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A Study on Stress Strain Behaviour of Concrete Containing Plastic Waste

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ABSTRACT

Now a day's one of the major problems in construction industries is insufficient and unavailability of construction materials, on the other side the main environmental problem is the disposal of the waste plastics. In this experimental study, an attempt has been made to use the plastics in concrete and studies have been conducted to focus on the Stress Strain Behaviour of plastic mix concrete and compared with Stress Strain Behaviour of conventional concrete Two types of plastics namely polythene sheets and plastic straws were selected and mixed with concrete in various proportions (0.5%, 1.0% & 1.5%). The use of plastics in various places as packing materials and the products such as bottle, polythene sheet, containers packing strips etc,. are increasing day by day. This results in production of plastic waste from all sort of livings from industrial manufacturers to domestic users. So, we are in need to search for new construction materials as well as a method to dispose the plastic waste.
Keywords: Construction Materials, Environmental Problems, Plastics, Stress Strain Behaviour.

I. INTRODUCTION

Disposal of plastic waste in environment is considered to be a big problem due to its very low biodegradability and presence in large quantities. In recent time significant research is underway to study the possibility of disposal of these wastes in mass concrete where strength of concrete may not be major criteria under consideration, such as heavy mass of concreting in PCC in pavements. If plastic wastes can be mixed in the concrete mass in some form, without significant effect on its other properties. Plastic is one component of municipal solid waste significantly been benefited from the usage of fly ash, silica fumes, and GGBS. For a constant workability, the reduction in water demand of concrete due to fly ash is usually between 5 and 15% when compared with Portland cement only mix.. The plastics in concrete and studies have been conducted to focus particularly on the behaviour of compression members with various proportions of plastic wastes. The plastics used in this investigation were polythene sheets and plastic straw. The above plastic wastes were mixed with cement concrete in various proportions (0.5% to 1.5 %) and stress strain behaviour of plastic mix concrete are plotted and compared.

II. METHODS AND MATERIAL

2.1. MATERIALS

In making any type of concrete, selection and type of materials is very important as all the properties depends on them. The following materials are being used and are listed below.

- Cement
- Fine aggregate(sand)
- Coarse aggregate
- Plastic straws
- Polythene sheets
- Water

2.2.1 CEMENT

It is a powered adhesive and cohesive substance which when mixed with fine aggregate, coarse aggregate and water form a paste which on curing for certain period turns in to mass of hard stone.

Proper selection of cement is at most important as the strength of concrete mostly depends on it. Here the Portland cement conforming to IS: 4031-1988 is being used. The properties of cement are shown in Table 1

Table 1 Properties of Cement

S. No	Characteristics	Value
1	Specific gravity	3.12
2	Normal consistency	31%
3	Initial setting time	80minutes
4	Final setting time	201minutes

2.2.2 FINE AGGREGATE

The selection of fine aggregate is also on important factor as it directly affects the strength of concrete with the varying utilisation of water. Fine aggregate with harsh surface requires high amount of water, so fine aggregate with smooth surface and rounded shape is being used as it requires low amount of water and hence produces high strength concrete.

Table 2 Properties of fine aggregate

S. No	Characteristics	Value
1	Zone	II
2	Specific Gravity	2.56
3	Density	14kN/m^3

2.2.3 COARSE AGGREGATE

It is well known fact that coarse aggregate occupies about 70% of concrete. Here coarse aggregate of 10mm size, crushed and angular shaped is used as they are found to have low stresses around them when loaded.

Table 3 Properties of Coarse aggregate

S. No	Characteristics	Value
1	Nominal maximum size	10mm
2	Specific gravity	2.75
3	Density	1624.83kg/m^3

Figure 1. Coarse Aggregates

2.2.4 PLASTIC STRAWS

These are tubular plastic products used in day today life. These were mixed along with concrete after cutting them along its cross section. Then the cast specimens were de-moulded next day and subjected to curing.

Figure 2 Plastic Straws

2.2.5 POLYTHENE SHEETS

The plastic wastes which are available on the road sides and dump yards around the town (Vidyanagar).

Figure 3. Showing Polythene Sheets

2.2.6 WATER

Water plays a vital role in achieving the strength of concrete. For complete hydration it requires about 3/10^{th} of its weight of water. It is practically proved that

minimum water-cement ratio 0.5 is required for conventional concrete.

2.2.7 MIX DESIGN

In this mix design of M20 grade concrete is done and designed as per Indian standard mix design method IS-10262-1982.

