coordinate:

	From	To
Latitude	28°5'00" N	28°8'05" N
Longitude	84°04'15" E	84°05'28" E

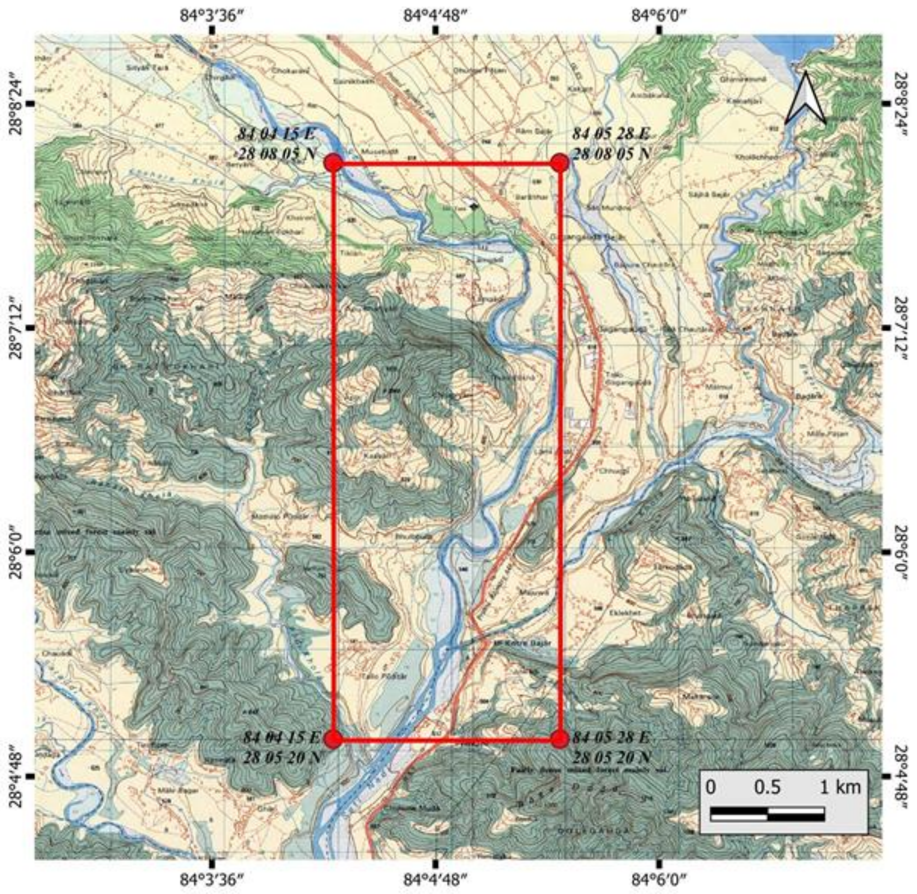


Fig1: Project License Boundary

Study Area of Project

Objective

Primary Objective

- To carry out the potential study of the Seti Khola Hydropower Project.

Secondary Objectives

- To perform hydrological analysis of the project area.
- To perform design of hydraulic components for the project.
- To perform cost and quantity calculations for construction of the designed components.
- To perform stability analysis of the hydraulic components.
- To perform structural analysis of the powerhouse.
- To compute the economic viability of the project.

Scope

- Topographical and hydrological study was carried out which formed the basis for hydraulic design.
- Structural analysis and design was carried out for the Powerhouse.
- Economic analysis and financial analysis of the project was carried out.

Limitations

- No long-term climate change projections were incorporated into water availability estimates.
- Geological hazards and land acquisition issue for construction of designed components were neglected .
- Hydrological data for the Seti river is unavailable for a period of 15 years. (1985 A.D. to 1999 A.D.)

Methodology

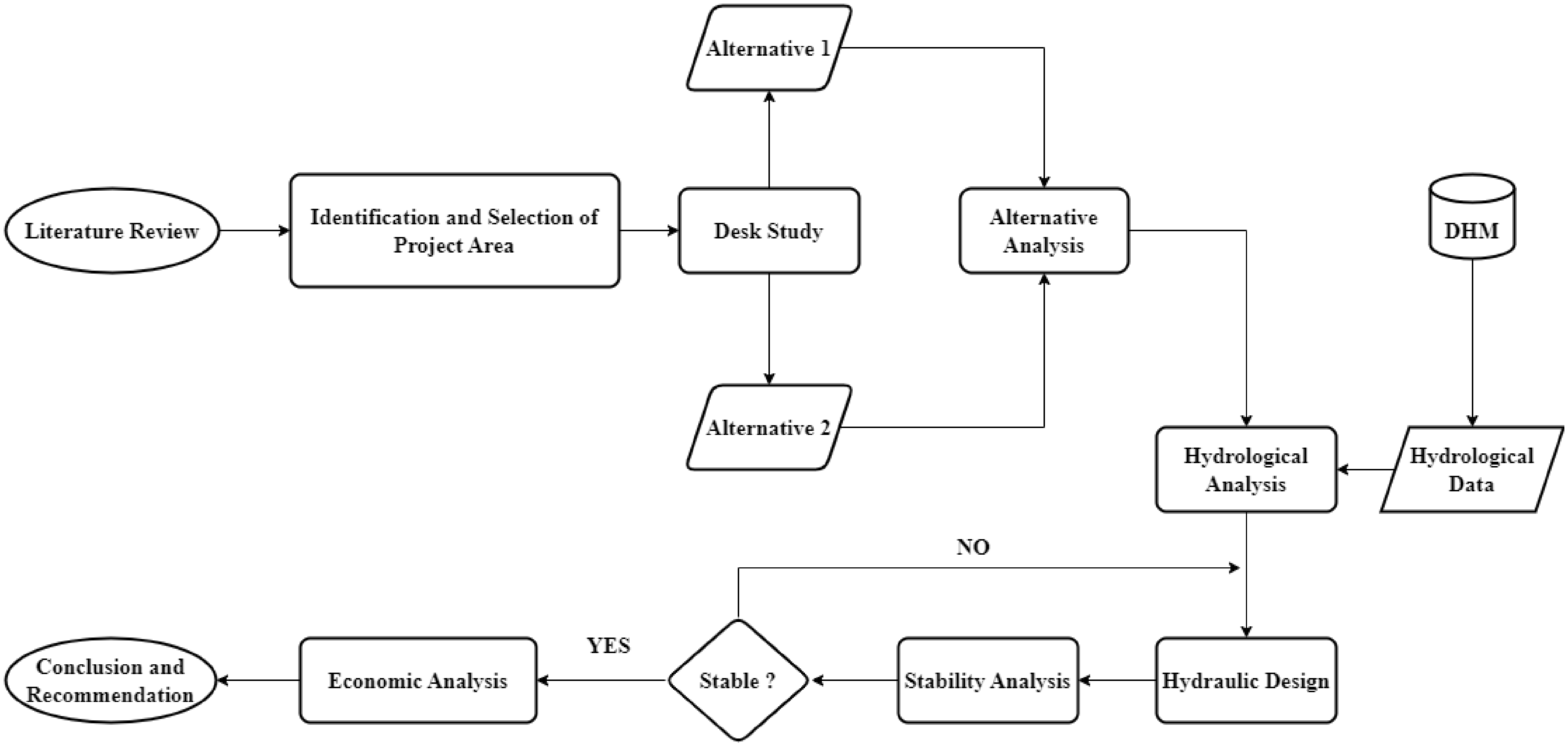


Figure: Methodology Flowchart

Desk Study

Possible project alternatives were explored and studied for their merit and demerit to select the best suited option for the project.

The components considered during alternatives exploration are:

- Type of conveyance – Tunnel or Canal or Pipe;
- Location of Headworks
- Location of Powerhouse and Tailrace
- Alignment of penstock/surge system-with powerhouse locations

Based on the available reference resources, the explored alternatives were selected and the alignment was differentiated into two alternatives.

Alternative Analysis

Particulars	Alignment I:	Alignment II:
HW and Channel	HW with direct Tunnel intake from Desander end	HW with 200m long Chanel connecting the Portal with Desander.
Water Conveyance	Headrace Tunnel is 3050m.	Headrace Tunnel is 3150m.
Penstock Pipe	610 m	578 m
Powerhouse	Lower Powerhouse location	Upper Powerhouse location
Tailrace	Short Tailrace about 440m	Long tailrace about 800m
Land and Social issues	Low encroachment to Forest and Other Lands	More Encroachment to Forest and private Land
Gross Head (m)	68 m	62 m
Net rated Head (m)	63.9 m	54.5 m
Design Discharge (m^3/s)	43.136	49.214
Installed Capacity (MW)	23.54	22.3

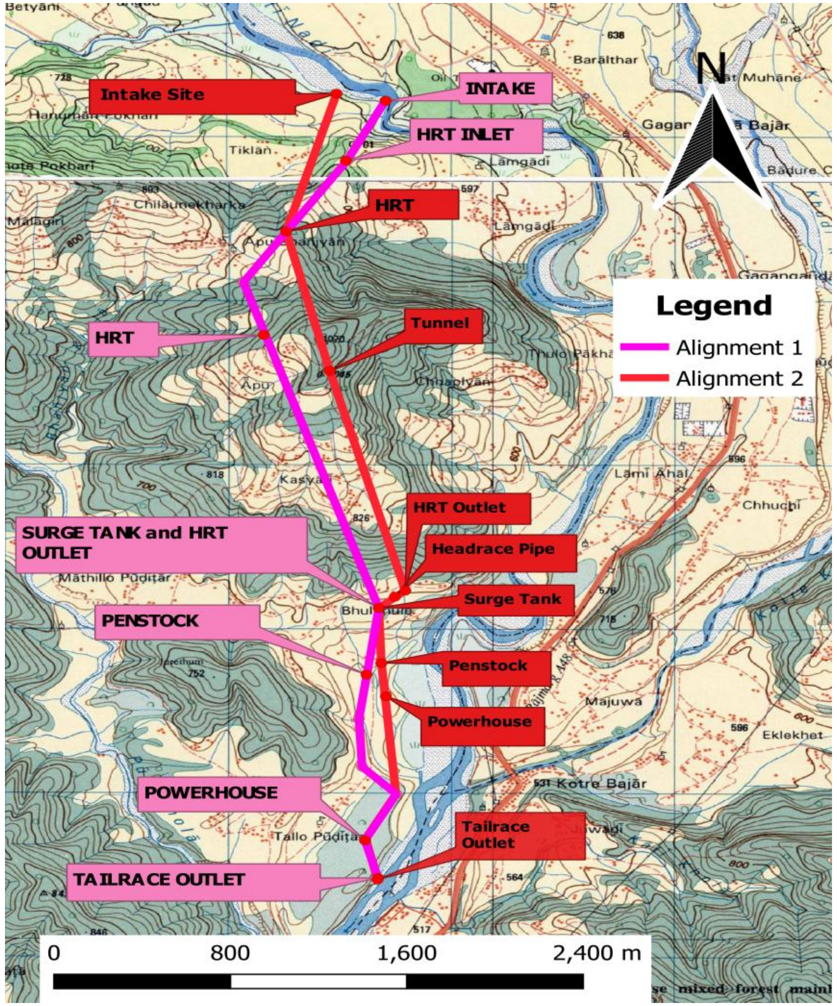


Figure: Project Alignment Alternatives

Hydrological Analysis

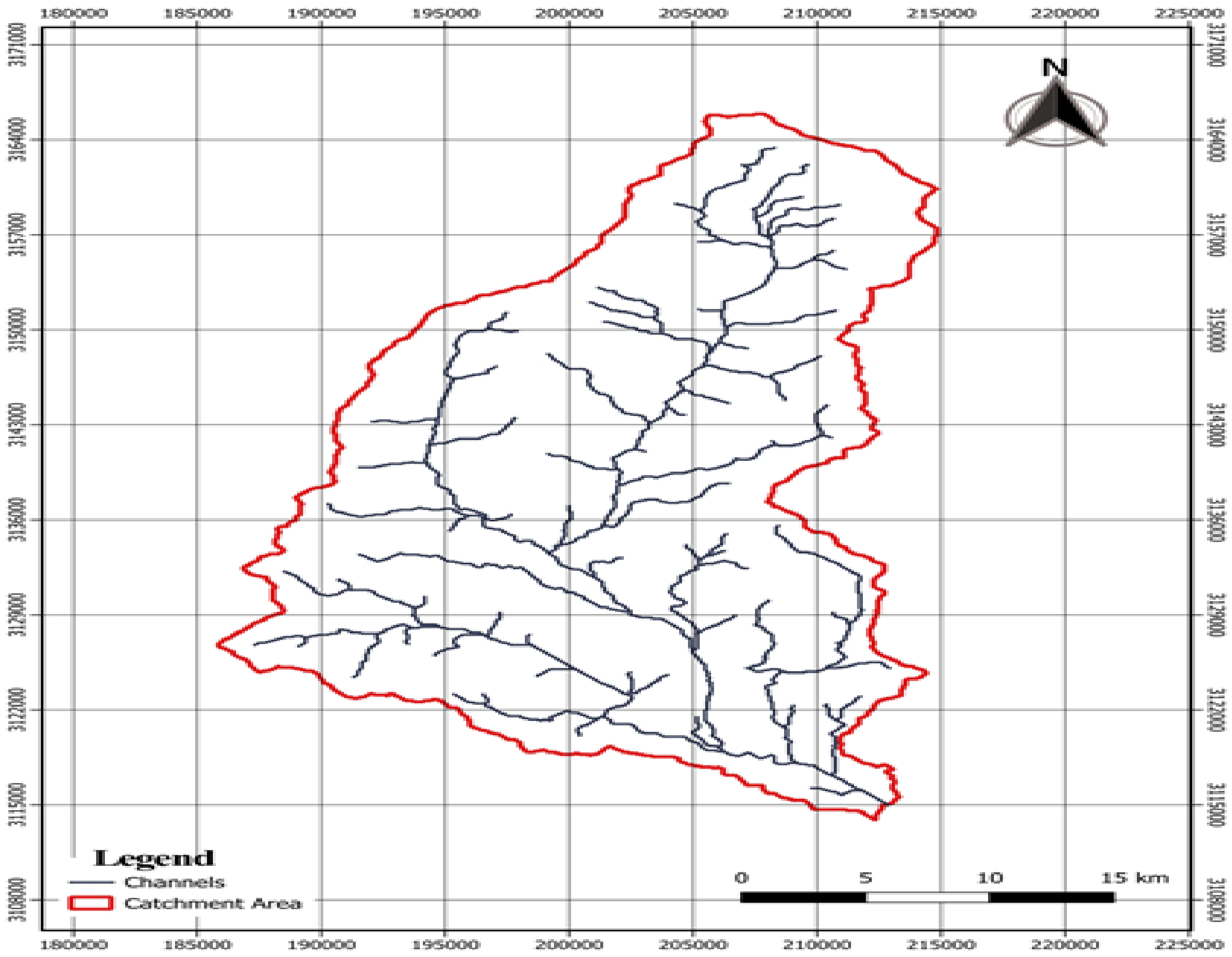


Figure: Catchment Area at Intake

Catchment Area (Intake) = 866.12 Sq.KM
Catchment Area (Powerhouse) = 981.38 Sq.KM

Hydrological Analysis

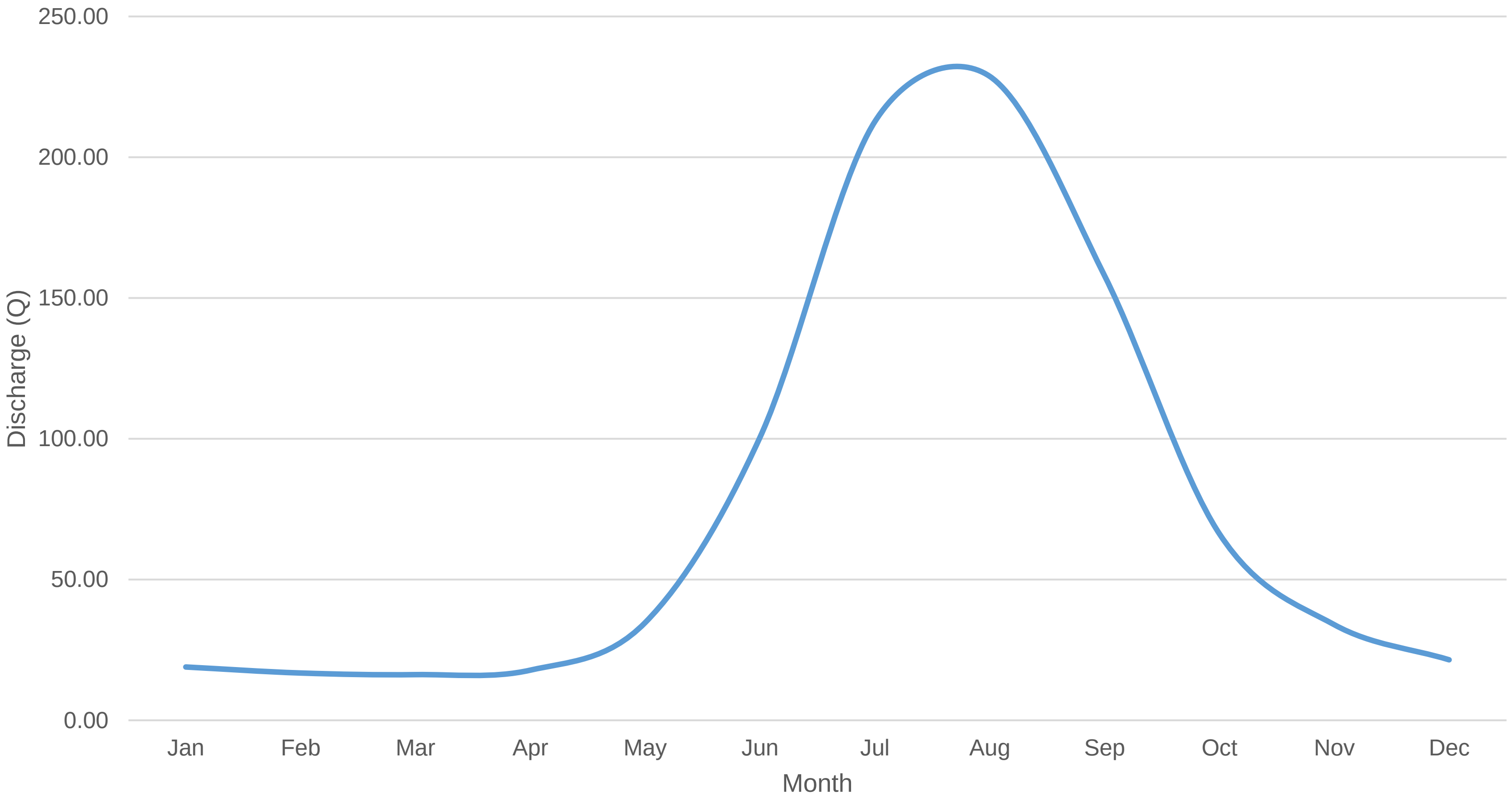


Figure: Monthly Hydrograph of Seti Khola

Hydrograph shows rate of flow against time.
From the Hydrograph,

- Minimum discharge is 16.22 m^3/s on the month of March.
- Maximum discharge is 228.77 m^3/s on the month of on August.

