Seismic Analysis of Group Action of Piles with Different Variations in Dimensions and Parameters: A Review

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A B S T R A C T

According to current construction needs, many projects are running, such as subway construction, bridges, building construction, industries, and so on. For this type of construction, where the soil conditions (SBC) are very low, the foundation of the pile must be provided. Dynamic analysis should also be performed for different groups of earthquakes. The resting effect of the tension increases with the group action of the piles.In the present study based on the different research carried out different researchers on the pile group. Under this analysis is based on the variation in para metric data used in the pile groups. The variation are included geometrical properties, grouping mechanics and arrangement method of analysis, mode of axial load applied, software used etc. The paper concluded that group action pile is necessary to ansysis so that it can be used by taking desirable arrangement based on the purpose and cost of project. It also say that new invention and method of arrangement is also analyzed in future so that it increase the strength in a minimal cost.

Keywords:.Pile, Group action of pile, SBC, pile group

1. Introduction

Seismic analysis is related to calculation of the response of a building or other structures under earthquakes It is a part of the process of structural design which includes earthquake engineering or structural assessment and retrofit in regions where earthquakes are prevalent. During earthquake many of the buildings collapse due to lack of understanding of the inelastic behavior of structure. Elastic analysis gives only elastic capacity of the structure and indicates where the first yielding occurs. This is applicable for wind analysis too. It cannot give any information about redistr ibution of forces and moments and failure mechanism. For study of inelastic behavior of structure nonlinear analysis is necessary. For structures used in transportation such as box culvert, inelastic behavior changes slightly and it gives optimum results.

The development of rational methodology that is applicable to the seismic design of new structures using available ground motion. Information and engineering knowledge, and yet is flexible enough to permit the incorporation of new technology as it becomes available has been supported for sometimes now. The major focus of several major research and development has efforts throughout the world. In majority of cases nonlinear analysis is used. Earthquake or seismic analysis is a subset of structural analysis which involves the calculation of the response of a structure subjected to earthquake excitation Major seismic input includes, ground acceleration, velocity/displacement data, magnitude of earthquake, peak ground parameters, duration etc. Pile foundation falls under the category of deep foundation. Pile group is a combination of pile having pile cap that is normally in contact with soil. Load applied on pile cap is distributed to individual pile. The ultimate capacity of pile group is the addition of the individual capacity of piles. A pile foundation can be constructed using different materials such as timber, concrete or steel. Pile foundations are mainly used transfer to the column. And its foundation mostly used that places ,where weak layer of the soil example marshy area, tall building, offshore platform, defense structure, dams and lock structures , transmission towers .the pile foundation proves advantageous in reduce, permeability, shrinkage, swelling, swelling pressure, improve soil bearing capacity. The pile foundation causes of lateral forces in wind action, wave action, traffic and wind movement, water pressure, with stand blasts, lateral pressure, ground movements, earthquakes.

Group Action of Pile: Load acting on a pile is of higher magnitude then instead of providing single pile, group of pile are u sed. Fig.(a) showing load acting on single pile with stress bulb. Fig.(b) showing load acting on group of piles and a combined stress bulb is formed which is summation of individual pile stress bulb.

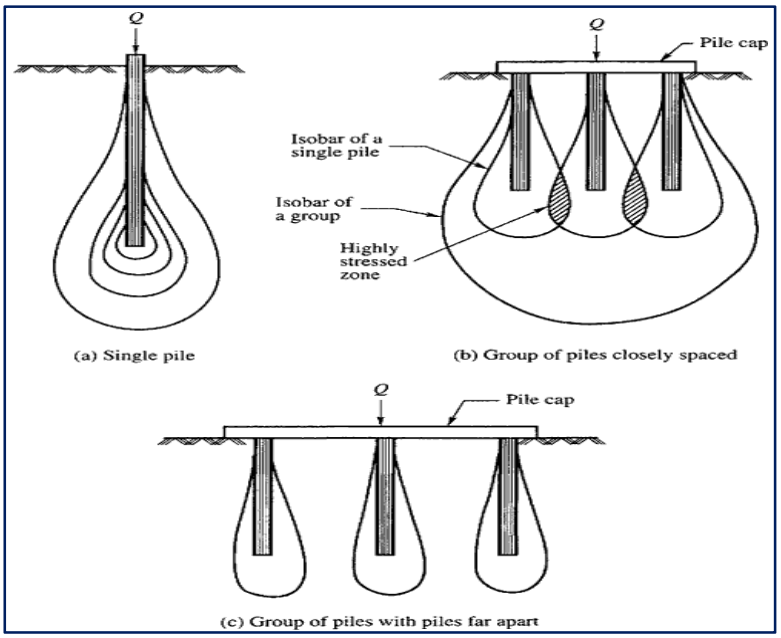

Fig.1 Group action of piles with stress zone effect (Ref. abuildersengineer.com)