III. RESULTS AND DISCUSSION

3.1 Stress Strain behaviour of plain concrete

For any Structural analysis, the evaluation of the stress-strain relationship of concrete is required. Though a number of expressions are available, yet it may not be possible to define the relationship using one approach and completely represent the actual concrete behaviour in both the ascending and descending portion under the test conditions. It is known to most investigators that this is due to the fact that stress-strain relationship is greatly influenced by a number of factors. The shape of stress-strain curve is affected by the duration of loading and straining which is associated with the mechanism of internal progressive micro cracking.

A Sample of cylinder is placed in compressometer with its ends fixed tightly and then it is placed in the Compression testing machine and load is applied constantly and initially a dial gauge is fixed to the compressometer. With the help of this deflection readings are taken at constant load. For every 10kN load, deflection values are taken until the specimen breaks.

Diameter of cylinder = 150mm
Height of the cylinder = 300mm
Area = 150 x 150 mm^2
Gauge Length = 148mm

The relationship between stress and strain is important in understanding the basic elastic behaviour of concrete in hardened state which is useful in design of concrete Structures. From the values of stresses and strains, average stress-strain curve for each mix is plotted, taking the average values of the results of the three cylinders. The stress-strain curves for conventional mixes at 7 days, 28 days, 90 days are shown in below.

Figure 4. Compressometer

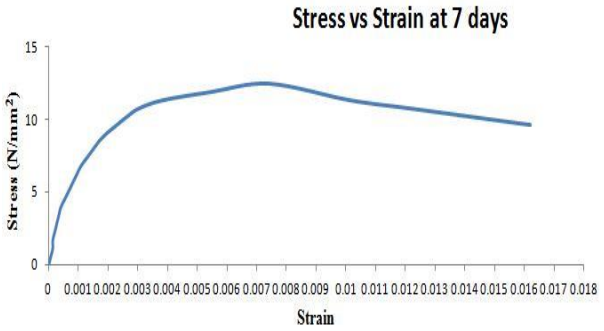

Figure 5. Stress Strain Behaviour of Plain concrete at 7 Days

Peak Stress = 12.44N/mm^2

At Peak Stress, Strain = 0.007

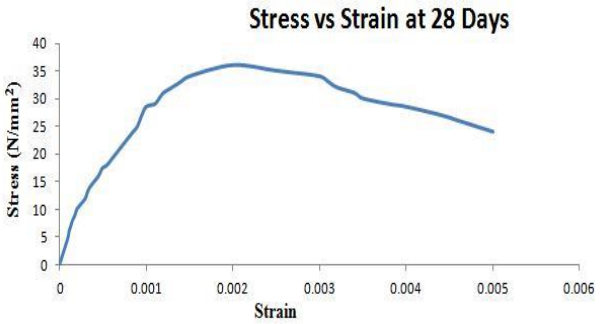

Figure 6. Stress Strain Behaviour of Plain concrete at 28 Days

Peak Stress = 34.80N/mm^2 At Peak Stress, Strain = 0.0021

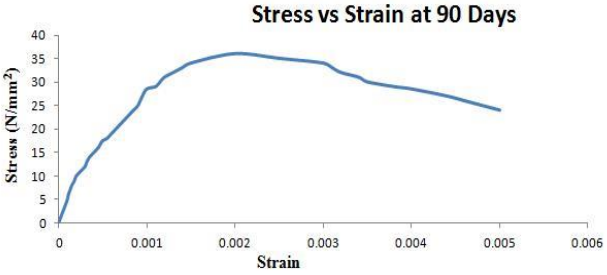

Figure 7. Stress Strain Behaviour of Plain concrete at 90 Days

Peak Stress = 35.20N/mm^2
At Peak Stress, Strain = 0.002

3.2 Stress Strain behaviour of concrete Containing plastic waste

A Sample of cylinder is placed in compressometer with its ends fixed tightly and then it is placed in the Compression testing machine and load is applied constantly and initially a dial gauge is fixed to the compressometer. With the help of this deflection readings are taken at constant load. For every 10kN load, deflection values are taken until the specimen breaks.

Diameter of cylinder = 150mm
Height of the cylinder = 300mm
Area = 150 x 150 mm^2
Gauge Length = 148mm

The relationship between stress and strain is important in understanding the basic elastic behaviour of concrete in hardened state which is useful in design of concrete Structures. From the values of stresses and strains, average stress-strain curve for each mix is plotted, taking the average values of the results of the three cylinders. The stress-strain curves for conventional mixes at 7 days, 28 days, 90 days are shown in below.

