Economical Design of Elevated Solar Evaporation Pan (ESEP)

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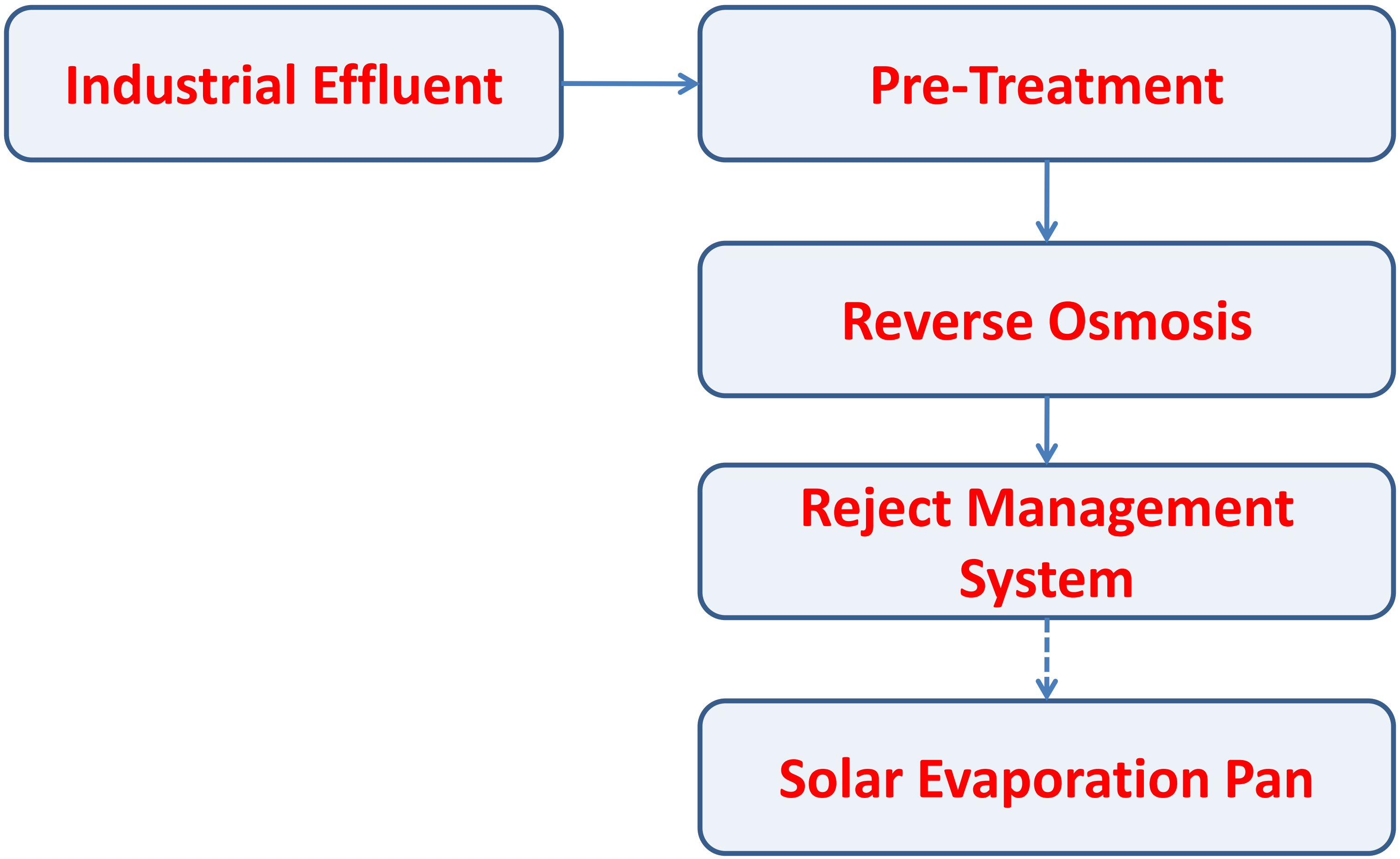
Role of Solar Evaporation Pan (SEP)

