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Finite Element Analysis of Hyper Paraboloid Shell Retaining Wall

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Abstract: ***Shells are curved shaped structures and because of its topology it possesses greater stiffness and strength than corresponding plane surface structures. This enables shells to have minimum of material to maximum structural advantages. This is an advantage having heavy soil loads to be retained. In the present study research is done on the behavior of Hyper paraboloid shell shaped retaining wall subjected to earth pressures***.

Keywords: Retaining wall, shell, hyper paraboloid shell, finite element analysis

1. Introduction

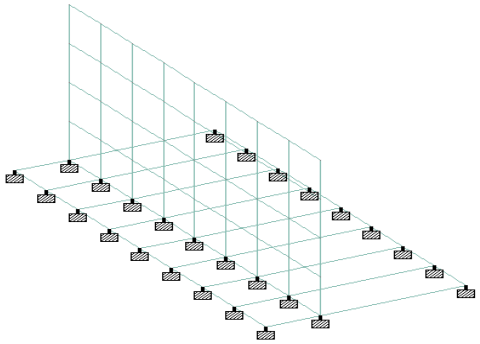
Retaining walls or retaining structure is used to retain earth (or any other material) in a position where the ground level changes abruptly. Whenever embankments are involved in construction, retaining walls are usually necessary. In the construction of building having basements, retaining walls are mandatory. The lateral force due to earth pressure is the main force that acts on the retaining wall which has the tendency to bend, slide and overturn it.

We can use as retaining wall in terms of shells because of their curved topology, possess larger stiffness and strength than compared to corresponding plane surface structural elements. This kind of form enables shells to put a minimum of material to maximum structural advantages. It is well known that the efficiency of the arch form is basically in resisting the transverse load with a thrust, which minimizes the shear force and bending moment.

2. Modal Formation

Modal are generated with the help of Staad Pro software which is good for Finite element analysis.

First of testing modal in staad pro is generated and which is validated by Textbook solution of advanced RCC design by B. C. Punamiaexample 18.1 page no. 485
Modal of flat stem is generated of dimension:
Height=5m
Width=12m
Thickness=0.3m

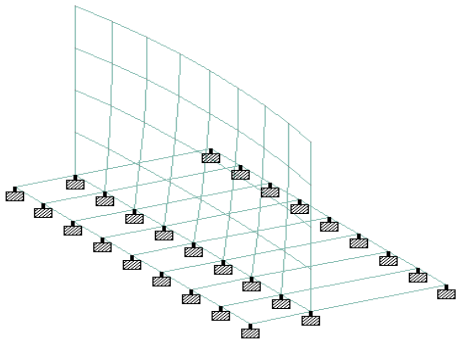


Which is compared by the Hyper paraboloid shell stem of dimension:
Height=5m
Width=12m
Thickness=0.3m
Rise=0.5m

Equation of Hyper parabolid is use for the rise calculation

$$z = \frac{z_{Max}}{a\ b}(x\ )(y\ )$$

In above equation x and y are the height and width coordinates and z is the rise coordinate. But in staad pro z is taken as y and vice versa.



3. Research Methodology

A Hyper parabolid shell of concrete with specific properties and support condition and kept above medium sand is analyzed for a particular loading and force deformation relationships are prepare to show the behavior

3.1 Analysis

Shell Properties

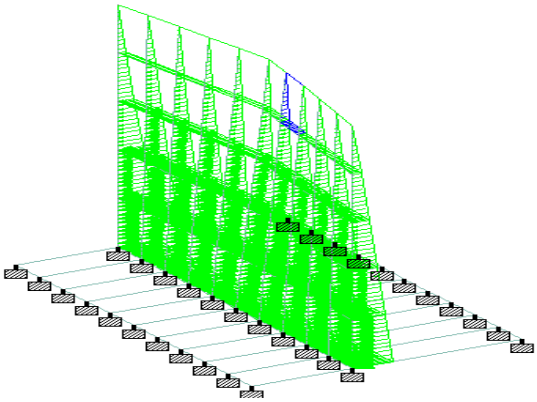
Property	
Material	Concrete
Compressive strength(fcu)	27.58 N/mm2
Elastic Modulus	21718 N/mm2
Density	2402.615 Kg/m3
Poission's ratio	0.170
Alpha/degree c	10E-6
Damping	0.05
Isotropic concrete	

