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A Building Frame Experimental Study Supported On Piles

Ch. Rajesh[1], B. Kesava Rao[2]

[1] M.Tech., Student, Department of Civil Engineering, RVR&JC College of Engineering, Guntur, INDIA
[2] Assistant Professor, Department of Civil Engineering, RVR&JC College of Engineering, Guntur, INDIA

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Abstract - *This study uses the findings of static vertical load testing to illustrate the impact of beam on a model building frame supported by a single pile buried in cohesion soil (red soil). The impacts of the beam on the building frame at column bases were examined. The materials used for experimental test are aluminum specimen with length of 300 mm, 500 mm and 700 mm of diameter 20 mm as pile below the building model frame along with pile cap of size 60mm×60mm and thickness of 20mm and hollow rectangular steel specimen of size 50×50mmx700mm whose thickness is 3mm .The interaction analysis is carried out on the beam, building frame and pile which are placed on the soil. The response includes the displacement at the bottom. The effect of the soil-structure interaction is observed to be significant for the type of foundation and soil considered in the present study*

***Key Words*: Soil Structure Interaction (SSI), Building Frame, Piles, Beam and Cohesion soil**

1. INTRODUCTION

The study of soil-structure interaction (SSI) is related to earthquake engineering. It is critical to understand that the structural response is primarily caused by soil-structure interaction forces that act on the structure. This is an example of earthquake stimulation. When compared to free-field ground motion, a committee of engineering research is only interested in the study of soil-structure interaction when these forces have a discernible effect on basement motion. The motion recorded on the soil's surface without the involvement of the structure is known as free-field ground motion.

1.1 SSI

It is commonly assumed that SSI is a purely beneficial effect that can be conveniently ignored for conservative design. Seismic design code SSI provisions are optional and allow designers to reduce building design base shear by considering soil-structure interaction (SSI) as a beneficial effect. The provisions' main idea is that the soil-structure system can be replaced with an equivalent fixed-base model with a longer period and, in most cases, a higher damping ratio. The majority of design codes employ oversimplified design spectra that achieve constant acceleration up to a certain period and then decrease monotonically with period. Considering soil-structure interaction makes a structure more flexible, increasing its natural period when compared to a rigidly supported structure. Furthermore, taking into account the SSI effect raises the system's effective damping ratio. The smooth idealisation of the design spectrum implies a smaller seismic response with increased natural periods and effective damping ratio due to SSI, which is the main reason for seismic design codes to reduce the design base shear when the SSI effect is taken into account. Furthermore, taking into account the SSI effect raises the system's effective damping ratio. The smooth idealisation of the design spectrum implies a smaller seismic response with increased natural periods and effective damping ratio due to SSI, which is the main reason for seismic design codes to reduce the design base shear when the SSI effect is taken into account.

1.2 Building frame and Pile

Deformation of the foundation resting on deformable soils is caused by the rigidity of the foundation, superstructure, and soil. Nonetheless, the traditional method of analysing framed structures assumes that bases are either completely rigid or completely flexible. As a result, interactive analysis is required to evaluate the response superstructure correctly. Numerous interactive analyses have been conducted. Several studies have been conducted on this subject. Many numbers work, and comparative studies on pile foundation can be found, but there has been little experimentation. Work on framed analysis was reported for structures supported by pile foundations in order to account for soil-structure interaction. A thorough experimental investigation was carried out in this study. Pile groups on the model supported the plane frame with beam. Embedded single piles. Individual piles embedded in red sand. The building frame is subjected to static loads (concentrated loads in the centre).

The study of a building frame supported by a single pile embedded in red soil has not been reported elsewhere, according to a review of the literature. As a result of this, the red soil is collected for the study.

2. STATIC STRUCTURE INTERACTION

The dynamic interaction of structure-soil-structure was introduced, and the research methods were discussed. A systematic summary of the history and status of structure-soil-structure and static interaction research that considers adjacent structures was proposed as a reference for researchers based on several documents. Given its complexity and oversimplification of the model for soil and structures, this study is still in its early stages, but it should be continued for its significance. A summary of the most common major computer programs in this field of study was attempted. Additionally, the benefits, drawbacks, and applicability of such programs were discussed. Existing problems and future research trends in this field were also investigated. The interaction of soil and structure is important in the behavior of structures under static or loading..It has an impact on the behavior of the soil as well as the response of the pile under load. The analysis is critical for predicting more accurate structural behavior and improving structural safety under extreme loading conditions. The behavior of the soil-pile system is predominantly nonlinear, which complicates the problem. The soil-pile interaction effect resists the load in a laterally and axially loaded pile, which is dependent on soil properties, pile material, pile diameter, loading type, and ground bed slope. The difficulty in determining the influencing factors necessitates a thorough investigation of the soil-structure interaction problem. With the introduction of powerful computers and simulation tools such as finite element analysis software, analysis became easier. A detailed literature review on soil–structure interaction analysis of laterally loaded and axial loaded piles.