Typical Process Route in Zero Liquid Discharge System



Role of Solar Evaporation Pan (SEP)

- **SEP is an essential component in ZLDS.**

- **Though SEP can be avoided using ATFD / Jacket Reactor / Pan Reactor, still State Pollution Control Boards insist for a minimum capacity of SEP.**

Evolution of SEP

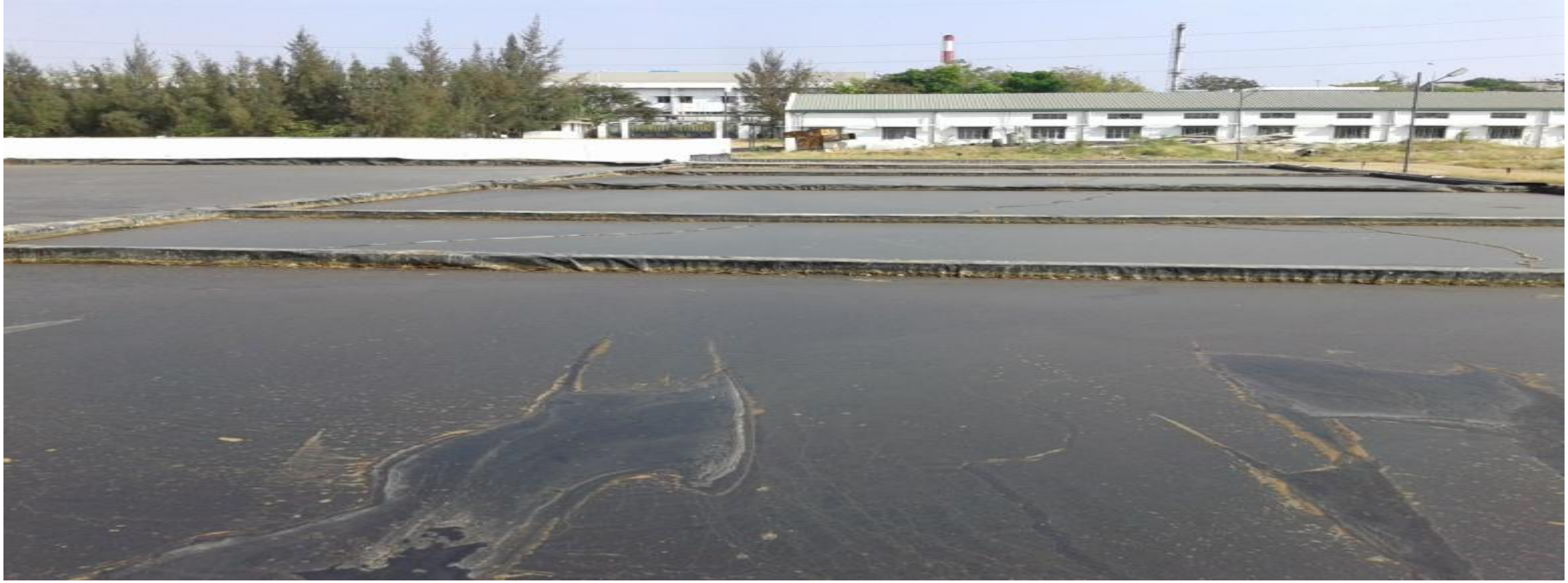
Stage I

Due to cracks in the bed, there is possibility for effluent seeping into the ground.

Evolution of SEP

Stage II

Usage of HDPE Sheet



During practical usage like scrapping of solid waste from SEP, HDPE sheets gets torn. The possibility of effluent leaking through cracks into ground still remains.

Evolution of SEP

Stage III

Elevated Solar Evaporation Pan

Evolution of SEP

Stage III

Elevated Solar Evaporation Pan

Elevated Solar Evaporation Pan

Advantage:

- **Any leakage in SEP due to cracks are easily identifiable.**
- **Easy to arrest leakages compared to ground level SEP.**

Disadvantage:

- **Higher civil construction cost compared to traditional SEP.**
- **No direct Return-on-Investment (RoI).**

Economical Design of ESEP

- Since this is a universal problem for all industries, IWMA conceived a project to solve this issue.