Hydrological Analysis

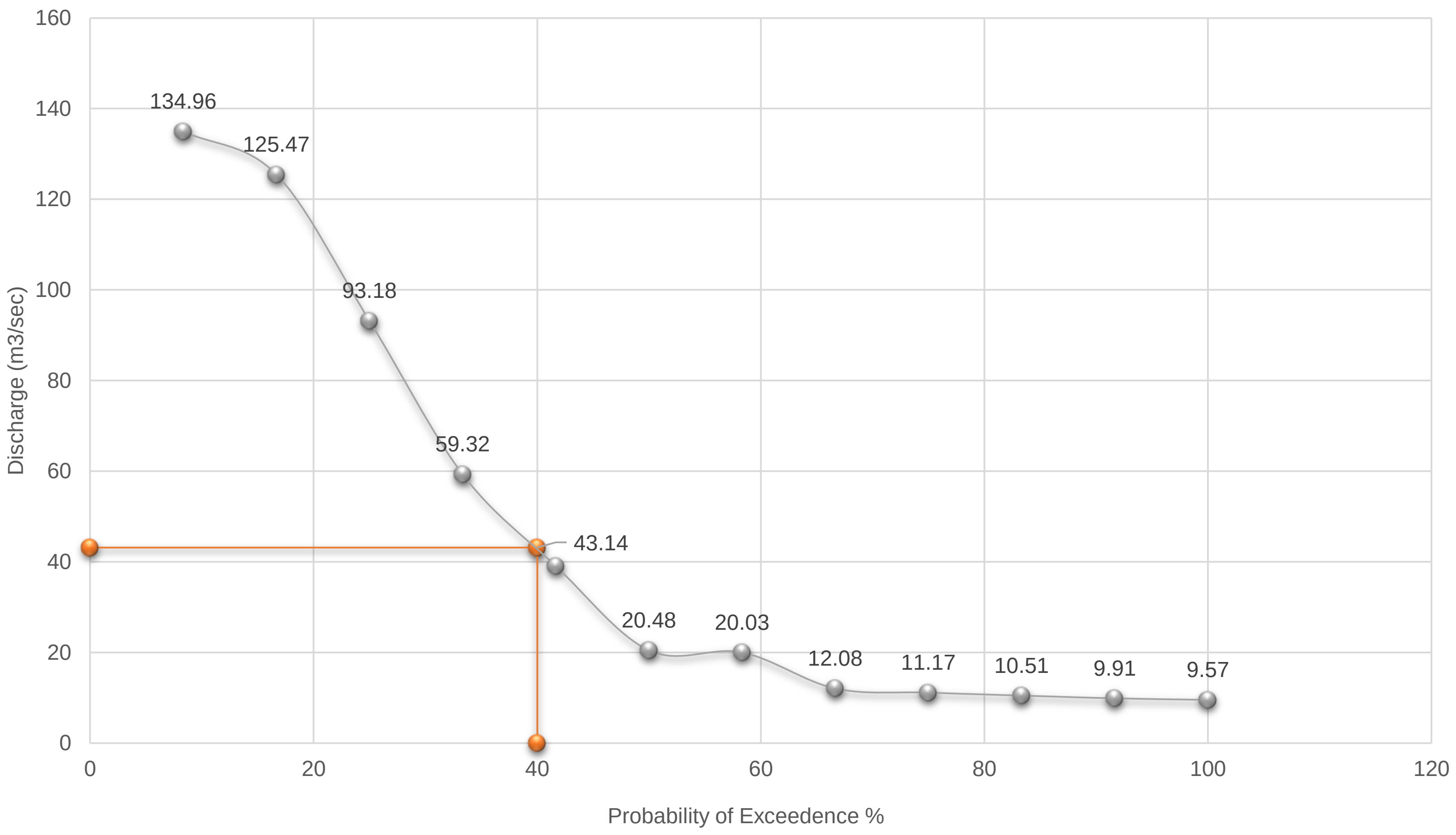


Figure: Flow Duration Curve of Seti Khola

Flow duration curve shows the percent of time discharges were equaled or exceeded.

From the Flow Duration Curve,

- Design Discharge (Q_{40}) was obtained to be 43.14 m^3/s.

Hydrological Analysis

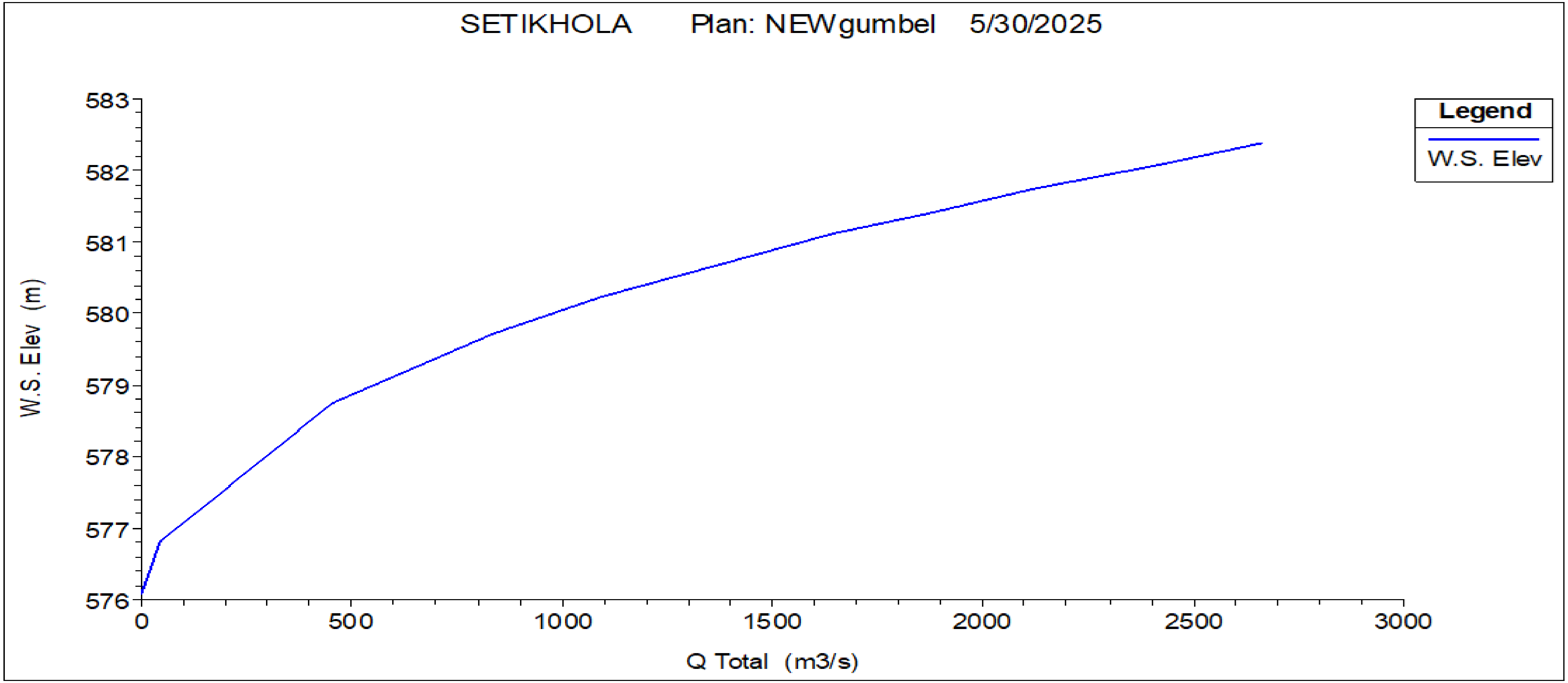
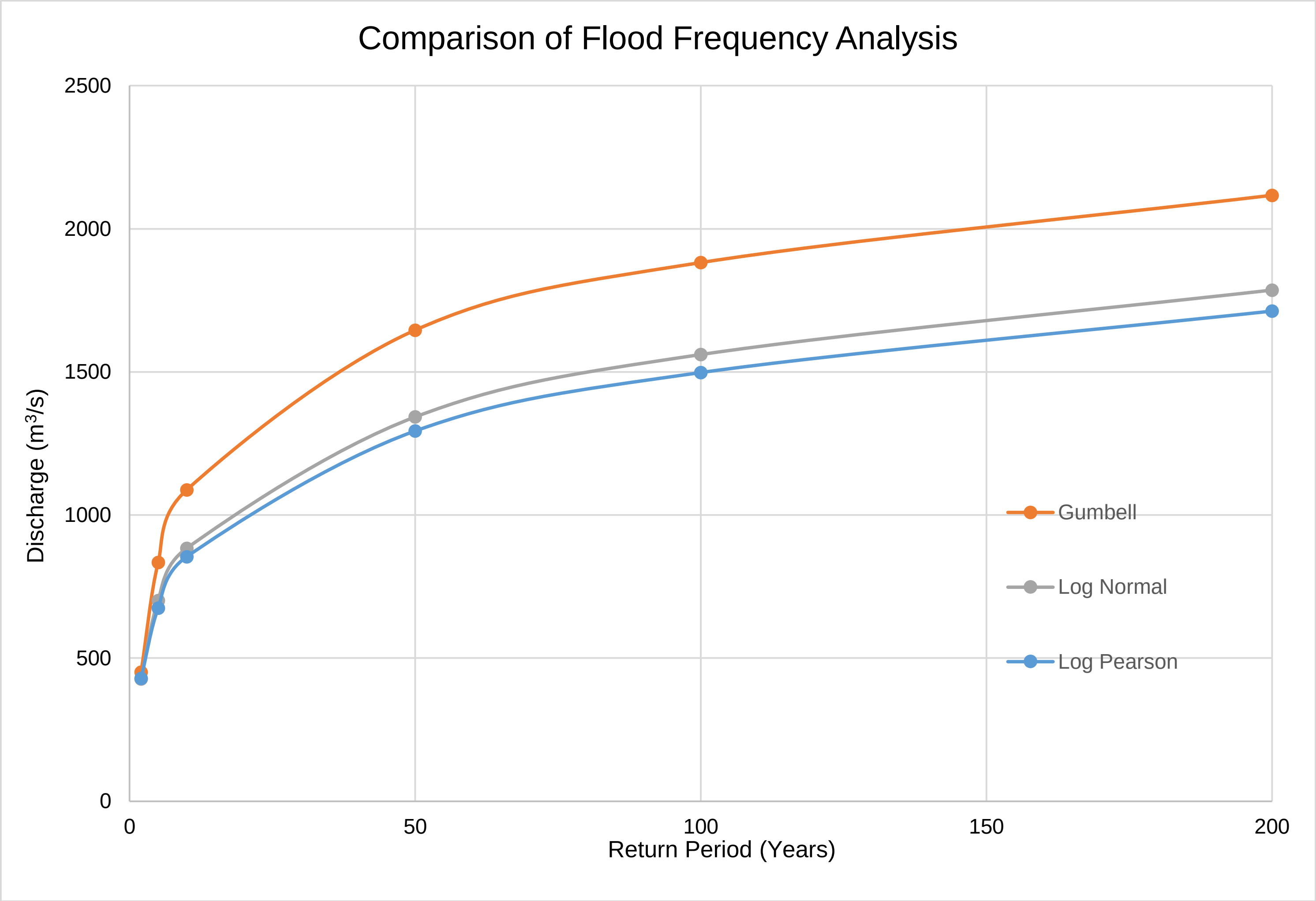


Figure: Rating Curve at Intake

Comparison of Flood Frequency Analysis



Results of 100 years flood discharge from different methods are:

Methods	**Discharge Q_{100} (m^3/s)**
Gumbel's Method	1882
Log Pearson III Method	1561
Log Normal Method	1498

Hydraulic Design of Weir and Undersluice

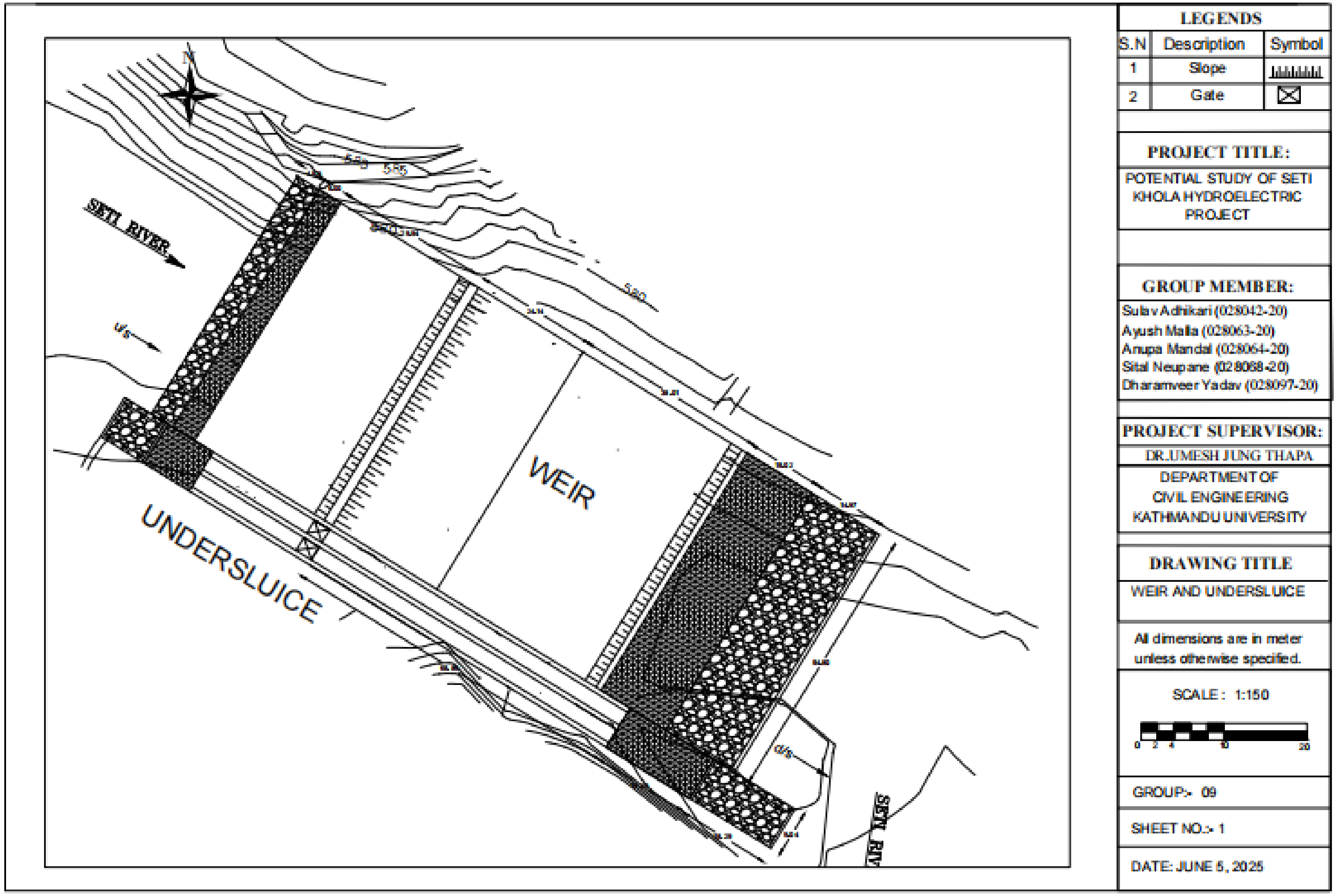


Figure: Plan view of Weir and Under sluice

Design Summary		
S. N	**Description**	**Values**
1	Lowest Riverbed Level	572.89
2	Weir Crest Level	575.81
3	Weir Length	134 m
4	Weir Width	55 m
5	Under sluice Length	155 m
6	Under sluice Width	9 m
7	Under sluice Openings	2 no.

Hydraulic Design of Weir and Undersluice

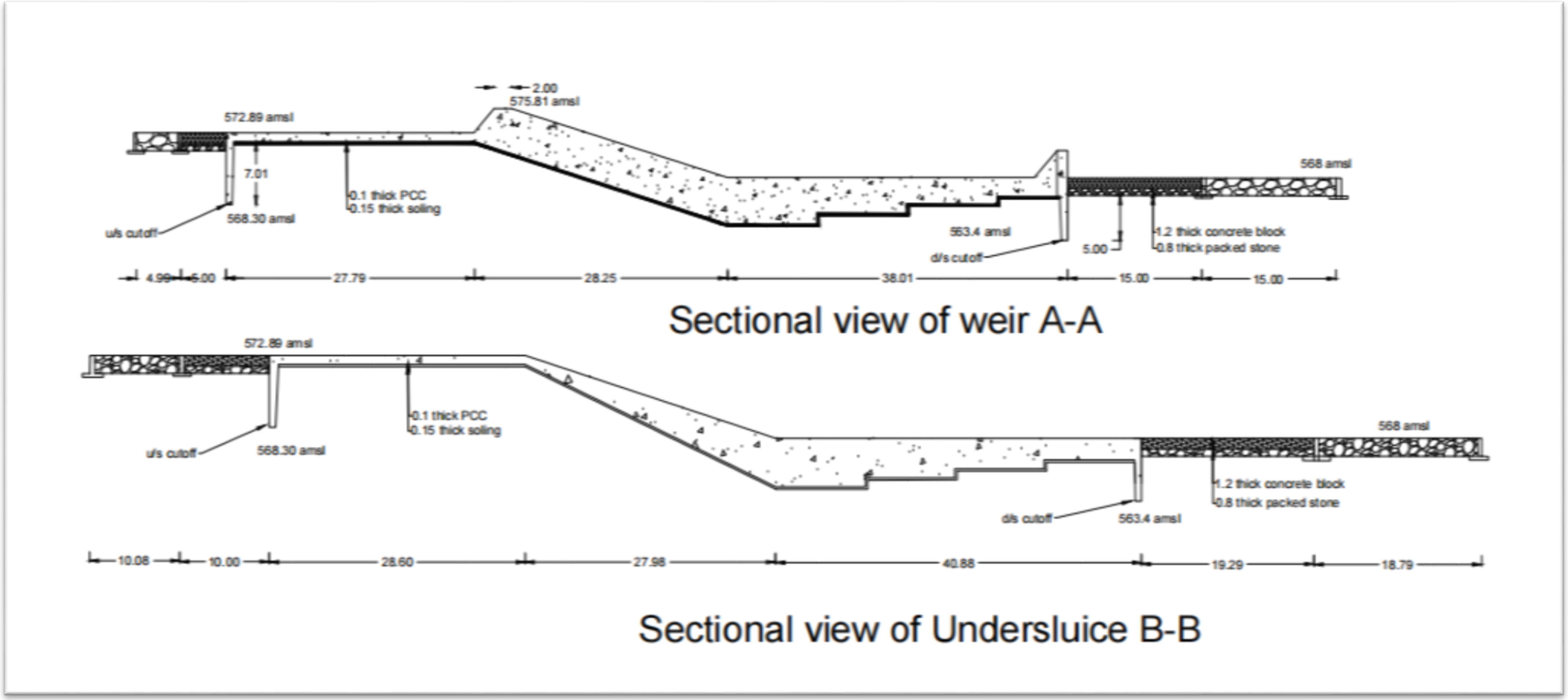
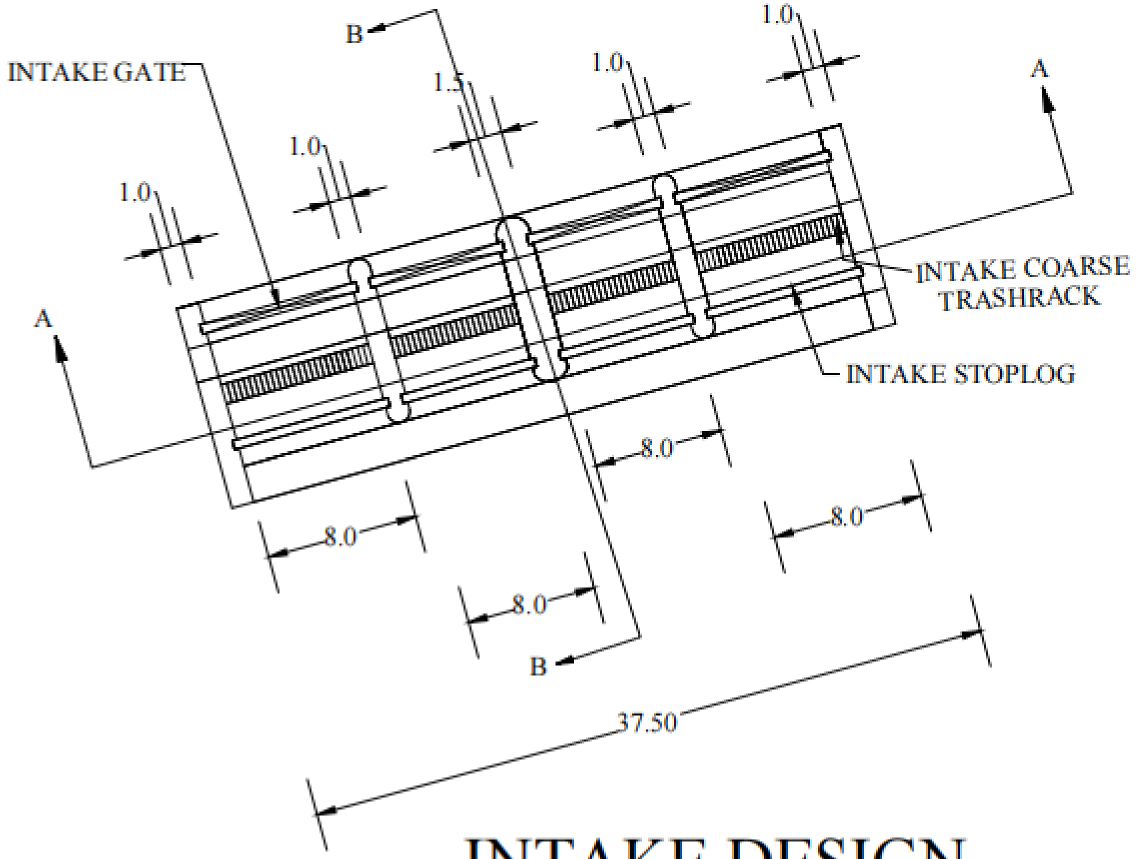
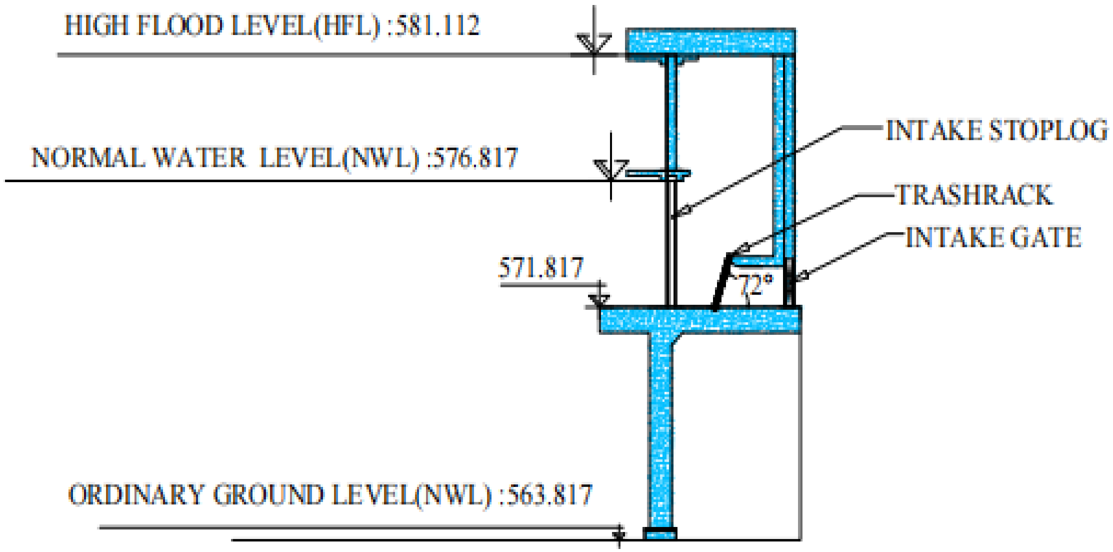


