Design And Analysis Of Sliding Segmental Retaining Wall.

[1]Y. L. Bhirud, [2]Madhur Gujrathi, [3]Ankita Chobharkar, [4]Babalu Jagtap, [5]Samiksha Ghogare, [6]Pranali Handge
[1]Associate Professor Dept. of Civil Engineering, SNJB's LSKBJ COE, Chandwad, Maharashtra, India.,
[2,3,4,5,6] Undergraduate students, Dept. of Civil Engineering, SNJB's LSKBJ COE, Chandwad, Maharashtra, India

Abstract - *Present invention provides specially design and development of a sliding segmental retaining wall. This retaining wall is designed to restrain against lateral earth thrust also in case of cohesive soil, to avoid failure of retaining wall, increasing the load carrying capacity and durability. Segmental retaining wall is new concept which replaces modular block facing units with flexible facing units. This is the first RCC moving structure. For avoiding failure of retaining wall by overturning, sliding mechanism is the new development. The pressure sensor which acts as a transducer, sense the pressure and rings the alarm and also send messages on mobile with the help of the computer application to nearby communities and to disaster management unit. The main object of this study is to save the human life.*

Index Terms:-Retaining wall, design of wall, sliding mechanism, sensors

I. INTRODUCTION

A retaining wall is defined as a structure to provide lateral support for soil or rock. In some cases, the retaining wall may support vertical loads also. It is also described as a structure that prevents retained soil from assuming its natural slope. More clearly, it is constructed to maintain level difference of the soil on either side of it. One of the major reason of failure of retaining wall is overturning. To safe the retaining wall from the overturning and tilting, sliding of the retaining wall from the actual position to some distance with the help of the sliding mechanism is proposed. In this project, sensors are used to detect the maximum pressure of backfill in the retaining wall and to also give the alert to near communities with the help of SMS. Segmental retaining walls (SRWs) forms new generation of reinforced earth retaining walls where flexible facing units are replaced with modular block facing units. The facing units may be of reinforced concrete, precast concrete or brick units. An important criterion in the design of these walls is the connection strength between the facing units and the reinforcement. The overall strength of the structure is thus imparted by the rigidity of the facing units and the friction between soil and reinforcement. Slope failures are major natural hazards that occur in many areas throughout the world. Slopes expose two or more free surfaces because of geometry. Plane, wedge, toppling, rock fall and rotational (circular/non-circular) types of failure are common in slopes .The first four are more predominant in rock slopes and are primarily controlled by the orientation and the spacing of discontinuities planes with respect to the slope face. The types of slope failure are primarily controlled by material properties, water content and foundation strength.

II. LITERATURE REVIEW.

Collin (2001) has analyzed the segmental retaining wall failure with respect to the design and construction to determine the causes of the failure. A hybrid segmental retaining wall system using both steel and geosynthetic reinforcement found to be failed in the year 1998. Three design methods of geosynthetic reinforced segmental retaining walls were compared to one another with respect to their details and idiosyncrasies by Koerner and Soong (2001). This was followed by a numeric example which concludes that the modified Rankine method was the most conservative, the FHWA method was intermediate and the NCMA method was the least conservative.Yoo and Lee (2003)have presented the measured behavior of an anchored segmental retaining wall. To understand the overall mechanical behavior of the anchored segmental retaining wall and to confirm the applicability of the design assumptions, an extensive monitoring program was implemented for a 7 m high anchored segmental retaining wall. The results showed that the maximum lateral wall displacement was comparable to or less than that of a typical geosynthetic - reinforced wall.Yoo and Ung (2004) have presented the observed behaviour of a geosynthetic reinforced segmental retaining wall. A 5.6 m high full scale wall in a tiered configuration was constructed and instrumented, in an attempt to examine the mechanical behaviour and to collect relevant data that will help improve the current design approaches. It was shown that for walls on a less competent foundation, significant post construction wall movements may occur. Ha et al (2006) has used a slider-crank mechanism. For sliding purpose, Hamilton's principle, Lagrange multiplier, geometric constraints and partitioning method were used..DianweiQian and Jianqiang Yi (2013) proposed combined sliding mode control method for overhead crane systems in his research work.The mechanism behind the combining sliding mode was intermediate variable introduced by dividing the system states into two groups and then a sliding surface is defined on basis of the intermediate variable.PoojaGujrathi and Mane S J (2015) have studied landslide zones of nearby areas of Malin village (Pune district, Maharashtra, India) using GIS technique.

