EFFECT OF FIBRE CONTENT ON CALIFORNIA BEARING RATIO VALUE OF POND ASH

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ABSTRACT: California Bearing Ratio (CBR) value is one of the important parameters for design of road. In the present investigation an experimental programme has been undertaken to study the effect of fibre content on California Bearing Ratio value of pond ash. Two types of fibres, synthetic (polypropylene) and natural (jute) have been used as reinforcement to the pond ash sample. From the experimental results it is found that the peak California Bearing Ratio value of reinforced pond ash is obtained at around 0.4% to 0.6% of fibre content. The improvement of California Bearing Ratio value for jute fibre reinforced pond ash is more than that for the polypropylene fibre reinforced pond ash for both unsoaked and soaked conditions.

INTRODUCTION
Construction of a road involves substantial investment and therefore proper planning, construction and maintenance of these national assets is of paramount importance. The excessive stress in subgrade, leads to an increased deformation with each application of load, which eventually results in the failure of layers above the subgrade. This is probably the most important cause of failure of a flexible pavement. For last several years, concentrated efforts have been made to develop a more fundamentally based design analysis and also evaluation of benefits of using sufficiently strong materials in different layers of a flexible pavement. Soil/pond ash reinforced with short fibre is one such alternative material, which may be used technically as well as economically in the different layers (subgrade, subbase, base) of roads. Many investigators conducted strength test through triaxial tests, unconfined compressive strength tests, CBR tests, direct shear tests, tensile & flexural strength tests. A number of researchers have studied the California Bearing Ratio of soil, sand / fly ash and also soil, sand / fly ash - synthetic fibre mixture [1-3]. In the present investigation an attempt has been made to study the California Bearing Ratio of pond ash - fibre (synthetic and natural) mixture.

MATERIALS AND METHODS
In the present investigations pond ash has been chosen as construction material and polypropylene fibre (synthetic) and also jute fibre (natural) as reinforcement.

Pond Ash
Pond ash used in the present investigation has been collected from ash pond of Kolaghat thermal power plant, West Bengal, India. Grain size analysis of pond ash has been carried out in the laboratory in accordance with IS: 2720. Fig.1 shows the grain size distribution curve for pond ash. In accordance with the ASTM D2487 (1992) the pond ash is designated as SM. To determine the values of maximum dry unit weight and optimum moisture content (OMC) of pond ash samples, compaction tests have been conducted in the laboratory in accordance with ASTM D698 ( 1991 ). Fig. 2 shows the dry unit weight versus moisture content curve for pond ash samples. The values of maximum dry unit weight and optimum moisture content obtained are 11.95 kN / m³ and 28% respectively and the corresponding degree of saturation is 73%. In case of pond ash, degree of saturation was found in the range of 63% - 89% (Bera et al.[4]). Specific gravity and permeability of the pond ash also have been determined in the laboratory and the corresponding values of specific gravity and permeability at maximum dry unit weight and OMC are 2.21 and 9.78 ×10⁻⁵ cm / s respectively.

Fig.1. Grain size distribution curve for pond ash
Two types of fibres, polypropylene (synthetic) fibre and jute (natural) fibre have been collected from local market at Kolkata, West Bengal, India. The characteristics of the fibres have been determined from the laboratory tests and the corresponding properties are presented in Table 1.

**Table 1** Characteristics of reinforcing fibre

<table>
<thead>
<tr>
<th>Properties</th>
<th>Jute</th>
<th>Polypropylene</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length (mm)</td>
<td>51</td>
<td>51</td>
</tr>
<tr>
<td>Aspect ratio</td>
<td>37</td>
<td>51</td>
</tr>
<tr>
<td>Cross sections (mm²)</td>
<td>1.490</td>
<td>0.785</td>
</tr>
<tr>
<td>Tensile strength (MPa)</td>
<td>56.37</td>
<td>131.46</td>
</tr>
<tr>
<td>Elongation at break (%)</td>
<td>4.5</td>
<td>17</td>
</tr>
</tbody>
</table>

**EXPERIMENTAL INVESTIGATION**

CBR tests were conducted on specimens prepared using a cylindrical mould of 150 mm diameter and 175 mm height. For unreinforced fly ash the CBR tests have been performed for both unsoaked and soaked conditions having dry unit weights of 10.89, 11.95, and 12.35 kN/m³ at moisture content 28% (OMC). In case of reinforced fly ash, CBR samples have been prepared at OMC (28%) and maximum dry unit weight (12.35 kN/m³) with varying fibre content (0% to 1.2%) for both the fibres (polypropylene and jute fibres) and also for both the conditions (soaked and unsoaked). The details of preparation of samples and test methods have been presented elsewhere (Bhattacharya, P [5]).

