# EXPERIMENTAL INVESTIGATION ON CONCRETE USING KAOLIN AND GEOPOLYPROPYLENE FIBRE

B.Umarfarhan[1], J.Dharsan[1], M Hariharan[1], M.Vishwajith[1], M.Lokeshwaran[1],
R.Sankar, Assistant Professor

**Department of Civil Engineering, PRIST, Institution Deemed to be University,**

**Abstract**

The behavior of nonnewtonian fluid concrete is different from that of normal concrete in which the bending stress distribution is linear across the depth and the shear strength is high in this concrete. This paper addressed the flexure and shear behavior of polypropylene fiber reinforced metakaolin added concrete(PFC) using non-Newtonian fluid. The variables of study include the characteristic strength of concrete, fck (30.0Mpa) and polypropylene fiber content 5%.

**KEYWORD:** Polypropylene, Metakaolin, Non-Newtonian fluid, Flexure, and Shear Failure

## I.INTRODUCTION

Many a structural element like walls of bunkers, load-bearing walls in buildings, sewer pipelines, plate elements in folded plates are heavily affected due to impact loads. The design of such structural elements requires innovative procedures to serve the functionality coupled with durability in an economical manner. We use nonnewtonian fluid in concrete which resists impact loads, but when the load is caused in a continuous manner it may fail. So we use polypropylene fiber it deforms and then cracks.

In deep beams, the bending stress distribution across any transverse section deviates appreciably from the straight line distribution assumed in the Simple beam theory based on Napier's hypothesis. Consequently, a transverse section that is plane before bending does not remain plane after bending and the neutral axis does not usually lie at the mid-depth. In deep beams, flexure and shear modes are dominated by tensile cleavage failure. The ultimate failure due to shear is generally brittle in nature, in contrast to the ductile behavior and progressive failure with a large number of cracks observed in normal beams. They typically have low reinforcement ratios and may fail in tension, in compression or by splitting of the web as a result of excessive bursting forces.

As a result, the strain distribution is no longer considered linear, and the shear deformations become significant when compared to pure flexure member. Floor slabs under horizontal load, short span beams carrying heavy loads, and transfer girders.

### 1.1 OBJECTIVES

- **Polypropylene fibers help reduce shrinkage and control cracking.**
- **polypropylene fibers are distributed throughout the concrete, they are effective close to where cracks start at the aggregate-paste interface.**To withstand against imapct load
- To reduce shear failure.

### 1.2 SCOPE

- Control the crack propagation and ability to retain load after cracking.
- Increased fatigue, impact and absorption resistance.
- Increased durability and reduced maintenance cost.
- Increased load bearing capacity of concrete.
- Corrosion free reinforcement.

- Metakaolin gives concrete a non-sticky and creamy texture. This makes the finishing job easier.
- Metakaolin used to boost the compressive strength of concre

## II. MATERIAL SPECIFICATION

A **non-Newtonian fluid** is a fluid that does not follow newtons law of viscosity. Most commonly, the viscosity (the measure of a fluid's ability to resist gradual deformation by shear or tensile stresses) of non-Newtonian fluids is dependent on shear rate or shear rate history. Some non-Newtonian fluids with shear-independent viscosity, however, still exhibit normal stress-differences or other non-Newtonian behavior. Many salt solutions and molten polymers are non-Newtonian fluids, as are many commonly found substancessuch as ketchup, toothpaste, starch suspensions , honey, paint ,blood, frog saliva, and shampoo.

Polypropylene is in many aspects similar to polyethylene, especially in solution behaviour and electrical properties. The additionally present methyl group improves mechanical properties and thermal resistance, while thechemical resistance decreases. The properties of polypropylene depend on the molecular weight and molecular weight distribution, crystallinity, type and proportion of comonomer (if used) and the isotacticity. In isotactic polypropylene, for example, the $CH_3$ groups are oriented on one side of the carbon backbone. This creates a greater degree of crystallinity and results in a stiffer material that is more resistant to creep than both atactic polypropylene and polyethylene. Polypropylene fibers are used as a concrete additive to increase strength and reduce cracking and spalling. In the areas susceptible to earthquake, PP fibers are added with soils to improve the soils strength and damping when constructing the foundation of structures such as buildings, bridges, etc.The properties of polypropylene depend on the molecular weight and molecular weight distribution, crystallinity, type and proportion of comonomer (if used) and the isotacticity.

