Effect of Traffic Load & Unit Weight of Backfill in Satiability of Cantilever Type Retaining Wall

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Abstract— To maintain the two different ground level retaining wall are constructed. Retaining wall is basically design for lateral force acting on it due to pressure force exerted by backfill retained by the wall and pressure force due to traffic. In the study of effect of traffic load and unit weight of backfill in stability of retaining wall design philosophy is based on Indian standard code IS 456. Traffic load and unit weight of backfill taken as variable to know the effect in stability.

Key words: Traffic Load, Unit Weight, Backfill

I. INTRODUCTION

As we know that design of retaining wall is trial and error process, very laborious and time taking process. So for the analysis purpose we have developed a design tool and tool coded in Visual basic application. Design tool results were compared with manual calculation and found correct. In this paper to know the effect of traffic load and unit weight of backfill in the stability analysis following input parameter taken:

1) Height of retaining wall above the ground.
2) Unit weight of backfill.
3) Traffic load.
4) Angle of internal friction.
5) Safe bearing capacity of soil.
6) Coefficient of friction between soil and concrete.

Only traffic load and Unit weight of backfill consider as a variables. While changed one variable rest of the input parameter were remain constant.\

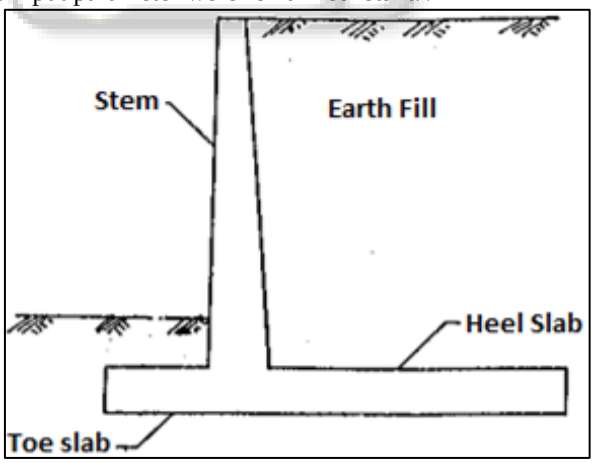

Fig. 1: Showing the Cantilever Type Retaining Wall

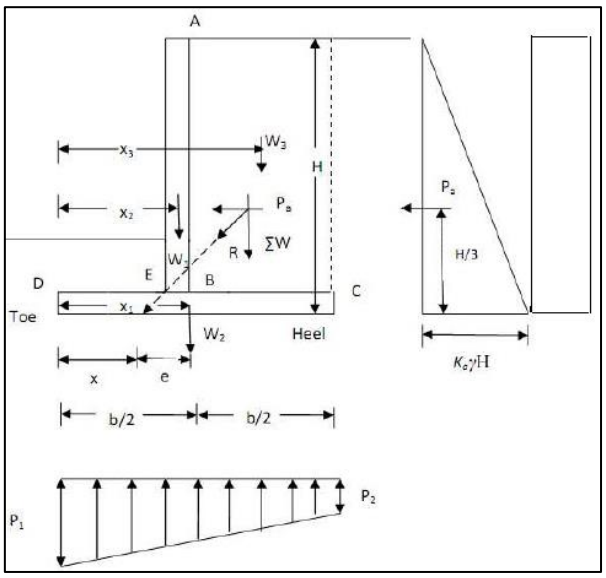

Fig. 2: Showing the Forces Acting on Wall.

A. Loads on Retaining Wall

Cantilever retaining wall subjected to the following forces

1) Vertical forces

1) Weight of the stem AB. (W1)
2) Weight of the base slab DC (W2)
3) Weight of the retained material above the heel slab BC (W3)

2) Horizontal forces

1) Earth pressure force due to retained material (Pa)
2) Pressure force due to traffic or surcharge load (P)

B. Stability of Retaining Wall

Following conditions must be satisfied for stability of cantilever type retaining wall

1) It should not overturn.
2) It should not slide.
3) It should not subside, i.e Max. Pressure at the toe should notexceed the safe bearing capacity of the soil under working condition.

C. Check for Overturning

Resistance against overturning of retaining wall created by the self-weight of the structure i.e. Weight of the stem (W1), Weight of the base slab (W2) and Weight of the retained material above the heel slab (W3) all these vertical force create a resisting moment about toe.

$$MR = W1x1 + W2x2 + W3x3$$

X1,x2 and x3 as shown in fig 2.