Figure 8. Cylinder fitted with Compressometer and tested in UTM 0.5% Plastic Straws

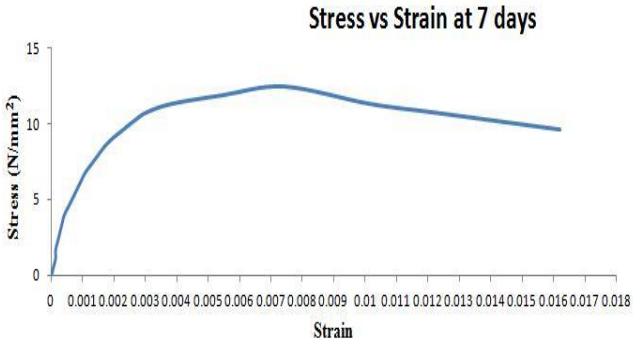

Figure 9. Stress Strain Behaviour of Plastic concrete with plastic straws 0.5% at 7 Days

Peak Stress = 13.40N/mm^2

At Peak Stress, Strain = 0.0072

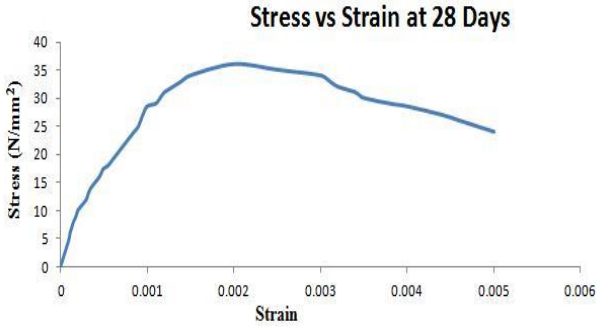

Figure 10. Stress Strain Behaviour of Plastic concrete with plastic straws 0.5 %at 28 Days

Peak Stress = 35.50N/mm^2

At Peak Stress, Strain = 0.0023

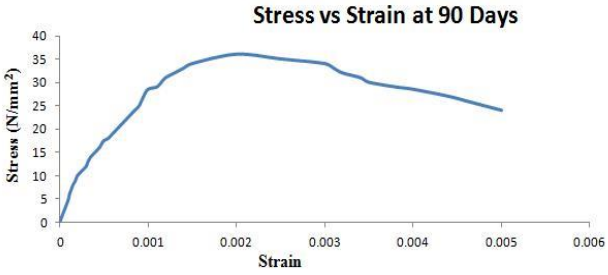

Figure 11. Stress Strain Behaviour of Plastic concrete with plastic straws 0.5% at 90 Days

Peak Stress = 36.10N/mm^2
At Peak Stress, Strain = 0.0024

1.0% Plastic Straws

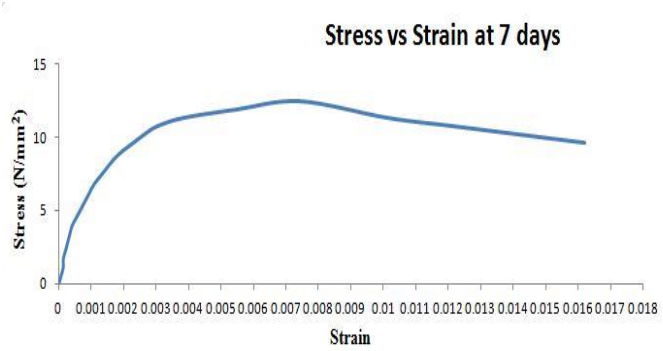

Figure 12. Stress Strain Behaviour of Plastic concrete with plastic straws 1.0% at 7 Days

Peak Stress = 13.90 N/mm^2
At Peak Stress, Strain = 0.008

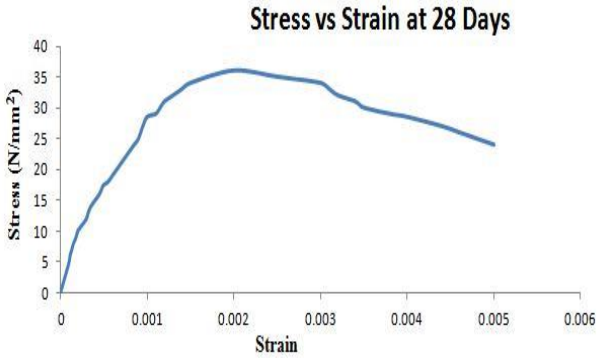

Figure 13. Stress Strain Behaviour of Plastic concrete with plastic straws 1.0% at 28 Days

