Soil strength enhancement by adding of fly ash

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Abstract. Fly ash is an industry development and also freely available so we intend to apply it. This paper deals with the experimental have a look at on development of homes of expansive soil via fly ash replacement. Soil pattern used on this task is an expansive soil that is collected from Bachupally. By engaging in diverse assessments like plastic restriction, liquid limit, free swell index, unconfined compressive test (UCC) and California bearing ratio (CBR) we came to know that the soil sample is weak in shear, bearing and plasticity hence we repeated those experiments by replacing the soil sample with fly ash in various percentages like 10%, 20%, 30% and 40% and came to know that the soil properties are improved at 30% replacement like max dry density increased by 5.5%, plasticity index decreased by 25.4% and CBR value increased by 200%.

1. Introduction
In India, Nearly 20% of land is covered by using expansive soils. With the rapid development of industrialization and urbanization, the lack of land appears to be an imminent challenge. So building civil engineering structures on expansive soils, but, pose a primary danger to the shape in itself, due to the extra diploma of instability in such kinds of soils. Quantified in billions of dollars consistent with yr is the loss in belongings every 12 months globally thanks to the uncertainty inside the expansive soils. Dumping of fly ash has ended up turning out to be an emerging difficulty. India, as a growing us of a, is exceedingly depends on thermal flora based on coal for production of electricity, and this dependency isn’t going to falter every time quickly. Coal pulverization in these power plants generate many waste substances, consisting of fly ash. As of the year 2012, the generation of fly ash rose to one hundred thirty MT/12 months. However, best 56% of this generated fly ash wastes had been simplest applied. The residual fly ash is disposed off in locations, and this leads hazard to health, and the land region reduces which can be in any other case applied for functions apart from the disposal of fly ash. The following targets are studied. To determine the Atterberg limits of the clay pattern for exceptional probabilities of fly ash replacements (0%, 10%, 20%, 30%, and forty%), CBR cost of the clay sample for special probabilities of fly ash replacements the use of CBR take a look at, shear power fee of the clay sample through UCC check, swelling of the clay sample by means of free swell index test.
2. Methodology

Various tests were conducted on expansive soils to assess the effect of the fly ash as a stabilizing agent, in which the fly ash in the expansive soil was varied in values of 10% to 40% (multiples of 10) by weight of the total quantity taken. The following standard Indian codes were taken as reference for conducting experiments:

1. Standard proctor compaction test IS : 2720 (Part 7) - 1980
2. Unconfined compressive strength (UCS) test IS : 2720 (Part 10) - 1991
3. California bearing ratio (CBR) test IS : 2720 (Part 16) - 1987 20
4. Free swell index test IS 2720 (Part 40) - 1977
5. Liquid & Plastic limit test IS 2720 (Part 5).

Table 1. Soil properties for various fly ash percentages

| PROPERTIES            | 0% Fly ash | 10% Fly ash | 20% Fly ash | 30% Fly ash | 40% Fly ash |
|-----------------------|------------|-------------|-------------|-------------|-------------|
| Liquid limit (%)      | 73         | 69.5        | 61          | 59          | 54          |
| Plastic limit (%)     | 29         | 28          | 26          | 24.2        | 17.3        |
| Plasticity index (%)  | 44         | 41.5        | 35          | 32.8        | 36.6        |
| Max dry density (g/cc) | 1.62      | 1.662       | 1.69        | 1.71        | 1.675       |
| Optimum moisture content (%) | 25.6   | 22.7        | 18.4        | 14.3        | 12.6        |
| UCC (N/mm²)           | 0.197      | 0.195       | 0.206       | 0.170       | 0.170       |
| CBR (%)               | 2.53       | 3.80        | 5.83        | 7.61        | 8.85        |
| Free swell index (%)  | 100        | 50          | 40          | 20          | 10          |

Fig 1 comparison curves of compaction for various fly ash percentages
III. Results and Discussions

1. From the graphs it is clear that dry density increases up to 30% and then decreases, whereas optimum moisture content goes on decreasing. It is also observed that OMC value goes on decreasing upon fly ash replacement and maximum dry density value is attained at 30% fly ash replacement.

![Graph 1: Variation of Optimum Moisture Content for Increase in Fly Ash Content](image1)

![Graph 2: Variation of Maximum Dry Density for Increase in Fly Ash Content](image2)

2. Soil can take greater load up to 30% replacement and maximum CBR value is attained at 30% fly ash replacement from the above graphical representations.

![Graph 3: Variation of CBR Curves for Increase in Fly Ash Content](image3)

![Graph 4: Variation of CBR Values for Increase in Fly Ash Content](image4)
The above curve shows that liquid limit goes on decreasing upon fly ash replacement and the above graph shows that liquid limit goes on decreasing upon fly ash replacement.

Fig 6: variation of liquid limit curves for increase in fly ash content

Fig 7: variation of liquid limit values for increase in fly ash content
4. Plastic limit goes on decreasing upon fly ash replacement and FSI goes on decreasing upon fly ash replacement from the above charts.

From the above graph it is observed that the peak UCC value is attained at 20% replacement.
IV. Conclusions

On basis of the results obtained and comparisons made in this research paper, it is determined that the soil pattern is properly graded clay. The most dry density (MDD) cost of the expansive soil expanded until 30% substitute with fly ash. Then MDD values continuously decreased thereafter. The share of boom of mdd at 30% is 5%.

The superior moisture content material (OMC) goes on reducing with growth in fly ash content in soil. It reached the favored value at 30% alternative. The percent of lower in OMC at 30% is 44%.

Soil unconfined compressive energy (UCC) with variant of fly ash material decrease to begin with then it reaches the peak price for 20% substitute of soil by fly ash then it diminishes. Within the california bearing ratio (CBR) test conducted on soil performed with various fly ash content, the cbr price expanded gradually with the growth in fly ash content material until 30% substitute then it decreased thereafter. The percentage of boom of CBR at 30% is 2 hundred%.

The liquid limit and plastic limit of the soil is going on reducing with the increase in fly ash content material. It reached the preferred cost at 30% substitute.

The free swell index of the expansive soil decreases swiftly for 10% and 30% replacements. This expansive soil sample can be changed by using fly ash up to 30%.

V. References

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