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Improving the Bearing Capacity of Circular Footing on Silty Clay with Pond ash Pile in Skirt

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Abstract—*As India is a developing country, so energy production demand is increasing at an exclusive rate. To meet this energy demand, thermal power plants which use coal as combustible material are increasing in number. These thermal power plants produce pond ash which needs a lot of space for disposal. This waste is considered as a threat to water as well as soil environment. It can also produce particulate matter as major air pollutant. In this paper extensive research was done for examining the behavior of mild steel skirt with pond ash as a fill material. Improvement in bearing capacity and reduction in settlement of soil was significantly observed by the use of pond ash as a fill material.*

1. INTRODUCTION

Pond ash, the by-product of thermal power plants is taken into account as solid waste and its disposal may be a major drawback from atmosphere point of view and additionally it needs lot of disposal areas. Utilization of pond ash to the utmost potential extent may be a worldwide problem, to resolve the matter, pond ash may be used as a structural fill for developing low-lying areas to construct structures on it. There are 2 varieties of ash produced by thermal power plants, viz., and bottom ash. These 2-ash mixed together are transported to the ash pond and this residue is named pond ash. Improvement of load bearing capacity of foundation with incorporating of pond ash as fill material was investigated by various researchers. The skirts form an enclosure in which soil is strictly confined and works as unit. Skirt foundation a new technique, bearing capacity is the prime significance for the strength of structures. Skirt acts as confining cell that restrained the soil and averts the failure of structure. The problem of bearing capacity of shallow foundations has been wide mentioned within the geotechnical engineering literature, until currently various strategies are given for determination of bearing capacity of foundations embedded in soils. Most of standard strategies are supported a limit equilibrium approach. supported the limit equilibrium theory, a general shear mechanism is assumed inside homogeneous soil beneath strip footing. The footing bearing capacity is then determined supported static equilibrium of the soil wedge shaped beneath the footing. therefore, the quantity of bearing capacity is directly dependent on the length of slip lines i.e. a lot of extended slip lines yield larger bearing capacity. a rise within the length of slip lines is also achieved by increasing either the footing width or embedment depth. Usage of structural skirts that encompass the soil beneath footing might also be economical. In addition, there are many investigations which were carried out to enhance the load bearing capacity of soft soil by adopting the soil reinforcement technique as presented by [7]. [1] worked on improving bearing capacity of footing on soft clay with fill material as sand. the study revealed improvement in bearing capacity by using sand as fill material with skirts.

Various researchers have examined that mixing of pond ash with soil has wide applications such as for under foundation material, fill material and embankment construction. These studies particularly focused on evolution of effect of pond ash as bearing capacity of soil. A.B listyawan [9] investigated effect of skirt on circular footing performance in resisting vertical load on clay soil. Result showed that skirt effectively reduced the foundation settlement on clay.in this study pond ash was used as fill material with skirts or confining cells.

2. LABORATORY MODEL TESTS

2.1. modal box

The setup consists of a circular tank, mild steel footing, proving ring and dial gauge. Suggestions from various research papers were taken to decide size of tank. Chumar (1973) suggested, maximum extension of influence of failure zone will be 2.5 times of footing width along the side and 3 times the width of footing below. From these suggestions 400mm height and 300mm diameter was taken. To maintain the same effects, wall of tank was kept rigid.

2.2. **Modal footing;** modal footing used in this study was made of a steel circular plate of diameter 100 mm and 10 mm thickness using epoxy glue and fixing thin layer of sand on to the base of modal footing base condition become rough.

2.3. **Structural skirts;** hollow circular mild steel pipe with sharp edge is used as confining cell with thickness of 3mm and different heights. The internal diameter of the skirts or confining cells is 105 mm.

Figure 1 structural skirts

3. TEST PROGRAM AND METHODOLOGY

To avoid the compaction effort first, the pond ash bearing layer is placed at bottom of the circular tank in layers till 180 mm height, keeping in mind the interference zone. The soil used in this research is silty clay coming from district Ludhiana of pamal village. The soil was first pulverized and then mixed with water content in such a way all soil particles gets uniform mixed with water content. Then place the soil in tank with 5 layers and giving 92 blows for each layer with the help of IS heavy. For each layer the required amount of soil to produce a desired bulk density was weighted out and placed in the test tank with the help of core cutter like apparatus, the soil was levelled out and compacted to achieve specific density. The pond ash of about 61kg is weighed and is stuffed in 50 mm thick layers into the model tank and is compacted to achieve the overall depth of 200 mm and is to be maintained constant throughout the testing program. The silty clay is pulverized and passing through IS 4.75-millimeter sieve is employed for the testing. regarding 25kg is measured and mixed fully with water content of 20% therefore as to get maintain the maximum dry density of 15.25 KN/m3. The soil is stuffed in layers of thickness 40 millimeter every layer and compacted to needed field density to a depth of 200 millimeter. The skirts are embedded to the desired depth and therefore the soil is taken out from the inner area of the skirt. The skirt is stuffed with pond ash by compacting in layers of thickness relying upon length of skirt. The model tank of size 400mm * 300mm is loaded on triaxial testing machine with hydraulic jack mechanism. After installation the soil bed, the circular footing is placed at the studied location with skirts to predetermined depth. The load was applied by manually using triaxial testing setup the load was applied in small increments, the settlement of skirted footing on replaced fill with skirts was measured using dial gauge.