Overturning moment created by the horizontal forces i.e. Earth pressure due to retained material (Pa) and Pressure force due to traffic or surcharge load (P) about toe. Overturning moment, due to active earth pressure, at toe is calculated by-

$$Mo = Ka\ \gamma e\ H3\ /6 + Ka\ H2\ /2$$

D. Check for Sliding

The horizontal force Earth pressure force due to retained material (Pa) and Pressure force due to traffic or surcharge load tends to slide the wall away from the fill. Resistance against sliding achieved by the friction at the base. Magnitude of the resistance force against sliding calculated by-

$$F = \mu \Sigma W$$

μ is the coefficient of friction between soil and concrete ΣW sum of all the vertical forces acting as show in Fig 2.

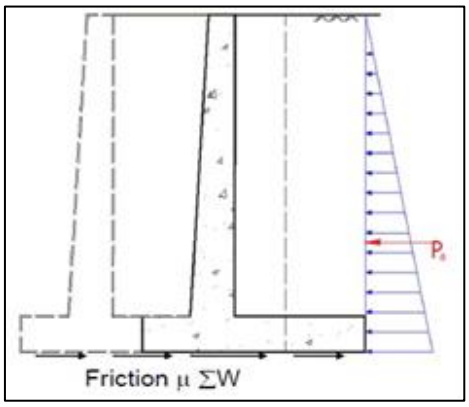

Fig. 3: Showing Sliding Of Retaining Wall.

E. Soil Pressure Distribution below the Base of Retaining Wall

As shown in Fig 2 various forces acting on the wall and soil pressure distribution below the base of the foundation. Resultant of the all the vertical forces and horizontal forces act at an eccentricity (e) from the midpoint of the base.

$$\text{Eccentricity } e = b/2 - x$$

x is the distance of resultant from the toe. Eccentricity should be less than one sixth of the base.

Magnitude of the soil pressure below the base at the toe is calculated by –

$$p_1 = \frac{\sum W}{b}\left(1 + \frac{6e}{b}\right)$$

Magnitude of the soil pressure (P1) below the base at the toe should not more than the safe bearing capacity of the soil.

Magnitude of the soil pressure below the base at the heal is calculated by –

$$p_2 = \frac{\sum W}{b}\left(1 - \frac{6e}{b}\right)$$

Magnitude of the soil pressure below the base at the heal always more than zero.

II. CODAL PROVISION

A. Codal Provision for Overturning of Retaining Wall

Factor of safety against overturning of cantilever type retaining wall is the ratio of resisting moment to the overturning moment.

As per IS code 456-2000 clause 20.1

$$\text{F.O.S.} = M_R / M_O > 1.55$$

B. Codal Provision for Sliding of Retaining Wall

Factor of safety against sliding of cantilever type retaining wall is the ratio of resisting force to the total horizontal force.

As per IS code 456-2000 clause 20.2

$$\text{F.O.S.} = \mu \Sigma W / (Pa + P) > 1.55$$

III. INPUT PARAMETER

In this chapter we will make different case of input parameter and in each case only one variable input parameter change rest of the parameter remain same. Stability of cantilever type retaining wall under the different cases find out based on their factor of safety against the overturning, sliding and tension at the base of retaining wall.

By increasing the surcharge load.

Input-1
Height of retaining wall above the ground - 4.0 m
Unit weight of backfill -18 KN/ M2
Angle of internal friction -30o
Traffic load or surcharge load - 18 KN/M2
Safe bearing capacity of soil- 175 KN/M2
Coefficient of friction between- 0.30 soil and concrete
Grade of concrete - M 25
Grade of concrete - Fe 415

Input-2
Height of retaining wall above the ground - 4.0 m
Unit weight of backfill - 18 KN/ M2
Angle of internal friction -30o
Traffic load or surcharge load - 19 KN/M2
Safe bearing capacity of soil - 175 KN/M2
Coefficient of friction between- .30
Soil and concrete
Grade of concrete - M 25
Grade of concrete - Fe 415

Input-3
Height of retaining wall above the ground - 4.0 m
Unit weight of backfill -18 KN/ M2
Angle of internal friction -30o
Traffic load or surcharge load - 20KN/M2
Safe bearing capacity of soil- 175 KN/M2
Coefficient of friction between- 0.30
Soil and concrete
Grade of concrete - M 25
Grade of concrete - Fe 415

Input-4
Height of retaining wall above the ground - 4.0 m
Unit weight of backfill - 22 KN/ M2
Angle of internal friction -30o
Traffic load or surcharge load - 18 KN/M2
Safe bearing capacity of soil- 175 KN/M2
Coefficient of friction between- 0.30
Soil and concrete
Grade of concrete - M 25
Grade of concrete - Fe 415

