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# INFLUENCE OF POLYPROPYLENE FIBRES ON GEOTECHNICAL PROPERTIES OF FLY ASH

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***Abstract*— Fly ash is a waste product. The only way to reduce the pollution of fly ash disposal efforts is recycled and reused in a variety of engineering applications. Properly managed, fly ash can be put in beneficial reuses. In this paper using fibre reinforcement techniques to improve geotechnical properties of fly ash. Polypropylene fibre is used to reinforce for stabilization of fly ash. The study involves standard proctor test, CBR test and direct shear test on unreinforced and reinforced fly ash. Polypropylene fibre is used in different length of 24mm and 40mm with different content i.e. 0.5%, 1% and 2%. Test results indicate that there is significant effect of synthetic fibre on geotechnical properties of Fly Ash.***

***Keywords*— Fly Ash, Polypropylene Fibre, Angle of Internal Friction, Shear Strength, CBR.***

## I. INTRODUCTION

Soil Reinforcement is an effective and reliable technique for improving strength and stability of soils. Recently it is more in use. In this study, randomly distributed polypropylene fibre is used for stabilization of fly ash. For stability in field problems like embankments and other structure fills, road sub base or sub grades construction, running tracks, earthen dams etc of fly ash is need to improve geotechnical characteristics like dry density, shear strength, bearing capacity, angle of internal friction and reduces moisture content. Polypropylene fibre is used in different length of 24mm and 40mm with different content i.e. 0.5%, 1% and 2% by dry weight of fly ash.

## II. LITERATURE REVIEWS

- **Dushyant Kumar Bhardwaj, J.N.Mandal: International Association for Computer Methods and Advances in Geomechanics (IACMAG): October, 2008:** *Study on Polypropylene Fibre Reinforced Fly Ash Slopes:* At many sites, availability of the land is a huge problem; in such situations construction of steep slope fly ash embankments is worth considering. The polypropylene staple fibre of 1% by dry weight was used with fly ash for the experimental work amount of water content increases. Fibre reinforcement increases the shear strength of fly ash and changes its brittle behaviour into ductile behaviour.
- **Boominathan, S. Hari: Soil Dynamics and Earthquake Engineering 22 (Elsevier Science Ltd.2002) 1027–1033:** *Liquefaction strength of fly ash reinforced with randomly distributed fibres*: In this paper a study on the improvement of liquefaction strength of fly ash by reinforcing with randomly distributed geosynthetic fibre/mesh elements is reported. Test results indicate that the addition of fibre/mesh elements increases the liquefaction strength of fly ash significantly and arrests the initiation of liquefaction even in samples of loose initial condition and consolidated with the low confining pressure.
- **Shenbaga. R. Kaniraj*, V. Gayathri : Geotextiles and Geomembranes 21 (2003) 123–149: accepted 7 January 2003:** *Geotechnical behavior of fly ash mixed with randomly oriented fibre inclusions*: Polyester fibres of two different types and a constant fibre content of 1% (by dry weight) were used in the experiments. The raw material content of the fibres was 100% recycled plastic waste. This paper presents the results of compaction tests, triaxial shear tests, and other geotechnical characterization tests carried out on the raw and fibre-reinforced fly ashes. The fibre inclusions increased the strength of the raw fly ash specimens and changed their brittle behaviour into ductile behaviour.

## III. MATERIAL USED

- **FLY ASH**

The fly ash produced from Kota super thermal power plant. The material was by product from coal thermal electricity production power plant dumping area. Index properties of fly ash are following in table 1:

TABLE 1
INDEX PROPERTIES OF FLY ASH

| S.NO. | PROPERTIES | RESULTS |
|---|---|---|
| 1 | Specific Gravity | 1.8096 |
| 2 | Average Grain Size (D50) | 0.021 |
| 3 | Liquid Limit | 24.5 |
| 4 | Plastic Limit | Non-Plastic |
| 5 | Grain Size Distribution | |
| | Gravel | 0.16% |
| | Sand | 29.18% |
| | Silt + Clay | 70.22% |
| 6 | Coefficient of Uniformity (Cu) | 6.2 |
| 7 | Coefficient of Curvature (Cc) | 1.26 |
| 8 | OMC (%) | 18.817 |
| 9 | MDD (gm/cc) | 1.363 |
| 10 | CBR unsoaked (%) | 3.0871 |
| 11 | C | 0.26 |
| 12 | Φ (in degree) | 25.6410 |