This study uses the findings of static vertical load testing to demonstrate the impact of beam stiffness on a model building frame supported by pile groups immersed in cohesion soil (red soil). Investigations were conducted into how the rigidity of the beam affected shears and bending moments in the building frame as well as displacements at the base of the columns along the length of pile in the axial direction.

The properties of the red soil were defined by conducting sieve analysis, specific gravity, relative density and direct shear test.

Table -1: Sieve analysis of red soil

Sieve sizes	Trail 1 (gm)	Trail 2 (gm)	Trail 3 (gm)
4.75mm	33.5	35	34
2.36mm	66.5	67.5	65.5
1.18mm	118	124.5	121
600µ	113.5	112	114
300µ	103	99.5	102
150µ	39	39.5	38.5
Pan	23	22.5	24

Soils having particle larger than 0.075mm size are termed as coarse-grained soils.coarse-ghrained soils may be have boulder, cobble, gravel and sand.the following particle classificatio names depending an the size of the particle.

Weigh accuratley about 500grams of oven-dried soil sample. Clean the sieves and pan with brush and weigh them up to 0.1 gram accuracy.Arrange the sieves in the increasing order of size from top to bottom as shown in table 1 Keep the required quantity of soil sample on the top sieve and shake it with mechanical sieve shaker for about 5 to 10 minutes care should be taken tightly fit the lid cover on the top sieve. After shaking the soil on the sieve shaker,weigh the soil retained on each sieve.the sum of the retained soil must tally with original weight of soil taken. We have done sieve analysis to to get required size material passing 2mm and reatining 1mm of sieve. Total 3 trails were done and the details were mentioned in the below along with figure 1(a,b,c,d,e,f,g).

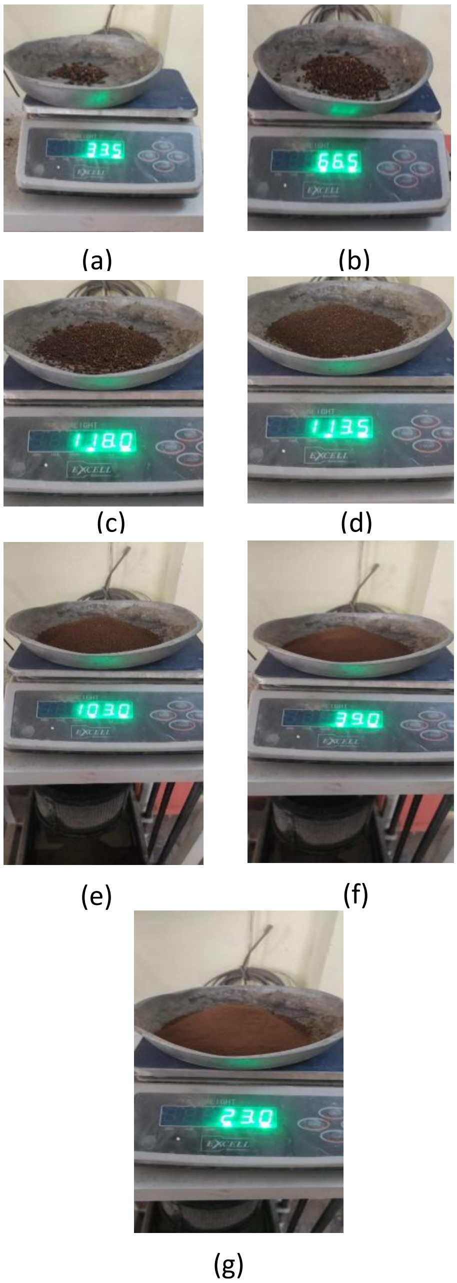


Fig. -1: Sieve analysis of red soil

Specific gravity is defined as the weight of soil solid at a given temperature divided by the weight of an equal volume of distilled water at that same temperature.

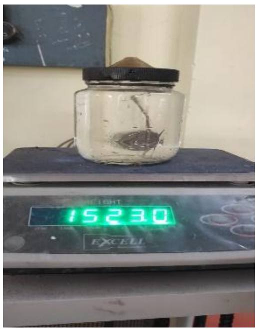
$$\text{Specific gravity (G)} = \frac{(W2-W1)}{(W2-W1)-(W3-W4)}$$

Along the conical cap and washer, the pycnometer is cleaned, dried, and weighed (W1).One-third of the pycnometer is filled with oven-dried soil collected directly from desiccators, and the weight is determined using a cap and washer (W2). The pycnometer is filled halfway with distilled water, stirred with a glass rod, and then filled to the brim with more water. The screwcap is weighed after being filled with water flush through the hole in the conical cap (W3). The pycnometer is cleaned and filled with distilled water until the surface of the water is flushed with the screw cap hole, and then it is weighed (W4). The temperature of the water is recorded. Figure 2(a,b,c,d) contain all of the pertinent information.

