Analysis and Design of Underground Retaining Wall by Using Beam and Column As Buttresses

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Abstract-*Retaining wall is relatively rigid wall used for supporting the soil mass laterally so that the soil can be retained at different level. Retaining wall is the structure which retain the soil. Active earth pressure acting on retaining wall which is also called as soil pressure. The design of underground retaining wall for pumping station, construction required careful analyse and design of retaining wall. The seismic coefficient method is adopted for dynamic analysis and design of underground retaining wall. The underground pumping station was assumed to be situated in zone IV. All the earthquake analysis has been done by considering all the parameters of zone IV (As per IS 1893-2002). Other parameters like shear force, bending moment and deflection of a structure are determined by STAAD PRO v8i, so the retaining wall contain the beam and column which reduces the thickness of retaining wall and make it economical. The column and beam which is constructed with the retaining wall are subjected to active soil pressure so that column behaves like flexural member and beam behave like as axial member.*

Keywords-seismic analysis, buttresses, underground retaining wall,

I. INTRODUCTION

The most important consideration in proper design and installation of retaining walls is to recognize and counteract the tendency of the retained material to move downslope due to gravity. This creates lateral earth pressure behind the wall which depends on the angle of internal friction (phi) and the cohesive strength (c) of the retained material, as well as the direction and magnitude of movement the retaining structure undergoes. Lateral earth pressures are zero at the top of the wall and – in homogenous ground – increase proportionally to a maximum value at the lowest depth. Earth pressures will push the wall forward or overturn it if not properly addressed. This study shows the structural elements behave according to the pressure or force exerted onto it(behaviour of beams as columns and columns as beams) . In order to justify it, we have created a 3D structural model of pumping station.(live project in Huda panipat) in which following parameters were studied and designed.

a) RCC retaining wall & wall footing
b) Buttresses (column & beam arrangement)
c) RCC beams, slabs etc.

Following were the parameters considered:-
1. Height of retaining wall = 9.4m
2. Planer dimensions shown in fig 2

a) Height of pump station floor =3.6m

The earthquake analysis has been done by considering all the parameters for zone IV (as Panipat comes in zone 4- refer IS 1893-2002)

Z=0.24 (zone factor) I=1.0 (importance factor) R=5 (response reduction factor)
SBC available at 1.5 m as 10.2 T/m^2
Gross SBC available at 9.4 m below GL
(Assume unit weight of Soil as 1.6 T/m^3)
= 10.2 + (9.4 – 1.5) x 1.6
=22.84 T/m^2
(Hence assuming 20 T/m^2 as gross SBC)

Seismic co-efficient method was performed on structures and is modeled by using STAAD PRO software. Load combination as per IS 1893(Part1):2002, Cl. 6.3.1.2, pg. 13

The design horizontal seismic coefficient A_h for a structure shall be determined by the following expression:

$$A_h = \frac{Z I S_a}{2 R g}$$

Provided that for any structure with Time period T < 0.1 sec. Other seismic data in shown in table

TABLE: Seismic analysis

Zone	IV
Reduction factor	5
Importance factor	1
Soil type	II

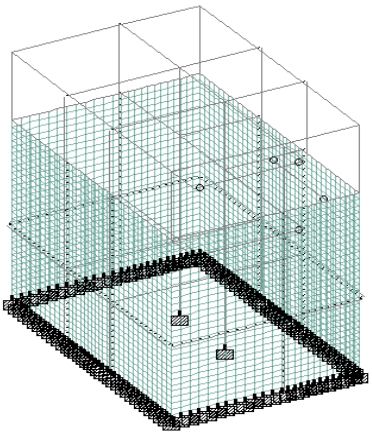
II. OBJECTIVES

1. The main objective of study is to examine the behaviour of underground retaining wall for different location.

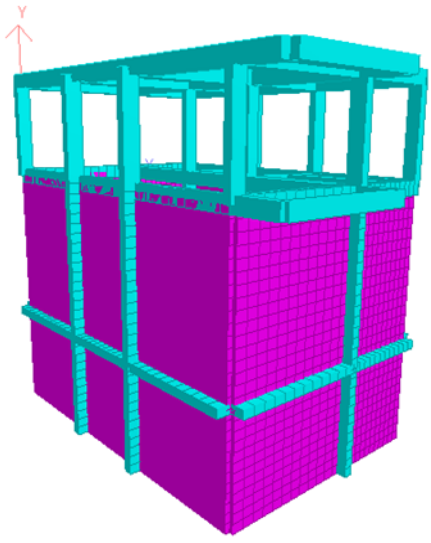
2. The objective is to study the effect of shear wall on various parameters like bending moment, shear force and deflection of a structure.