- In collaboration with IIT-Madras, decided to design a very economical solution for constructing ESEP.

- At the same time, confirming to civil standards.

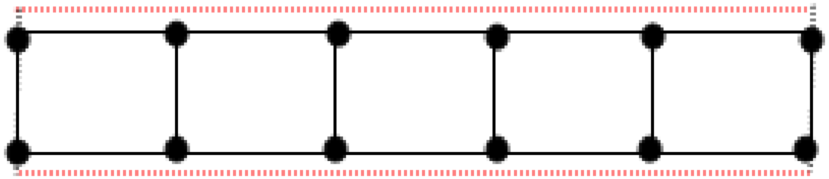
Special thanks to: **Prof. Devdas Menon,**
Dept. of Civil Engineering,
IIT-Madras.

ESEP – Design Criteria

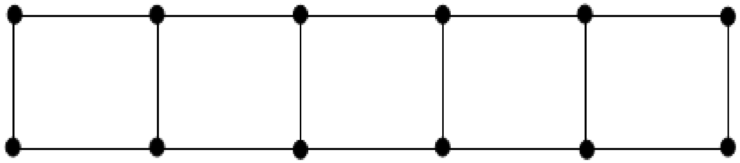
Sl. No.	Parameter	Value
1.	Seismic Zone of ESEP	Zone III
2.	Maximum Wind Velocity	150 mph
3.	Grade of Concrete	M40
4.	Grade of Steel	Fe500
5.	Maximum Effluent Storage Depth	5 mm