(a)

(b)

(c)



(d)

Fig -2: specific gravity

Fig -3: Test setup

A hallow rectangular beam is taken of size length 700mm, width 50mm and height of 50mm and is placed on the building frame model below it pile a 30cm pile is embedded in cohesion soil. Place a hangar at the center of the beam add weights gradually from lower to higher load along with hanger place three dial gauges one at center of beam and remaining 2 dial gauges placed on both sides of pile cap. By adding load at center of the beam the dial gauge show deflection values and note down. And Plot the graph between load vs deflection. As the loads gradually increases the dial gauge shows the displacements produced in both sides of the piles and plot graph for both.

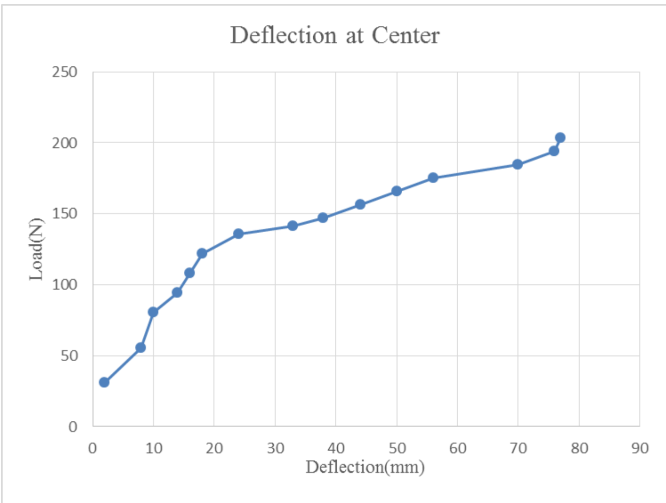


Fig. -4: Beam deflection

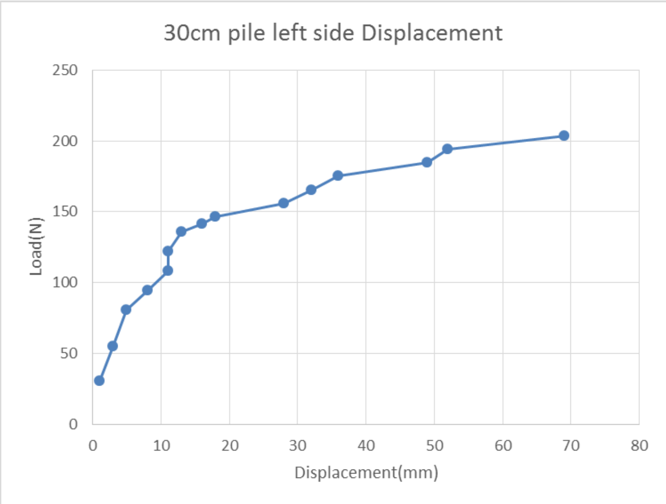


Fig -4: Displacements of pile left (30 cm)

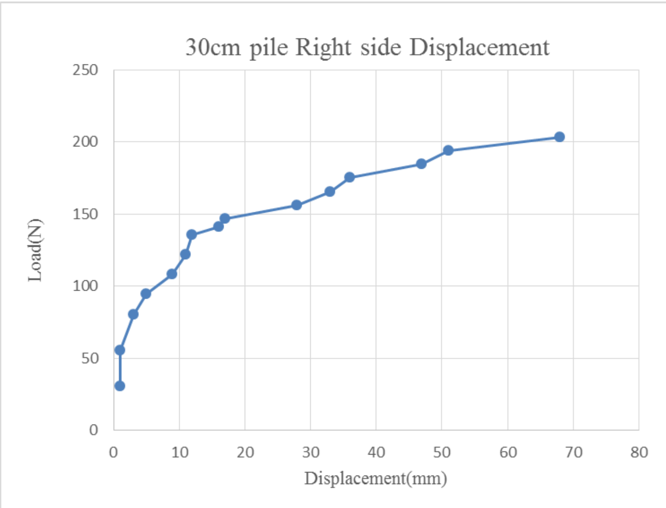


Fig -5: Displacements of pile right (30 cm)

3. CONCLUSIONS

The top displacement of the frame is significantly affected by soil-structure interaction. When the effect of SSI is considered, displacement increases in the range of 97% - 230% for the conventional analysis, i.e., fixed base condition. The displacement at the top of the frame decreases as pile spacing increases. The configuration of the pile group has a significant impact on displacement. The series arrangement is more rigid than the parallel arrangement. The diameter and number of piles in a group with the same arrangement are critical. Increases in these two parameters increase the stiffness of the pile group, resulting in a decrease in displacement.

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