Peak Stress = 35.80N/mm^2
At Peak Stress, Strain = 0.0024

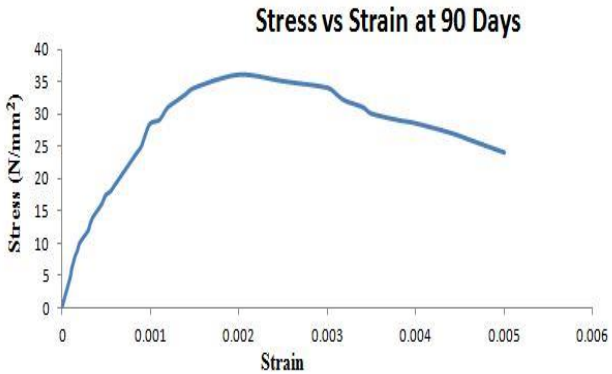

Figure 14. showing Stress Strain Behaviour of Plastic concrete with plastic straws 1.0% at 90 Days

Peak Stress = 36.20N/mm^2
At Peak Stress, Strain = 0.0024

1.5% Plastic Straws

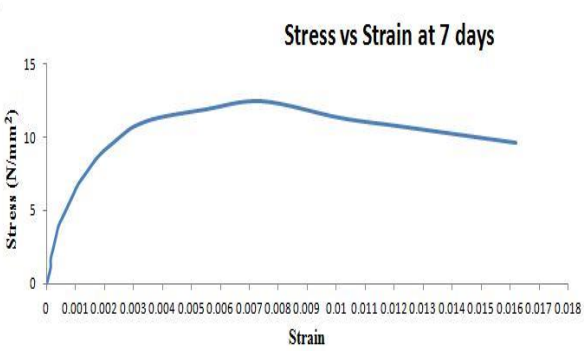

Figure 15. Stress Strain Behaviour of Plastic concrete with plastic straws 1.5% at 7 Days

Peak Stress = 13.00 N/mm^2
At Peak Stress, Strain = 0.0078

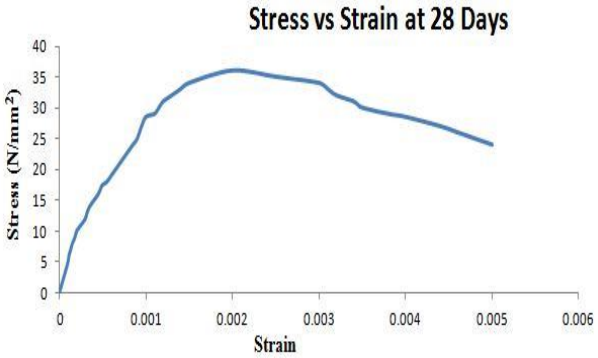

Figure 16. Stress Strain Behaviour of Plastic concrete with plastic straws 1.5% at 28 Days

Peak Stress = 35.00N/mm^2
At Peak Stress, Strain = 0.0022

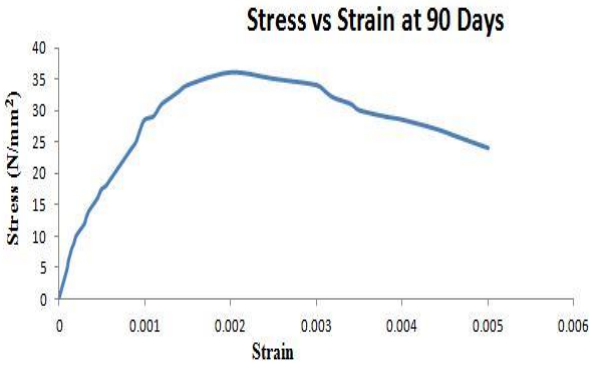

Figure 17. Stress Strain Behaviour of Plastic concrete with plastic straws 1.5% at 90 Days

Peak Stress = 35.90N/mm^2
At Peak Stress, Strain = 0.0026

0.5% Polythene Sheets

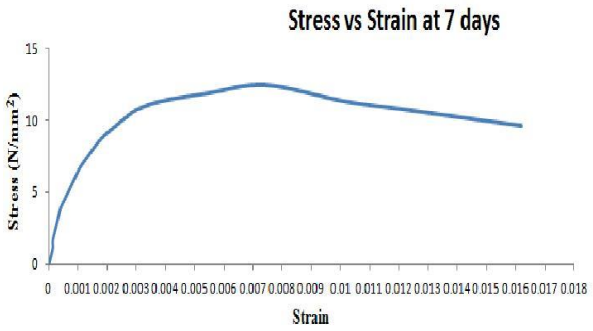

Figure 18. Stress Strain Behaviour of Plastic concrete with Polythene sheets 0.5% at 7 Days