Figure: Sectional view of weir and under sluice

Hydraulic Design of Intake



INTAKE DESIGN



LONGITUDINAL-SECTION OF INTAKE AT SECTION B-B

Hydraulic Design of Gravel Trap

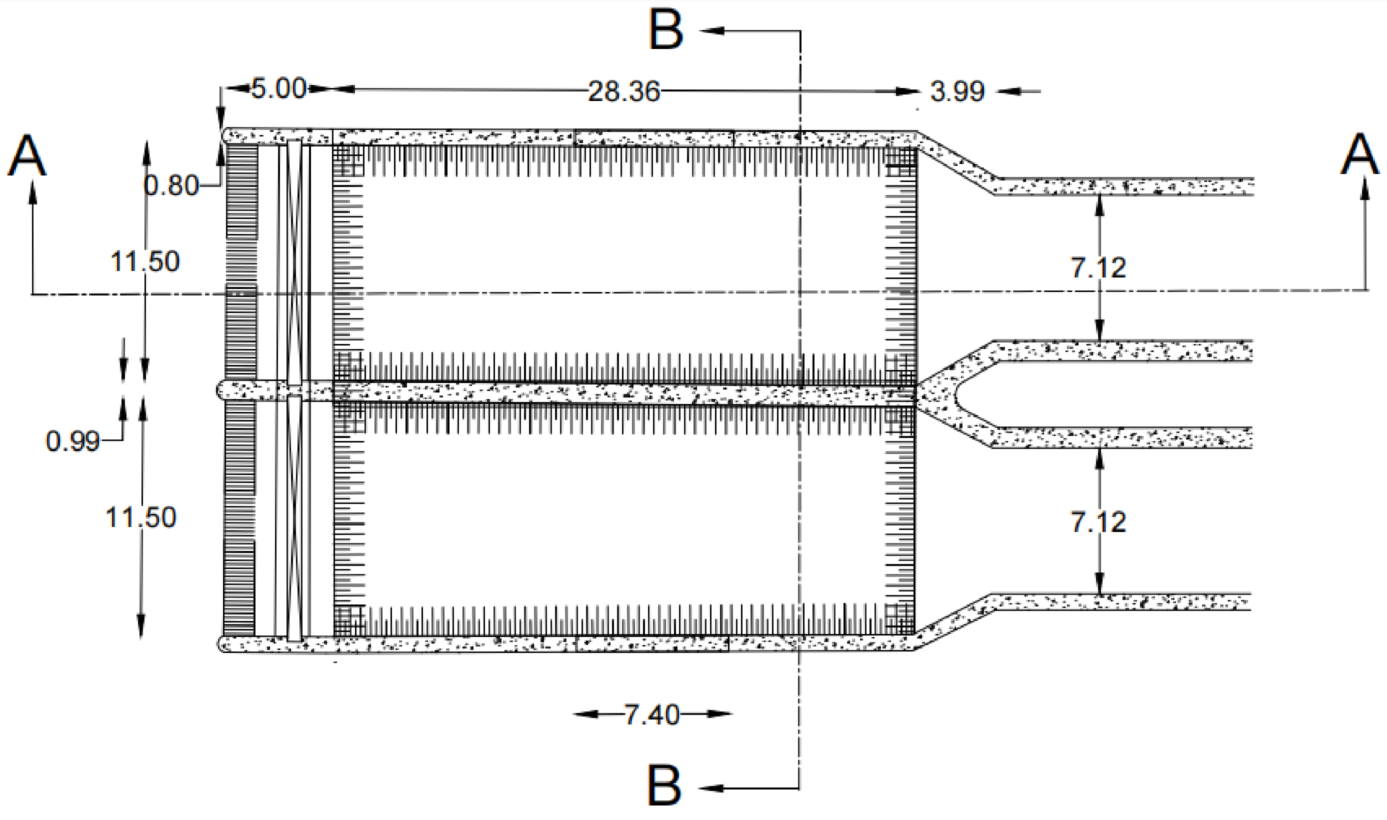
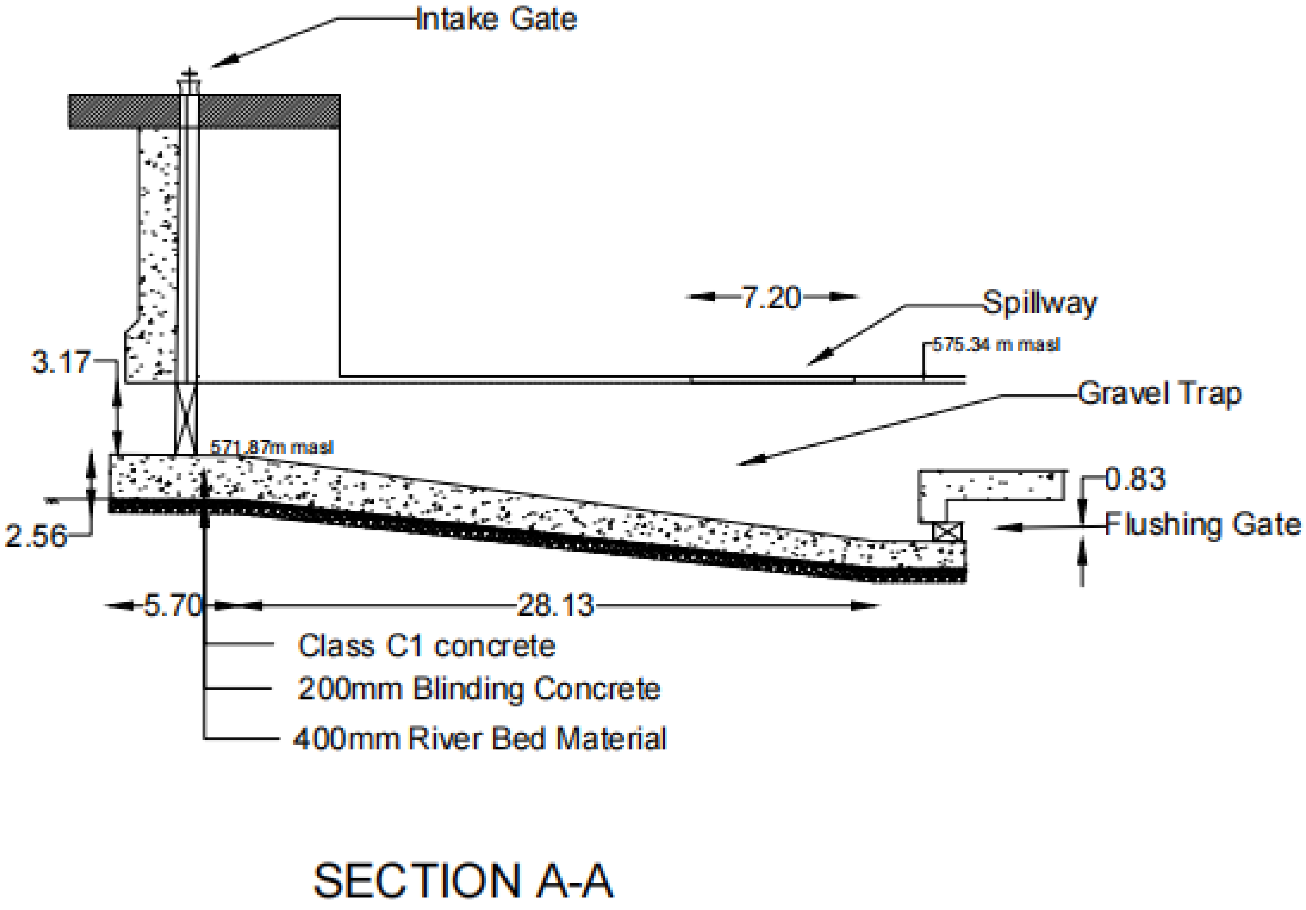


Figure: Plan view of Gravel Trap

Gravel Trap Design Summary		
S.N	**Description**	**Values**
1	Discharge through basin	$51.75\ m^3/s$
2	Area of Gravel Trap Basin, A_s	$64.29\ m^2$
3	Width of Basin, B	23 m
3	Depth of Basin, H	2.80 m
4	Length of Basin, L	14.23 m
5	Settling time of Particles, t_s	11.89 s
7	Flushing velocity, v_f	$7.442 m^2/s$
8	Length of spillway	7.4 m
11	Inlet transition angle	25^0
12	Inlet transition length	17.030 m
13	Outlet transition angle	30^0
14	Outlet transition length	13.755 m

Hydraulic Design of Gravel Trap



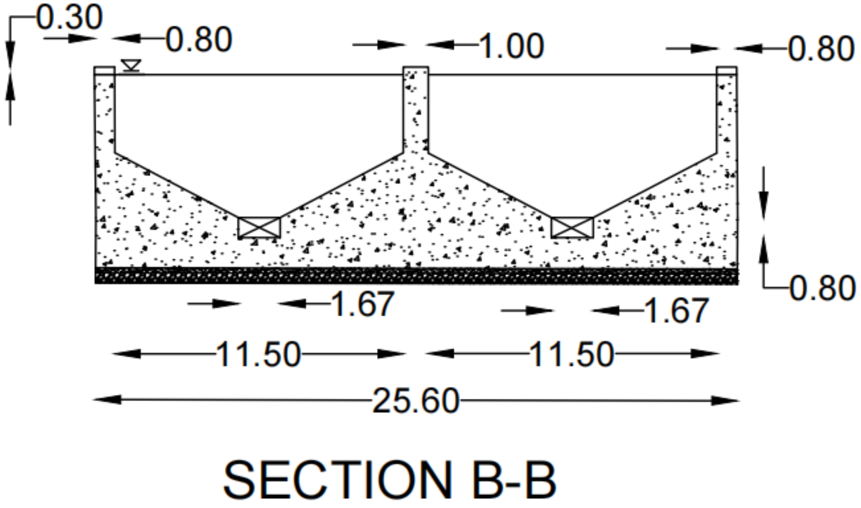


Figure: Sectional view of Gravel Trap

Hydraulic Design of Settling Basin

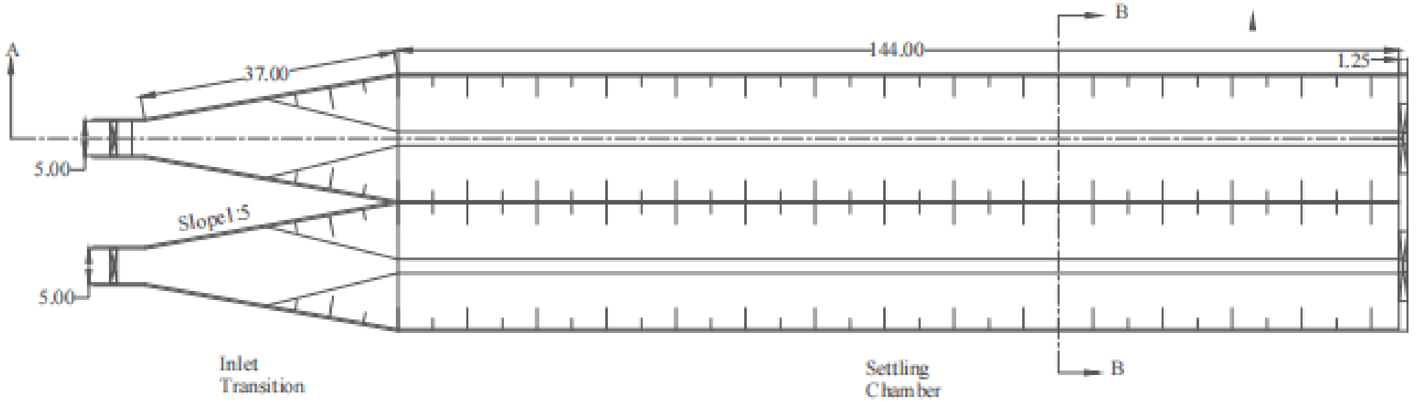


Figure: Plan View of Settling Basin view of Gravel Trap

Settling Basin Design Summary		
S.N	**Description**	**Values**
1	Total discharge(Q_t)	49.61
2	No of bays	2
3	Adopted particle fall velocity	0.0175 m/s
4	Length of settling basin	144 m
5	Width of settling basin	18 m
6	Actual area of Settling basin	2592.000 m^2
7	Efficiency of Settling basin	0.840
8	Length of horizontal transition	37 m

Hydraulic Design of Settling Basin

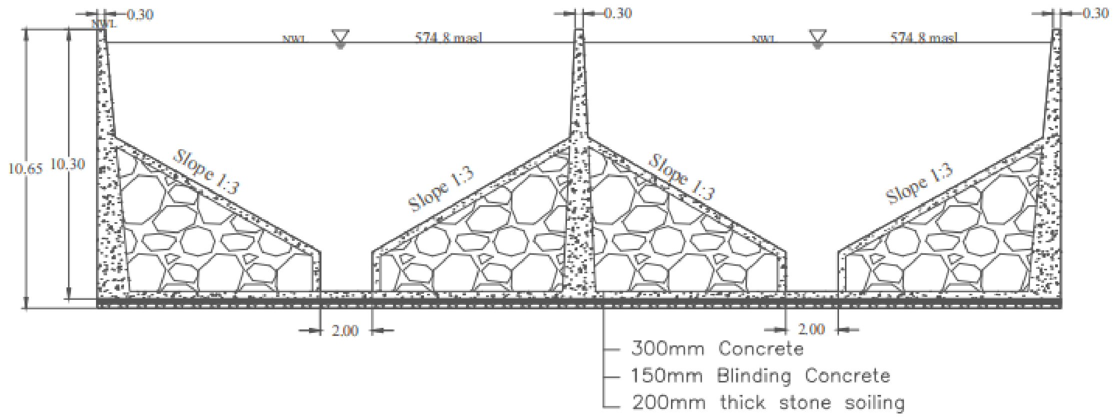


Fig: Section B - B

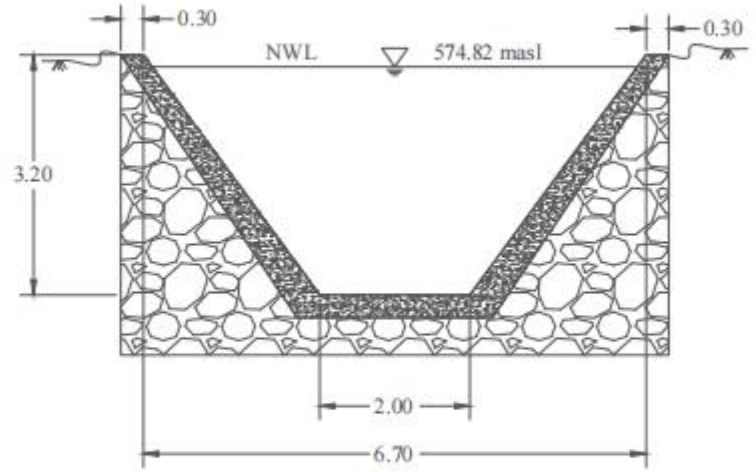


Figure: Sectional view of Settling Basin

Figure: Sectional view of Approach Canal

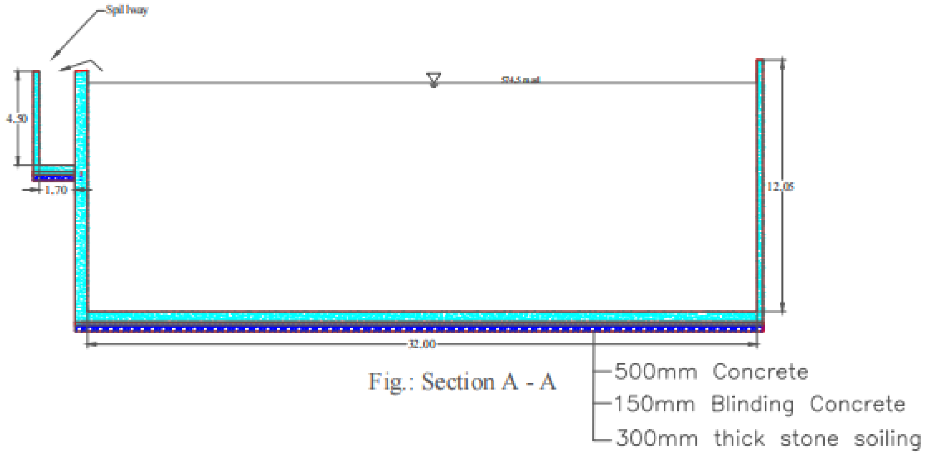


Fig.: Section A - A

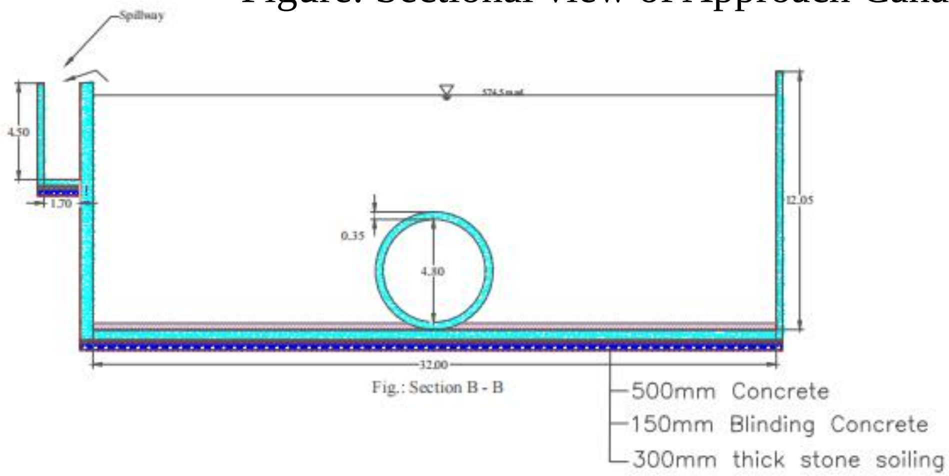


Fig.: Section B - B

Figure: Sectional view of Head Pond

Stability Analysis of Weir

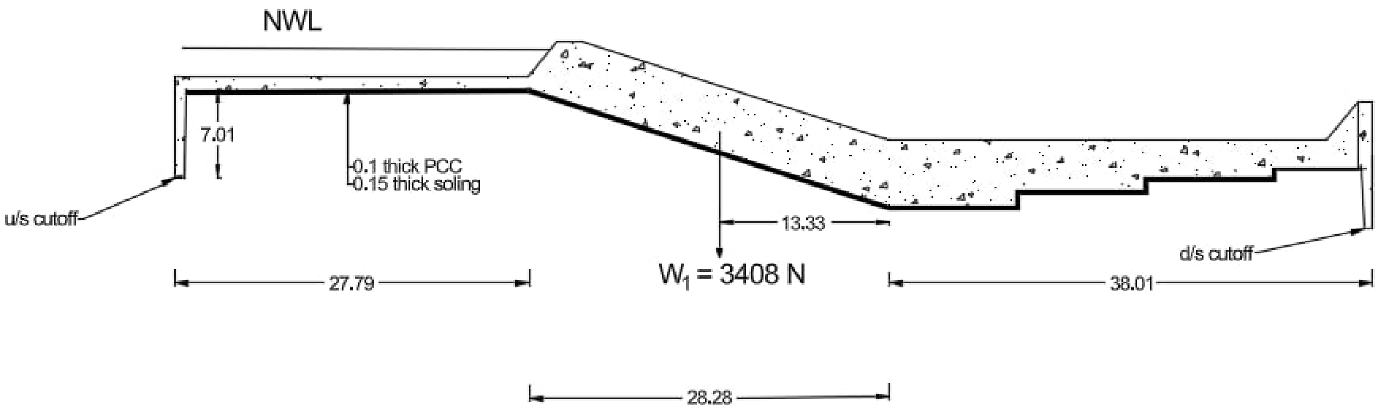


Figure: Sectional view of Weir

Name of the Force	Force(A*G)	
	Vertical	Horizontal
Vertical Force calculation		
Self-weight force calculation(w)		
Weir body	3408	
Weight of water during pool level	67.15	
Weight of water during high flood level	354.38	
Hydrostatic forces		
Pool level condition(H=3.7m)		-67.15
High flow condition (H=8.5m)		-354.35
Uplift pressure		
For pool level	-505.05	
High flood level	-1160.35	
Earthquake forces		
Horizontal earthquake force		-340.8
Vertical earthquake forces	-170.4	
	1993.67	-762.37