Structural Modelling.

For this study, the structure of pumping station(refer fig 1) was analysed in standard software STAAD pro V8i (based on finite element method) .seismic analysis was done in the software using latest IS code(IS 1893:2002).

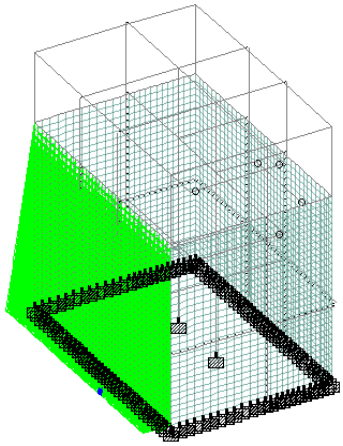


3D-View Of Station (Fig:-1)

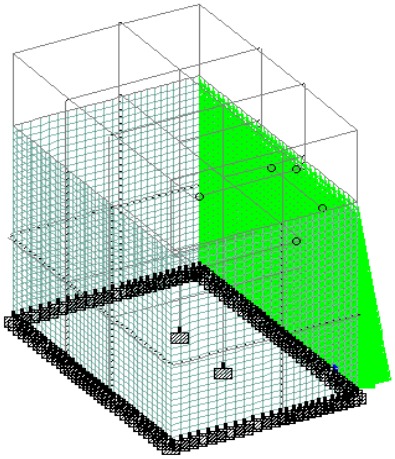


3D-Rendered View (Fig:-2)

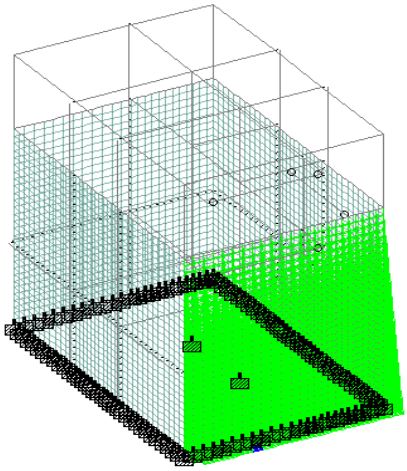
The active earth pressure which is acting on the underground retaining wall, The active earth pressure acting on the different direction on the retaining wall .Which determine by the below diagram.



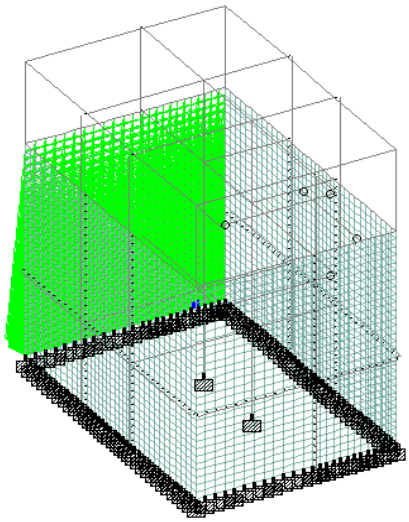
Lateral soil press in +x direction (FIG:-3)

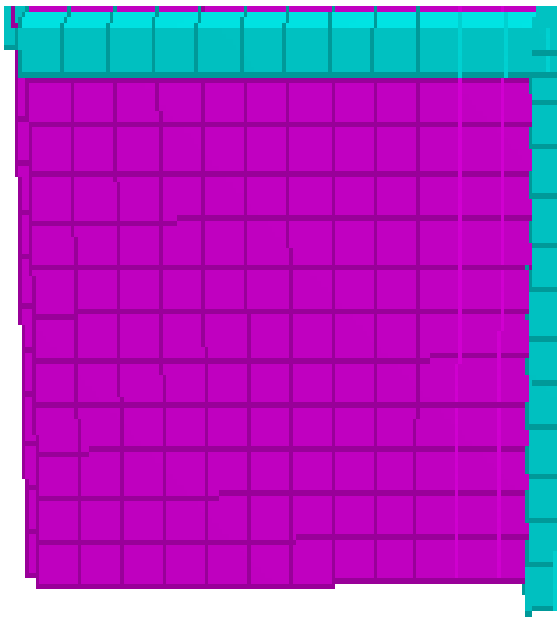


Lateral soil press in +x direction (FIG:-3)