Now the combined action of piles is termed as Group action of pile used the different diameter pile for determine the group action of pile. The results are summarized in different result for the Staad Pro analysis by fem methods of pile group. So the arrangement also emphasis on t he group action of piles, referred the other software like FLAC and the data are to be get with the help of P-Y curves for influence of pile. The effects of pile cap with variation of thickness are discussed in it and deal with lateral and vertical loads on it with cohesive and non cohesive soil types in it. The group action of pile are based on different arrangement, method , different dimensions, soil types , analysis method on which the different researchers deals with group action of pile and pile cap.

2. Literature Review

The Study of pile and pile group following repute articles are studied which are based on use of different software used in t he study such Staad pro, etabs, safe etc and different parameters. The Summarized reports of literature review are as described below:

AsimGoswami, Soumya Roy (2019) In the present work, an empirical relation has been developed to predict the ultimate load carrying capacity of vertical piles subjected to combination of both vertical and lateral load in cohesion less soil. Effects of lateral load on vertical load deflection behavior of vertical piles when axial loads are present are discussed through several experimental results obtained from tests on model piles. Ultimate capacity is found to be a continuous function of ultimate lateral load, ultimate vertical load capacity and tangent of angle of resultant load made with vertical axis of pile. The present work provides results of model vertical pile tested under controlled conditions for load displacement and ultimate resistance under central inclined compressive loads. Present work was intended to study the assumed simple but rather complex behavior of a single pile-soil interaction mechanism under different inclined loading system. The final conclusion are made that Polar bearing capacity diagrams suggests that bearing capacity of vertical pile is a function of applied load inclination angle, θ, vertical pile capacity, and ultimate lateral load carrying capacity of vertical pile. Determination of ultimate bearing capacity of vertical pile subjected to load combination of vertical and lateral load would be under safe if one or the other component Pcosθ or Psinθ is neglected or assumed to be zero for predicting ultimate capacity of a vertical pile subjected to a general loading condition.

Panchal and Rangari (2019) The researchers worked on behavior of pile foundation for a bridge pier in a cohesion less soil ,piles arranged in group of 3 and 4.The shape of pile cap consist of triangular and square for 3 and 4 respectively. The pile systems are subjected to lateral loads. The piles are arranged in series and non series and comparison is carried out between the two. The parameters of study are axial force, shear force and bending moment analyzed on staad.pro using finite element method. It is concluded that maximum value of taken parameters are obtained for series arrangemen.

Kushal M. panchaland, sunil M. Rangari (2018) This present paper studied the behavior of the piles in group arranged in series subjected to dynamic load due to earthquake. Various combinations of group piles in series like 2 piles, 3 piles and 4 piles are considered for various spacing 2D, 3D, 4D, 5D and 6D, where D is the diameter of the pile. The pile foundation is assumed to be enclosed within cohesion-less soil and soil properties are considered from a live soil report and similarly the load applied is also considered from the same live project report. The models are analyzed in the finite element method based software naming STAAD Pro. to obtain the responses such as deflection, axial force, shear force and bending moment for piles in group.

While pile cap is analyzed for bending moment in „x" and „y" direction. It is seen that deflection increases till a certain length of pile and then reduces as the length increases for all cases and it is also noticed that deflection is more for the closely placed piles. Similarly it is noticed that axial force increases as the length increases for all cases. However, bending moment and shear force decreases as the length of piles increases for all cases and maximum value is observed for closely placed piles.

Stefano Stacul, NunzianteSqueglia&et. al. (2017) The research consist a hybrid BEM-p-y curves approach was developed for the single pile analysis with free/fixed head restraint conditions. The method considers the soil non-linear behavior by means of p-y curves in series to a multi-layered elastic half-space. The non-linearity of reinforced concrete pile sections, also considering the influence of tension-stiffening, has been considered. The model reproduces the influence of suction by increasing the stress state and hence the stiffness of shallow soil-layers. Suction is modeled using the Modified-Kovacs model. The hybrid BEM-py curves method was validated by comparing results from data of 22 load tests on single piles. In addition, a detailed comparison is presented between measured and computed data on a large-diameter reinforced concrete bored single pile.

Suneethaand Prasad (2017) The paper analyzed on pile foundation in black cotton soil. As black cotton soil shows anonymous behavior with temperature variations. It has a tendency to shrink during summers and expands a lot during monsoon which affects the super structure. In this paper authors have designed a foundation which will protect the structure from ill effects of black cotton soil. For study G+ 2 storey"s is chosen and analysis is done by both software and manually.