Stability analysis of Weir

Pond Level

Fos against Overturning	4.76	>1.5, Safe
FoS against Sliding	18.75	>1, Safe

Pond Level with Earthquake

Fos against Overturning	3.28	>1.5, Safe
FoS against Sliding	4.46	>1, Safe

High Flood Level

Fos against Overturning	2.20	>1.5, Safe
FoS against Sliding	4.57	>1, Safe

High Flood Level with Earthquake

Fos against Overturning	2.02	>1.5, Safe
FoS against Sliding	2.17	>1, Safe

Optimization of Headrace Tunnel

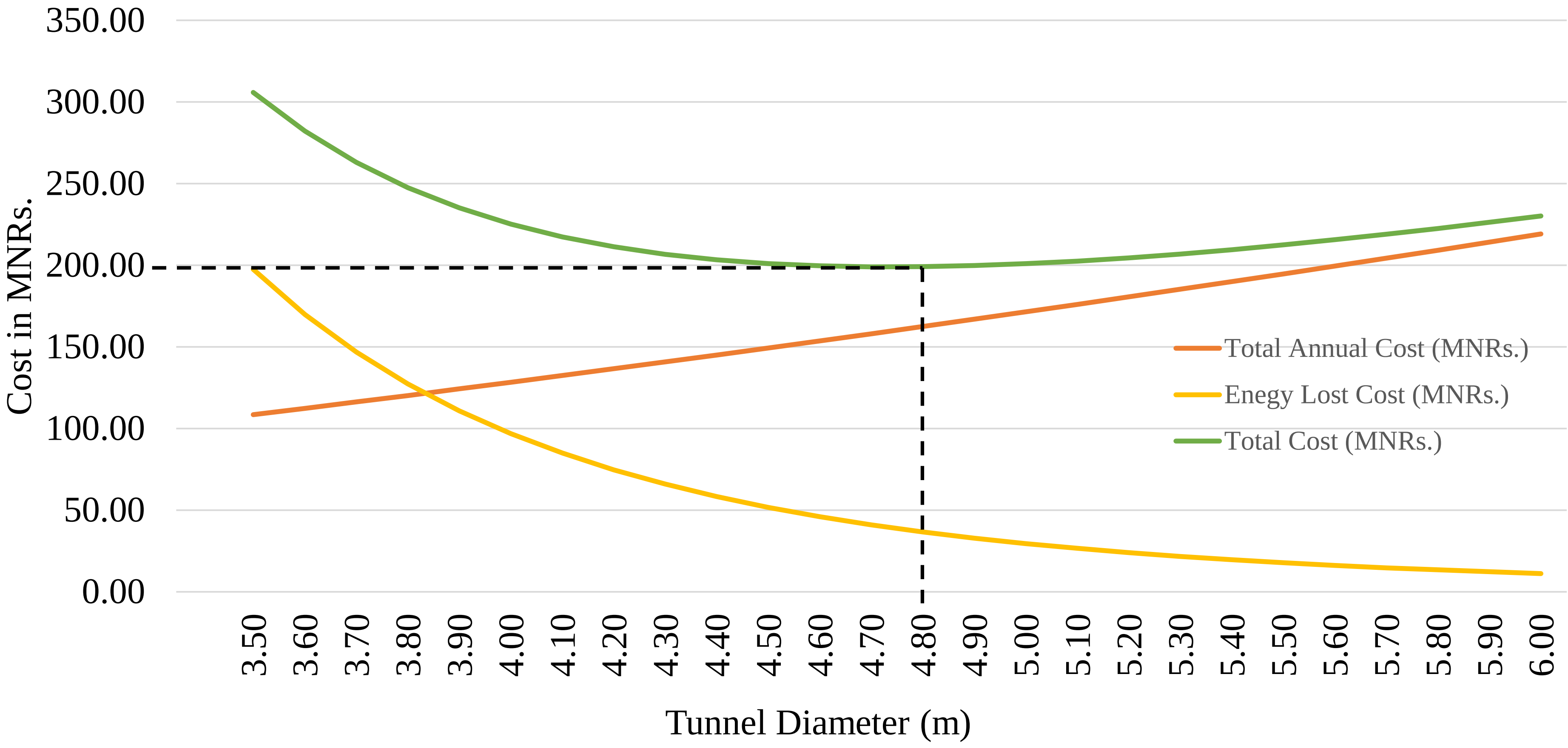
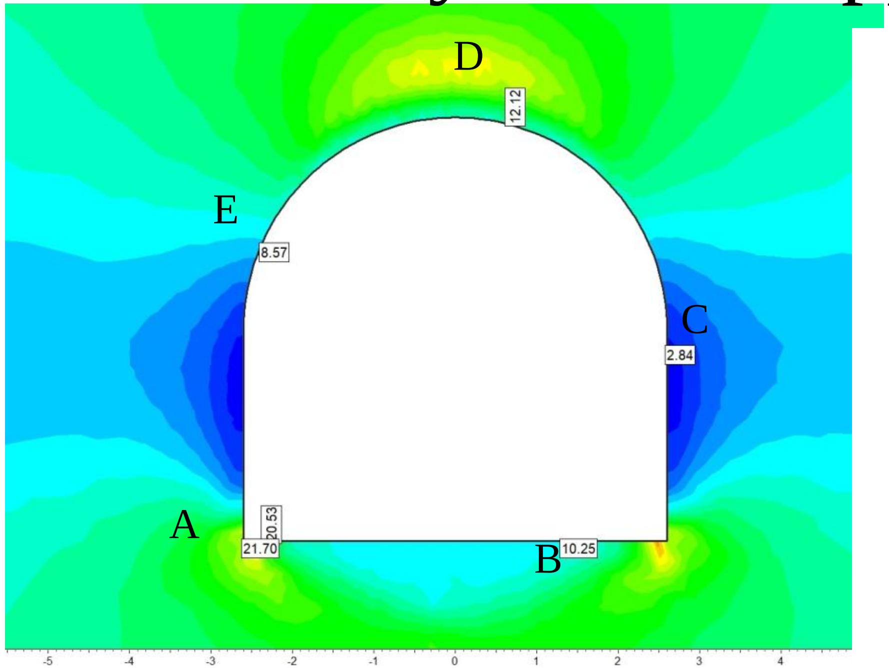


Figure: Headrace Tunnel Optimization

- Optimized Tunnel Diameter- 4.8m
- Total Cost of optimized diameter- NRs.198.72 Million

Static Analysis and Support Design of Headrace Tunnel



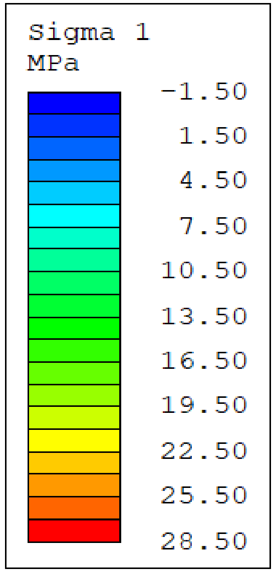


Figure : Stress (Sigma 1) before support installation for Rock class-III

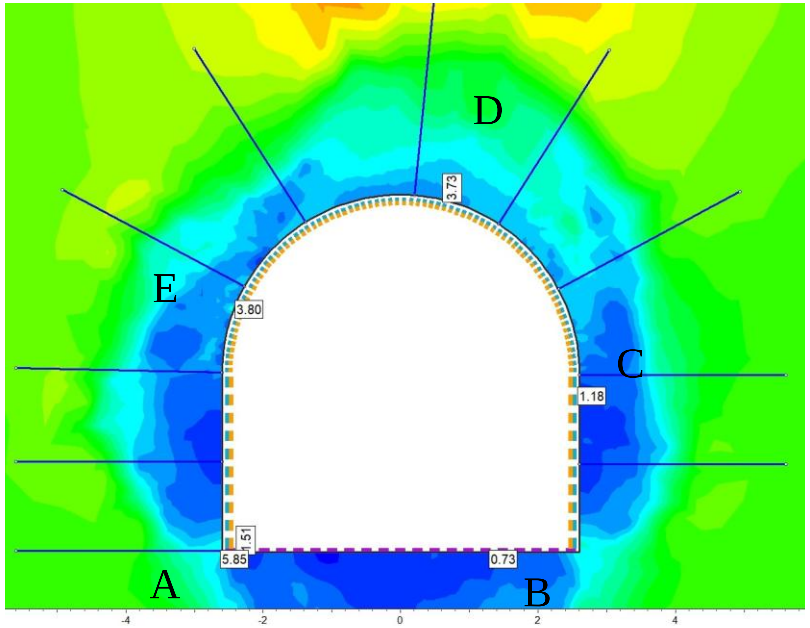


Figure : Stress (Sigma 1) after support installation for Rock class-III

Description	Stress (sigma1, Mpa.)				
	A	B	C	D	E
Before support Installation	21.70	10.25	2.84	12.12	8.57
After support Installation	5.85	0.73	1.18	3.73	3.80

Static Analysis and Support Design of Headrace Tunnel

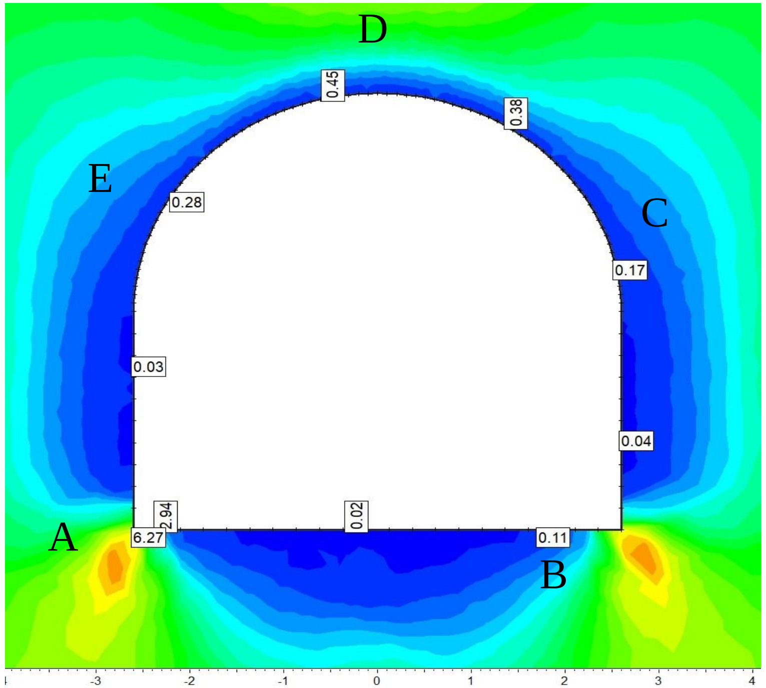
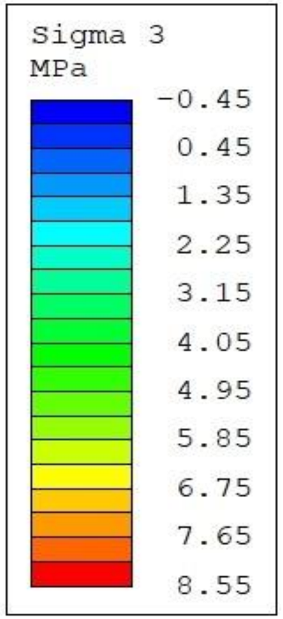


Figure : Stress (Sigma 3) before support installation for Rock class-III



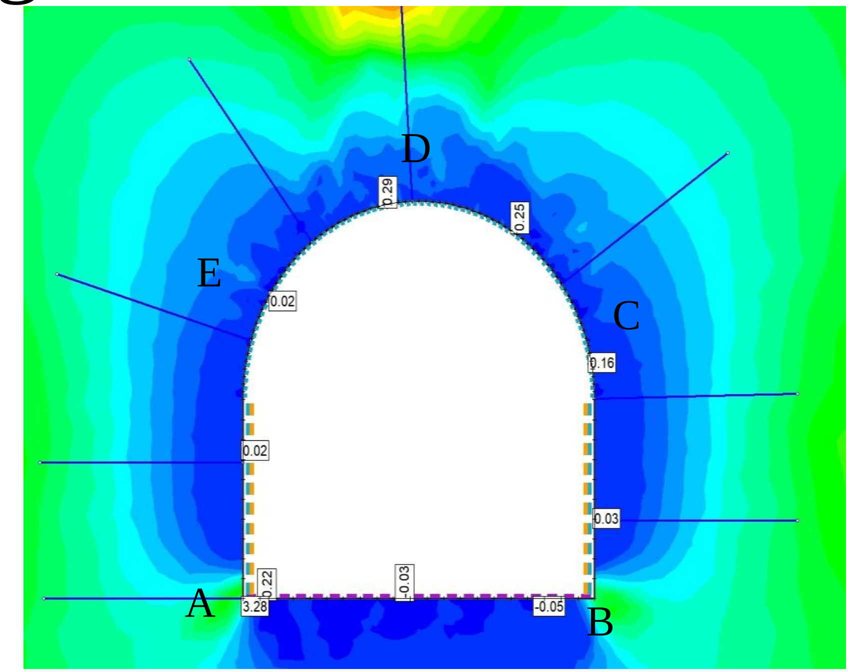


Figure : Stress (Sigma 3) after support installation for Rock class-III

Description	Stress (sigma3, Mpa.)				
	A	B	C	D	E
Before support Installation	6.27	0.11	0.17	0.45	0.28
After support Installation	3.28	-0.05	0.16	0.29	0.02

Static Analysis and Support Design of Headrace Tunnel

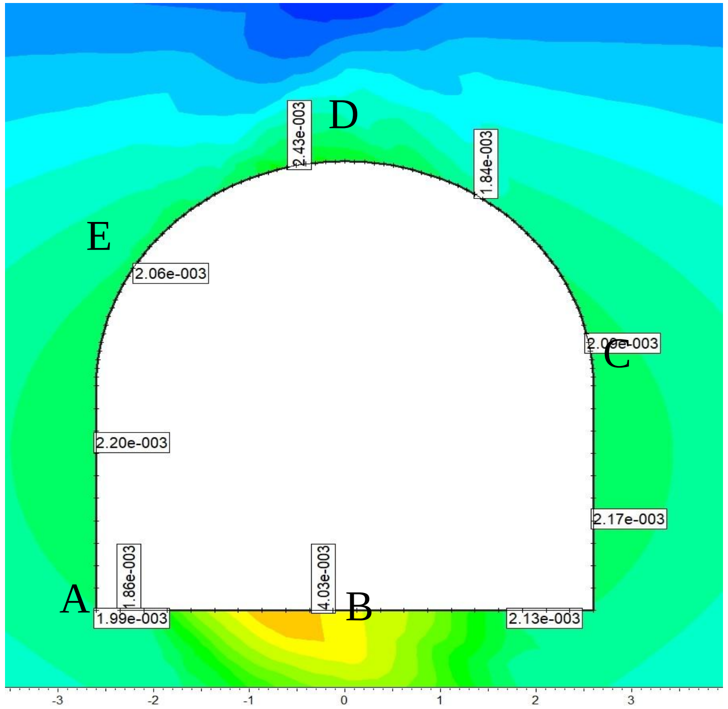
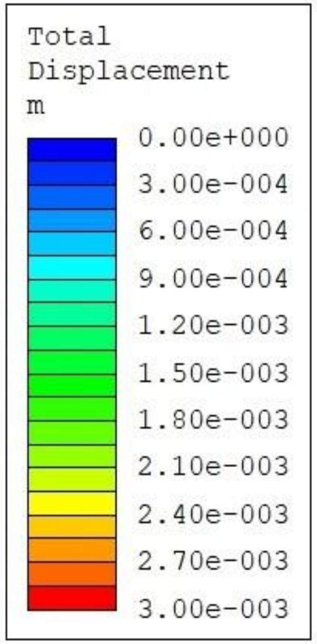


Figure: Displacement along tunnel face before support installation



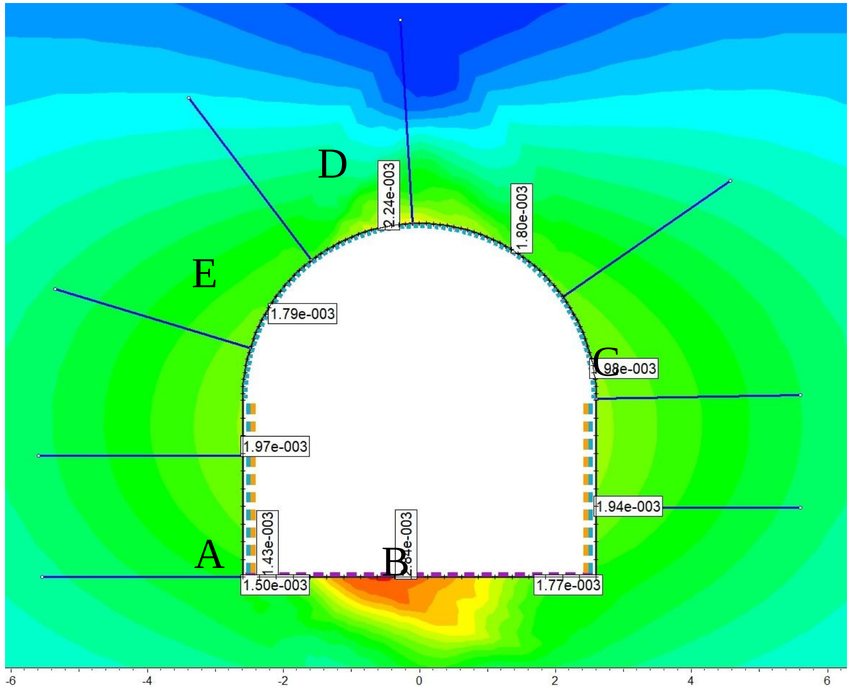


Figure: Displacement along tunnel face after support installation

Description	Displacement (mm)				
	A	B	C	D	E
Before support Installation	1.99	4.03	2.09	2.43	2.06
After support Installation	1.50	2.84	1.98	2.24	1.79