Input-5
Height of retaining wall above the ground - 4.0 m
Unit weight of backfill -18 KN/ M2
Angle of internal friction -30o
Traffic load or surcharge load - 24 KN/M2
Safe bearing capacity of soil- 175 KN/M2
Coefficient of friction between- 0.30
Soil and concrete
Grade of concrete - M 25
Grade of concrete - Fe 415

By increasing unit weight of backfill.
Input-1
Height of retaining wall above the ground - 4.0 m
Unit weight of backfill -18 KN/ M2
Angle of internal friction -30o
Traffic load or surcharge load - 18 KN/M2
Safe bearing capacity of soil- 175 KN/M2
Coefficient of friction between-0.30
Soil and concrete
Grade of concrete - M 25
Grade of concrete - Fe 415
Input-2
Height of retaining wall above the ground - 4.0 m
Unit weight of backfill -19.50 KN/ M2
Angle of internal friction -30o
Traffic load or surcharge load - 18 KN/M2
Safe bearing capacity of soil- 175 KN/M2
Coefficient of friction between- 0.30
Soil and concrete
Grade of concrete - M 25
Grade of concrete - Fe 415
Input-3
Height of retaining wall above the ground - 4.0 m
Unit weight of backfill -21.0 KN/ M2
Angle of internal friction -30o
Traffic load or surcharge load - 18 KN/M2
Safe bearing capacity of soil- 175 KN/M2
Coefficient of friction between- 0.30
Soil and concrete
Grade of concrete - M 25
Grade of concrete - Fe 415
Input-4
Height of retaining wall above the ground - 4.0 m
Unit weight of backfill-23.5 KN/ M^2
Angle of internal friction -30o
Traffic load or surcharge load - 18 KN/M^2
Safe bearing capacity of soil- 175 KN/M^2
Coefficient of friction between- 0.30
Soil and concrete
Grade of concrete - M 25
Grade of concrete - Fe 415
Input-5
Height of retaining wall above the ground - 4.0 m
Unit weight of backfill -25KN/ M^2
Angle of internal friction -30o
Traffic load or surcharge load - 18 KN/M^2
Safe bearing capacity of soil- 175 KN/M^2
Coefficient of friction between- 0.30
Soil and concrete
Grade of concrete - M 25
Grade of concrete - Fe 415

IV. RESULTS & DISCUSSION

A. For Overturning of Retaining Wall

Here result is Factor of safety, if the numerical value of factor of safety against overturning increase means stability against overturning of retaining wall increase and vice versa.

B. For Sliding of Retaining Wall

Here result is Factor of safety, if the numerical value of factor of safety against sliding increase means stability against sliding of retaining wall increase and vice versa.

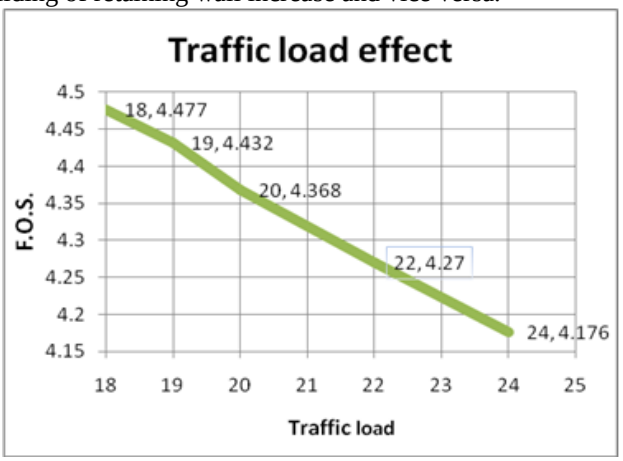

Fig. 4: Effect of Increase in Traffic Load in Overturning

Discussion- From the fig 4 it is clear that as the traffic load intensity increase stability of retaining wall against overturning decrease.

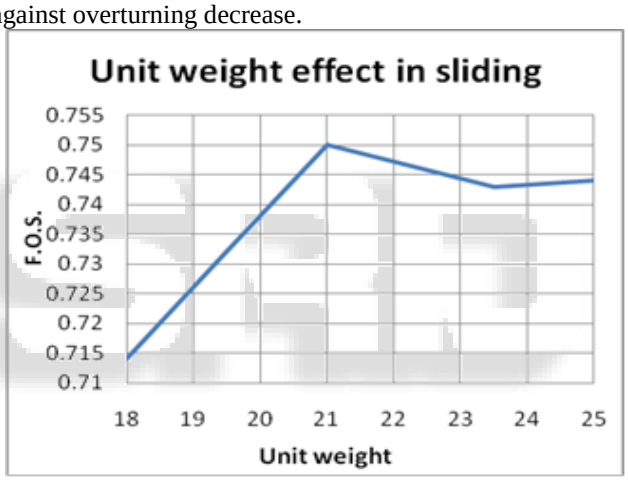

Fig. 5: Effect of Increase in Traffic Load in Sliding.