Note: Design depth for effluent storage = 15 mm

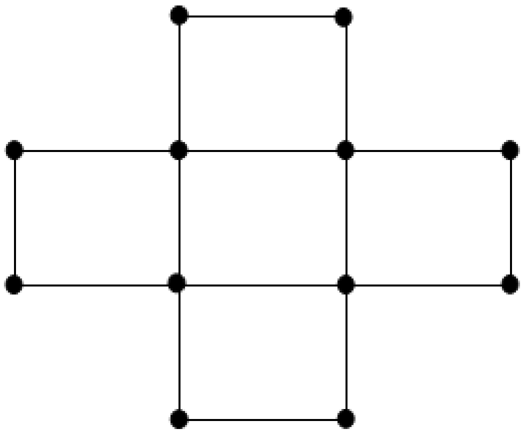
ESEP – Design Configurations



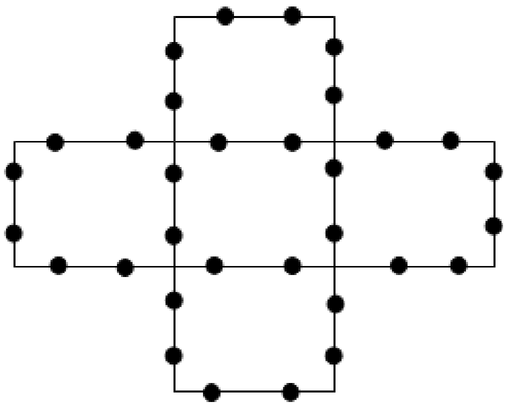
Option 1



Option 2



Option 3

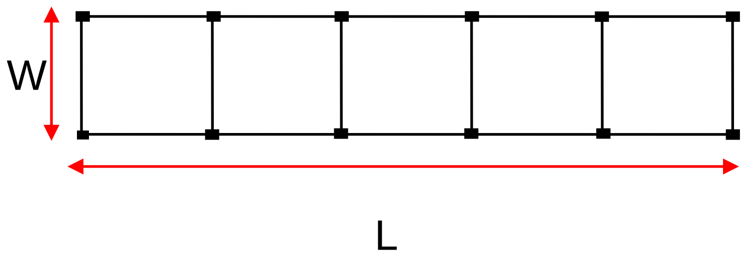


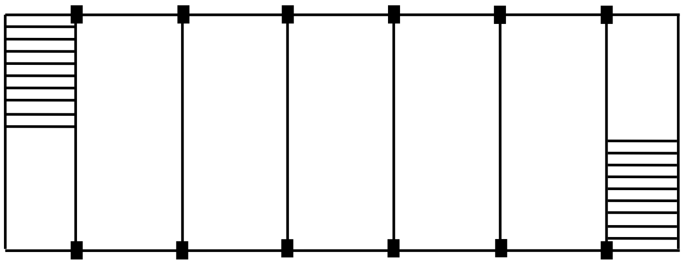
Option 4

Decided to proceed with Option 2

ESEP – Finalized Design Configuration

Plan view of structure





ESEP – Design Options

Sl.No.	Parameter	Range	No. of Options
1.	Height (m)	1.2m to 2.7m (step of 0.3m)	6
2.	Width (m)	3.0m to 6.0m (step of 1.0m)	4
3.	Length (m)	10m to 40m (step of 5m)	7
4.	Soil Bearing Capacity (KN/m2)	150KN/m2 to 350KN/m2 (step of 50KN/m2)	5

Total Options = 6 * 4 * 7 * 5 = 840 options

ESEP – Design Methodology

1: Structural Analysis in SAP2000

A typical combinations of members sizes (for beam and column is proposed). Structural modeling for each combination of the above three variables is done.

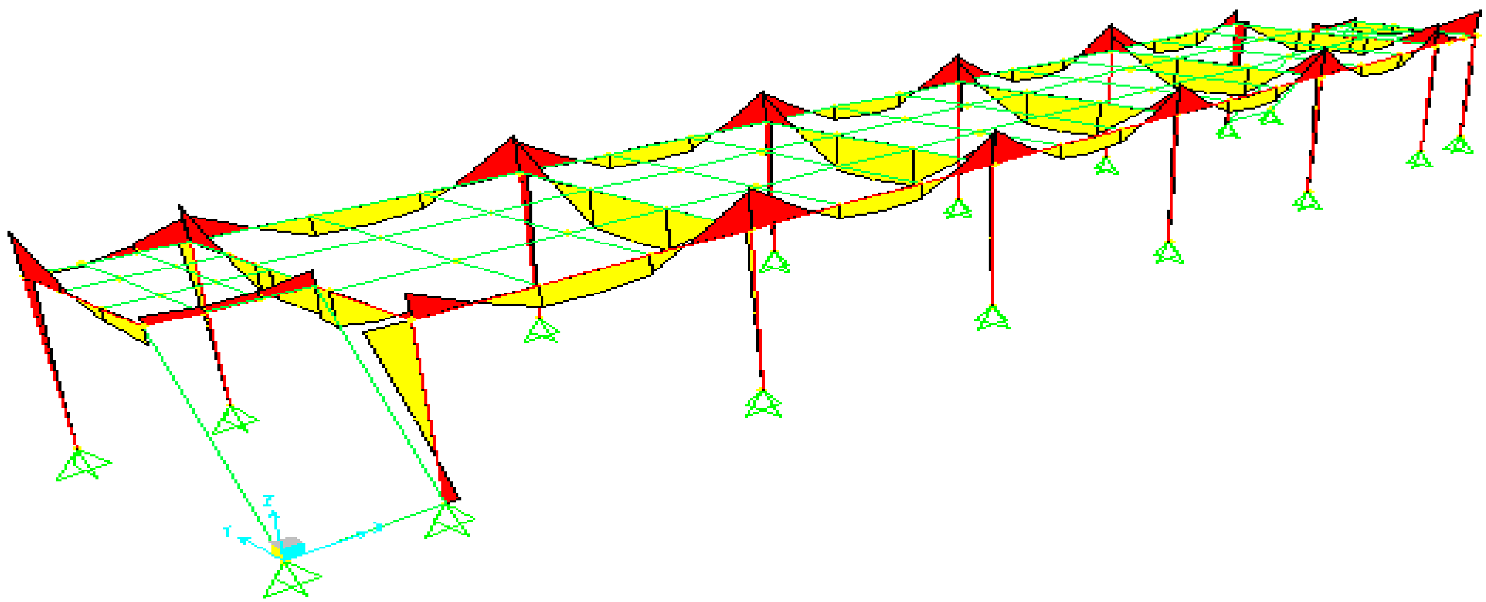
Critical stress resultants in the structural elements is taken as output from the SAP analysis.