### 2.1 SPECIFIC GRAVITY TEST

**Procedure:-**

Dry the pycnometer and weigh it with its cap ($W_1$). Take about 200 g to 300 g of oven dried soil passing through 4.75mm sieve into the pycnometer and weigh again ($W_2$). Add water to cover the soil and screw on the cap. Shake the pycnometer well and connect it to the vaccum pump to remove entrapped air for about 10 to 20 minutes. After the air has been removed, fill the pycnometer with water and weigh it

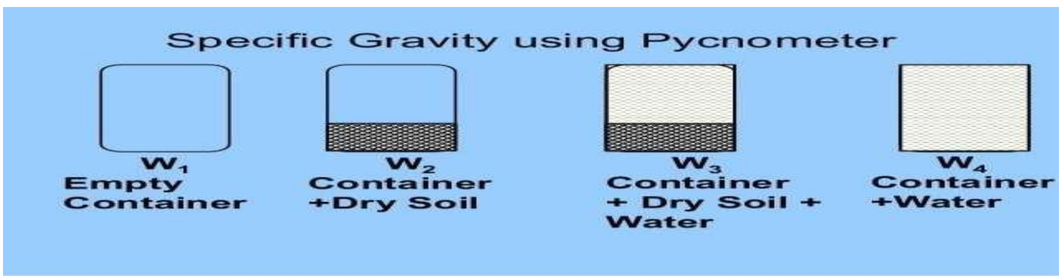
Fig 1 : Pynometer

($W_3$). Clean the pycnometer by washing thoroughly. Fill the cleaned pycnometer completely with water up

to its top with cap screw on. Weigh the pycnometer after drying it on the outside thoroughly ($W_4$).

water up to its top with cap screw on. Weigh the pycnometer after drying it on the outside thoroughly ($W_4$).

**Formula to find specific gravity,**



RESULT

Specific gravity of fine aggregate : 2.72

### III. WATER ABSORPTION TEST FOR COARSE AGGREGATE

**Procedure**

The aggregates placed on the absorbent clothes are surface dried till no further moisture could be removed by this cloth. Then the aggregates are transferred to the second dry cloth spread in single layer and allowed to dry for at least 10 minutes until the aggregates are completely surface dry. The surface dried aggregate is then weighed =$W_1$ g

The aggregate is placed in a shallow tray and kept in an oven maintained at a temperature of 110° C for 24 hrs. It is then removed from the oven, cooled in an air tight container and weighted=$W_2$ g.

The surface dried aggregate is then weighed =$W_1$ g

**Calculation**

**Water absorption = $((W_3 – W_4) / W_4) \times 100$**

RESULT

Water absorption of coarse aggregate : 0.50

### 3.1 WATER ABSORPTION TEST FOR FINE AGGREGATE

**Procedure**

Absorption values are used to calculate the change in the mass of an aggregate material due to water absorbed in the pore spaces within the constituent particles, compared to the dry condition, if it is deemed that the aggregate has been in contact with water long enough to satisfy most of the absorption potential. The laboratory standard for absorption is that obtained after submerging dry aggregate for a prescribed period of time. Aggregates mined from below the water table commonly have moisture content greater than the absorption determined by this test method, if used without opportunity to dry prior to use. Conversely, some aggregates that have not been continuously maintained in a moist condition until used are likely to contain an amount of absorbed moisture less than the 24-h soaked condition. For an aggregate that has been in contact with water and that has free moisture on the particle surfaces, the percentage of free moisture is determined by deducting the absorption from the total moisture content determined by Test Method C566 by drying.

The general procedures described in this test method are suitable for determining the absorption of aggregates that have had conditioning other than the 24-h soak, such as boiling water or vacuum saturation. The values obtained for absorption by other test methods will be different than the values obtained by the prescribed 24-h soak, as will the relative density (specific gravity) (SSD).

RESULT

Water absorption of fine aggregate: 1.0%

### 3.2 SPLIT TENSILE STRENGTH TESTING OF CONCRETE CYLINDRICAL MOULD

SPLIT TENSILE is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failure in bending. Concrete, as we know, is relatively strong in compression and weak in tension. In reinforced concrete members, little dependence is placed on the tensile strength of concrete since steel reinforcing bars are provided to resist all tensile forces. However, tensile stresses are likely to develop in concrete due to drying shrinkage, rusting of steel reinforcement, temperature gradients, and many other reasons. Therefore, the knowledge of the tensile strength of concrete is of importance. A concrete road slab is called upon to resist tensile stresses from two principal sources– wheel loads and volume change in the concrete. Wheel loads may cause high tensile stresses due to bending when there is inadequate subgrade support. Volume changes, resulting from changes in temperature and moisture, may produce tensile stresses, due to warping and due to the movement of the slab along the subgrade. Stresses due to volume changes alone may be high. The longitudinal tensile stress in the bottom of the pavement, caused by restraint and temperature warping, frequently amounts to as much as 2.5 MPa at certain periods of the year and the corresponding stress in the transverse direction is approximately 0.9 MPa. These stresses are additive to those produced by wheel loads on unsupported portions of the slab.