**Results and Discussion**

Figs. 3 and 4 show the plots of degree of saturation versus CBR value of pond ash and dry unit weight versus CBR value of pond ash respectively. The plots of fibre contents versus CBR value of reinforced pond ash in soaked condition and fibre content versus CBR value of reinforced pond ash in unsoaked condition are shown in Figs. 5 and 6 respectively. Based on the above experimental results, discussions are made in the following sections:

**Effect of Degree of Saturation on CBR value of Unreinforced Pond Ash**

Degree of saturation is an important parameter for partially saturated fly ash or pond ash compacted fill. In general with increase in degree of saturation of fly ash, the strength of fly ash increases and reaches a peak value at certain degree of saturation after that it decreases. McLaren and DiGioia [6] reported that the shear strength of class ‘F’ fly ash is primarily dependent on the cohesion component under partially saturated condition, when the sample is fully saturated or dried, it loses its cohesive part of the strength. Fig. 3 shows the plots of degree of saturation versus California Bearing Ratio curve for pond ash samples. From the curve it is found that with increase in degree of saturation CBR value increases and reaches a peak value (41.42%) at certain degree of saturation (73%) after that it decreases.

**Effect of Dry Unit Weight on CBR value of Unreinforced Pond Ash**

Dry unit weight of any compacted fill material is the main governing parameter for strength. Fig. 4 shows the plots of dry unit weight versus CBR value curve (soaked condition). From the curve it is found that with increase in dry unit weight CBR value of pond ash increases. It is may be due to the reason that with increase in dry unit weight of pond ash.
ash in soaked condition, the shear strength of pond ash increases and as a result the CBR value of pond ash also increases. At low dry unit weight (10.89 kN/m³) the CBR value of pond ash was only 8.79%, which is of fair quality and can be used for subbase construction (Bowles [7]). But with increase in dry unit weight (12.35 kN/m³), CBR value of the pond ash increases around 22.20% which is of fair quality, thus it becomes suitable for use of construction of base and subbase of road (Bowles [7]).

Effect of Fibre Content on CBR value of Reinforced Pond Ash

It is observed from the figure (Fig.4) that the CBR value for pond ash at maximum dry unit weight and OMC is 15.04%, which can be used only for subbase construction (Bowles, [7]). Therefore, improvement of strength is necessary in pond ash to use for construction of base of roads. Figs.5 and 6 show the plots of fibre content (%) versus CBR (%) curve of fly ash in soaked and unsoaked conditions respectively. From both the figures (soaked and unsoaked) it is found that with increase in fibre content the CBR value increases and reaches a peak value at certain fibre content around 0.4% – 0.6%, after that it decreases. Fig.7 presents the peak CBR value of polypropylene fibre mixed pond ash and jute fibre mixed pond ash for both soaked and unsoaked conditions. From the figure (Fig.7) it is found that the peak CBR value of polypropylene fibre mixed pond ash increases by 12% and 80% for unsoaked and soaked conditions respectively than CBR value of unreinforced pond ash. Whereas the peak CBR value of jute fibre mixed pond ash increases by 17% and 112% for unsoaked condition and soaked conditions respectively than those for unreinforced pond ash.
CONCLUSIONS
Based on the experimental results and discussions made in the previous sections the following conclusions may be drawn:

- With increase in degree of saturation of pond ash samples, the CBR value increases and reaches a peak value at certain degree of saturation (73%) after that it decreases.

- With increase in dry unit weight (10.89 kN/m$^3$ to 12.35 kN/m$^3$) of pond ash samples, the CBR (soaked) value also increases from 8.9% to 22.20%.

- With increase in fibre contents the CBR value (both soaked and unsoaked conditions) of reinforced pond ash increases, and reaches a peak value at certain percentage of fibre contents around 0.4% - 6% after that it decreases irrespective of type of fibre (Synthetics and natural).

- The enhancement of CBR value is more in case of jute fibre reinforced pond ash compared to polypropylene reinforced pond ash for both unsoaked and soaked conditions.

REFERENCES


