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Behaviour of Anchored Pile Wall Under Dynamic Load & Earthquake

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ABSTRACT:- The purpose of this study is to observe the behaviour of concrete pile wall that to be constructed in the Gazino Station of Ulus–Keçiören under the determined soil properties and site conditions, the studied area consisting existing four-storey building, excavation of two layers and supporting the pile wall with anchors, the water pressure is involved in this study and the ground water level is changeable to three levels, dynamic load to be applied and concentrated on the top of pile wall which will be subjected to earthquake on basement recorded by USGS in 1989.
Keywords:- Plaxis, Pile wall, Material behaviour, water pressure, Dynamic load, earthquake.

I. INTRODUCTION

The problem modelled with a geometry model of 35 m width and 20 m depth, A ground anchor modelled by a combination of a node-to-node anchor and a geotextile, The geotextile simulates the grout body whereas the node-to-node anchor simulates the anchor rod. In reality there is a complex three dimensional state of stress around the grout body. Although the precise stress state and interaction with the soil cannot be modelled with this 2D model, it is possible in this way to estimate the stress distribution, the deformations and the stability of the structure on a global level, assuming that the grout body does not slip relative to the soil. With this model it is certainly not possible to evaluate the pull-out force of the ground anchor.

The pile wall is modelled as a beam. The interfaces around the beam are used to model soil-structure interaction effects. They are extended under the wall for 1,0 m. Interfaces should not be used around the geotextiles that represent the grout body.

The water table is below the excavation level but initially there is a water level to be raised steeply and water pressures will effect of pile wall and existing building. As the excavation commences water drained and no groundwater is observed during excavation stages. The schematic view of the analysed model of the studied section of the Gazino station is given in Fig. 1

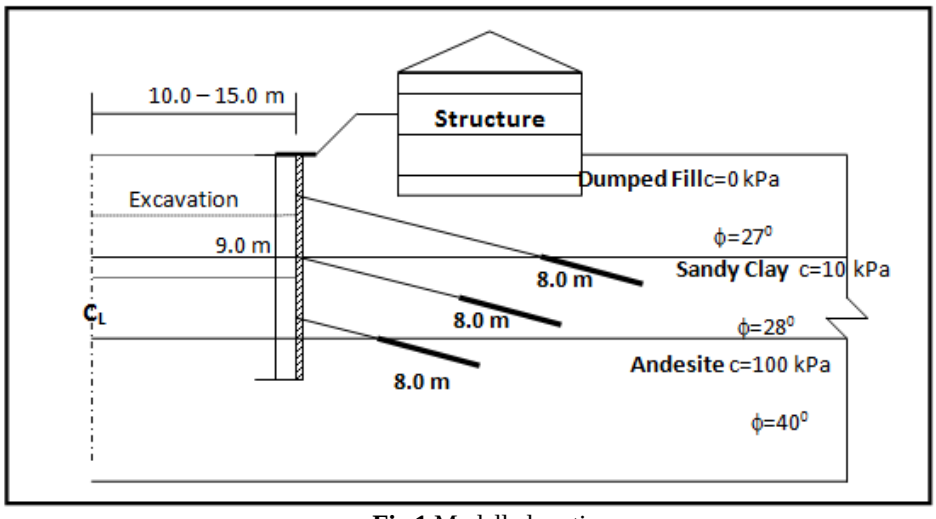


Fig.1 Modelled section

II. MATERIALS AND METHODS

2.1 Soil and interface properties:-

The properties of soil three layers and interface materials are assumed and obtained from the plaxis tutorial manual-V8 as the following table :

Table 1 Soil and interface properties

Parameter	Name	Fill	Sandy Clay	Andesite	Building Fill	Unit
Material model	*Model*	MC	MC	MC	MC	
Type of material behaviour	*Type*	drained	drained	drained	drained	-
Dry soil weight	γdry	17,5	20	24	17	kN/m^3
Wet soil weight	γwet	19	23	27	20	kN/m^3
Horizontal permeability	Kx	0	0	0	5	m/day
Vertical permeability	Ky	0	0	0	5	m/day
Young's modulus	E_{tef}	4000	20000	200000	30000	kN/m^2
Poisson's ratio	ν	0,353	0,346	0,263	0.2	-
Cohesion	*Cref*	0,2	10	100	1.0	kN/m^2
Friction angle	ϕ	27	28	40	35	^{0}
Dilatancy angle	ψ	0	0	10	4	*o*
Interface reduction factor	*Rinter*	Rigid	Rigid	Rigid	Rigid	-
Interf Permeability	*Perm.*					-