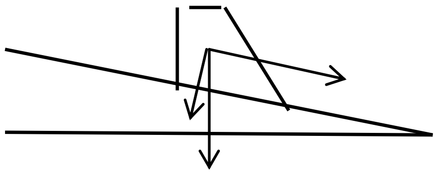
Based on above study, it was noted that, in case of overload, the retaining wall fails due to overturning or collapse and thus purpose of retaining wall is not satisfied. Hence, there was need of alternate solution to solve the problem. Sliding the retaining wall may solve the problems stated above and hence decided to design a retaining wall with sliding mechanism.

III. CONCEPT OF SLIDING SEGMENTAL RETAINING WALL.

In case of land slide, when back feel collides on the retaining wall, the retaining wall resists the load by developing flexural action in cantilever beam format. The sliding of retaining wall is restricted either by friction between base of wall and soil. If this frictional force is not sufficient to avoid sliding, shear key is designed to avoid sliding. This restriction on sliding puts limitation on quantity of back feel stored. If back feel exceed the designed capacity, it overflows above the retaining wall and purpose of retaining wall fails. If retaining wall can slide, it is possible to accommodate this additional back feel.

Wheels are provided at the bottom of retaining wall and rails are provided on the top surface of the foundation over which the wheels can move. These wheels are attached with the help of shaft to bottom of retaining wall. Bearings are used to connect shaft and wheels, which give proper movement of wheels on the rails. This arrangement is proposed provided on inclined surface. This will avoid instant movement of the retaining wall. Separate foundation of trapezoidal shape in cross section is proposed which is having inclined surface. Thickness of foundation increases towards the heel. Rails are provided on top of this foundation over which wall can slide. When retaining wall starts sliding on rising inclining surface, the component of weight of retaining wall parallel to inclined surface will resist the back feel. The angle of inclination of foundation may vary depending upon frictional force and amount of total lateral earth pressure which in turn depends on type of back feel and height of retaining wall.

Parallel component



Weight of wall.

1 Figure Concept of resistance by sliding on inclined plane.

IV. DESIGN OF WALL.

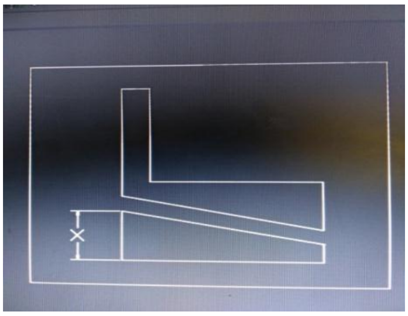
Design of components parts of retaining wall such as stem, heel and footing are performed. Design of stem and heel is a usual design. A typical design with assumed data is given as below:

1. Stem :- Top and bottom thickness = 500mm
   Width of Each Segment = 3500mm
   Length of each segment = 3000mm
2. Heel :- length of Base slab = 3000mm
3. Foundation :- Inclined foundation Provided
   Angle of inclination = 5 degree
4. Total self-weight of Retaining wall =165.82 kN For each segment
5. Total weight on wall (soil+surcharged) = 764.80kN
6. Checks:- For Overturning = Safe
   For sliding = Unsafe.
7. Factor of safety =2 (For impact load).

With increase in angle of footing, the volume of backfill found to be increasing. The range of the angle between 4 to 8 degree is found to be safe for overturning. This can be observed from **Table 1**.

Sr.No.	Angle	X (m)	Volume (m^3)
1	4	0.20	22.88
2	5	0.26	22.98
3	6	0.31	23.09
4	7	0.36	23.18
5	8	0.42	23.28
6	10	0.52	22.89
7	12	0.63	23.69
8	14	0.78	23.89
9	15	0.80	24.00
10	18	0.97	24.31
11	20	1.09	24.55
12	22	1.21	24.76
13	25	1.39	25.11
14	30	1.73	25.74

Relation between angle of inclination and retained volume of backfill is shown in Figure 2 and angle of inclination is shown in Figure 3. Observation of Figure 3 shows effect of increase in angle of foundation and found to be incurring with increase in angle. Though higher angle shows higher retention of volume of backfill, it needs to be check for overturning.