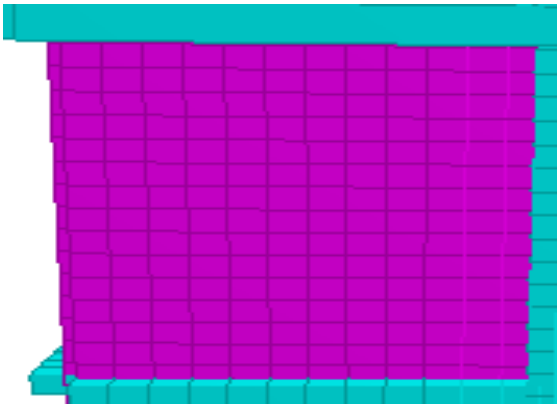


Lateral soil press in +-z direction (FIG:-3)





Bottom Panel Of Wall Ht3.8M

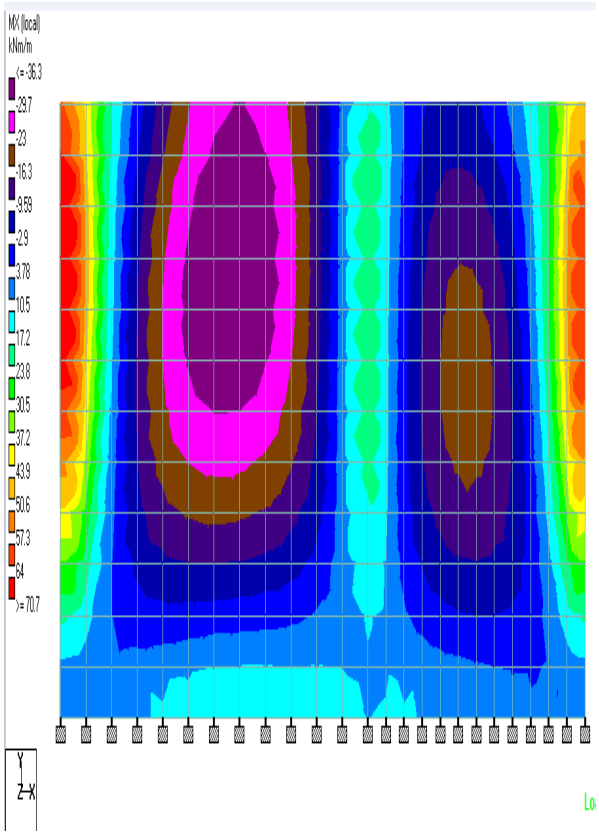


Top Panel Of Wall Ht 5.6m

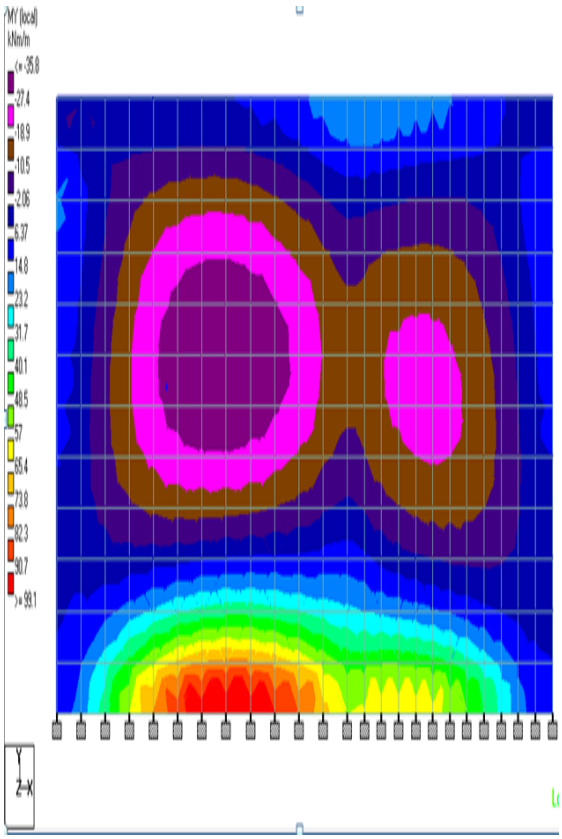
Load Considered:-

component	Size (thickness)	Load
slab	150mm	3.75 kN/m²
Floor finish	50mm	1 kN/m²
Live load (panel room)		10 kN/m²
Pump floor		5kN/m²
Roof live load		0.75 kN/m²
Brick bat coba		2 kN/m²
Brick wall	230mm	14.2 kN/m
Parapet wall	230mm	4.416 kN/m
Mono rail	Lifted weight 5 MT	68.75kN
Active earth pressure	9.4 m	65.18 kN/m²

