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Design of Free Cantilever, Counter fort and T-flanged Cantilever Type Retaining Wall

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Abstract*: Retaining walls are widely used as permanent structures for retaining soils at different levels.Type of the wall depends on the soil pressure, such as active or passive earth pressure and earth pressure at rest and drainage conditions. Types of walls generally used are gravity walls, RCC walls, counterfort walls and buttress retaining walls. Retaining walls behavior depends on the wall height and retention heights of the soil at its backfill. Retaining walls are used with tying with more than one wall at perpendicular joints to retain liquids, water storage and materials storages such as dyke walls and tanks. Retaining walls excessively used in culverts and as well as in the bridges for construction of abutment wing walls supposed to resist soil pressures laterally applied perpendicular to the axis of the walls.Based on the present scenario used in retaining structures within the civil industries there requirements of height of walls are being increased due to lake of land and cost of sub structures being incurred in the project work, higher height of walls develops huge bending moment at the base because of the cantilever action of the walls, thus resulting in higher sections at the base which deploys into a uneconomical zone so different wall systems are required in different arrangements so as to transfer the loads with limited sections. In the present study retaining walls of height 6m, 9m and 12m are considered for study and the length of the walls considered as 30m and the material properties considered are M20 and Fe415 steel bars and the supports considered to be fixed at the base.

Keywords : retaining wall,backfill,culvert,Rcc walls, counterfort walls, buttress walls.

I. INTRODUCTION

Retaining wall is a rigid one which supports the soil mass at the different levels and also soils with different sloped profiles, reinforced retaining walls uses reinforcing steel to take care of thetension forces and stresses being developed in the concrete mass. Retaining walls are supported by a wide base to stabilize the structure against the sliding, overturning ,etc. Different types of retaining walls behaves based on the load dissipation .

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Common types are listed gravity walls,cantilever retaining walls,counterfort retaining walls,counterfort retaining walls with relieving platforms, buttress walls.

Loads acting on the retaining walls can be classified based on load categories such as self weight of the wall, lateral loads from the soil, water table effect, the superimposed load with the provision of vehicles transportation and the earthquake loads originating from the vibrations of the ground

1. Dead load
2. Soil pressure
3. Surcharge load
4. Seismic loads

When a soil mass is retained at a higher level by a retaining wall, the retained mass of the soil tends to slide and assume a flat slope for equilibrium, which is resisted by the retaining wall.

1. Active earth pressure
2. Passive earth pressure
3. earth pressure at rest

II. LITERATURE REVIEW

Mu'azu Mohammed ABDULLAHI made Evaluation of Causes of Retaining Wall FailureRetaining structures are vital geotechnical structure, because the topographyof the earth surface is a combination of plain, sloppy and undulating terrain.The retaining wall resists thrust of a bank of earth as well as providing soilstability of a change of ground elevation. Earth pressures on retaining wall aredesigned from theories of Soil Mechanics, but unfortunately the engineersusing them do not always realize the significance of the assumption in theirdevelopment. and concluded that A design of retaining wall should be thorough and at least the engineer should appreciate the assumption in the derivation of these formulas used. A good backfill material should be used with good drainage characteristics to prevent hydrostatic pressure build – up. A situation where it is not available, water should be prevented from getting into the backfill material to prevent a build – up hydrostatic pressure . The word failure does not necessarily imply catastrophic failure some like a slight sliding of retaining wall should be more aptly described as unsatisfactory performance than a seriously failure.

B.S. Tasildar investigated Stability of Retaining Wall under Seismic Load: A Review, A wall
designed to maintain a difference in the elevations of the ground surfaces on either side of the wall is called a retaining wall. It is a very common civil engineering structure and is extensively used in railways, bridges, canals and other engineering works, Provision of a horizontal relief shelf projecting from the stem of retaining wall into backfill is known to reduce the total active earth pressure acting on the wall .This results in a reduction in the overturning moment and consequent economy in the design of the stem and slab base.. It is observed stability of retaining wall is a very crucial matter. There are number of failure modes for the retaining walls. Horizontal shelves on on the vertical wall (stem) of retaining wall can be proved to be useful parameter for stability of wall. By offering number of changes stability of retaining wall can be enhanced.