❖ **POLYPROPYLENE FIBRE**

Polypropylene is normally tough and flexible. The polypropylene synthetic fibre in different of fibre length (24mm and 40mm) was used in this investigation. Polypropylene fibre used in the present study was obtained from Walter Enterprises, Mumbai. Some Physical and Engineering properties of the polypropylene synthetic fibre are:

TABLE 2
PROPERTIES OF FIBRE

| S.NO. | PHYSICAL PROPERTIES | DESCRIPTION |
|---|---|---|
| 1 | Material | Polypropylene Fibre |
| 2 | Type | Fibrillated Mesh Fibre |
| 3 | Shape | Straight |
| 4 | Colour | White |
| 5 | Specific Gravity | 0.91g/cc |
| 6 | Length | 24mm, 40mm |
| 7 | Diameter | 28 micron, 40micron (approx) |
| 8 | Aspect Ratio | 860, 1000 (approx) |
| 9 | Thermal & electric conductivity | Low |
| 10 | Alkali resistance | 100% Alkali Proof |
| 11 | Acid & salt resistance | High |

## IV. EXPERIMENTAL PROGRAMME

❖ **STANDARD PROCTOR TEST (COMPACTION PARAMETERS)**

A mould of 1000 ml volume used in samples were compacted in 3 layers and with each layer compacted by 25 blows from a rammer of 2.489 kg falling through a height of 310 mm, the blows should be uniformly distributed over the surface of each layer. The density and moisture content of the compacted specimen is plotted on curves and a maximum dry density and optimum moisture content obtain. Based on the Results of Standard proctor test classification is done as per IS 2720 (Part 7) (1980).

❖ **CALIFORNIA BEARING RATIO TEST (CBR) (UNSOAKED)**

It is a load deformation test performed in the laboratory or the field whose results are then used with an empirical design chart to determine the thickness of flexible pavement, base and other layers for a given vehicle loading. In order to study the effect on CBR value of Fly Ash, CBR test were conducted in accordance with IS 2720 (Part-16) (1987) and IRC 37 (1970).

❖ **DIRECT SHEAR TEST**

In order to know the Shear Strength Parameters (C and Ø) of Reinforced Fly Ash, Direct Shear Test (UU test) in accordance with IS 2720 (Part-13) (1986) were conducted in laboratory for each selected fibre parameters i.e. percentage fibre content an different length of fibre.

## V. RESULTS AND DISCUSSION

### ❖ EFFECT ON COMPACTION TEST

It is observed that maximum dry density is increases with increases in fibre and the optimum moisture content is decreases with increases in fibre content of fly ash with fibre as compared to fly ash without fibre. When mix of fly ash and randomly distributed polypropylene fibre with different (0.5%, 1%, and 2%) fibre content and length of 24mm and 40mm is prepared then the MDD is an increase from 1.363gm/cc to 1.423gm/cc and 1.363gm/cc to 1.527gm/cc respectively and on the other hand, OMC is decreases from 18.817% to 17.355%.and 18.817% to 15.533% respectively.

TABLE 3
COMPARISON OF OMC & MDD OF FLY ASH

| S.NO. | Fly Ash | % Fibre | OMC (%) | | MDD (gm/cc) | |
|---|---|---|---|---|---|---|
| | | | Fibre Length 24mm | Fibre Length 40mm | Fibre Length 24mm | Fibre Length 40mm |
| 1 | 100% | 0 | 18.817 | 18.817 | 1.363 | 1.363 |
| 2 | | 0.5 | 18.396 | 16.911 | 1.393 | 1.419 |
| 3 | | 1 | 18.095 | 16.170 | 1.401 | 1.484 |
| 4 | | 2 | 17.355 | 15.533 | 1.423 | 1.527 |