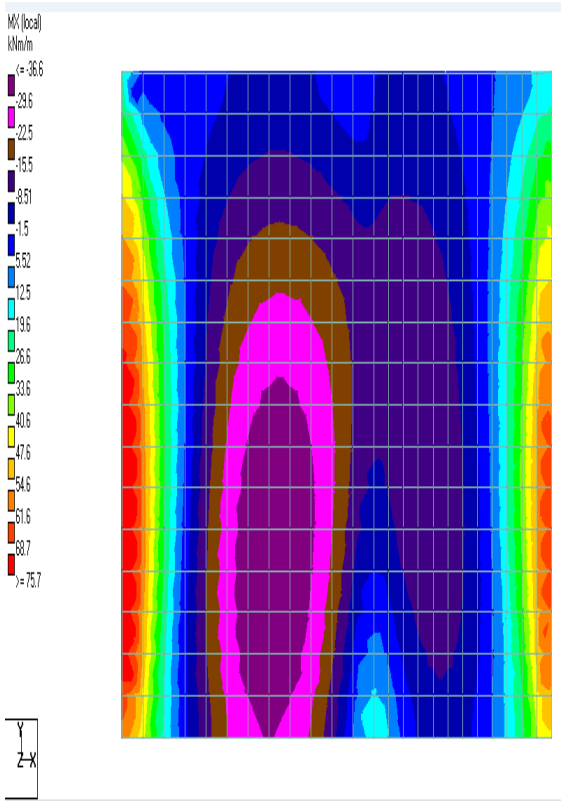
Contour Envelope Results Of Rc Wall:-



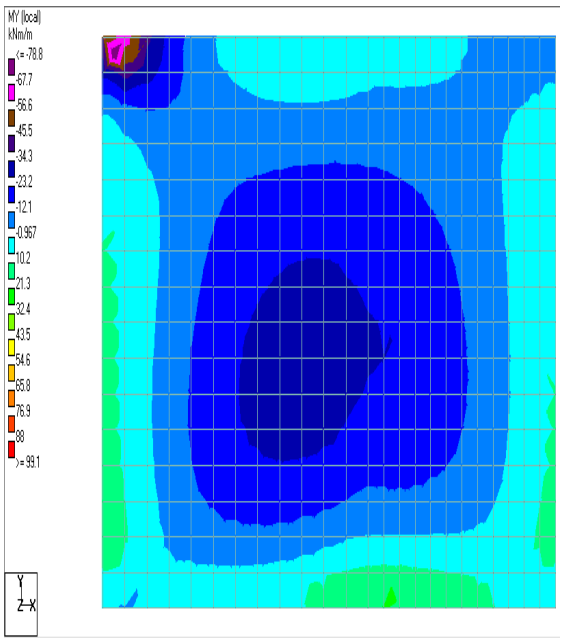
Horizontal Moment In Bottom Portion Of Wall



Horizontal Moment In Bottom Portion Of Wall



Horizontal Moments In Top Portion Of Wall



Vertical Moments In Top Portion Of Wall_Results Of Wall Panel:-

PANEL	HORIZONTAL MOMENTS		VERTICAL MOMENTS	
	-Mu (KN-m)	+Mu (KN-m)	-Mu (KN-m)	+Mu (KN-m)
BOTTOM	70.7	36.3	99.1	35.8
TOP	52.4	24.4	37.9	22.9