2: Structural Design based on MATLAB R2012b Programming

A program is written in MATLAB which takes critical stress resultants and carries out structural design, varying member sizes of 49 combinations.

The output of the program is the set of optimum design parameters namely breadth (b), depth (d) and area of reinforcement (A) to be used in the structural elements design.

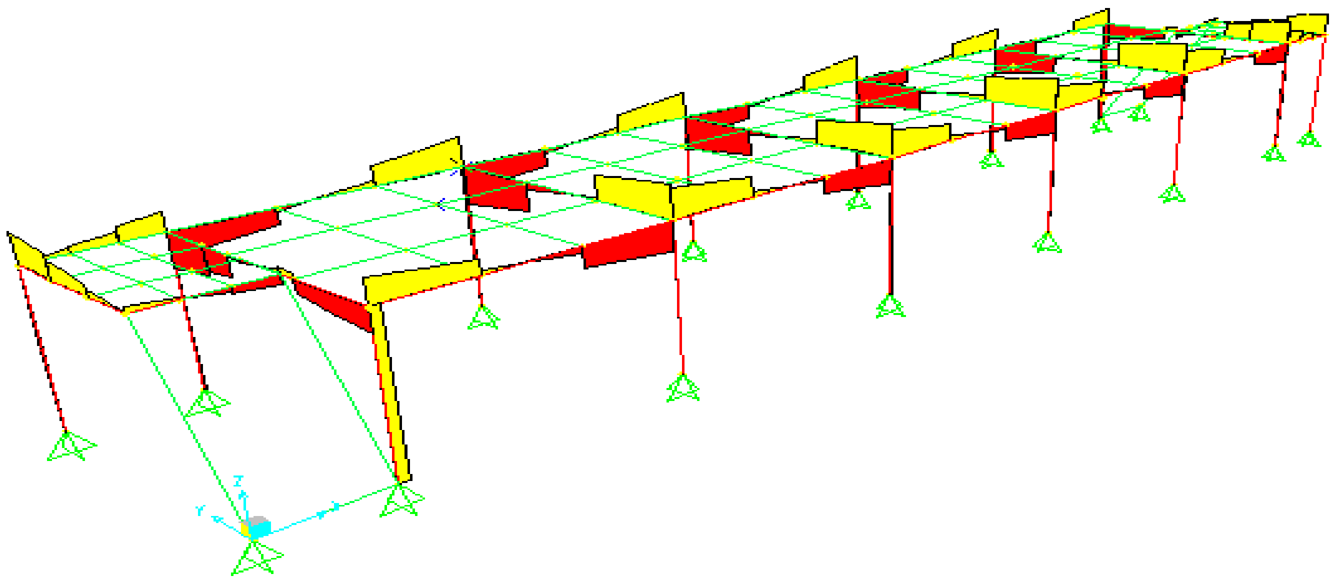
ESEP – Design Analysis in SAP 2000



Bending moment distribution – gravity loading

The analysis shown here is : H= 1.2, W= 3, L=10

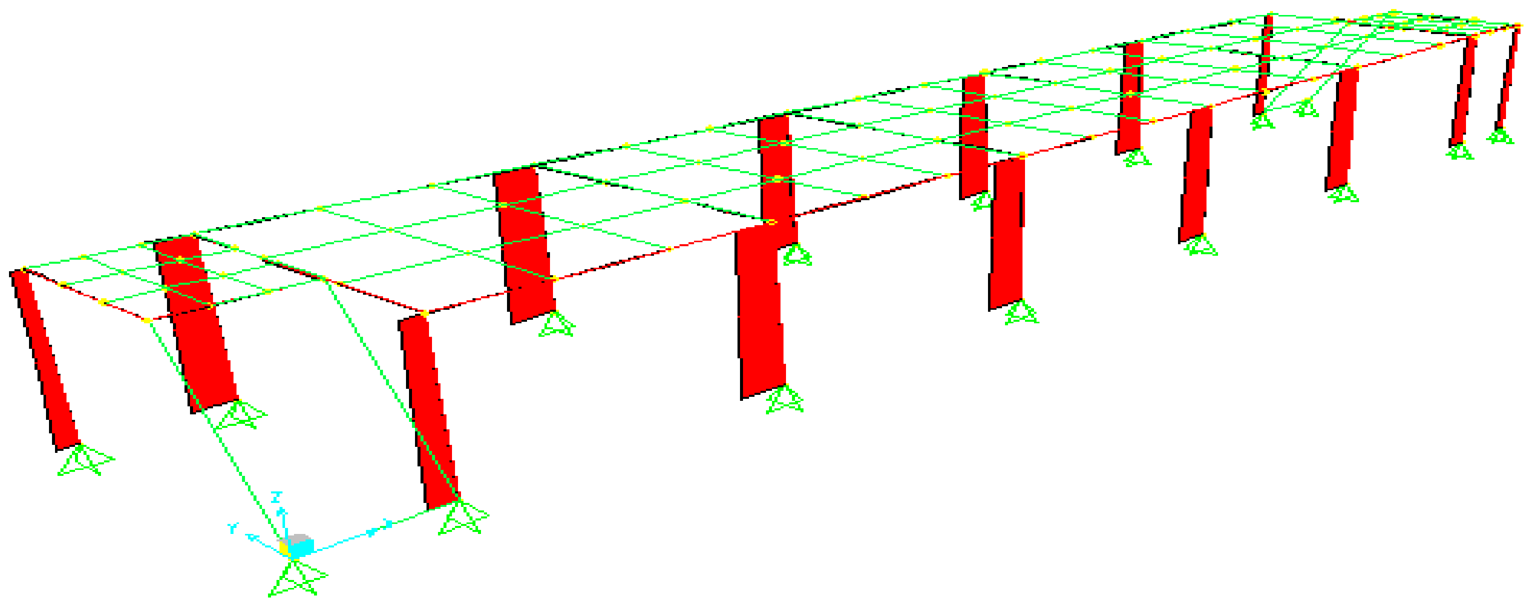
ESEP – Design Analysis in SAP 2000



Shear force distribution – gravity loading

The analysis shown here is : H= 1.2, W= 3, L=10

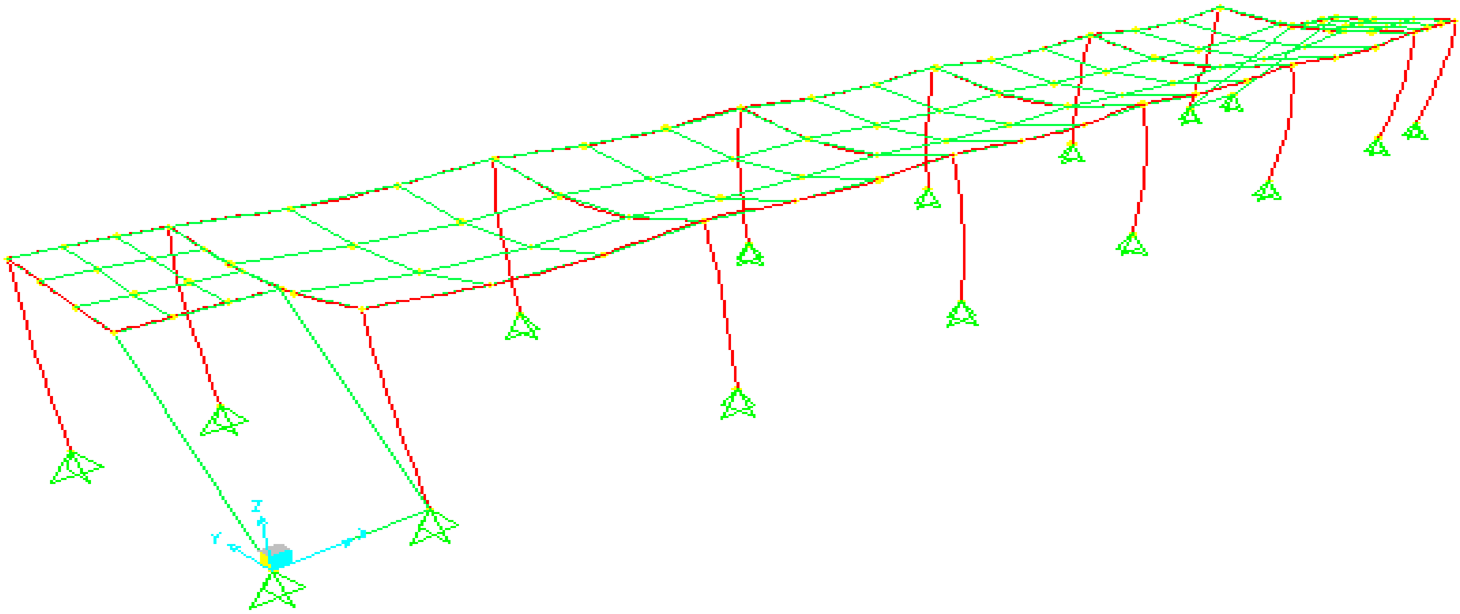
ESEP – Design Analysis in SAP 2000



Axial force distribution – gravity loading

The analysis shown here is : H= 1.2, W= 3, L=10