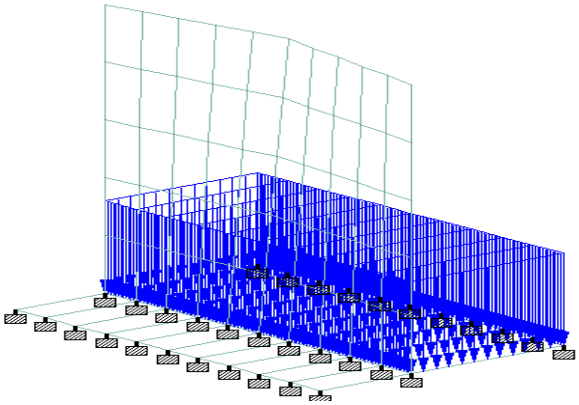
Soil Properties

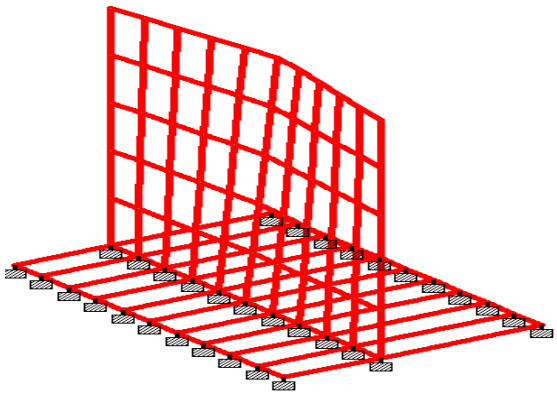
Property	
Material	Soil
Type	Medium Sand
Density	2000.0 Kg/m3
Angle of Internal Friction	30^0

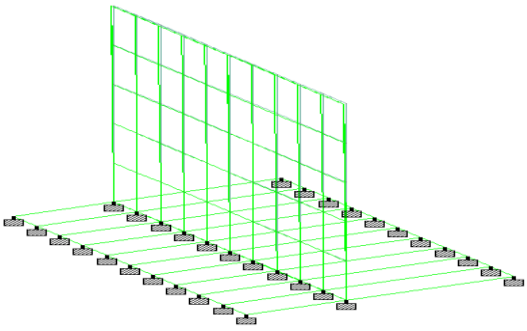
Three types of loads are assigned on the model as shown below:

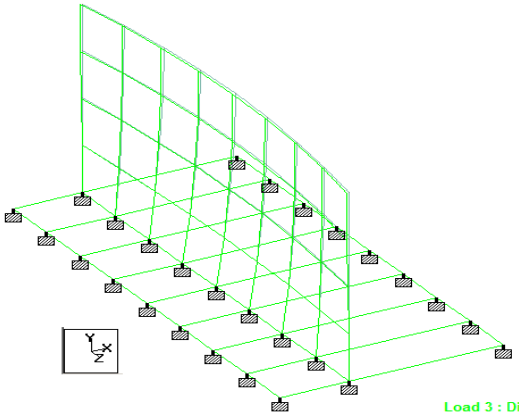
1) Self-weight with F.O.S. 1.5 acting in direction of gravity
2) Soil Pressure on Heel slab
3) Soil triangular hydrostatic Pressure on Stem







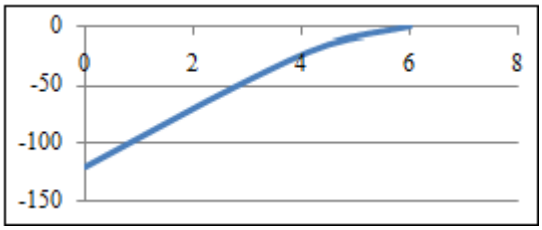




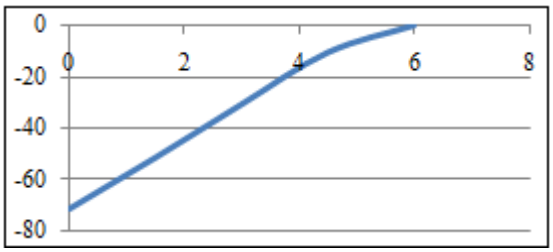
3.2 Figures and Tables

Static linear analysis is carried out for determination of stress conditions. The post processing data for Hyper paraboloid shell retaining wall 6x12 m in plan and rise of 0.5m and thickness 200mm

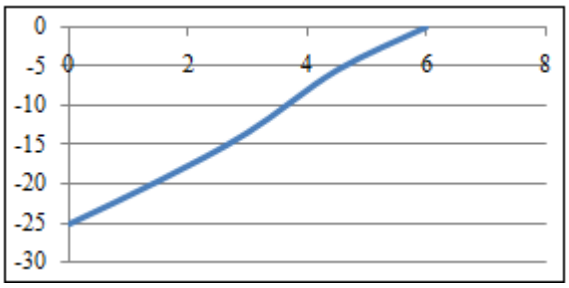
Displacement in 200mm thickness stem along the centre
Flat Stem 6x12 200 mm thickness



