ANALYSIS OF G+4 AND G+9 STOREY BUILDING FOUNDATION CONSIDERING SSI

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Abstract : Foundation are used to carry the load of super structure in dynamic condition. Generally, foundation are design as a fix support. But foundation are also depend on soil strata. In this project, use different types of soil (clay, sand and hard rock) and analysis the two types of foundation (Pad footing and mat foundation) and compare the analysis results. Use the software for analysis of building in ETABS 2018 and analysis of foundation in SAFE2016.

Index Terms **– Multi storey building, base reaction, analysis the foundation**

I. INTRODUCTION

The study of soil-structure interaction (SSI) is related to the field of earthquake engineering. It is very important to note that the structural response is mainly due to the soil-structure interaction forces that brings an impact on the structure. This is a form of seismic excitation. A committee of engineering research deals with the study of soil-structure interaction only when these forces brings an appreciable effect on the basement motion when we are comparing it with the free-field ground motion.

The free-field ground motion can be defined as the motion recorded on the surface of the soil, without the involvement of the structure. The structural response to an earthquake is highly dependent on the interactions between three linked systems, namely:

1. The structure
2. The Foundation
3. The underlying soil

The soil-structure interaction analysis is the method of evaluating the collective response of the three linked systems mentioned above for a specified ground motion. The soil-structure interaction can be defined as the process in which the response from the soil influences the motion of the structure and the motion of the given structure affects the response from the soil. This is a phenomenon in which the structural displacements and the ground displacements are independent to each other. Soil-structure force are mainly interaction forces that can occur for every structure. But these are not able to change the soil motion in all conditions.

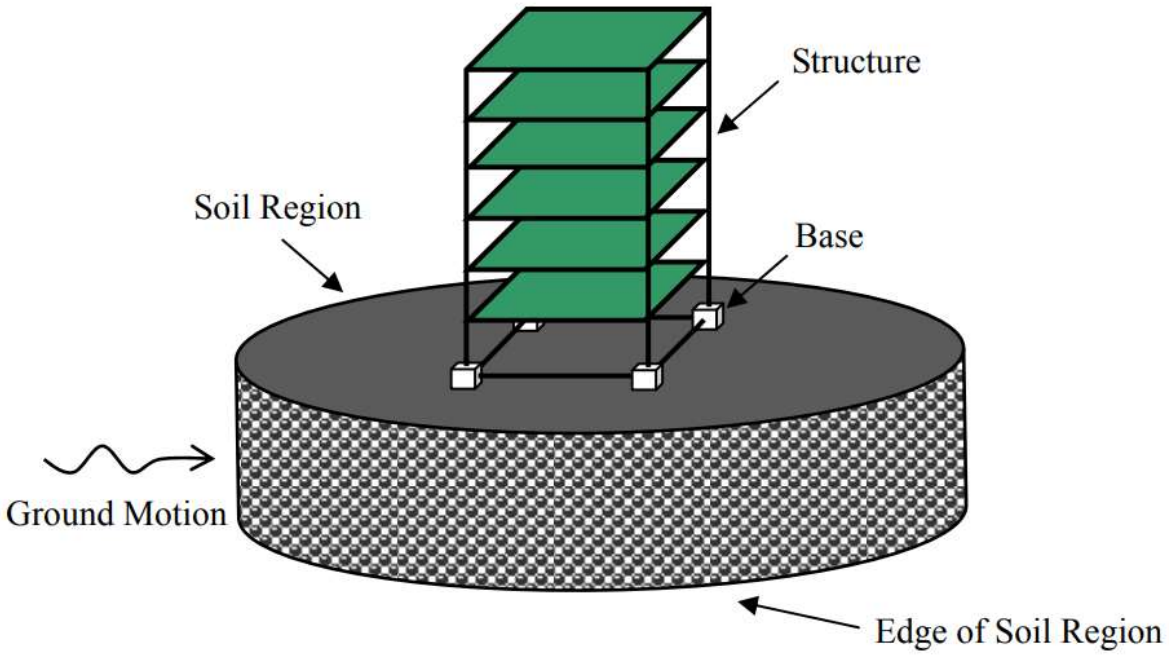

Figure I-1 Schematic diagram of soil structure interaction system

The soil structure interaction can have two types of phenomena:

Kinematic interaction: The soil displacement caused by the earthquake ground motion is called as the free-field motion. This free field motion is not followed by the foundation that is located on the soil. The kinematic interaction is caused by the inability of the foundation to sink with the free field motion of the ground.