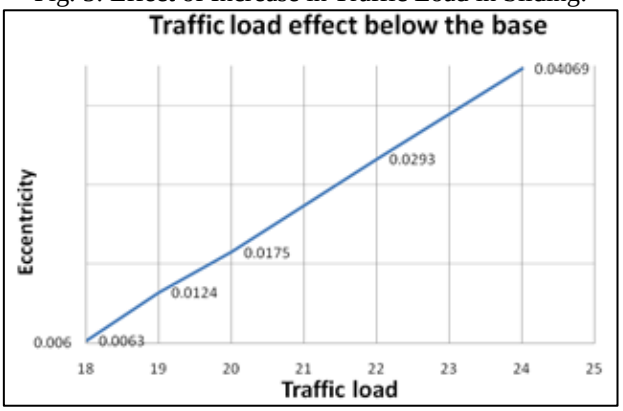

Fig. 6: Effect of Increase in Traffic Load in Eccentricity.

Discussion- From the fig 4 it is clear that as the traffic load intensity increase stability of retaining wall against sliding decrease.

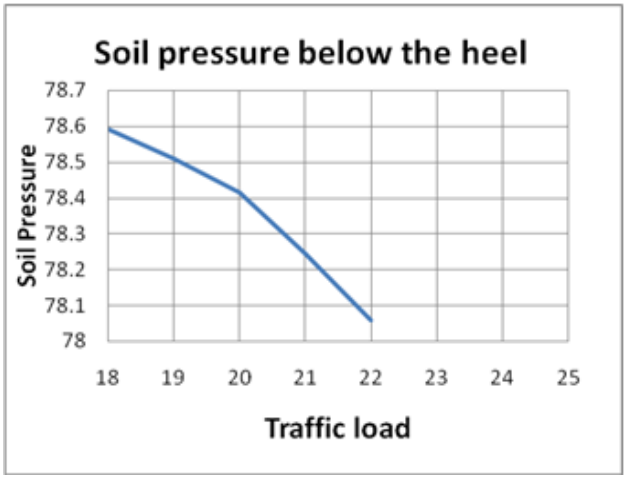

Fig. 7: Effect of Increase in Traffic Load in Below the Toe

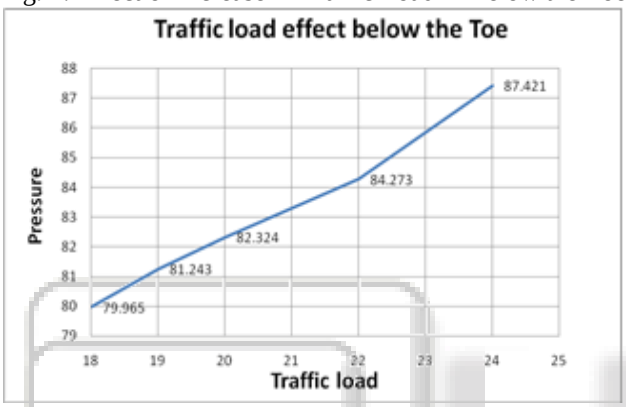

Fig. 8: Effect of Increase in Traffic Load in Below the Heel.

Discussion- Fig 6. Showing the effect of increase traffic load. It is clear that as the intensity increase numeric value of eccentricity increase and soil pressure below the toe increase and below the heel reduces.

By increasing the unit weight of backfill

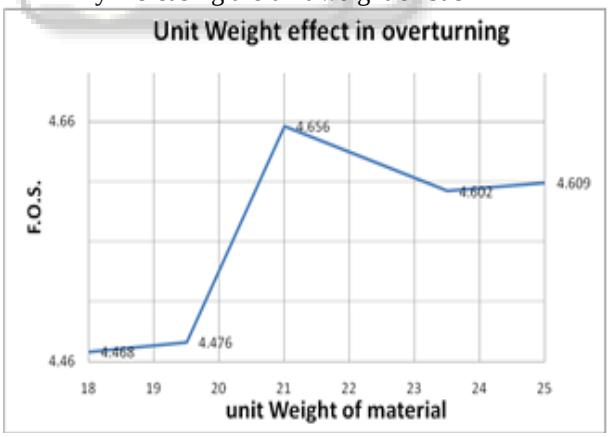

Fig. 9: Effect of Increase in Unit Wt in Overturning

Discussion- From the fig 9 it is clear that as the intensity of unit weight of backfill stability of retaining wall against overturning increase.