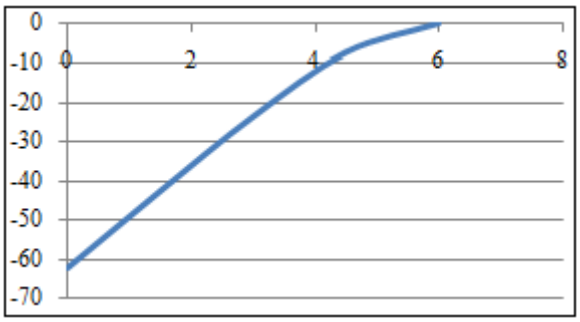
Hyper paraboloid Stem 6x12 200 mm thickness and rise 0.5



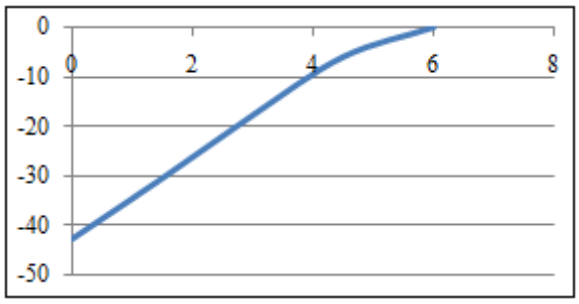
Hyper paraboloid Stem 6x12 200 mm thickness and rise 1.5



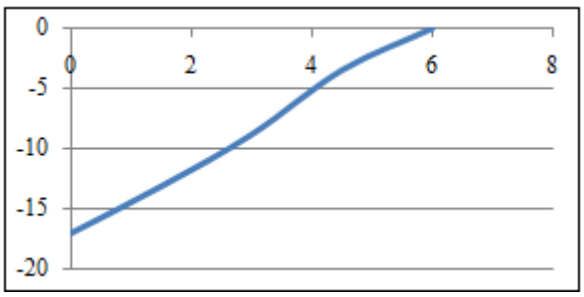
Displacement in 250mm thickness stem along the centre
Flat Stem 6x12 250 mm thickness