Inertial interaction: The additional deformation caused in the soil due to the transmission of inertial force to the soil by the superstructure is called as the inertial interaction.

II. OBJECTIVE OF STUDY

To compare the deformation, soil pressure, punching shear for different type of soil condition like, clay, send and hard rock considering SSI.

III. MULTI STOREY BUILDING DATA AND MODELING

3.1 Building parameter

Table III-1 Building parameter for G+4 and G+9 storey building

Properties	G+4	G+9
	Dimensions	
Number of storey	G+4	G+9
Storey height	3.00m	3.00m
Plan size	16.00mm X 16.00m	24.00mm X 24.00m
Number of bays in X direction	4	6
Number of bays in Y direction	4	6
Size of column	400mm X 400mm	500mm X 500mm
Size of beam	300mm X 450mm	300mm X 450mm
Slab thickness	135mm	135mm
Shear wall thickness	-	200mm
External wall thickness	230mm	230mm
Internal wall thickness	150mm	150mm

3.2 Loading condition

Table III-2 Loading condition

Types of load	Load
Live load	2.00 kN/m^2
Foor finish	1.50 kN/m^2
External wall load	13.80kN/m
Internal wall load	9.00kN/m

3.3 Seismic properties

Table III-3 Seismic properties

Properties	Data
Types of structure	SMRF
Seismic Zone	II
Importance Fact	1
Response reduction factor	5
Damping ratio	5.00%

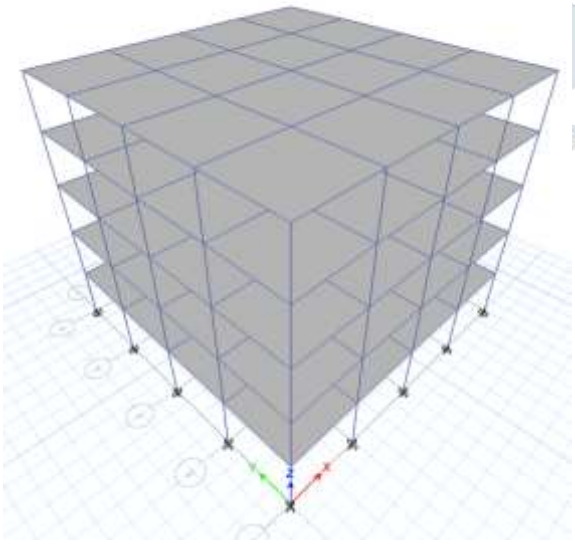

Figure III-1 Modeling of G+4 storey building

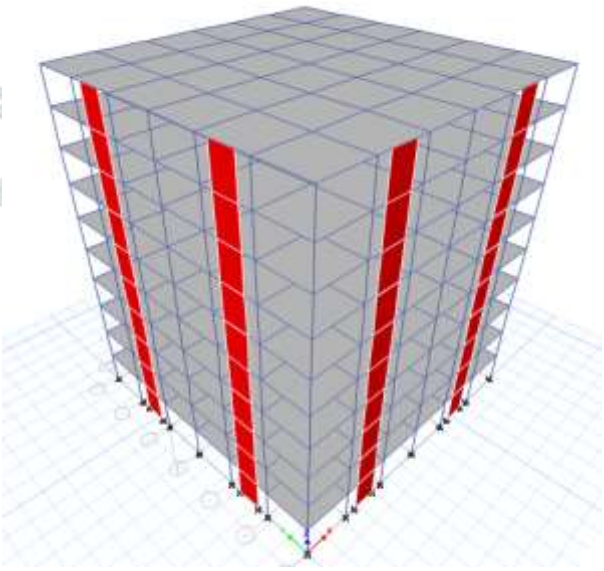

Figure III-2 Modeling of G+9 storey building

IV. FOOTING DATA FOR ANALYSIS OF FOUNDATION

Maximum base reaction for 1.5(DL + LL) load combination for G+4 storey building and 1.5(DL + EQX) load combination for G+9 storey building

4.1 Soil properties

Table IV-1 Soil properties for G+4 and G+9 storey building

Types of soil	SBC of soil (kN/m^2)	Soil subgrade modulus(kN/m^3)
Clay	245	800
Send	440	17600
Hard rock	880	32000

4.2 Initial footing size

4.2.1 Pad footing for G+4 storey building

Table IV-2 Pad footing size for G+4 storey building

Position		Size
Size	Corner	1.8m X 1.8m
	Side	2.2m X 2.2m
	Middle	2.8m X 2.8m
Thickness of footing		500mm