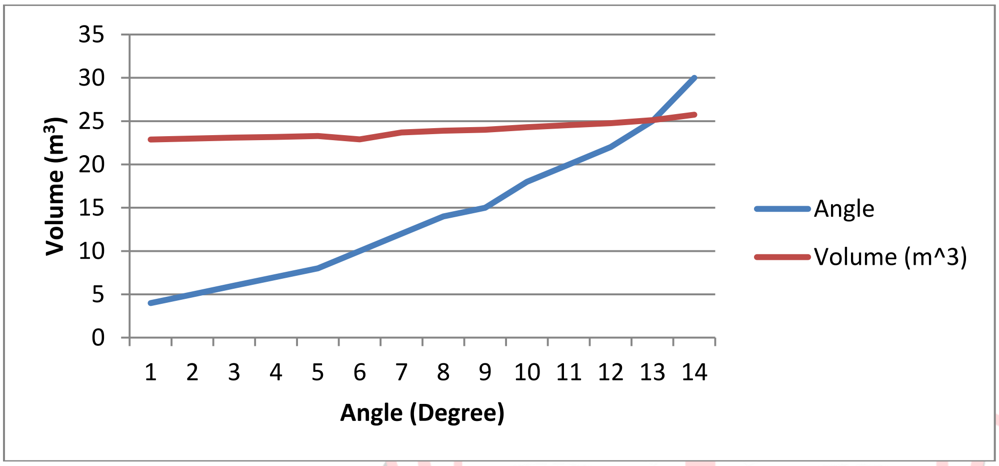


Figure 2 Relation between angle of inclination and retained volume

- Pressure sensor with alarm and massaging System are provided in the retaining wall on the side of backfill, which is used to detect pressure on this wall. If pressure exceeds the limit, this will triggered to blowing of alarm and SMS will be broadcasted to the mobile numbers stored in device. This will make the peoples alert and necessary help can be mobilized quickly to the place. A lock is provided at the end of sliding where wall will stop and failure can occurs because of overturning. After removal of back fill, the wall can regain its original position.

CONCLUSION.

- This project is suitable for only cohesive soil.
- The wall will stable up to 230 KN as per design and after that load, wall start sliding.
- The wall may be fails due to the overturning after reaching the dead end.
- As the inclination angle of foundation increases the volume of soil acquired behind the retaining wall as backfill also increases.
- The range of the angle between 4 to 8 degree is safe for overturning.

REFERENCES.

1) Collin (2001) has analyzed the segmental retaining wall failure with respect to the design and construction to determine the causes of the failure.
2) DianweiQian and Jianqiang Yi (2013) proposed combined sliding mode control method for overhead crane systems in his research work.
3) Ha et al (2006) has used a slider-crank mechanism. For sliding purpose, Hamilton's principle, Lagrange multiplier, geometric constraints and partitioning method were used.
4) Koerner and Soong (2001)Three design methods of geosynthetic reinforced segmental retaining walls were compared to one another with respect to their details and idiosyncrasies.
5) Meyerhof, G. G., (1953). "The Bearing Capacity of Foundations Under Inclined and Eccentric Loads," Proceedings, 3rd International Conference on Soil Mechanics and Foundation Engineering, Vol.1.16-16.
6) Nadim, F. (1980). "Tilting and Sliding of Gravity Retaining Walls", M.S. Thesis,Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge,Massachusetts.
7) Nagarjan. R., R., Khire. M.V. (1998), Debris slide of Varandhghat, West coast of India, Bulletin Engineering Geology and Environment, Vol: 57, pp.59-63.
8) PoojaGujrathi and Mane S J (2015) have studied landslide zones of nearby areas of Malin village (Pune district, Maharashtra, India) using GIS technique.

9) Richards, R. and Elms, D.G. (1979). “Seismic Behavior of Gravity Retaining Walls,”Journal of the Geotechnical Engineering Division, ASCE, 105(4).
10) Shi, X. and Richards, R. (1995). “Seismic Bearing Capacity with Variable Shear Transfer,” Bulletin of the NewZealand National Society for Earthquake Engineering,28(2), 153-163.
11) Siddharthan, R., Ara, S., and Norris, G. (1992). "Simple Rigid Plastic Model ForSeismic Tilting of Rigid Walls", Journal of Structural Engineering, ASCE, pp. 469-487.
12) Steedman, R.S. and Zeng, X. (1996). “Rotation of Large Gravity Retaining Walls on Rigid Foundations UnderSeismic Loading”, Analysis and Design of Retaining Walls Against Earthquakes, ASCE Geotechnical Special Publication No. 60, edited by S. Prakash, ASCE, NY, NY, pp. 38-56.
13) Tateyama, M., Tatsuoka, F., Koseki, J., and Horii, K. (1995). “Damage to Soil Retaining Walls for Railway Embankments during the Great Hanshin-Awaji Earthquake, January 17, 1995,” Earthquake Geotechnical Engineering, Ishihara (Ed), Balkema, Rotterdam, pp. 49-54.
14) Vesic, A.S., (1973). “Analysis of Ultimate Loads on Shallow Foundations,” Journal of the Soil Mechanics and Foundation Division, ASCE, 99(SM1), 45-73.
15) Wadekar .V.S. (2003) Rock cuttings in konkanrailway“Geo technical issues of Konkan region” Konkan Railway corporation Mumbai
16) Yoo and Lee (2003)have presented the measured behavior of an anchored segmental retaining wall.
17) Yoo and Ung (2004) have presented the observed behaviour of a geosynthetic reinforced segmental retaining wall