2.2 Properties of the plates:-

The properties of plates members including:

- Pile wall
- Pile cap
- Building beams

All these plates are assumed and obtained from the plaxis tutorial manual-V8 as the following tables

Table 2 Pile (beam) Properties

Parameter	Name	Value	Unit
Type of behaviour	*Material type*	Elastoplastic	_
Normal stiffness	*EA*	$2.4\text{-}10^7$	kN/m
Flexural rigidity	*EI*	$1.28\text{-}10^6$	kNm/m
Equivalent thickness	*D*	0.80	m
Weight	*W*	19.2	kN/m/
Poisson's ratio	ν	0.15	-

Table 3 Pile cap (beam) Properties

Parameter	Name	Value	Unit
Type of behaviour	*Material type*	Elastoplastic	_
Normal stiffness	*EA*	$1.5\text{-}10^7$	kN/m
Flexural rigidity	*EI*	$3.125\text{-}10^5$	kNm/m
Equivalent thickness	*D*	0.50	m
Weight	*W*	12	kN/m/
Poisson's ratio	ν	0.15	-

Table 4 Building members Properties

Parameter	Name	Value	Unit
Type of behaviour	*Material type*	Elastoplastic	_
Normal stiffness	*EA*	$5\text{-}10^6$	kN/m
Flexural rigidity	*EI*	$9\text{-}10^6$	kNm/m
Equivalent thickness	*D*	0.147	m
Weight	*W*	5	kN/m/
Poisson's ratio	ν	0	-

2.3 Properties of anchores:-

The properties of anchors anchor rods and grout bodys are assumed and obtained from the plaxis tutorial manual-V8 as the following tables:

Table 5 Anchor rod (node-to-node anchors)Properties

Parameter	Name	Value	Unit
Type of behavior	*Material type*	Elastoplastic	kN
Normal stiffness	*EA*	128000	kN
Spacing out of plane Maximum	L_s	1,6	kN

Table 6 Grout body (geotextile)Properties

Parameter	Name	Value	Unit
Normal stiffness	*EA*	$3{,}0\text{-}10^6$	kN/m

2.4 Steps and prosedures:-

The problem Plaxis version 8 has been used for this study, all above said properties of materials and plates are filled, the study including three scopes as following:

2.4.1 Study of pile wall behavior under water pressure:

This including raising the ground water level for three stages started from the bottom of excavtion and ended with submirsion of all pile wall with water.

2.4.2 Study of pile wall behavior under dynamic load:

This including concentrating of dynamic load on the top of pile wall.

2.4.3 Study of pile wall behavior under Earthquake:

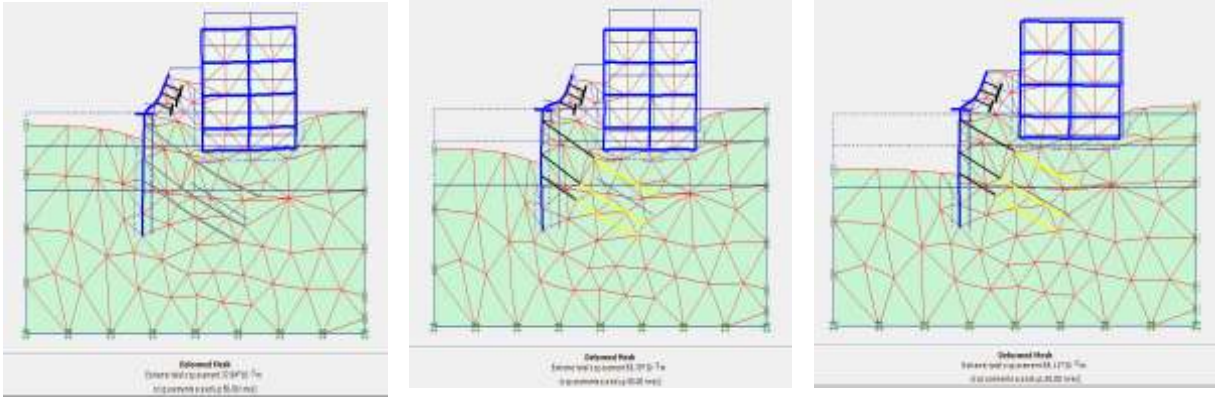
This including applying earthquake on basement recorded by USGS in 1989.