Support Capacity Plots for Rock Class III

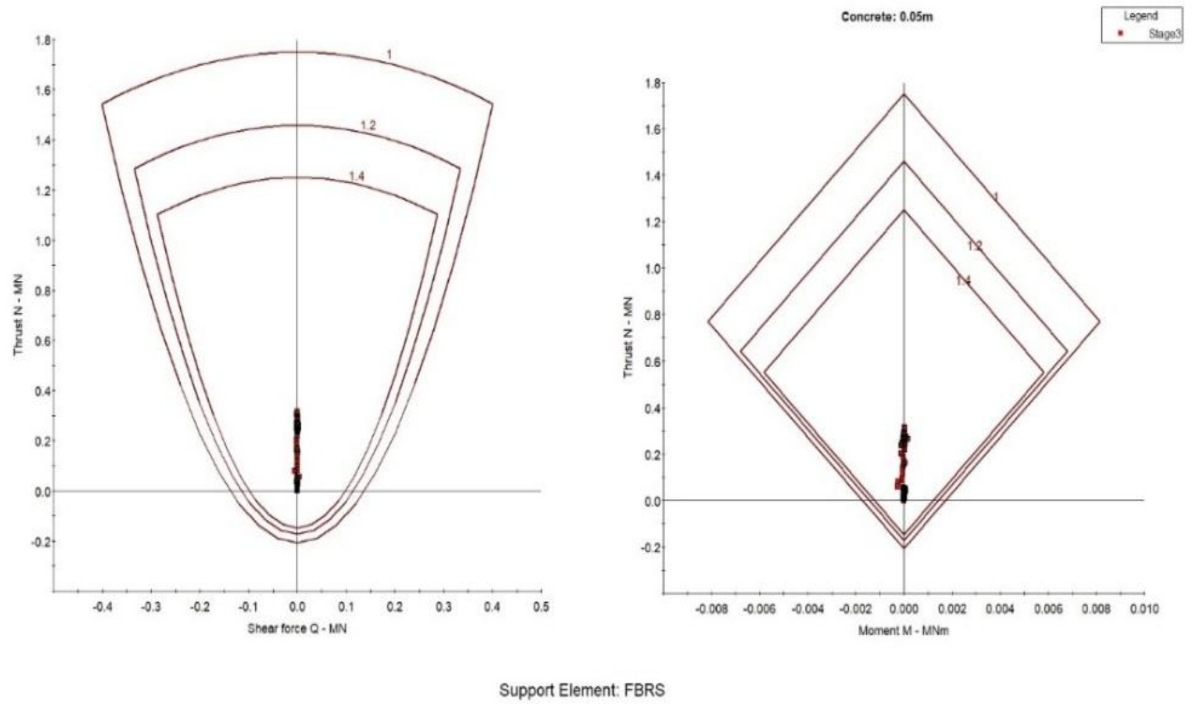


Figure: Support capacity plots of 50mm SFRS of HRT

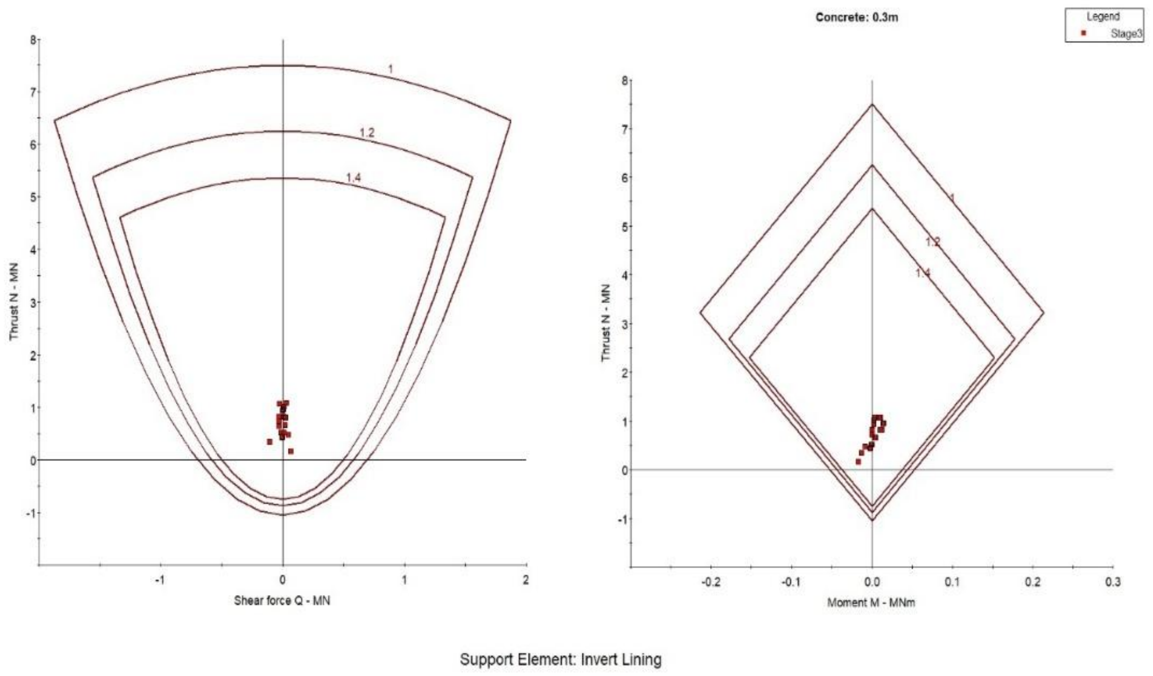


Figure: Support capacity plots of 30 cm M25 concrete in invert lining of HRT

Support Capacity Plots for Rock Class IV

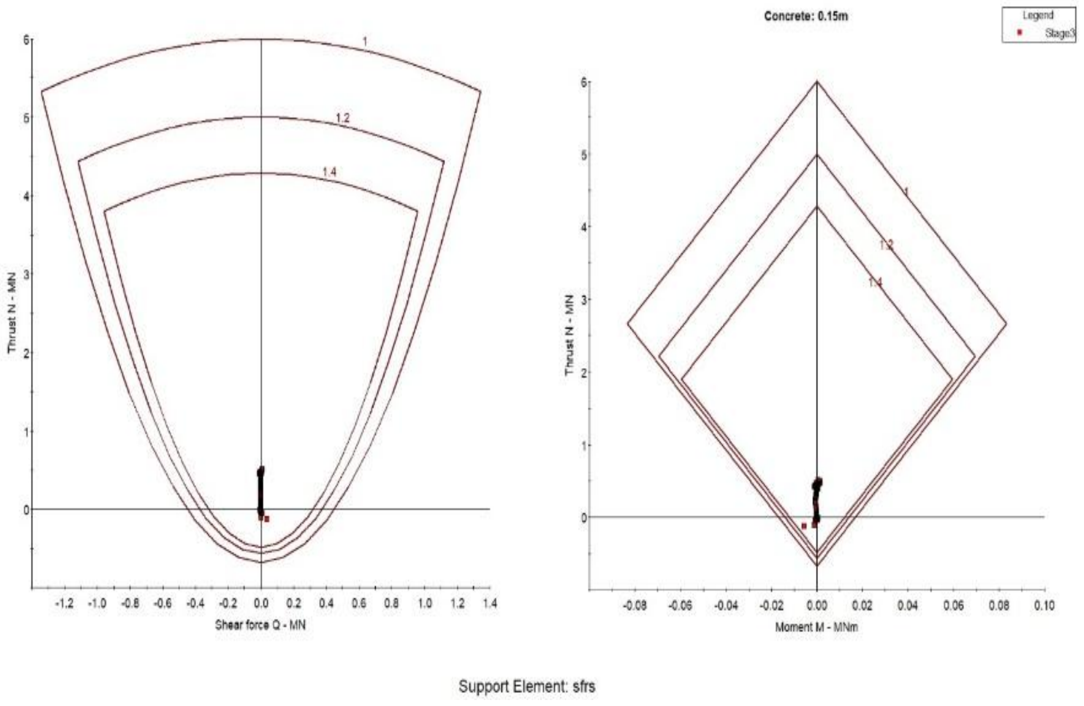


Figure: Support capacity plots of 150mm SFRS of HRT

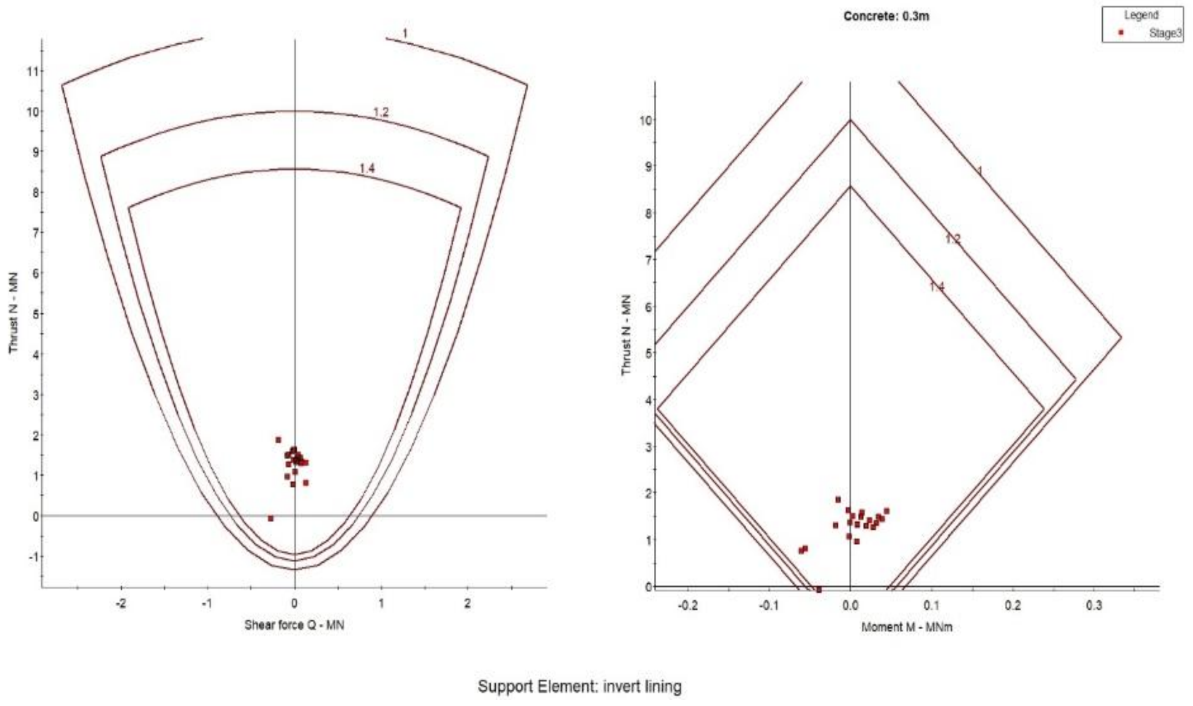


Figure: Support capacity plots of 30 cm M25 concrete in invert lining of HRT

Support Capacity Plots for Rock Class IV

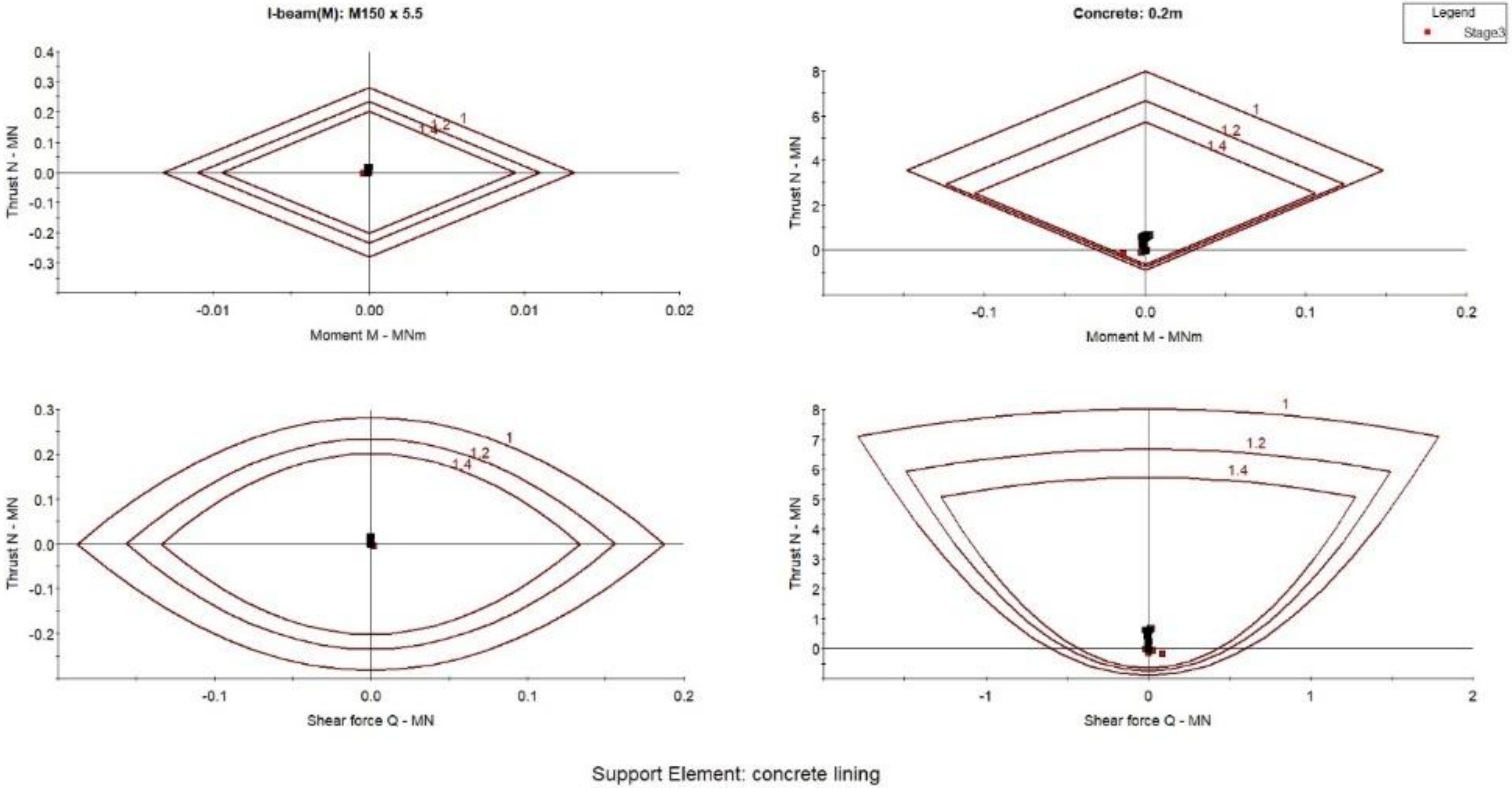


Figure : Support capacity plots of ISMB 150*75 Steel Ribs with 20 cm M25 concrete lining on the tunnel face of HRT

Support Design of Headrace Tunnel

Support Elements for Class III Rock Support:

- Bolt pattern of 3m length and 25mm diameter at 2m interval

- Walls and Crown: 50 mm Steel Fiber Reinforced Shotcrete (M35)

- Invert: 30cm Reinforced M25 concrete.

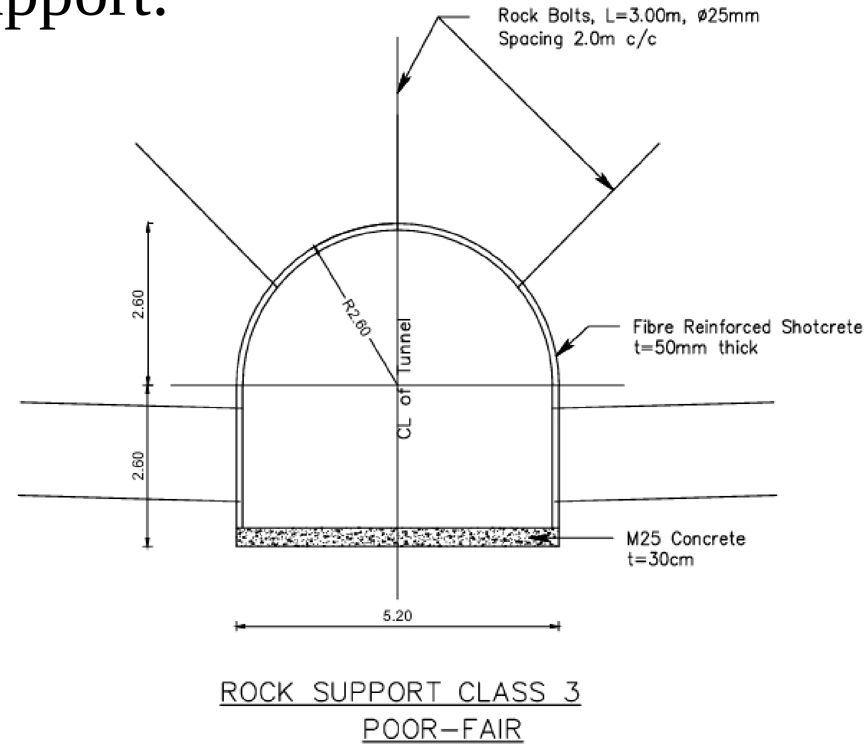


Figure : Tunnel section of Class III rock support

Support Design of Headrace Tunnel

Support Elements for Class IV Rock Support:

- Bolt pattern of 3m length and 25mm diameter at 1.5m interval

- Walls and Crown: 150 mm Steel Fiber Reinforced Shotcrete (M35) with steel ribs of ISMB 150*75mm and 20 cm M25 concrete lining.

- Invert: 30cm Reinforced M25 concrete.

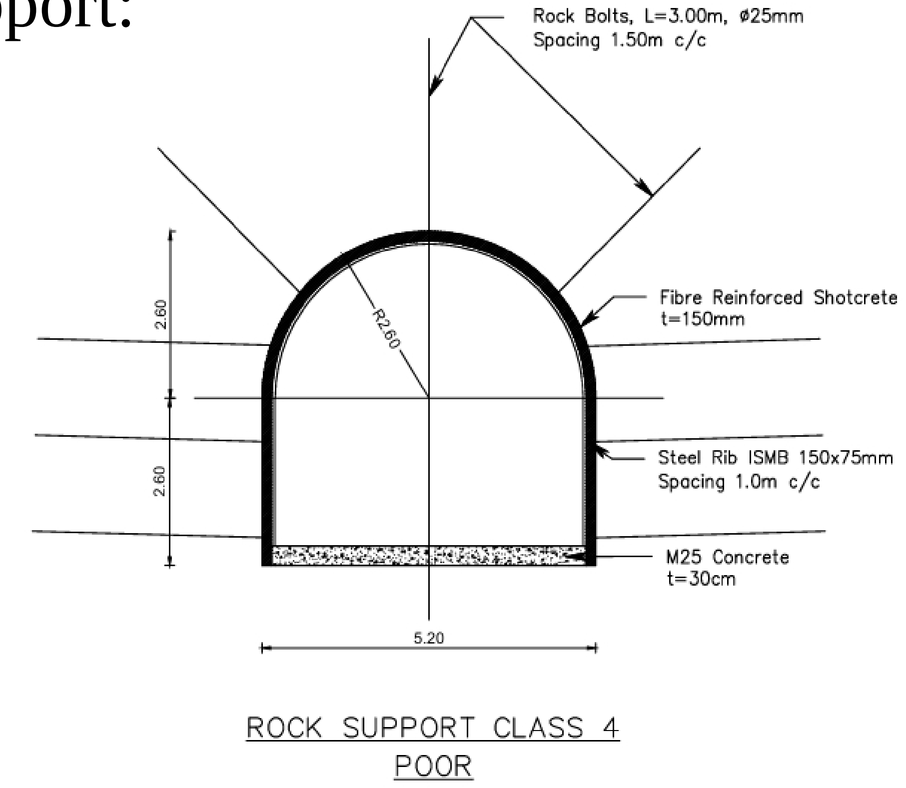
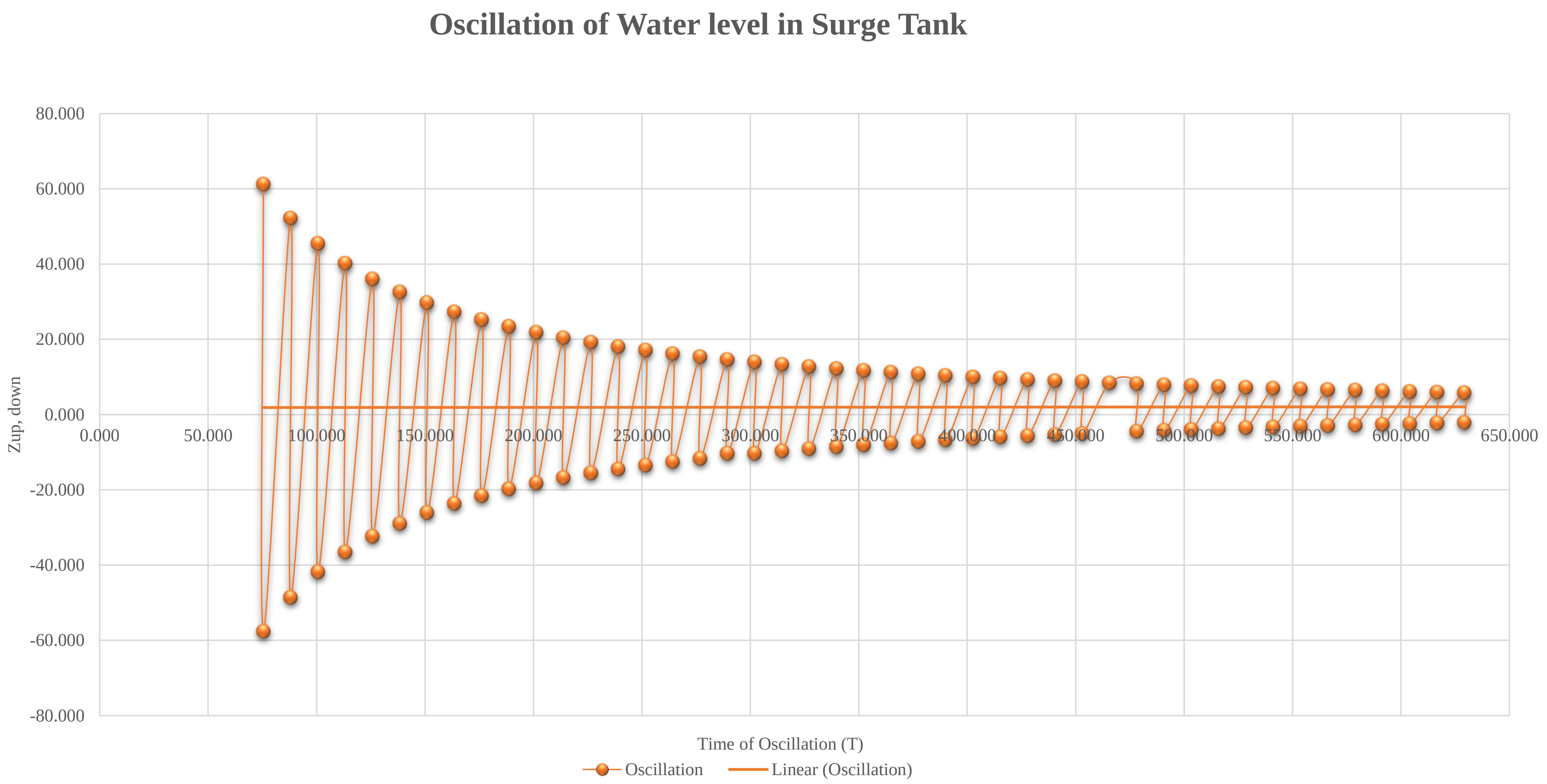