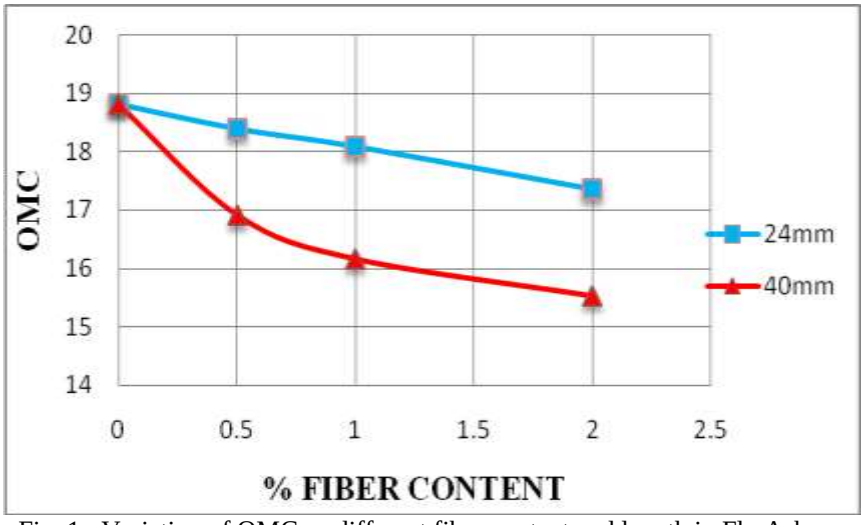

Fig. 1: Variation of OMC vs different fibre content and length in Fly Ash

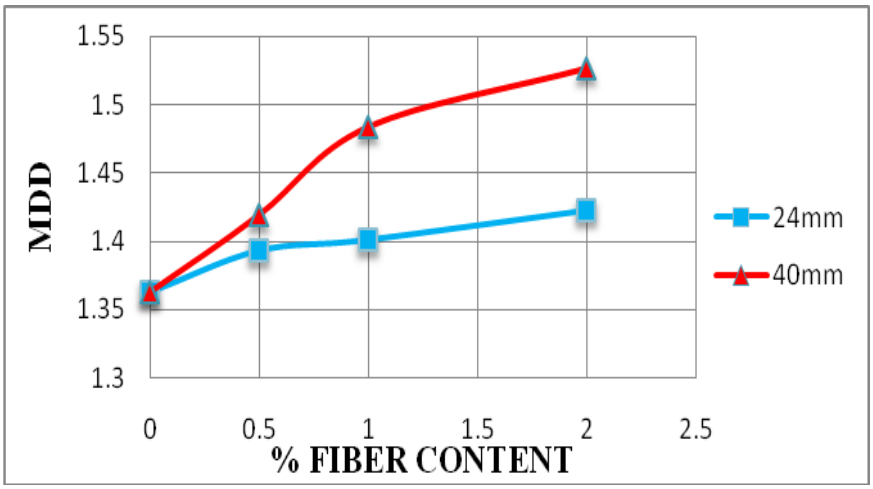

Fig. 2: Variation of MDD vs different fibre content and length in Fly Ash

❖ **EFFECT ON CBR TEST**

It is observed that CBR value is proportionally increasing with increasing in fibre content of fly ash with fibre as compared to fly ash without fibre. When mix of fly ash and randomly distributed polypropylene fibre with different (0.5%, 1%, and 2%) fibre content and length of 24mm and 40mm is prepared then the CBR value is increases from 3.0871% to 11.8929% and 3.0871% to 12.3990% respectively.

TABLE 4
COMPARISON OF CBR VALUE OF FLY ASH

| S.NO. | FLY ASH | % FIBRE | CBR VALUE (in %) | |
|---|---|---|---|---|
| | | | Fibre Length 24mm | Fibre Length 40mm |
| 1 | 100% | 0 | 3.0871 | 3.0871 |
| 2 | | 0.5 | 9.3625 | 10.8808 |
| 3 | | 1 | 10.3747 | 11.6399 |
| 4 | | 2 | 11.8929 | 12.3990 |