Reddy and Kala (2017) In this articles the modeling is modeled on G+5 building in a clay and sandy soil taking live, dead load and weight of structure. Using Staad pro modeling and foundation design is done .The support reactions derived from Staad pro is applied in. It was concluded from their research that sandy soil possesses more bearing capacity than clayey soil. Also in clayey soil the vertical settlement in isolated footing is more than embedded pile. Pile foundation of sandy soil shows more vertical settlement as compared to isolated footing.

Thadapaneni and Ganesh (2017) The research article used various methods to analyze the vertical and horizontal loads applied on structure. To calculate vertical load-Y curve and Vesic"s method are used taking cohesion less and cohesive soil. Piles are considered as linear elements and soil interaction effect is taken assuming Winkler soil spring. Using IS code 2911 lateral and vertical sub grade modulus is derived. Using finite element method in Staad pro lateral load is derived; also L-pile software and Brom"s method are used.

Thadapaneni and Venkataet. al. (2017) The researcher examined the pile subjected to lateral and vertical loads subjected to deflection using finite element method. The vertical loads in piles are distributed in two parts, namely skin friction and end bearing at the base. Using static analysis on c-φ values, ultimate bearing capacity of vertical load in pile is determined for cohesive and cohesion less soil. The deflection occurred in pile is checked using Staad pro software. Calculations for Lateral load carrying capacity, depth of fixity and maximum moment in pile are done using IS Code 2911(Part I/Sec2).

Sreeshna (2016) The paper includes a simple experiment on B+G+4 building modelling and analysis on Staad pro software using a pile foundation. For calculating dead and live load IS:875 (Part I)- 1987, IS: 875 (Part II)-1987 are referred respectively. The structural components like beam column staircase, slab, shear wall, retaining wall

Zhang et .al. (2016) This research used of FLAC-3D software,3D-Lagrangious analysis is performed in which concrete Piles and different cap size and length subjected to lateral load are investigated using numerical Simulations. With this P-Y curves are drawn and influence of piles on these curves was analyzed, it was concluded that with increase in pile cap soil resistance increases. the authors also discussed about the effect of cap on soil with different length.

Jayarajan and Kouzer (2015) In this study worked upon raft foundation analysis taking into account the pile-soil-pile and pile-soil-cap interaction. They discussed about the combined piled raft foundation by calculating relative proportions of load taken by raft &piles, the effect of piles on total and differential settlement. The paper dealt with the analysis of CPRF by simplified methods and finite element analysis. The Software PLAXIS was used.

Cairo and Chidichimo (2011) The article discussed about the waves generated by seismic forces through the soil. With these waves kinematic effects are introduced on pile foundation. For this author used lumped –mass parameter models to get the value of kinematic response of pile and P-Y curves are obtained. To affirm the approaches theoretical and experimental comparisons

Devi's and Sawant (2009) The study is based onselection of cohesion less soil and used two grouping arrangements, 3 and 4 pile groups arranged in series. Response of foundation head is considered displacement at top of the pile group and bending moment in pile. Various parameter of the pile group such as pile spacing, pile size, and configuration of the pile group on the behavior of the pile group.

Bhattacharya and Madabhushi (2008) The author talks about the damage to pile supported structure in a liquefiable soil due to Earthquake. Pile foundation have shown a poor performances again earthquake two Importance theories of pile failure are discussed namely flexural mechanism and

buckling Instability. The applied both theories so as to see and compare the better performance of pile Foundation.

Teerawut and Scott (2004) In this paper used to full scale lateral spreading experiments were conducted a pile foundation .the port of Teach, Hokkaido, Island, Japan, and single pile use in its foundation . Group of four pile & nine pile group. In this paper some result from the test. Method are used P-Y analysis method analyzed the pile response during lateral spreading. The calculated and measuring response of all types of pile foundations.

3. Conclusions

As per the study of different research on pile group by different researches which are mentioned above. It is concludes the following points.

- The construction industry need the pile foundation as major role for some huge structure such bridges, tall buildings so it is compulsory to analyze the seismic effects on pile before construction.
- The effective shape of pile is circular of pile proved most effective due to easy way to installed and friction produced.
- The soil condition like Low bearing capacity of soil. Make it necessary requirement of pile.
- The review of papers explained that Piles can be used in different shapes, size and spacing between them.
- The group action of piles can be Analysis by different software such Staad, pro, etbas, Analysis safe etc. It is easy to gets the results on software & time reducing concept.
- The different arrangement of pile groups such group of 2,3,4,6,8etc are taken by different researchers. The effect show that regular square &rectangular arrangement is efficient in group action.
- Impact of load pattern also applied to find resting capacity of group of pile in terms of axial load.

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