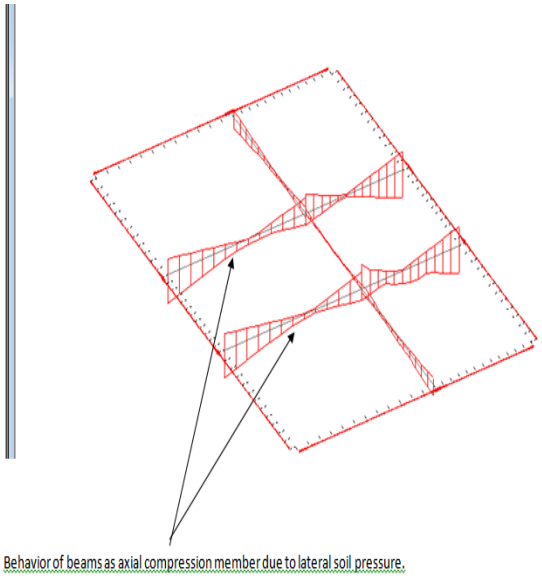
Displacements Of Structure:-

All \ Summary /

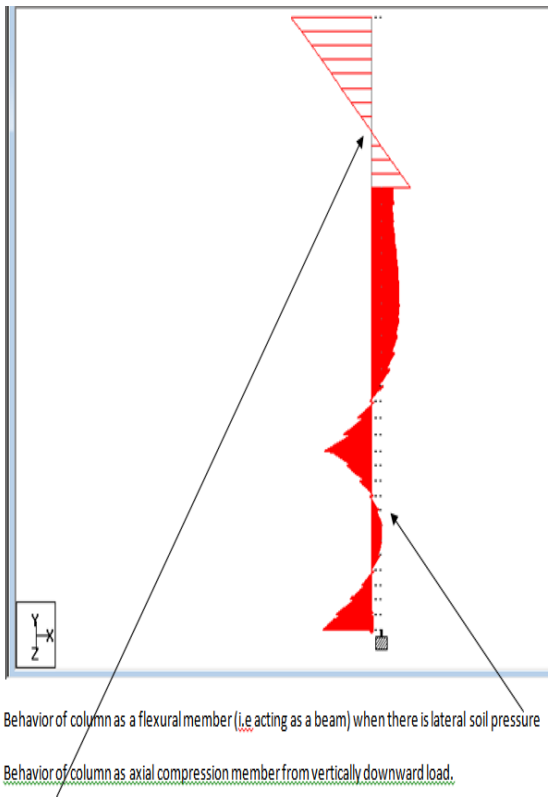
			Horizontal	Vertical	Horizontal	Resultant	Rotational	
	Node	L/C	X mm	Y mm	Z mm	mm	rX rad	rY rad
Max Z	3501	104 1.5DL +1.	0.886	-5.358	3.878	6.673	0.003	0.000
Min Z	1636	5 SOIL-3	-0.010	0.007	-3.593	3.593	0.000	-0.000
Max rX	3502	101 1.5DL + 1	-0.174	-5.486	0.017	5.488	0.004	-0.000
Min rX	406	5 SOIL-3	-0.004	-0.001	-1.062	1.062	-0.001	-0.000
Max rY	3040	3 SOIL-1	3.017	0.033	0.023	3.018	0.000	0.002
Min rY	3406	3 SOIL-1	2.893	0.035	-0.028	2.893	-0.000	-0.002
Max rZ	878	4 SOIL-2	-1.663	-0.015	-0.000	1.663	-0.000	0.000
Min rZ	275	3 SOIL-1	2.178	-0.020	-0.001	2.178	-0.000	-0.000
Max Rst	3245	3 SOIL-1	8.401	0.012	-0.004	8.401	-0.000	-0.000

MAX DISPLACEMENT = 8.401/1.5= 5.60mm.

Behaviour structural elements:-



Behavior of beams as column



Column acting as a beam

III. CONCONCLUSION

1. The results show that the all structural elements behave according to force acting/applied on the structure.(the column behaving as beam and beam behaving as column).
2. So the detailing of such members becomes tremendously important, so that there is no confusion on site.
3. If we divide the wall panel in two parts,(different parts), the thickness of wall gets reduce thus achieving economy.
4. The structure being in zone iv, produced only 5.60mm of maximum
5. Ultimate displacement thus showing high stiffness of structure.
6. Thus selection of sizes of all structural members justified.
7. The presence of shear wall can affect the seismic behavior of underground retaining wall, structure to large extent, the shear wall also increases strength and stiffness of structure.
8. The max. Bending moment, shear force and deflection of structure having underground retaining wall is less as compared to bare frame.

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