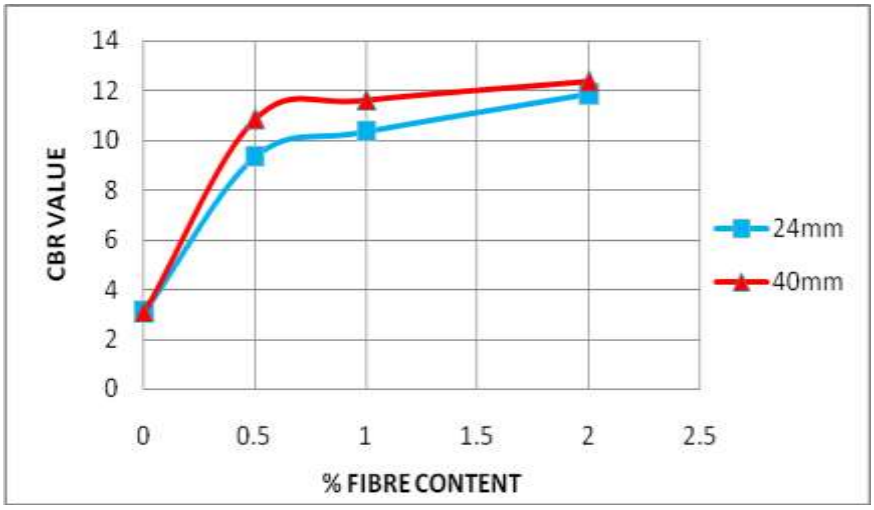


Fig. 3: Variation of CBR value vs different fibre content and length in Fly Ash

❖ **EFFECT ON DST TEST**

It is observed that Φ is increases with increases in fibre content of fly ash with fibre as compared to fly ash without fibre. When mix of fly ash and randomly distributed polypropylene fibre with different (0.5%, 1%, and 2%) fibre content and length of 24mm and 40mm is prepared then the Φ is increases from 25.6410˚ to 29.7264˚and 25.6410˚ to 32.0877˚ respectively.

TABLE 5
COMPARISON OF ANGLE OF INTERNAL FRICTION (Φ) OF FLY ASH

| S.NO. | Fly Ash | % Fibre | Angle of Internal Friction (Φ) (in degree) | |
|---|---|---|---|---|
| | | | Fibre Length 24mm | Fibre Length 40mm |
| 1 | 100% | 0 | 25.6410 | 25.6410 |
| 2 | | 0.5 | 27.4293 | 30.4981 |
| 3 | | 1 | 28.7227 | 31.1320 |
| 4 | | 2 | 29.7264 | 32.0877 |

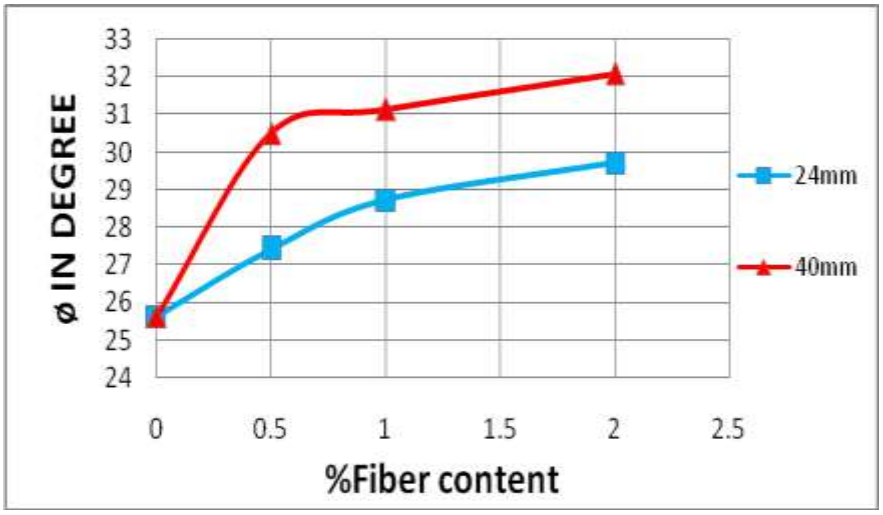


Fig. 4: Variation of Φ value vs different fibre content in Fly Ash

## VI. CONCLUSIONS

1. Moisture-Density relationship of fly ash significantly affected by adding of randomly distributed fibre. Maximum increase value of MDD is 1.527gm/cc and maximum decrease value of OMC is 15.533% in Fly Ash with 2% fibre content and 40mm fibre length.
2. By adding randomly distributed fibres with fly ash, the CBR value is significantly improved. Fly ash with 2% fibre content and 40mm fibre length gives maximum increased CBR value is 12.3990%.
3. In direct shear test, angle of shearing resistance (Φ) of fly ash is consequentially improved by adding of randomly distributed fibre. The maximum increment in Φ value is 32.0877˚ due to addition of 2% fibre content and 40mm length with Fly Ash.

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7) IRC 37 (1970).
8) IS 2720 (Part-13) (1986)' "Methods of Direct Shear Test".