Analysis of Cavities on Performance of Shallow Footing: A Review

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***Abstract* : The stability of any structure depends on bearing capacity of foundation soil, which plays major role in geotechnical engineering. The bearing capacity will change with presence of minerals in soil, with level of water table and with presence of cavities or voids in soil. Design of geotechnical structures over an underground voids is one of the key challenges faced by geotechnical engineers. Voids can occur in subsoil due to many reasons like tension cracks, settlement of localized pockets, melting of subsurface ice etc. Different parameters of voids and their influence on bearing capacity are studied numerically using software PLAXIS 2D**

Keywords: Stability, cavities, Shallow footing, Bearing Capacity, PLAXIS 2D.

I. INTRODUCTION

Natural soil deposits are stratified and have erratic and varying properties. There is abundant evidence that stratified soil deposits contain voids. The frequency of voids occurring under structures is high in areas having soluble rock formations and in areas having active mining operations. Voids can develop in subsoil due to many reasons like tension cracks in cohesive soils, settlement of localized pockets of compressible soil, differential settlement of municipal soil waste, melting of subsurface ice, settlement of poorly compacted backfill, collapse of underground cavities etc. The presence of void in the soil beneath the footing can cause instability to the foundation and thereby severely damaging the entire structure.

It has been reported that the soil below the loaded footing collapses in the form of a wedge into the underlying void. It is also reported that there could be three modes of failure such as, bearing failure without void failure, bearing failure with void failure and void failure without bearing failure. If a void is located in the subsoil the most economical solution is to place the foundation at a suitable depth so that the depth of void below the foundation is more than the critical depth and the presence of void does not affect the proposed foundation. If the thickness of soil above the void is less than the critical depth, an additional layer of reinforced granular soil should be provided on the ground and over this the foundation must be placed.

The presence of underground voids can cause serious engineering problems leading to instability of foundations incurring structural damages .The severity of damage depends on the degree of vertical as well as lateral proximity of the voids.

The alternatives available to a geotechnical engineer are (a) filling up the void with a suitable bearing material (b) using piles and caissons to penetrate to a depth beyond the void and to bear on soil or rock (c) excavating and placing the footing below the void and (d) shifting the foundation away from the void. These alternatives may be either impracticable or expensive or 2 infeasible. It is desirable to have a systematic analytical approach to design a stable foundation above a void.

II. LITERATURE REVIEW

Jaymohan J et al. (2016) : A series of finite element analysis is done using PLAXIS2D software to investigate the improvement in bearing capacity of strip footing resting on a weak clayey soil with voids due to the addition of reinforced foundation bed. Results are validated using laboratory plate load test. Results were that effect of void is considerable only when located within a critical depth and critical eccentricity and also the use of reinforced foundation bed improved load settlement behavior [1].

A. Asakereh et. al (2011): A series of laboratory model test on strip footing supported on unreinforced and geogrid reinforced sand with an inside void is considered. Influence of parameters such as embedement depth of void, number of reinforcement layers, amplitude of cyclic load were studied. Results were that settlement increased when void is placed at failure zone and settlement decreased with increasing distance of void and increasingreinforcement layers [2].

Thore Rehka Lahanu et. al (2021): Different parameters of voids which affects the stability of foundations such as number of voids, shape of voids, size of voids, spacing between void, depth of void, arrangement of voids and load inclination were studied using software PLAXIS2D. Bearing capacity ratio (BCR) were found to increase with increase in crest depth of cavities and tend to decrease with increase in size of cavity and also circular cavity possess highest BCR than that of cavities of other shapes [3].

Tarek Mansouri et. al (2021) : The effect of underground circular void on strip footing placed on the edge of a cohesionless slope subjected to eccentric load were studied using a series of laboratory scale load test. Each test were carried out thrice using parameters such as vertical distance between void and footing, load eccentricity and horizontal distance of void from footing

centre. The results prove that influence of void has an influence on the stability of strip footing and also voids appeared insignificant when it was positioned at a depth or eccentricity equal to twice the width of the footing [4].

M Ramachandran et. al (2020) : the effect of underground circular void on strip footing placed on edge of cohesionless slope subjected to eccentric load. A series of laboratory scale load test were conducted and each test were carried out thrice using parameters such as vertical distance between void and footing, load eccentricity and horizontal distance of void from footing centre. The results prove that stability of strip footing is influenced by underground void and also void has negligible effect when it was positioned at a depth or eccentricity equal to twice the width of footing. [5].

Dr Sunil S Pusadkar et. al (2017) : Numerical investigation is done to find the bearing capacity of surface strip footing on C-Φ soil with multiple square voids using PLAXIS 2D software. Different parameters of voids considered were width of void, embedement depth and horizontal and vertical spacing between voids. It was concluded that as the size and depth of void increases the bearing capacity decreases and the voids in single row influences more thanthat in other positions [6].

M. C. Wang et. al (1985) : Numerical analysis is done using 3D finite element analysis programme to study the effect of underground void on stability of shallow foundation supported by compacted clay in kaolinite soil. Different conditions like footing shape, void shape, orientation of void with respct to strip footing axis and void location were analysed and it was found that void has effect on stability only when located above critical depth and this critical depth varies as the soil and void parameters varies[7].

Djamel Saadi et. al (2020) : experimental analysis is done using a test model designed in the laboratory to find the effect of cavities on bearing capacity of two interfering footings based on granular soil. Parameters used in the study includes spacing between footings, distance between footings and cavities and between cavities axes. The results here indicated that the impact of cavity is eliminated when the distance between footings and cavity is greater than 3[8].

Ali A. Al-Jazaairy et. al (2017) : Finite element software PLAXIS is used to understand the behaviour of strip footing located above cavitied soil. Load carrying capacity was analysed using the result and it was also clear that the cavities lying below the critical depth have minimal effect on foundation stability and those above critical depth depends upon factors like location andsize of cavity and depth of footing [9].

A. A Khalil et. al (2009) : Finite element analysis programs like PLAXIS2D and PLAXIS3D is used to study the effect of cavities on foundation stability. Effect of parameters like shape, size, sectional area, location and depth of cavity on settlement and stress distribution was studied on isolated square, strip and round footing were considered. Results indicated that shape and volume of cavity influence the settlement and stress concentration when located at depth less than twice the width of strip foundation [10].

III. CONCLUSIONS

The following conclusions are deduced from the literature study:

- Effect of cavities have a significant effect on the foundation stability.
- Effect of cavities is considerable only when located at a critical depth and critical eccentricity
- Use of reinforced foundation beds tend to improve the load settlement behaviour of the foundation subjected to cavities.

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