While a number of investigations involving the direct measurement of tensile strength have been made, beam tests are found to be dependable to measure flexural strength property of concrete. The value of the modulus of rupture (extreme fiber stress in bending) depends on the dimension of the beam and manner of loading. The systems of loading used in finding out the flexural tension are central point loading and third point loading. In the central point loading, maximum fiber stress will come below the point of loading where the bending moment is maximum. In the case of symmetrical two-point loading, the critical crack may appear at any section, not strong enough to resist the stress within the middle third, where the bending moment is maximum. It can be expected that the two-point loading will yield a lower value of the modulus of rupture than the center point loading. Figure 10.4 shows the modulus of rupture of beams of different sizes subjected to the center point and third point loading. I.S. 516-1959, specifies two points loading. The details of the specimen and procedure are described in the succeeding paragraphs

The standard sizes of the specimens are 15 x 27.5cm. The mold should be of metal, preferably steel or cast iron and the metal should be of sufficient thickness to prevent spreading or warping. The mold should be constructed with the longer dimension horizontal and in such a manner as to facilitate the removal of the molded specimens without damage. The tamping bar should be a steel bar weighing 2 kg, 40 cm long and should have a ramming face 25 mm square. The testing machine may be of any reliable type of sufficient capacity for the tests and capable of applying the load at the rate specified. The permissible errors should not be greater than ± 0.5 percent of the applied load where a high degree of accuracy is required and not greater than ± 1.5 percent of the applied load for commercial type of use. The bed of the testing machine should be provided with two steel rollers, 38 mm in diameter, on which the specimen is to be supported, and these rollers should be so mounted that the distance from center to center is 40 mm for 15 cm specimen. The load is applied through two similar rollers mounted at the third points of the supporting span that is, spaced at 13.3 cm center to center. The load is divided equally between the two loading rollers, and all rollers are mounted in such a manner that the load is applied axially and without subjecting the specimen to any torsional stresses or restrains.

**Apparatus required**

The tamping bar has 40 cm long, weighing 2 kg and tamping section having the size of (25 mm x 25 mm)

**Procedure**

Test specimens are stored in water at a temperature of 24° to 30°C for 48 hours before testing. They are tested immediately on removal from the water whilst they are still in a wet condition. The dimensions of each specimen should be noted before testing. No preparation of the surfaces is required.

The bearing surfaces of the supporting and loading rollers are wiped clean, and any loose sand or other material removed from the surfaces of the specimen where they are to make contact with the rollers. The specimen is then placed in the machine in such a manner that the load is applied to the uppermost surface as cast in the mold, along two lines spaced 13.3 cm apart. The axis of the specimen is carefully aligned with the axis of the loading device. No packing is used between the bearing surfaces of the specimen and the rollers. The load is applied without shock and increased continuously at a rate such that the extreme fiber stress increases at approximately 0.7 kg/sq cm/min that is, at a rate of loading of 400 kg/min for the 15.0 cm specimens. The load is increased until the specimen fails, and the maximum load applied to the specimen during the test is recorded. The appearance of the fractured faces of concrete and any unusual features in the type of failure is noted.

The Split tensile strength of the specimen is expressed as the modulus of rupture FB which if„a ‟ equals the distance between the line of fracture and the nearer support, measured on the centerline of the tensile side of the specimen, in cm, is calculated to the nearest 0.05 MPa as follows:

FB = PxL/bxd2

When „ a ‟ is greater than 20.0 cm for 15.0 cm specimen or greater than 13.3 cm for a 10.0 cm specimen, or

FB = 3pxa/ bxd2

when "a" is less than 20.0 cm but greater than 17.0 cm for 15.0 specimen, or less than 13.3 cm but greater than 11.0 cm for a 10.0 cm specimen where b = measured width in cm of the specimen.

The load is increased until the specimen fails, and the maximum load applied to the specimen during the test is recorded. The appearance of the fractured faces of concrete and any unusual features in the type of failure is noted.

## IV. RESULT AND DISCUSSION

We have conducted flexural strength tests on test specimens with Non-Newtonian fluid of PPF and Metakaolin with non-Newtonian fluid at an age of 7 and 21 days.