Figure : Tunnel section of Class IV rock support

Hydraulic Design of Surge Tank



Hydraulic Design of Surge Tank

S.N.	Descriptions	Values	Units
1.	RL of static level of surge tank	574.07	m amsl
2.	RL of minimum Submergence Level Required	568.6	m amsl
3.	RL of down Surge from static level	569.05	m amsl
4.	Minimum submergence head available	7.05	m
5.	RL of upsurge from static level	582.83	m amsl
6.	Total Height of Surge Tank, (H_{st})	24.8	m
7.	Optimized diameter of surge tank, (D_{st})	18	m
8.	Time of Oscillation ,T	389.69	sec
9.	In 100 sec, Surge Height	3.35	m

Hydraulic Design of Surge Tank

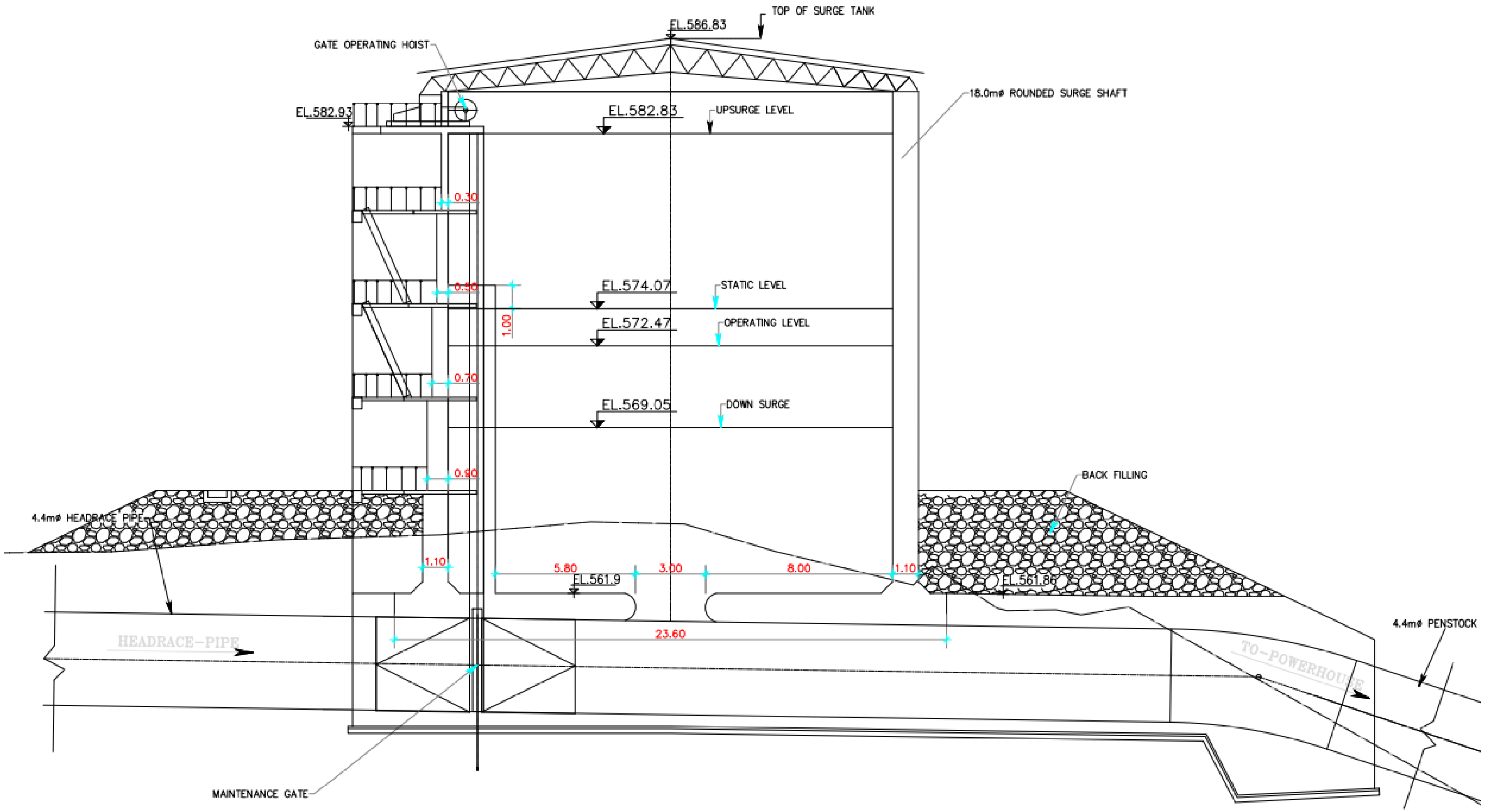
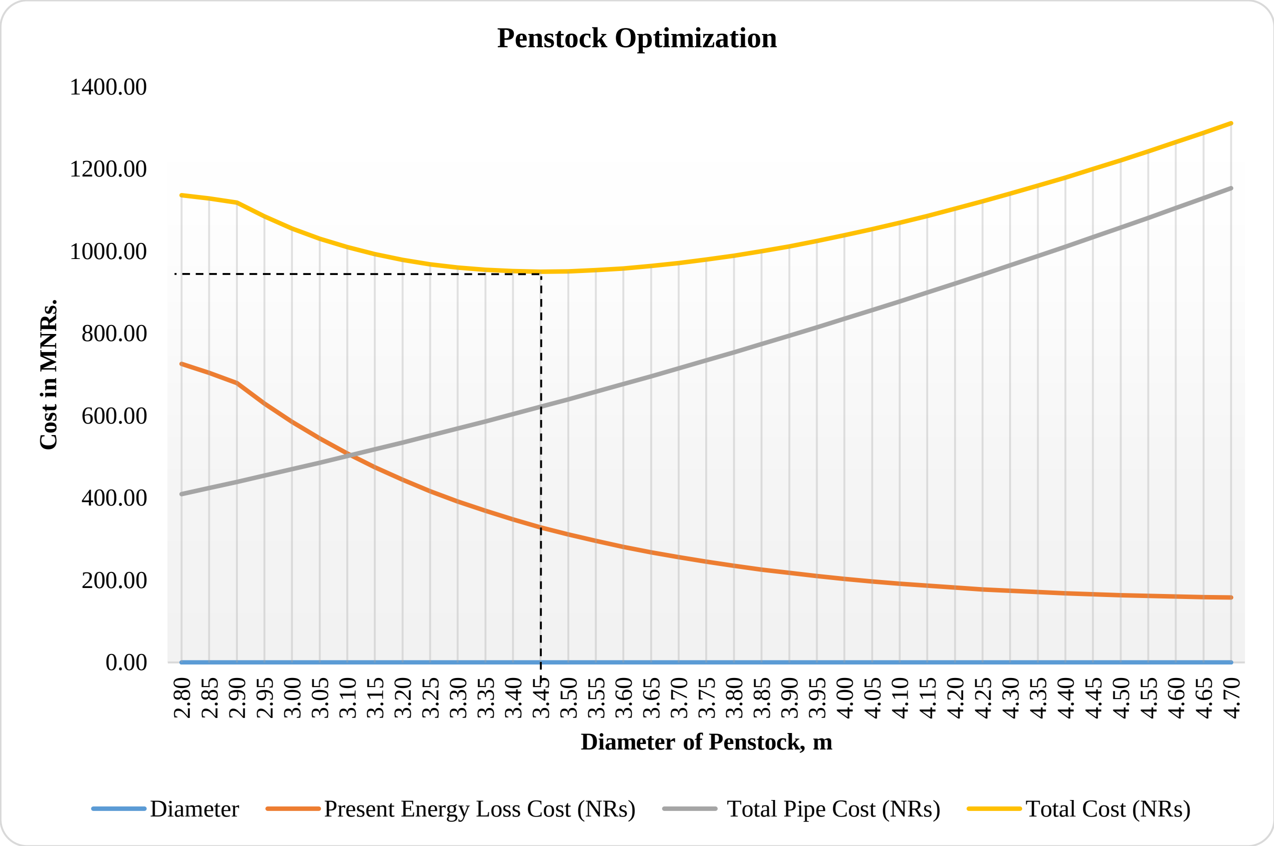


Figure: Sectional View of Surge Tank

Optimization of Penstock

Cost (in Million Rupees)



Pipe Diameter (mm)

Figure: Graph of Penstock Optimization

Table for Optimisation

Diameter (m)	Present Energy Loss Cost (NRs)	Total Pipe Cost (NRs)	Total Cost (NRs)
2.80	726,423,463	409,452,424	1,135,875,887
2.85	704202519	424,206,290	1128408809
2.90	679,443,112	439,221,287	1,118,664,399
2.95	629,974,199	454,497,413	1,084,471,612
3.00	585,223,193	470,034,671	1,055,257,864
3.05	544,688,352	485,833,058	1,030,521,410
3.10	507,928,998	501,892,576	1,009,821,574
3.15	474,557,220	518,213,224	992,770,444
3.20	444,230,821	534,795,003	979,025,824
3.25	416,647,300	551,637,912	968,285,212
3.30	391,538,706	568,741,951	960,280,657
3.35	368,667,227	586,107,121	954,774,348
3.40	347,821,403	603,733,421	951,554,824
3.45	**328,812,858**	**621,620,852**	**950,433,710**

Optimization of Penstock

Optimization using E. Mosoney(Ref: Prof E. Mosoni, IHE Delft)				
1	Design discharge	Q	47.45	m^3/s
2	Design head	Hg	101.7	m
3	Friction co-efficient	f350	0.01	
4	Ultimate Strength of Steel	Fe 400	400	N/mm^2, MPa
	Safety Factor		4000	kg/cm^2
	Base Safety	1.5	71.90%	
	Material Uniformity	1.11	90%	
	Welding Efficiency	1.25	80%	
	Erection Accuracy	1.2	83%	
	Over all FOS		2.5	
5	Allowable stress for steel	s	1400	kg/cm^2
6	Non-Payable hours		142	Hrs
7	Scheduled Maintenance		14	Days
8	Annual operation hours	t	8282	Hrs
9	Rate of kWh	c_2	6.6	Rs/KWH
10	Unit cost of penstock per kg	c_o	150	Rs/kg
11	Annual maintenance and replacement cost	%	10	
	Annual Rate of maintenance	c_1	15	
12	**Economic diameter (d) = m**	**d**	**4.74**	**m**
13	Velocity	v	2.69	m/s

Obtained Economic diameter : 4.74m

Optimization of Penstock

Optimization using IS11625-1986				
1	Design discharge	Q	47.45	m^3/s
2	Design head	H	67.8	m
3	Max Pressure including Water Hammer			
	Increase in head		50%	
	Max Head	H	101.7	m
4	Cost of Concrete Lining	C_C	10000	Rs/m3
5	Unit cost of Excavation	C_e	383	Rs/m3
6	Price of Energy	C_p	6.6	Rs/KWH
7	Cost of Steel	C_s	150	Rs/kg
8	Overall Plant Efficiency	e	86%	
9	Joint Efficiency of Penstock	e_j	90%	
10	Per provision for stiffness and corrosion	i	0.2	
11	Rugosity Coefficient of Mannings	n	0.013	
12	O& M Charges as ratio of cost of penstock	p	10%	
13	Annual Load Factor	p_l	71.90%	
14	Allowable Stress	s	100	MPa
15	Economic Diameter	D-inside	4.40	m
		velocity	3.07	

Obtained Economic diameter : 4.40m

Optimised Economic diameter used in our project: 4.40m

Design of Powerhouse

Selection of Turbine based on Head & Discharge

According to the Head and Discharge			
	Value	**Unit**	**Remarks**
Gross Head(H_g)	68.00	metres	Low head and High discharge
Net Head (H_n)	63.90	metres	
Discharge (Q)	43.14	cumecs	
Choice of turbine based on Head vs Discharge Graph	Francis Turbine (Overlap)		

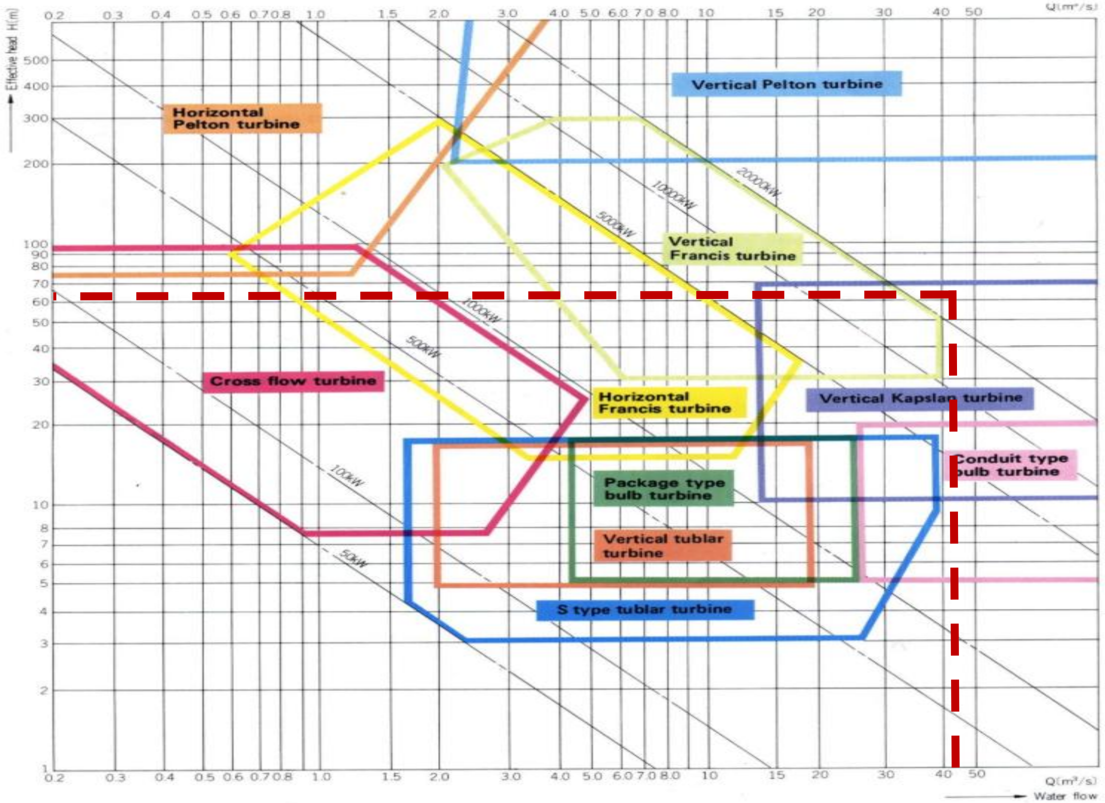


Figure: Net Head v/s Discharge (DoED, 2018)

Design of Powerhouse

Selection of Turbine based on Head & Specific Speed

According to the specific speed			
	Value	**Unit**	**Remarks**
Turbine efficiency	0.90		Assumption
Generator efficiency	0.97		Assumption
Transformer efficiency	0.99		Assumption
Overall efficiency	0.87		
No. of units (n)	2.00		
Discharge per unit (q)	21.57	cumecs	
Power generated by each unit (P)	11,694.88	kW	23389.7642
Frequency (f)	50.00	Hz	
No. of poles (p)	8.00		Assumption
Speed in rpm (N)	375.00	rpm	
Specific Speed (N_q)	77.06		
Choice of turbine based on head vs specific speed graph	Francis Turbine (Overlap)		

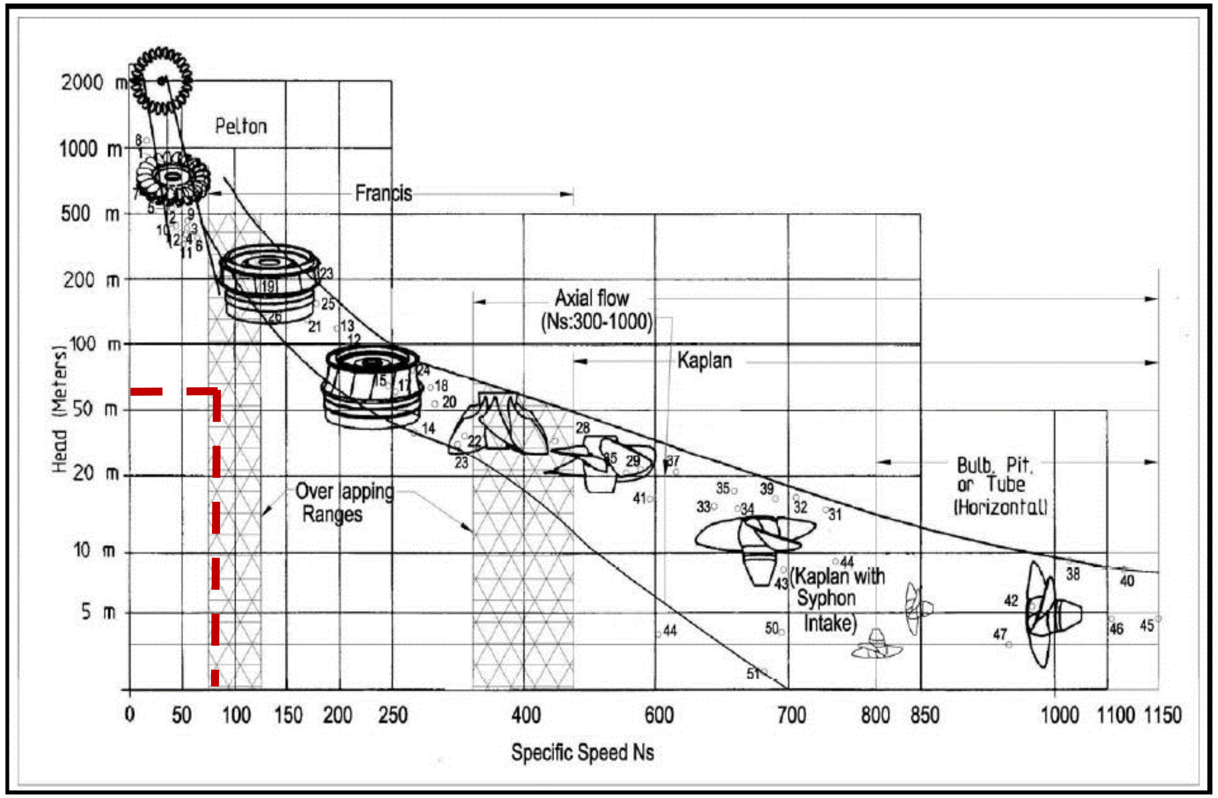


Figure: Net Head v/s Specific speed (DoED, 2018)

Design of Powerhouse

Selection of Turbine based on Speed Number

According to the speed number			
	Value	**Unit**	**Remarks**
ω	39.27		Angular velocity
ϖ	1.11		Speed factor
$\bar{Q}$	0.61		
Ω	0.87		Speed number
Choice of turbine based on Speed number	Francis Turbine		