4.2.2 Pad footing for G+4 storey building

Table IV-3 Pad footing size for G+9 storey building

Position		Size
Size	Corner	2.2m X 2.2m
	Side	2.9m X 2.9m
	Middle	3.5m X 3.5m
Thickness of footing		700mm

4.2.3 Mat foundation for G+4 storey building

Table IV-4 Mat foundation size for G+4 storey building

Foundation size	16.6m X 16.6m
Thickness of foundation	500mm

4.2.4 Mat foundation for G+4 storey building

Table IV-5 Mat foundation size for G+9 storey building

Foundation size	24.75m X 24.75m
Thickness of foundation	700mm

V. RESULTS AND DISCUSSION

5.1 Results

5.1.1 Deflection of footing

5.1.1.1 Pad footing for G+4 storey building

Table IV-6 Maximum deflection for different types of soil for G+4 storey building

Types of soil	Maximum Deflection (mm)
Clay	25.62
Send	14.33
Hard rock	7.99

5.1.1.2 Pad footing for G+9 storey building

Table IV-7 Maximum deflection for different types of soil for G+9 storey building

Types of soil	Maximum Deflection (mm)
Clay	26.40
Send	14.31
Hard rock	8.41

5.1.1.3 Mat foundation for G+4 storey building

Table IV-3 Maximum deflection for different types of soil for G+4 storey building

Types of soil	Maximum Deflection (mm)
Clay	17.14
Send	10.40
Hard rock	6.30

5.1.1.4 Mat foundation for G+9 storey building

Table IV-4 Maximum deflection for different types of soil for G+9 storey building

Types of soil	Maximum Deflection (mm)
Clay	24.28
Send	14.09
Hard rock	8.21

5.1.2 Soil pressure

5.1.2.1 Pad footing for G+4 storey building

Table IV-5 Soil pressure for different types of soil for G+4 storey building

Types of soil	Soil pressure (kN/m^2)	SBC (kN/m^2)
Clay	251.11	245
Send	252.22	440
Hard rock	255.58	880

5.1.2.2 Pad footing for G+9 storey building

Table IV-6 Soil pressure for different types of soil for G+9 storey building

Types of soil	Soil pressure (kN/m^2)	SBC (kN/m^2)
Clay	258.12	245
Send	262.93	440
Hard rock	263.80	880

5.1.2.3 Mat foundation for G+4 storey building

Table IV-7 Soil pressure for G+4 storey building

Types of soil	Soil pressure (kN/m^2)	SBC (kN/m^2)
Clay	237.91	245
Send	248.05	440
Hard rock	262.5	880

5.1.2.4 Mat foundation for G+9 storey building

Table IV-8 Soil pressure for G+9 storey building

Types of soil	Soil pressure (kN/m^2)	SBC (kN/m^2)
Clay	168.00	245
Send	182.05	440
Hard rock	201.47	880

5.1.3 Punching shear

5.1.3.1 Pad footing for G+4 storey building

Table IV-9 Punching shear for different types of soil for G+4 storey building

Types of soil	Punching shear
Clay	0.9915
Send	0.9859
Hard rock	0.9758

5.1.3.2 Pad footing for G+9 storey building

Table IV-10 Punching shear for different types of soil for G+9 storey building

Types of soil	Punching shear
Clay	1.09
Send	1.08
Hard rock	1.05

5.1.3.3 Mat foundation for G+4 storey building

Table IV-8 Punching shear for G+4 storey building

Types of soil	Punching shear
Clay	1.0603
Send	1.0615
Hard rock	1.058

5.1.3.4 Mat foundation for G+9 storey building

Table IV-9 Punching shear for G+9 storey building

Types of soil	Punching shear
Clay	0.98
Send	0.96
Hard rock	0.95

5.2 Conclusion

For G+4 storey building,

1) In pad footing, deflection of footing are decrease in send 42.8% and hard rock 68.81% compare to clay and in mat foundation, deflection of footing are decrease in send 39.32% and hard rock 76.66%.

2)In pad footing and mat foundation, Soil pressure value are nearly same, but in sand and rock Soil pressure value in very less compare to soil bearing capacity.
3)In pad footing and mat foundation, punching shear value is nearly 1.00.

For G+9 Storey building,

1) In pad footing, deflection of footing are decrease in send 45.80% and hard rock 68.14% compare to clay and in mat foundation, deflection of footing are decrease in send 41.97% and hard rock 66.19%.
2) In pad footing and mat foundation, Soil pressure value are nearly same, but in sand and rock Soil pressure value in very less compare to soil bearing capacity.
3) In pad footing and mat foundation, punching shear value is nearly 1.00

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