**Table 1 spilled tensile strength test for a conventional cylinder of M30 grade:**

| Type of specimen | Days | Split tensile strength in $N/mm^2$ |
|---|---|---|
| Conventional | 7 | 2.51 |
| Conventional | 14 | 3.04 |
| Conventional | 28 | 4.806 |

**Table 2 spilt tensile strength of 7 days cylinder of 2.5% of PPF and 5% of metakaolin concrete $M_{30}$ grade:**

| S.No | Trail No. | Stress $F_B$ ($N/mm^2$) |
|---|---|---|
| 1 | T1 | 2.13 |
| 2 | T2 | 2.9 |
| 3 | T3 | 2.447 |

**Table 3 spilt tensile strength of 14 days cylinder of 2.5% of PPF and 5% of metakaolin concrete $M_{30}$ grade:**

| S.No | Trail No. | Stress $F_B$ (N/mm$^2$) |
|---|---|---|
| 1 | T1 | 5.12 |
| 2 | T2 | 5.27 |
| 3 | T3 | 5.43 |

**Table 3 spilt tensile strength of 28 days cylinder of 2.5% of PPF and 5% of metakaolin concrete $M_{30}$ grade:**

| S.No | Trail No. | Stress $F_B$ (N/mm$^2$) |
|---|---|---|
| 1 | T1 | 6.4 |
| 2 | T2 | 6.54 |
| 3 | T3 | 6.31 |

**Table 4 Cumulative analysis of spilt tensile strength of 2.5% of PPF and 5% of metakaolin concrete $M_{30}$ grade:**

| S.No | Days | Stress N/mm$^2$ |
|---|---|---|
| 1 | 7 | 2.9 |
| 2 | 14 | 5.27 |
| 3 | 28 | 6.54 |

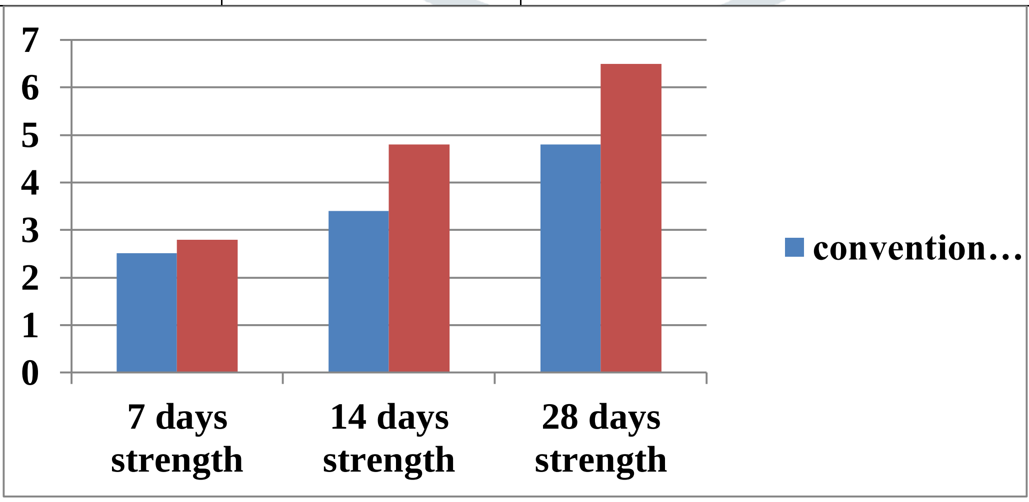



**Fig 2 Cumulative analysis spilt tensile strength of cylinder of 2.5% of PPF and 5% of metakaolin concrete**

## V. CONCLUSION

1. On using nonnewtonian fluid with PPF, brittle failure is totally eliminated and only shear cracks are formed, thus ductile failure (failure with a warning) takes place. Conventional concrete gives more strength, but failure is sudden without the formation of plastic hinges. Whereas on the addition of PPF fiber, though flexural strength is less, the concrete does not break and only cracks are formed and hence giving a full warning before failure. By replacing cement with metakaolin, 7days strength of deep beams may be slightly below the targeted strength but 28 days strength of concrete is more than the target strength since metakaolin has to be cured for more days to achieve the required strength.

## V1. REFERENCE


2. 1. Shetty, M.S.(2006) "Concrete Technology Theory and Practice" (S.Chand and Company Ltd.New Delhi.
3. 2. Gambhir. M.L,( 2006) "Concrete Technology", (Tata McGraw-Hill Publishing Company Limited, New Delhi,)
4. 3. Indian Standard code of practice for plain and Reinforced Concrete,
5. 4. IS456:2000, Bureau of Indian Standards, New Delhi.
6. 5. Recommended guidelines es of concrete mix design, IS 10262:1982, Bureau of Indian Standards, Delhi.