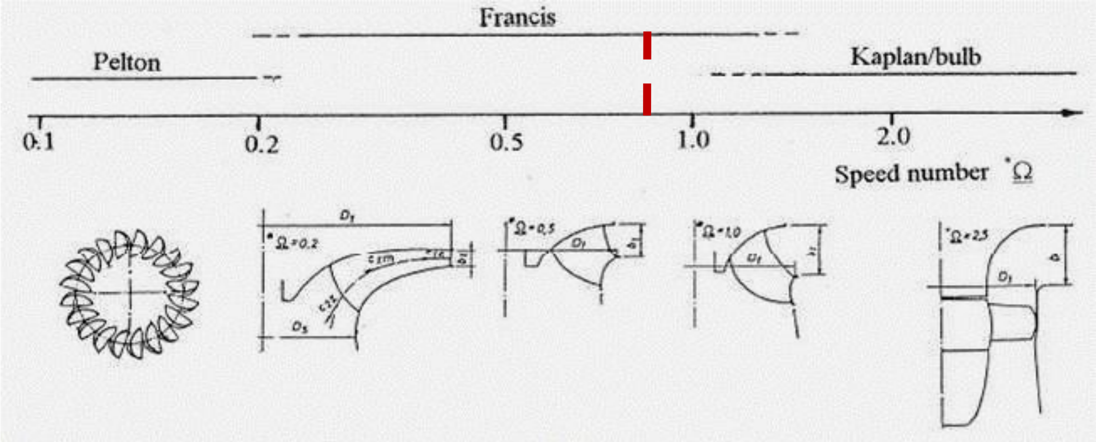


Figure: Relation between turbine and speed number (DoED, 2018)

Design of Powerhouse

Preliminary Sizing of Unit Bay

Description	Value	Unit
Length	15	m
Breadth	17.25	m
Height	14.71	m

According to IS 12800 part 1

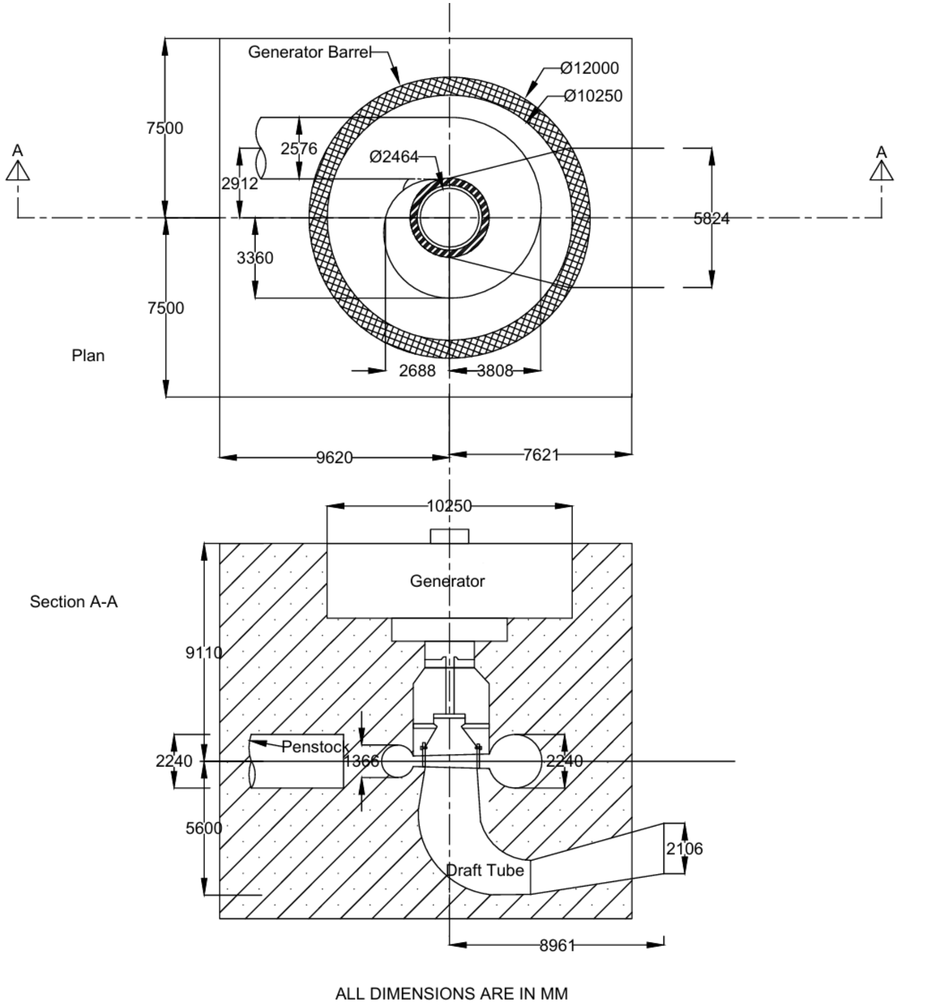
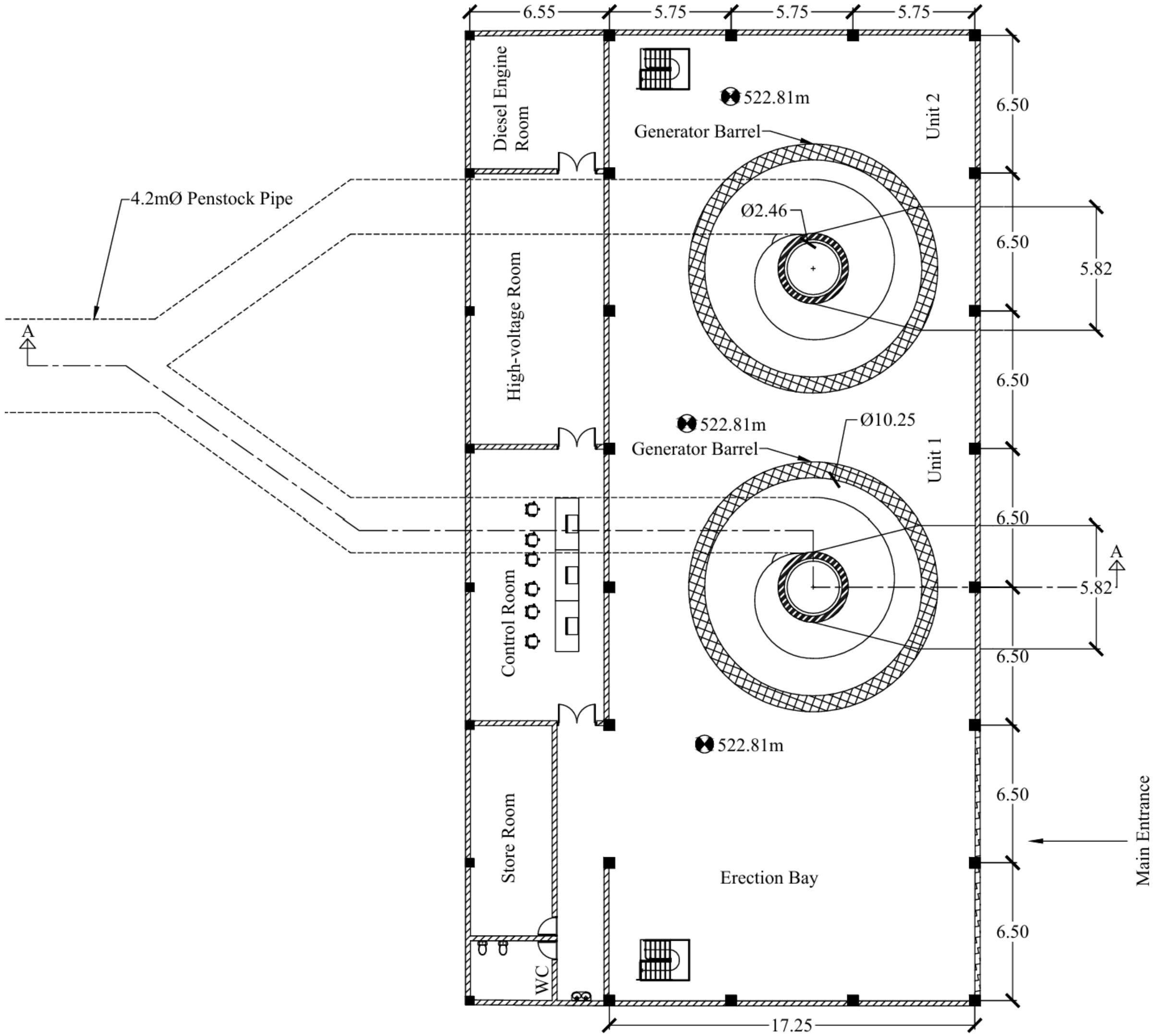
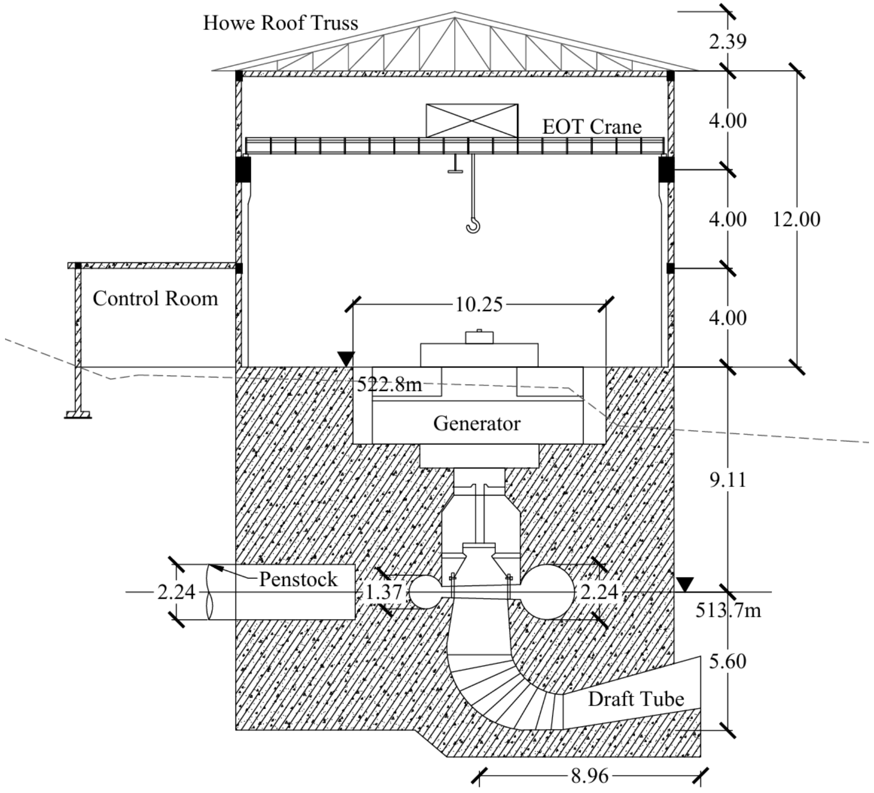


Figure: Dimension of machinery and unit bay

Plan & Section of Powerhouse



Plan

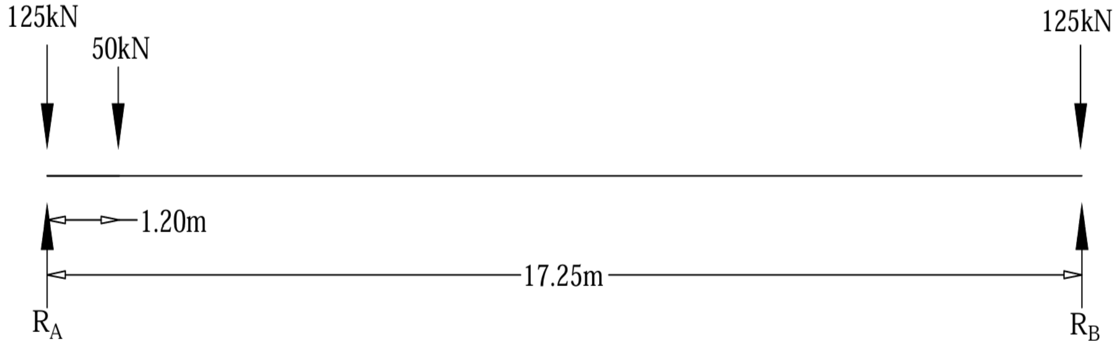


Section A-A

Load Details (Crane load)

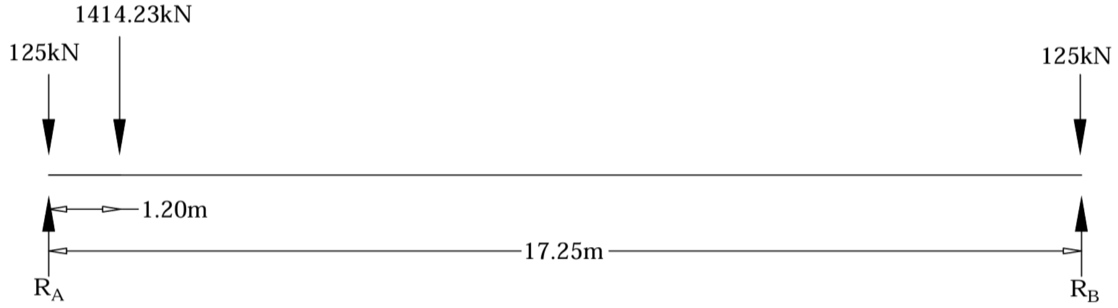
Calculation of critical load condition of crane at rest (case1)

R_a	171.47	kN
R_b	128.53	kN
Maximum load per wheel	85.74	kN
Minimum load per wheel	64.27	kN



Calculation of critical load condition of crane at rest (case2)

R_a	1439.40	kN
R_b	224.83	kN
Max Vertical Load on wheel with max carrying load and impact load	899.63	kN



Design of Powerhouse

Load Details (Roof Load)

Dead Load			
Weight of CGI Sheets	0.14	Thickness 1.25mm [kN/m^2]	DoED Powerhouse Guideline
Weight of bracings	0.02	[kN/m^2]	
Weight of purlins	0.63	[kN]	
Weight of truss	0.11	$(\frac{Span}{3} + 5) * 10$[kN]	
Concentrated load at intermediate node	7.98	[kN]	
Concentrated load at support node	3.99	[kN]	
Live Load			
Roof live load	0.67	0.75-0.02(α-10) [kN/m^2]	IS 875 (part2)
Concentrated load at intermediate node	18.76	[kN]	
Concentrated load at support node	9.38	[kN]	

Design of Powerhouse

Load Details (Wind load on Roof)

Basic Wind Speed (V_b)	47.00	[m/s]	NBC 104-1994
Risk Coefficient (K_1)	1.07	For Design Life 100yrs	Table 1, IS:875 (Part 3)-1987
Factor (K_2)	1.00	Class B, Category 2	Table 2, IS:875 (Part 3)-1987
Topography Factor (K_3)	1.00	Slope less than 3^o	Sec. 5.3.3.1, IS:875 (Part 3)-1987
Design Wind Speed (V_z)	50.09	$K_1K_2K_3V_b$ [m/s]	Sec. 5.3, IS:875 (Part 3)-1987
Design Wind Pressure (p_z)	1.51	$0.6V_z^2$ [kN/m²]	Sec. 5.4, IS:875 (Part 3)-1987
Height/Width Ratio (h/w)	0.70		
External Pressure Coefficient is given as:			Table 5, IS:875 (Part 3)-1987
Internal Pressure Coefficient (C_{pi})	-0.20	Assuming opening of less than 5 percentage	Sec. 6.2.3, IS:875 (Part 3)-1987
Internal Pressure Coefficient (C_{pi})	0.20		
Concentrated Wind Load on intermediate node	-49.51	[kN]	
Concentrated Wind Load on support node	-24.76	[kN]	

Design of Powerhouse

Load Details (Seismic parameters)

Parameters	Value	Remarks	Reference
Sesmic Zone factor (Z)	0.36	Zone V (Nepal)	*IS 1893:2016, Table 3*
	0.3	Pokhara	*NBC 105:2020, cl 4.1.4*
Importance Factor (I)	1.50	Power station building	*IS 1893:2016, cl 7.2.3*
Response reduction factor, R	5.00	SMRF	*IS 1893:2016, cl 7.2.6*
Ductility Factor, Ru	4		*NBC 105:2020, Table 5-2*
Over-strength Factor, Ωu	1.5		
Height of building	12.00	m	*Considering superstructure only*
Fundamental Time Period, T	0.48	RC MRF building	*IS 1893:2016, cl 7.6.2*
	0.64		*NBC 105:2020, cl 5.1.2*
Soil Type	1 & A	Rock or hard soil	

Design of Powerhouse

Design of Roof Truss in SAP2000

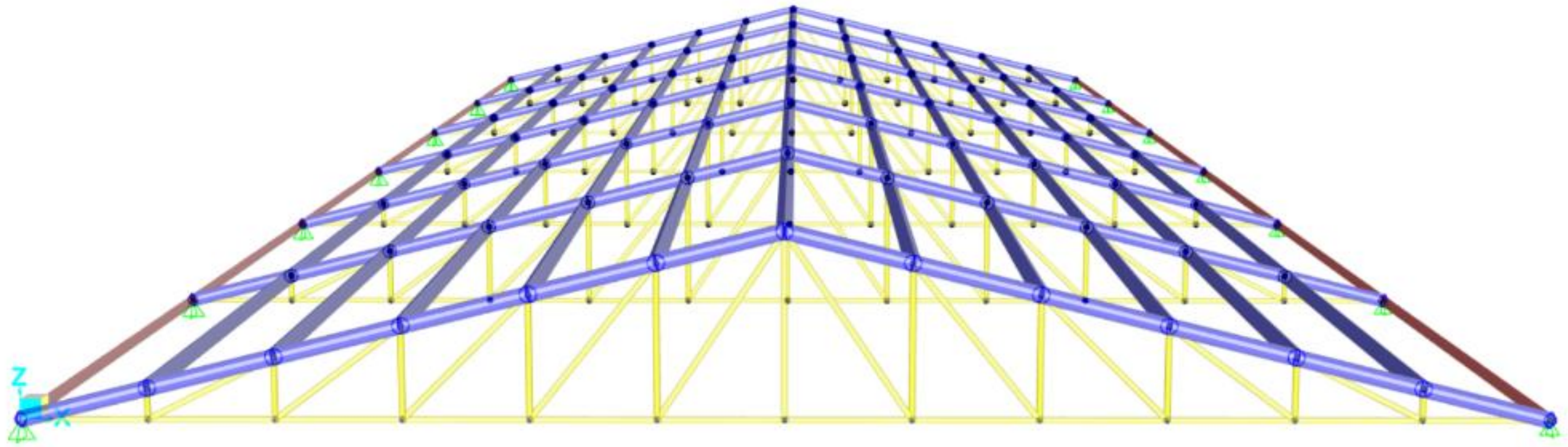


Fig: 3D model view of Howe roof truss in SAP2000

Design of Powerhouse

Design of Roof Truss in SAP2000

Members	Design Section
Top Chords	ISNB 175M
Bottom Chords	ISNB 65M
Vertical Web	ISNB 65M
Inclined Web	ISNB 65M
Intermediate Purlin	ISNB 175M
End Purlin	ISNB 125M

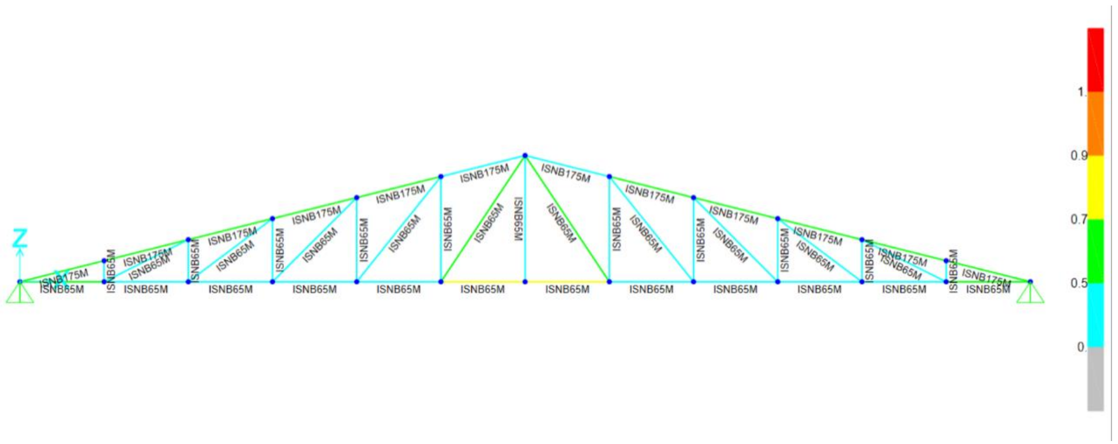


Fig: Demand/Capacity ratio passed steel section of roof truss

Design of Powerhouse

Design of Superstructure in SAP2000

- Material and Section define
  Concrete (M30), Rebar (Fe500)
- Load pattern and combination define
  According to powerhouse design guideline, DoED, 2018
- Mass source definition
  According to IS 1893: 2016
- Run Equivalent Static Method analysis
- Interpretation of seismic parameters
  Base shear, Time period
- Concrete frame design
  According to IS 456