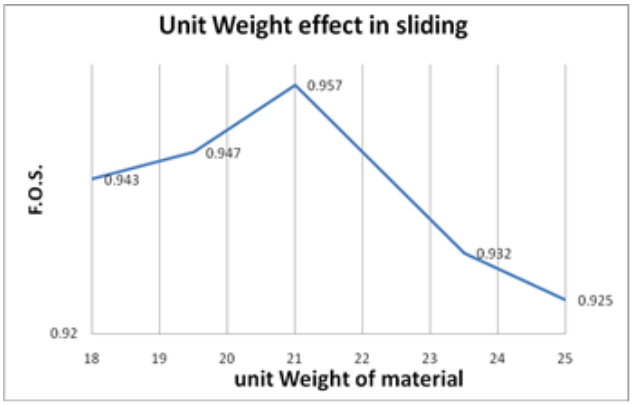

Fig. 10: Effect of Increase in Unit Wt in Sliding

Discussion- From the fig 10 it is clear that as the intensity of unit weight of backfill stability of retaining wall against sliding increase.

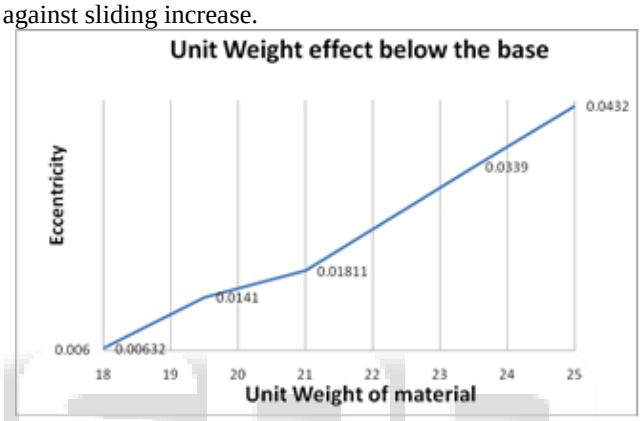

Fig. 11: Effect of Increase in Unit Wt in Eccentricity

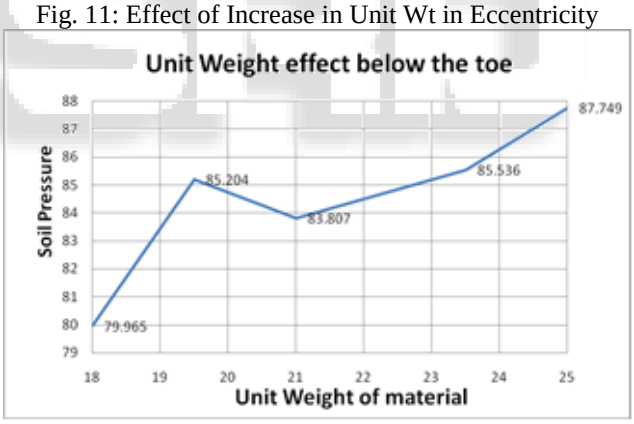

Fig. 12: Effect of Increase in Unit Wt in Below Toe

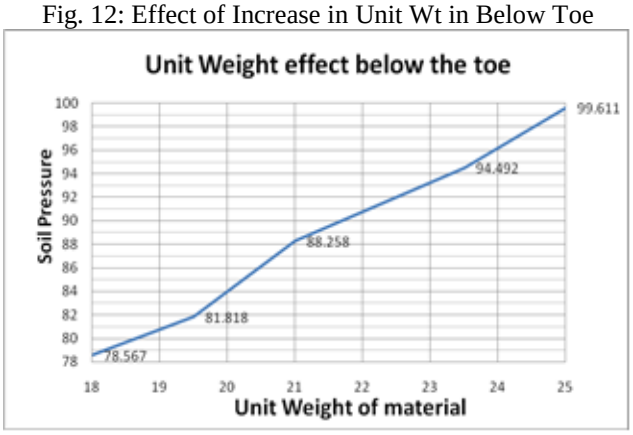

Fig. 13: Effect of Increase in Unit Wt in Eccentricity

Discussion – fig 11 shows that as the intensity of unit weight of backfill increase numeric value of eccentricity

increase. Soil pressure below the toe increase and below the heel decrease.

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