# Assessment of engineering behaviour of coal ash for wider application in Civil engineering

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Keywords: coal ash, engineering behaviour, bulk utilization.
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The disastrous impact of coal ash on the environment and its current disposal systems brings the attention of the Civil engineers to determine its possible applications in construction sector. India is the second largest producer of coal after China that results in predominant contribution of coal in power generation. The burning of coal leads to the production of huge amount of coal combustion residue and their complete utilization is the present need of the hour. In India the amount of fly ash produced over a period of 25-year is approximately 3335.9 million tonnes (MT), of which only 55% (1834.83 MT) have been used and the remaining 45% (1501 MT) are still in their unutilized form (CEA 2022). This dependency on coal will take another 2-3 decades to minimize and to promote other green energy sources. Hence, the objective of the present study is to explore all the possible sector of Civil engineering that can support bulk utilization of different types of coal ash (fly ash, bottom ash, and pond ash). In order to cover all types of coal ash (i.e. fly ash, bottom ash and pond ash) the samples were collected from Nalco, Talcher, Renukoot and Rihand part of India. The physical and chemical characterization of all the coal ash has been done that can be seen in Table 1. Along with that the world and Indian coal ash behavior has also been critically reviewed in this study for better understanding. The coal ash usually consists of silt and sand size particles with the size range between 1-100 micron. The coal ash exhibits lower maximum dry density and higher optimum moisture content as compared with soil. The silica, alumina, and iron oxide contributes more than 85% among all chemical compounds. Under natural ground water levels and at temperatures below 4 °C, the use of coal ash must be avoided. It is recommended by IRC-SP-58 that the coal ash having density <0.9 g/cc should be avoided in embankment applications.

Table 1. Basic geotechnical properties of the considered coal ashes (Ram *et al* 2022).

| Properties | Fly ash (FA1) Renukoot | Fly ash (FA2) Rihand | Fly ash (FA3) NALCO | Bottom ash (BA) NALCO | Pond ash (PA1) NALCO | Fly ash (FA4) Talcher | Pond ash (PA2) Talcher |
|---|---|---|---|---|---|---|---|
| D90 (mm) | 0.16 | 0.19 | 0.13 | 0.14 | 0.32 | 0.15 | 0.165 |
| D60 (mm) | 0.09 | 0.12 | 0.075 | 0.073 | 0.165 | 0.065 | 0.093 |
| D50 (mm) | 0.08 | 0.095 | 0.07 | 0.07 | 0.135 | 0.06 | 0.085 |
| D30 (mm) | 0.018 | 0.072 | 0.062 | 0.055 | 0.08 | 0.03 | 0.072 |
| D10 (mm) | 0.004 | 0.0133 | 0.025 | 0.021 | 0.065 | 0.014 | 0.06 |
| Cu | 22.5 | 9.023 | 3 | 3.48 | 2.54 | 4.64 | 1.55 |
| Cc | 0.9 | 3.25 | 2.05 | 1.97 | 0.59 | 0.99 | 0.93 |
| SPAN | 1.95 | 1.86 | 1.5 | 1.7 | 1.88 | 2.27 | 1.24 |
| Sand (%) | 52.5 | 67 | 37.5 | 35 | 75 | 32 | 60 |
| Silt (%) | 42.5 | 33 | 62.5 | 65 | 25 | 68 | 40 |
| Clay (%) | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| MDD (g/cc) | 1.26 | 1.51 | 1.27 | 1.27 | 0.95 | 1.29 | 1.08 |
| OMC (%) | 30.5 | 15.25 | 22.5 | 22.85 | 41 | 22.9 | 33.5 |
| Bulk density (g/cc) | 1.66 | 1.75 | 1.56 | 1.56 | 1.34 | 1.58 | 1.41 |
| k (cm/sec) | $4.232 \times 10^{-5}$ | $3.288 \times 10^{-5}$ | $3.72 \times 10^{-5}$ | $18.41 \times 10^{-4}$ | $3.67 \times 10^{-5}$ | $4.86 \times 10^{-5}$ | $4.67 \times 10^{-4}$ |
| $k^*$ (cm/sec) | $1.60 \times 10^{-5}$ | $17.7 \times 10^{-5}$ | $62.5 \times 10^{-5}$ | $4.41 \times 10^{-4}$ | $42.3 \times 10^{-4}$ | $19.6 \times 10^{-5}$ | $36.0 \times 10^{-4}$ |
| Initial void ratio | 0.92 | 0.54 | 0.58 | 0.61 | 1.15 | 0.64 | 0.93 |

*Hazen

References

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