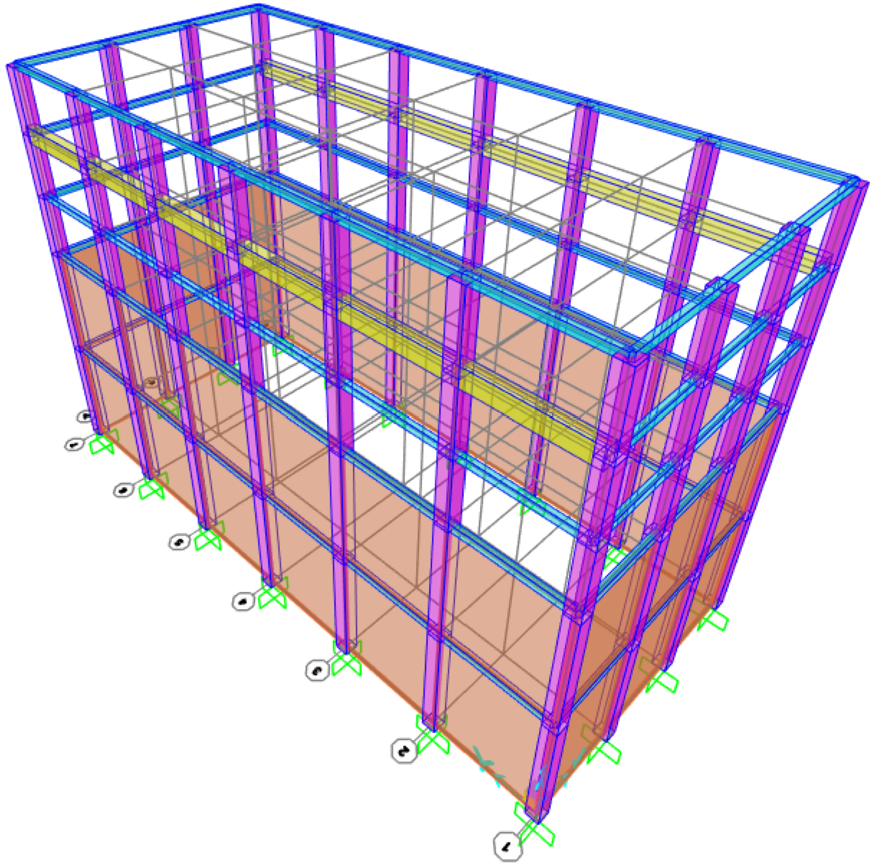


Fig: 3D model of Powerhouse Machine Hall in SAP2000

Design of Powerhouse

Design of Superstructure in SAP2000

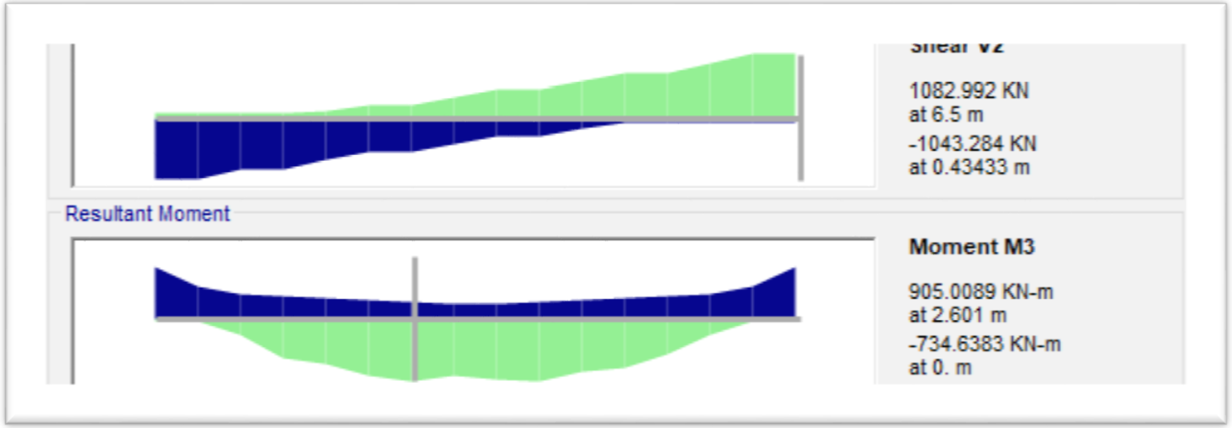


Fig: Max BM & SF value in crane beam from wheel load

Fig: Defining moving load in SAP2000

Design of Powerhouse

Design of Superstructure in SAP2000

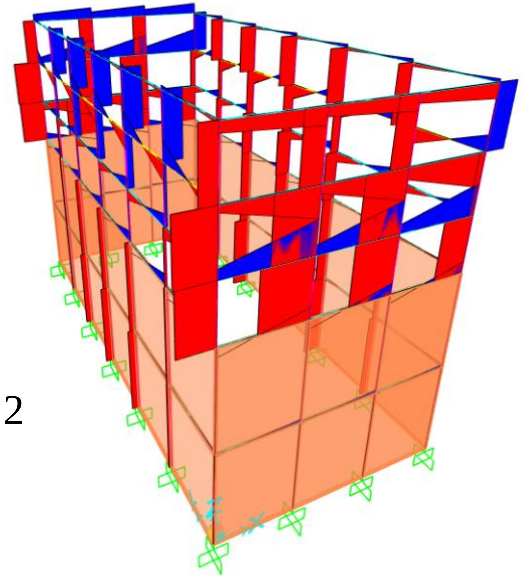


Fig: SF diagram at Load combination 2

Table: Time period and frequency in different mode

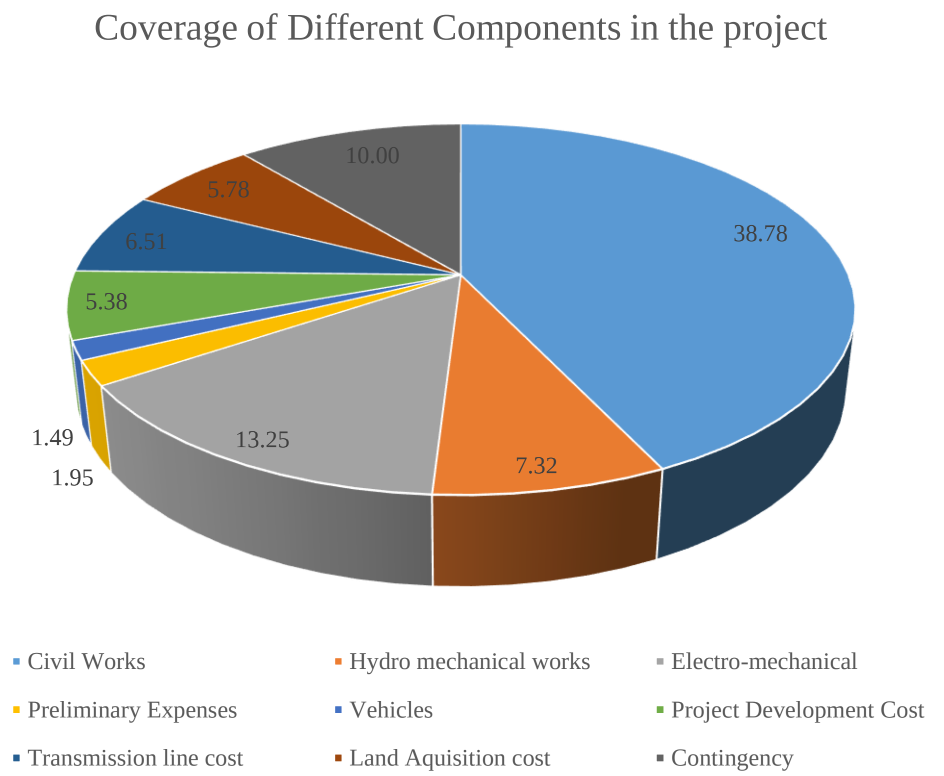
Modes	Time Period (Sec)	Frequency (Cyc/sec)
1	1.532692	0.652447
2	1.464447	0.682852
3	0.714104	1.400355
4	0.651744	1.534344
5	0.537443	1.860663
6	0.482928	2.070701
7	0.435249	2.297538
8	0.426526	2.344526
9	0.371711	2.690263
10	0.340077	2.940512
11	0.332088	3.01125
12	0.322021	3.105392

Table: Comparison of Base Shear

	IS 1893-2016	NBC 105-2020
Base Shear	2674.985 kN	3849.726 kN

Cost Analysis

S.N.	Description of work	Amount (NRs)	Coverage %
1	Civil Works	2,047,480,422	38.78
2	Hydro mechanical works	386,560,014	7.32
3	Electro-mechanical	699,680,089	13.25
4	Preliminary Expenses	102,720,056	1.95
5	Vehicles	78,432,046	1.49
6	Project Development Cost	284,000,011	5.38
7	Transmission line cost	343,760,023	6.51
8	Land Aquisition cost	305,280,079	5.78
Total Cost		**4,247,912,741**	
Contingency		**424791274.1**	10%
Total Project Cost excluding VAT		**4,672,704,015**	
Total Project Cost including VAT		**5,280,155,536**	13%



Financial Analysis

S. No.	Parameters	Outcomes	Remarks
1	Annual Energy Generation	144.39GWh	
2	Annual Revenue	NRs 765 million	
3	Total Cost	NRs 5280.16 million	
4	Per MW Cost	NRs 224.305 million	
5	Construction Period	3.5 years	
6	Generation Period	30 years	
7	Net Present Value	NRs 8146.482 million	
8	IRR	13%	> 12% discount rate (Profitable)
9	B/C Ratio	1.96	>1(Profitable)
10	Payback Period	8 years	

Financial Analysis

Sensitivity Analysis	
Capital Investment	NRs 5,280,155,536
Annual Revenue	NRs 764,995,739
Useful Life	30 Years
B/C Ratio	1.96
MARR and IRR	10% and 13%

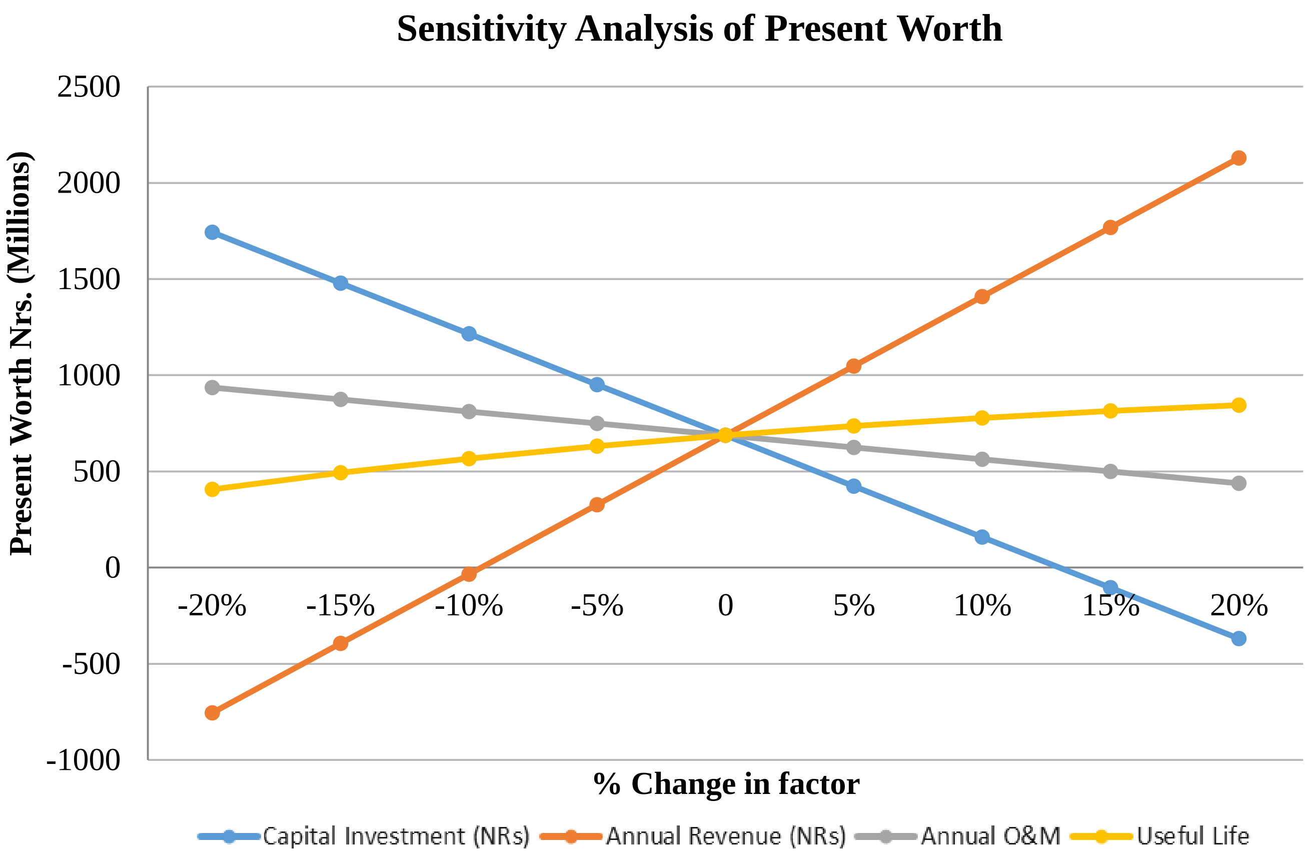


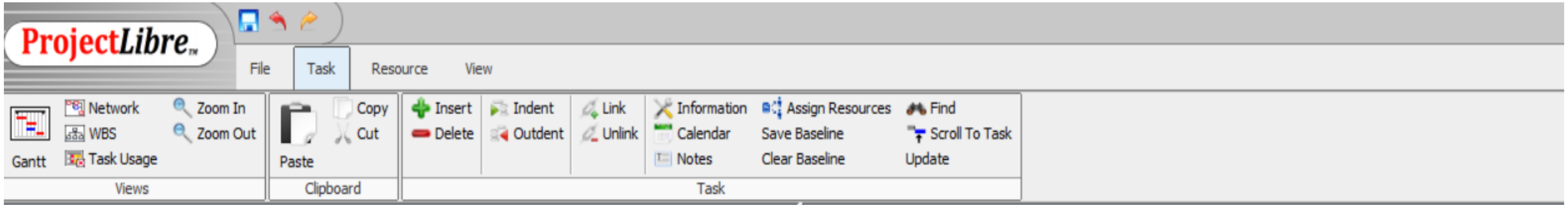
Figure : Sensitivity Analysis Spider Plot

PROJECT MANAGEMENT

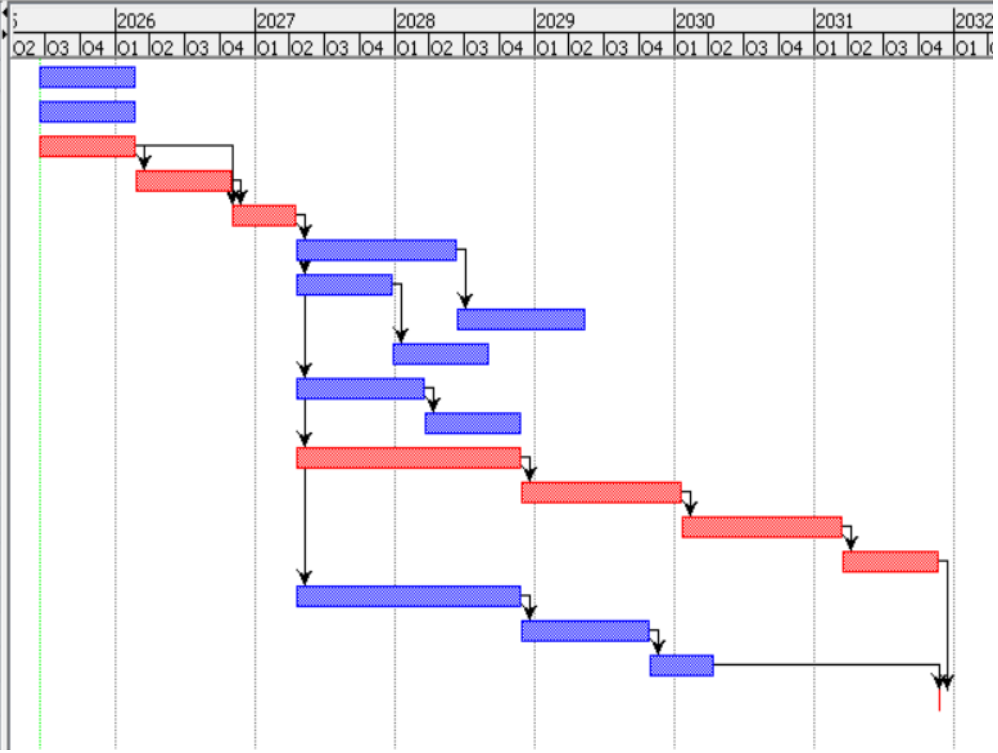
Machinery And Equipment

Types	Estimated Quantity	Types	Estimated Quantity
Excavator	4–5 units	Shotcrete Machine	1 unit
Bulldozer	2-3 units	Ventilation Fan	2 units
Backhoe Loader	2-3 units	Concrete Batching Plant	1 unit
Wheel Loader	2 units	Concrete Pump	1–2 units
Dump Truck / Tipper	8–10 units	Concrete Vibrator	4–6 units
Crawler Tractor	2–3 units	Welding Machine	2–4 units
Mobile Crane	2 units	Portable Generator	2 units
Boomer	1 unit	Water Pump (Dewatering)	6-8 units
Concrete Mixer Truck	2–3 units	Total Station	1–2 units
Water Tanker	1–2 units	GPS Survey Equipment	1 unit
Fuel Tanker	1-2 unit	Turbines (Francis)	2 units
Jeep / Utility Vehicle (for staff/engineer movement)	7-8 units	Generator	2–3 units
Drilling Rig / Jumbo Drill	1–2 units	Control Panel & Switchgear	1 set
Air Compressor	2–3 units	Transformer	1–2 units
Jack Hammer	6–8 units	Cooling System (Air/Water)	1 set

Construction Management Schedule



	Name	Duration	Start	Finish	Predecessors
1	EIA & Approvals	180 days	6/16/25 8:00 AM	2/20/26 5:00 PM	
2	Feasibility Study & DPR	180 days	6/16/25 8:00 AM	2/20/26 5:00 PM	
3	Land Acquisition & Resettlem	180 days	6/16/25 8:00 AM	2/20/26 5:00 PM	
4	Procurement & Contracting	180 days	2/23/26 8:00 AM	10/30/26 5:00 PM	3
5	Site Mobilization	120 days	11/2/26 8:00 AM	4/16/27 5:00 PM	3;4
6	Weir Construction	300 days	4/19/27 8:00 AM	6/9/28 5:00 PM	5
7	Gravel Trap	180 days	4/19/27 8:00 AM	12/24/27 5:00 PM	5
8	Intake Structure	240 days	6/12/28 8:00 AM	5/11/29 5:00 PM	6
9	Approach Canal	180 days	12/27/27 8:00 AM	9/1/28 5:00 PM	7
10	Settling Basin	240 days	4/19/27 8:00 AM	3/17/28 5:00 PM	5
11	Headpond	180 days	3/20/28 8:00 AM	11/24/28 5:00 PM	10
12	Tunnel Excavation	420 days	4/19/27 8:00 AM	11/24/28 5:00 PM	5
13	Tunnel Lining	300 days	11/27/28 8:00 AM	1/18/30 5:00 PM	12
14	Penstock Installation	300 days	1/21/30 8:00 AM	3/14/31 5:00 PM	13
15	Anchor Blocks	180 days	3/17/31 8:00 AM	11/21/31 5:00 PM	14
16	Powerhouse Civil Works	420 days	4/19/27 8:00 AM	11/24/28 5:00 PM	5
17	Electromechanical Installatio	240 days	11/27/28 8:00 AM	10/26/29 5:00 PM	16
18	Testing & Commissioning	120 days	10/29/29 8:00 AM	4/12/30 5:00 PM	17
19	Operation Begins	5 days	11/24/31 8:00 AM	11/28/31 5:00 PM	15;18



Conclusion

- The hydropower potential of Seti Khola Hydropower project, for a design discharge (Q_{40}) of 43.136 m^3/s and net head of 63.9 m was found to be 23.54 MW.
- Hydraulic design of components of hydropower have been carried out following the DOED standards/guidelines and IS codes where needed.
- Structural analysis of powerhouse roof truss and superstructure was done.
- The total cost of the project was estimated to be NRs. 5280.16 Million with a Benefit Cost (B/C) of 1.96 which is more than 1; so the project was found to be economically feasible.
- The payback period of the project was found to be 8 years with an Internal Rate of Return (IRR) of 13% for 30 years project life.

Recommendation

- For the purpose of detailed design of components, an extensive field assessment, including direct hydrological measurements, topographical survey, and geological survey along with socio economic and environmental impact assessment should be carried out.
- To further optimize the project, hydraulic models of the project components should be created and tested in order to make informed decisions and changes in designs.

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Thank You!