Punde Gayatri V.1, Auti Akanksha S.2, Yendhe Rutuja R.3, Yendhe Aishwarya A.4 ,Shelar Trijeta R.5 madeDesign of Retaining Wall, Retaining walls are usually built to hold back soil mass to retail soil which is unable to stand vertically by themselves. However, retaining walls can also be constructed for aesthetic landscaping purposes. They are also provided to maintain the grounds at two different levels. Retaining walls shall be designed to withstand lateral earth and water pressures, the effects of surcharge loads, the self-weight of the wall. All analysis and design are based on the ACI code. The existing shear stack was of great help in a designing the two models . both where set up as full scale model or prototype with accordingly adapted dimension to avoid the breakage of reinforcement during testing , the quantity of geogrids was a deliberately increase this way from the two limit state of internal stability ,only the pull out failure was allowed.

III. METHODOLOGY

Modeling of structures: In the present study three retaining walls types of height 6m, 9m and 12m are considered for study and the length of the walls considered as 30m for free cantilever, counterfort and T flanged retaining walls and the material properties considered are M20 and Fe415 steel bars and the supports considered to be fixed at the base. The structures modeled in STAAD.Pro structural analysis and design software.

Structure-1: free cantilever retaining walls of heights 6m, 9m and 12m

Structure-2: counterfort retaining walls of heights 6m, 9m and 12m

Structure-3: T flanged retaining walls of heights 6m, 9m and 12m

Table 3.1: Design data for analysis of structures

Design data	***Design values***
Column	300x600mm
Beam	300x600mm
Column to column distances	6m
Wall heights	6m, 9m,12m
Counterfort size	300x900mm
Length of wall	30m
Thickness of wall`	150mm
SBC of soil	250kN/m2
Material grades	M20, Fe415
Type of retaining walls	Cantilever, counterfort and T flanged walls
Supports	Fixed
Φ of soil	30^0
Density of soil	18kN/m3

IV. RESULT AND DISCUSSION

Table:4.1Displacement in different retaining walls

Height of wall(m)	**Cantilever (mm)**	**Counterfort(mm)**	**T flanged (mm)**
6m	424.53	52.13	213.44
9m	2830.88	355.60	1529.41
12m	11081.16	1370.85	6145.81

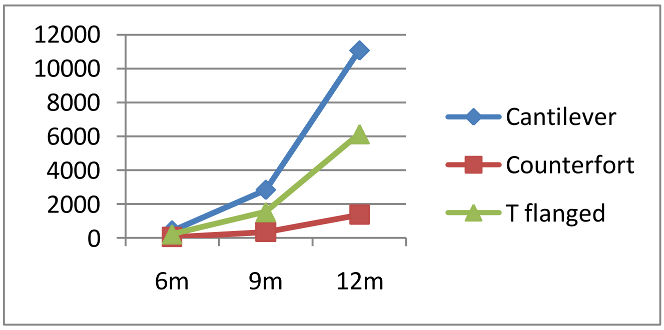

Chart:4.1 Displacement in different retaining walls

Table:4.2 Support reaction in different retaining walls

Height of wall(m)	**Cantilever (kN)**	**Counterfort(kN)**	**T flanged(kN)**
6m	646.3	1086.86	648.61
9m	1449.91	5080.36	1455.40
12m	2600.66	14828.73	2591.15

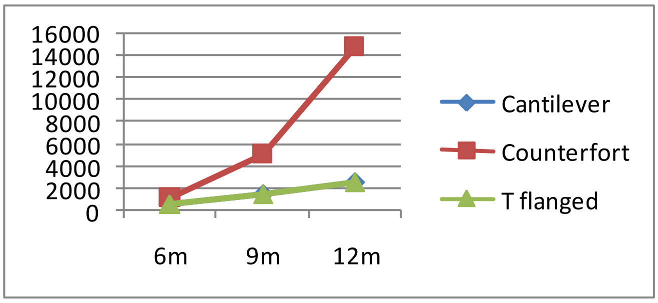

Chart:4.2 Support reaction in different retaining walls

Table:4.3 Support moment in different retaining walls

Height of wall(m)	Cantilever(kNm)	Counterfort(kNm)	T flanged (kNm)
6m	1284.85	767.06	1258.79
9m	4369.85	6437.3	4188.95
12m	10401.65	26301.40	9872.38