Table 1 properties of soil

Soil classification	CL
Specific gravity	2.64
Liquid limit (%)	42
Plastic limit (%)	25
Plasticity index (%)	17
Water content (%)	18
Bulk density (kN/m^3	18.3
Dry density (kN/m^3	15.25

Figure 2 charging of pond ash

Table 2 properties of pond ash

C_U	3.52
C_C	2.16
D_{10}	0.33
D_{30}	0.40
D_{60}	0.62
Specific gravity (G)	1.98
Optimum moisture content (%)	40
Maximum dry density (kN/m^3)	12
Maximum shear angle (ϕ)	29^0

3.1. Testing parameters

Experimentations were conducted to analyze the behavior of skirted footing on replaced pond ash column.

A series of tests were performed on skirts without pond ash and with pond ash column in this study.

4. RESULTS AND DISCUSSION

A total of ten modal tests are conducted. The research is conducted in same water content and compaction method. The result of the investigation shows load settlement curves for all model footing. Load settlement curves for without pond ash column

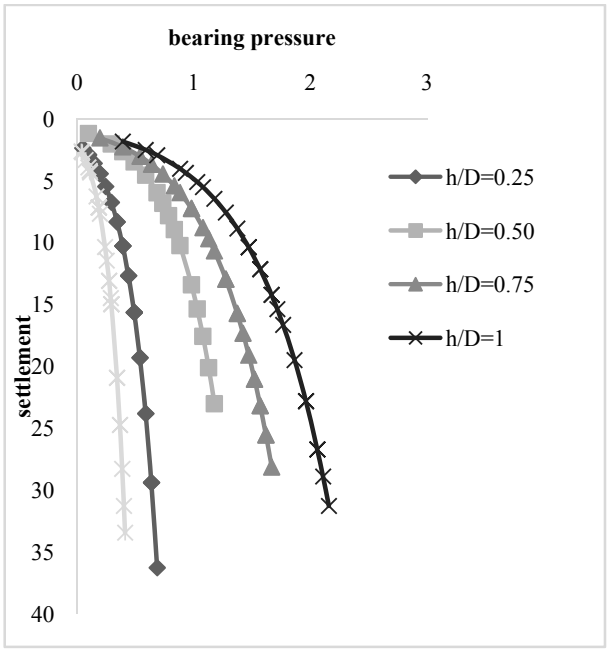

Figure 3: load settlement curves for skirts without pond ash column

it is evidently known from the figure 3 the presence of skirts can greatly modify the stress settlement curves, the bearing capacity is increased with increases of skirt length, due to the increase in area the skirt gives resistance due to sleeve friction between clay and skirt (pipe). This resistance incorporates on minimizing the settlement due to vertical loading. As the skirt get longer, the area of shaft also increases consequently the resistance also increases to produce a smaller settlement.

4.1 Effect of pond ash with skirts

The presence of skirts with pond ash as fill material improves bearing capacity extensively. The confining cells minimized the lateral movement and acted as restraint for partial replacement of pond ash column inside the skirt and it prevents occurrence of bulging. It was observed that as the depth of silty clay increases the bearing capacity also increased.

4.2 load in similar settlement as reference

It could be observed in the similar settlement in 5 mm and the results can be seen on table 3. Figure 4 shows the longer skirt the higher load in similar diameter. It obviously can be analysed that the longer skirt the larger area of resistant due to sleeve friction between cohesive soil and the shaft and end up with the magnitude of load gets higher. As shown in table 3, the higher h/D ratio the higher load in similar settlement 5 mm with different height.

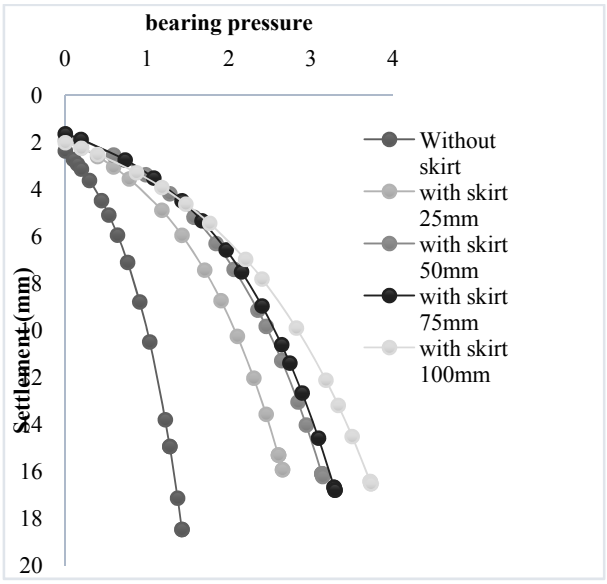

Figure 4 load settlement curves for skirts with pond ash

Table 3 load magnitude in similar settlement on 5mm

Footing dia mm(D)	Skirt length (h)mm	h/D	Load (kN)
100	0	0	0.55
100	25	0.25	1.10
100	50	0.50	1.50
100	75	0.75	1.90
100	100	1.00	2.10

Table 4 Settlement in similar load as reference 1kN

Footing dia mm(D)	Skirt length(h)mm	h/D	Settlement (S) (mm)
100	0	0	10.00
100	25	0.25	4.5
100	50	0.50	3.00
100	75	0.75	2.10
100	100	1.00	2.00

5. CONCLUSIONS

From the accomplished experimentation we derived some conclusions

- In cases where structures are terribly sensitive to settlement, soil confinement may be used to acquire a similar allowable bearing capacity at a much lower settlement.

- Increasing the height of the confining cell, leads to increasing the surface area of the cell–model footing, that transfers footing loads to deeper depths and leads to improving the bearing capacity.
- Skirts with pond ash improves bearing capacity considerably and reduces settlement.

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