Hyper paraboloid Stem 6x12 250 mm thickness and rise 0.5

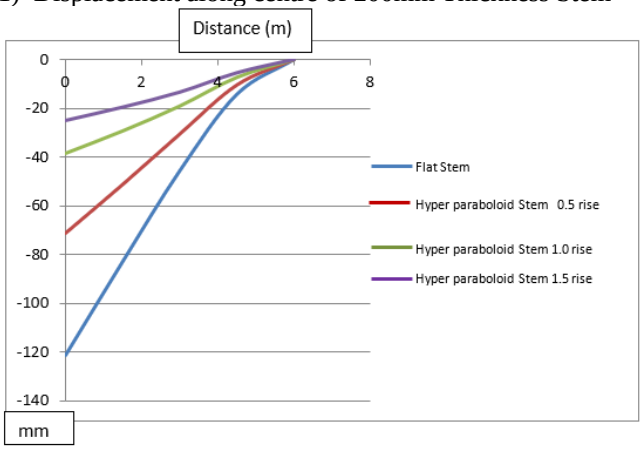


Hyper paraboloid Stem 6x12 250 mm thickness and rise 1.5

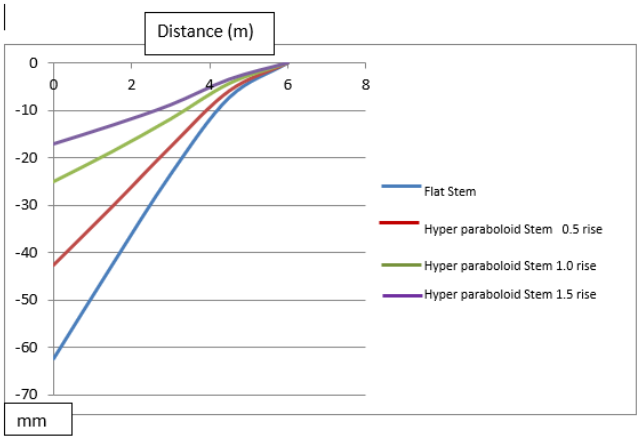


Displacement along centre combined graph for different stem thickness

1) Displacement along centre of 200mm Thickness Stem

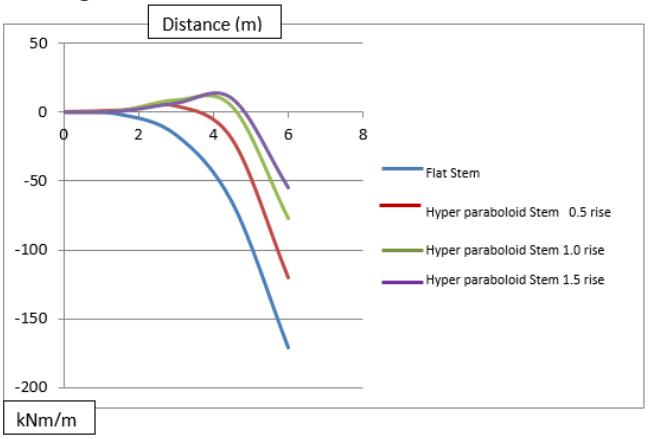


2. Displacement along centre of 250mm Thickness Stem

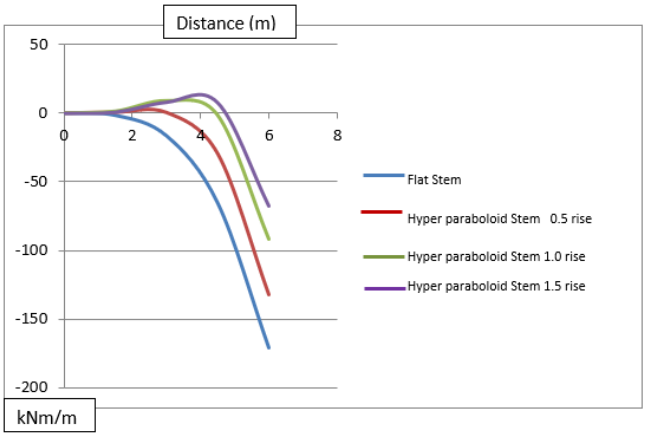


Bending moment-combined graph for different stem thickness

1) Bending Moment in 200mm Thickness Stem



2) Bending Moment in 250mm Thickness Stem



If you are using *Word*, use either the Microsoft Equation Editor or the *MathType* add-on (http://www.mathtype.com) for equations in your paper (Insert | Object | Create New | Microsoft Equation *or*MathType Equation). "Float over text" should not be selected.

Number equations consecutively with equation numbers in parentheses flush with the right margin, as in (1). First use the equation editor to create the equation. Then select the "Equation" markup style. Press the tab key and write the equation number in parentheses.

$$E = \sum_{p=1}^{P} \sum_{k=1}^{K} (\delta_{pk}^{o})^2 \quad (1)$$

4. Conclusion

Hyper paraboloid Shell shaped Retaining Wall have been found to be economical in areas having high material to labor cost ratio. Hyper paraboloid Shell shaped Retaining Wall has greater load carrying capacity compared with Flat Stem Retaining Wall. Moreover, shells are essentially thin structures, thus structurally more efficient that flat structures. This is an advantage in situations admitting heavy super structural loads to be transmitted to weaker soils

The study on Hyper paraboloid shell in comparison to Flat Stem depicts the following major conclusions:-

a) Decreases the horizontal displacement by about (79.25 %) along the center from top to bottom and by about (67.16%) along the corner from top to bottom of Stem.
b) Decreases Bending Moment by about (68.16 %).
c) Decreases Shear Stress by about (17.6 %).

The parametric study on Hyper paraboloid shell depicts the following major conclusions:-

1) Increasing the shell rise from 0.5 m to 1.5 m.
   a) Decreases the horizontal displacement by about (64.7 %) along the center from top to bottom and by about (53 %) along the corner from top to bottom of Stem.
   b) Decreases the bending moments by about (54.5%).
   c) Increases the shear forces by about at (21.7%).
2) Increasing shell thickness from 0.2 m to 0.3 m for rise 0.5m
   a) Decreases the horizontal displacement by about (61.94 %) along the center from top to bottom and by about (64.96%) along the corner from top to bottom of Stem.
   b) Decreases the bending moments by about (54.5%).
   c) Increases the shear forces by about at (21.7%).

5. Future Scope

The following topics of investigation are recommended for future study:

1) To find out behaviour of Hyper paraboloid Retaining Wall under action of lateral loads like seismic force, wind load etc.
2) To conduct experimental field–testing on different
3) Hyper paraboloid Retaining Wall models under variable loading conditions. To further validate the shell models presented in the paper.
4) To develop various parameters like factor of safety for sliding, overturning and bearing capacity of Hyper paraboloid shell Retaining wall used in retaining walls. Study of the three of lateral earth pressures including at rest, active and passive pressures applied to a shell supported retaining wall.
5) To study the behaviour of group action of shell footings as a composite pile group and compare their efficiency as an individual Retaining Wall of same number.
6) To investigate the performance of Hyper paraboloid shell retaining wall on fiber reinforced soil and there efficiency when the placement of fiber reinforcement mat varies in depth.

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