# Response of Bearing Capacity of Footings Resting of Fibre-Reinforced Pond Ash Overlying Soft Clay: A Review

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***Abstract*— The disposal of pond ash and building on soft clay are currently two of the biggest issues facing the construction sector. There are several studies being done all over the world to improve the characteristics of clayey soil. Fly ash, pond ash, and other industrial wastes are utilised to increase the strength and bearing capacity of soil. This paper examines a comparison of the bearing capacities of strip footing and circular footing when placed on soft clay utilising fiber-reinforced pond ash. The effects of variables including pond ash layer thickness, fibre length, and the proportion of fibres in the randomly distributed fibre reinforced pond ash (RDFP) layer are studied in model footing tests of strip footing and circular footing sitting on a RDFP layer covering soft clay.**

***Keywords—Fibre-reinforced pond ash; model footing test***

## I. INTRODUCTION

About 200 million $m^2$ of land are covered in millions of tonnes of pond ash in India. Due to the creation of leachate compounds, which contain harmful elements, the soil and adjacent water bodies get contaminated. Engineers have a difficult time determining the optimal location in the building industry to use industrial waste, such as fly ash and pond ash. Pond ash is a waste substance that is produced as a by-product of thermal power plants. Its disposal presents significant environmental challenges and calls for several disposal sites. Actually, fly ash, bottom ash, and pond ash are the three types of ash that thermal power plants create. Compared to the other two ash types, the amount of pond ash produced by thermal power stations is relatively considerable. Throughout the world, there is still a significant issue with how best to utilise pond ash. Pond ash has potential uses in a variety of settings, including structural fills and highway embankments, to help alleviate the issue. Compared to natural soil, pond ash is a self-draining and lightweight material. Understanding the fill material's compaction characteristics is crucial for the successful application of pond ash as a fill material in civil engineering work.

The disposal of pond ash and building on soft clay are currently two of the biggest issues facing the construction sector. The qualities of clayey soil have been the subject of several investigations. Numerous research used waste products including rice husk ash, fibres, and cement in experimental programmes to improve the varied qualities of clayey soil. The conventional method of increasing the bearing capacity of soft clay is to replace some of its thickness at the top with granular material, but this results in a huge heap of the granular material, which again necessitates the use of large amounts of granular material and indirectly raises the project's cost.

The problem of the land needed for its deposition can also be resolved by using industrial hazardous waste, such as pond ash, to strengthen the soft clay (weak soil). Pond ash, a by-product of coal-based thermal power plants whose production rate is rising daily, might be used in large quantities as a foundation material, which would solve the issue of how to dispose of it.

## II. LITERATURE REVIEW

A series of cyclic plate load tests and a number of numerical simulations were performed by Chowdhury, *et al.* (2021) to study the settlement behavior of circular footing on geocell and geogrid-reinforced pond ash bed The findings indicated that the maximum settlement reduction of circular footing for geocell-geogrid-reinforced pond ash bed is around 46.4% and 35.4% in the presence of water table for vertical and horizontal directions, respectively.

Model footing tests with circular footing resting on a randomly distributed fiber-reinforced pond ash (RDFP) layer overlying soft clay was conducted by Kumar *et al.* (2020). They evaluated the impact of altering the thickness of the pond ash layer over soft clay, and they also looked at the strengthening effect by incorporating polypropylene fibres of various lengths with changing content percentages. This study examined whether employing a significant amount of industrial waste instead of soft clay was feasible. The findings demonstrated that adding a layer of granular waste material on top of soft clay can boost its load bearing capability, solving the issue of disposing of industrial waste as well. The results indicated that there is significant improvement in the ultimate bearing capacity with an increase in fiber length, fiber percentage, and RDFP layer thickness. The results also indicated that there is significant improvement of 80% in ultimate bearing pressure when soft clay at the top is replaced by a compacted pond ash layer of 1.5D thickness. The ultimate bearing pressure increased 54% with an increase in fiber length from 6 to 18 mm for a 1.5D thickness of the RDFP layer at 1% fiber content. The results were validated with PLAXIS 3D software.

Arora *et al*. (2019) examined the circular footing's bearing capability when it was resting on fiber-reinforced pond ash on top of soft clay. The study examined the effects of varying the pond ash layer's thickness on soft clay. The strengthening effect was also investigated by adding polypropylene fibres of various lengths and content percentages to the pond ash layer that lies on top of soft clay. The final bearing pressure was found to increase by 54% when the fibre length was increased from 6 to 18 mm. The ultimate bearing pressure is greatly increased by 80% when the thin layer of soft clay at the top is replaced with a 1.5D thick layer of compacted pond ash. The numerical simulations for the study were run using the PLAXIS 3D programme.

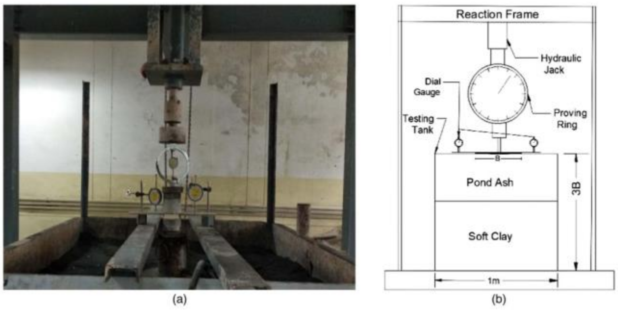


Fig.1 (a) shows the experimental setup and Fig. 1 (b) shows the schematic representation of the experimental setup.

The theoretical equation for the bearing capacity of a circular footing resting on layered soil profile using punching shear failure mechanism following projected area approach is presented by Joshi *et al*. (2015). For the analytical portion, the actual shape of failure was assumed to be a linearized curve for the purpose of the frustum, and a bearing capacity expression was derived under specific assumptions. After analysing the stresses on the frustum, a series of integrated bearing capacity equations were generalised. The features of the top and lower layers have been used to develop the proposed bearing capacity equation. The parametric study was later completed. The parametric study's findings were compared to the available equations. The experimental findings were used to validate the results. The findings obtained were in good agreement with the plate load tests performed by Ibrahim (2014), indicating that the suggested equation is effective, in contrast to Meyerhof's (1974) equation, which overestimates the ultimate bearing capacity for high values of load spread angle.

## III. CONCLUSION

The following conclusions are obtained from the literature study

- Placing a layer of granular waste material on top of soft clay will boost its ability to support weight.
- The bearing pressure increases as the thickness of the top, strong layer increases because the pressure over the bottom, weak layer decreases.
- The bearing pressure was 145.4 kN/m$^2$ for a 1.5D thick layer of pond ash over soft clay, which is 80% more than the bearing pressure of 79.5 kN/m$^2$ when the footing was only supported by soft clay strata.
- Fibers with an ideal content tend to link soil particles and spread stresses over a broader region, raising the ultimate bearing pressure.
- At 1.5D thickness of the RDFP layer with 1% content of 18 mm fibres, a bearing pressure of 460.2 kN/m$^2$ was discovered, 162% higher than the bearing pressure of 175.5 kN/m$^2$ noticed at 0.5D thickness of the RDFP layer with 0.5% content of 18 mm fibres.
- With the 18 mm fibre length, the ultimate bearing pressure improved the most.
- In comparison to the bearing pressure of soft clay, the bearing pressure of soil mass increases by 11.3%, 24.9%, and 40%, respectively, when the depth of the unreinforced pond ash layer increases from 0 to 0.5B, 1B, and 1.5B.

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