ESEP – Design Analysis in SAP 2000



Deflected shape – gravity loading

The analysis shown here is : H= 1.2, W= 3, L=10

ESEP – Design Output

Sl.No.	Parameter	Unit	Value
1.	Effluent Storage Area	Square Meter	
2.	Drying Capacity of ESEP	Litres per Day	

ESEP – Civil Design

Element	Size (mm)	Steel (kgs)	Concrete (m3)	Form Work (m2)
Column				
Footing				
Slab				
Beam 1				
Beam 2				

Soil Excavation Volume	m3
PCC Area	m2
PCC Thickness	100 mm
Plastering (Outer)	m2
Plastering (Inner)	m2
Water Proofing Area	m2

ESEP – Cost Calculation

1. Steel Cost (per kg)
2. Concrete Cost (per m3)
3. Form Work Cost (per m2)
4. Plastering Outer (per m2)
5. Plastering Inner (per m2)
6. Soil Excavation Cost (per m3)
7. PCC Cost (per m2)
8. Water Proofing (per m2)

Total cost for the ESEP construction will be provided. Also, cost per square meter of effluent holding area.

ESEP – Web Based Application

Above details and calculations are available in the IWMA website: www.iwma.in

1. **Users choose the design options**
   (Height, Width, Length, Soil Bearing Capacity)
2. **Users choose the cost of civil components**

Users are provided with all civil designs and total cost.

Note: Only members can access this section.

Thank You !

Any Questions ...

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ESEP – IWMA_ESEP_D001

Design Parameter

Height	**:**	**1.2 m**
Width	**:**	**3.0 m**
Length	**:**	**10.0 m**
Soil Bearing Capacity	**:**	**150 KN/m2**

ESEP – IWMA_ESEP_D001

Costing Estimate

1.	Steel Cost (per kg)	: Rs.56/-
2.	Concrete Cost (per m3)	: Rs.6,000/-
3.	Form Work Cost (per m2)	: Rs.450/-
4.	Plastering Outer (per m2)	: Rs.310/-
5.	Plastering Inner (per m2)	: Rs.310/-
6.	Soil Excavation Cost (per m3)	: Rs.350/-
7.	PCC Cost (per m2)	: Rs.350/-

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