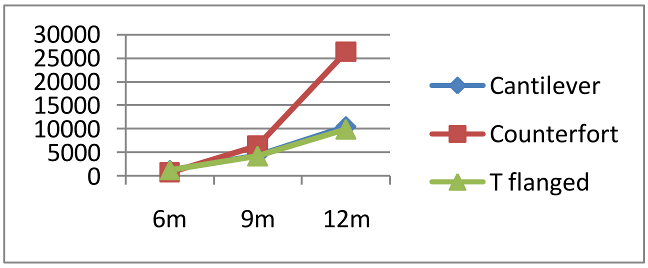

Chart:4.3 Support moment in different retaining walls

Table:4.4 Wall moment along length, Mx in different retaining walls

Height of wall(m)	Cantilever	Counterfort	T flanged
6m	109.29	25.72	58.40
9m	366.84	80.33	193.75
12m	865.35	176.66	455.23

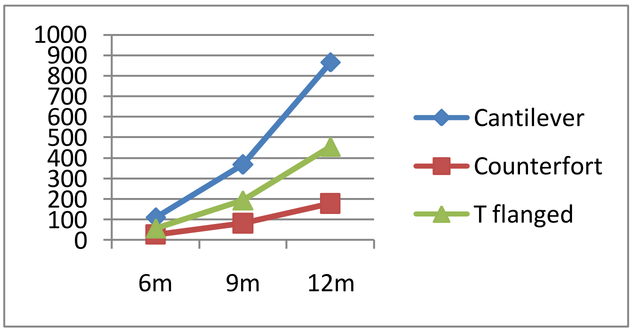

Chart:4.4 Wall moment along length, Mx in different retaining walls

Table:4.5 Wall moment along thickness, My in different retaining walls

Height of wall(m)	Cantilever	Counterfort	T flanged
6m	31.23	4.35	10.17
9m	77.46	12.58	33.66
12m	146.90	29.5	76.82

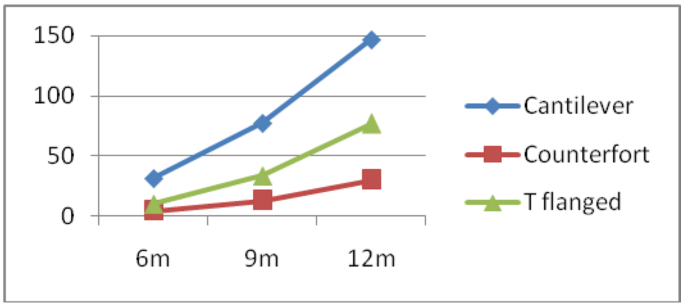

Chart:4.5 Wall moment along thickness, My in different retaining walls

V. CONCLUSION

It is observed that with increase in the height of walls from 6m, 9m and 12m the results are found to be increased.

1. It is observed that counterfort retaining walls shown better results when compared with the t flanged and free cantilever retaining walls.
2. It is observed that the support reactions and support moments are increased in counterfort retaining walls when compared with the t flanged and free cantilever retaining walls.
3. For higher height of retaining walls counterfort retaining walls are better suitable.
4. Displacement in counterfort retaining walls are 87.72% lesser when compared with cantilever retaining walls and 75.57% lesser when compared with T flanges retaining walls.
5. Support reactions and moments in counterfort retaining walls are 67.57% higher when compared with cantilever retaining walls and 67.57% higher when compared with T flanged retaining walls.
6. Wall moments in counterfort retaining walls are 76.46% lesser when compared with cantilever retaining walls and 55.95% lesser when compared with T flanges retaining walls.

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