III. RESULTS AND DISCUSION

By using Plaxis.8 program all above data are filled according to the three cases, the following results are obtained:

3.1 Pile wall behavior under under water pressure:-

After raising the ground water level for three stages, It is clerely observed that the displacement are decreased with progess of phases due to raising of the ground water level, as it clearly in the figure 2.



First Phase (Phase 1) — Pile is dry, not submerged in water

(Phase 4) — Pile submerged in water for only 4 m from the bottom

Last Phase (Phase 6) — Pile completely submerged in water

Fig.2 Comparation of Output phases

3.2 Pile wall behavior under dynamic load:-

The displacement is increasing with time progress specially at phase 3 after applying the dynamic load, the most effected area is around the anchor area and in the area that located between the building and pile wall as it viewed from plastic points figure3.

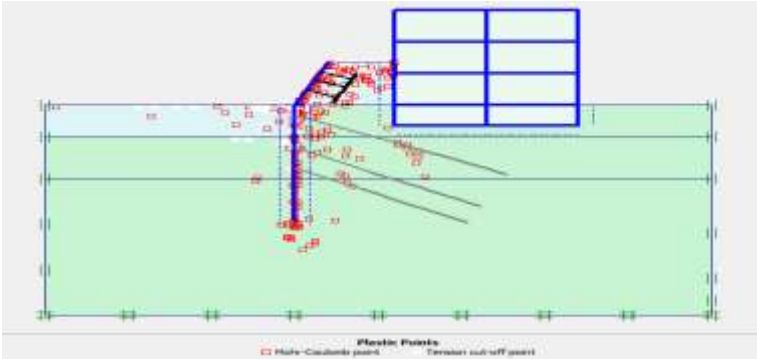


Fig.3 shows the plastic points

3.3 Pile wall behavior under Earthquake:-

The maximum vertical displacement occured in the bottom of basement due to applying of earthquake load, The displacement of top and bottom of pile wall observed with same values (approximately), but sudenly at dynamic time of 4.08 s big different in the displacement between top and bottom pile wall has been observed, the top pile wall displacement values are bigger than the displacement values of the bottom pile wall, which is clear vesible in the figure4.

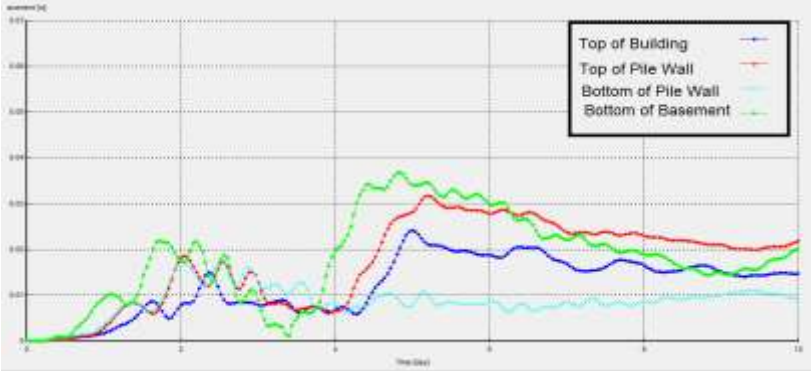


Fig.4 The pile wall time Vs Displacement

IV. CONCLUSION

The results shows that pile wall affected negatively with the earthquake and the dynamic load cases while it is not effected in case of raising the ground water level, and we recommended to change and improve the properties of materials and plates for guarantying stable pile wall and also keeping the existing building not affected.

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