Peak Stress = 13.45 N/mm^2
At Peak Stress, Strain = 0.0078

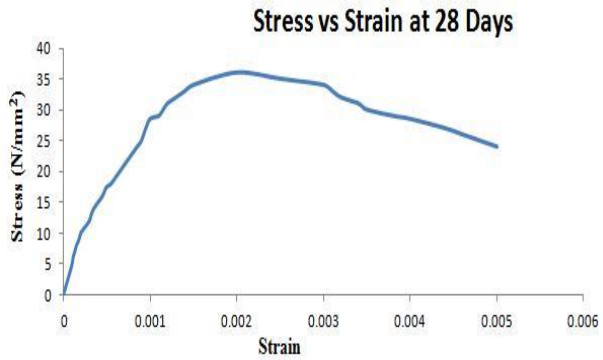

Figure 19. Stress Strain Behaviour of Plastic concrete with Polythene sheets 0.5% at 28 Days

Peak Stress = 35.60N/mm^2
At Peak Stress, Strain = 0.002

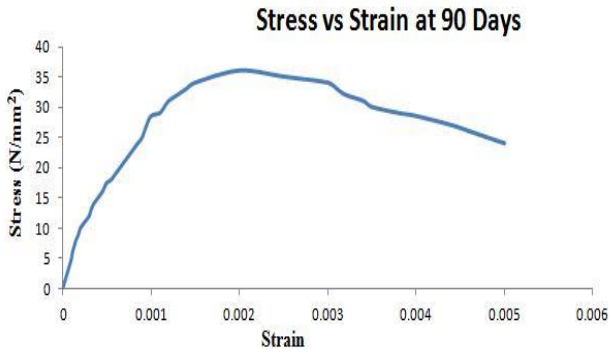

Figure 20. Stress Strain Behaviour of Plastic concrete with Polythene sheets 0.5% at 90 Days

Peak Stress = 36.15N/mm^2
At Peak Stress, Strain = 0.0025

1.0% Polythene Sheets

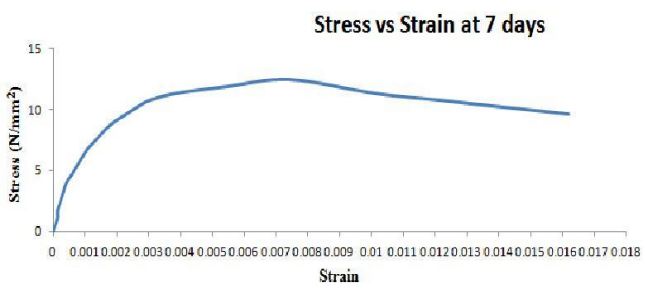

Figure 21. Stress Strain Behaviour of Plastic concrete with Polythene sheets 1.0% at 7 Days

Peak Stress = 13.95 N/mm^2
At Peak Stress, Strain = 0.0081

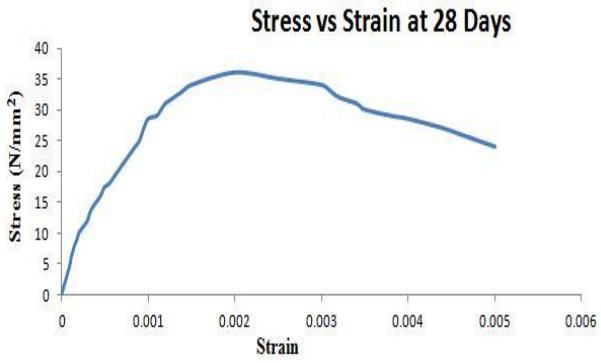

Figure 22. Stress Strain Behaviour of Plastic concrete with Polythene sheets 1.0% at 28 Days

Peak Stress = 35.90N/mm^2
At Peak Stress, Strain = 0.0023

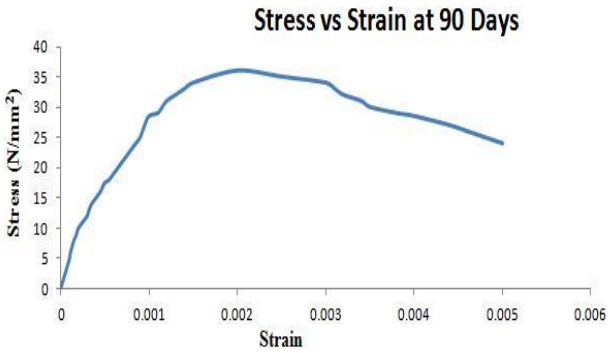

Figure 23. Stress Strain Behaviour of Plastic concrete with Polythene sheets 1.0% at 90 Days

Peak Stress = 36.25N/mm^2
At Peak Stress, Strain = 0.0025

1.5% Polythene Sheets

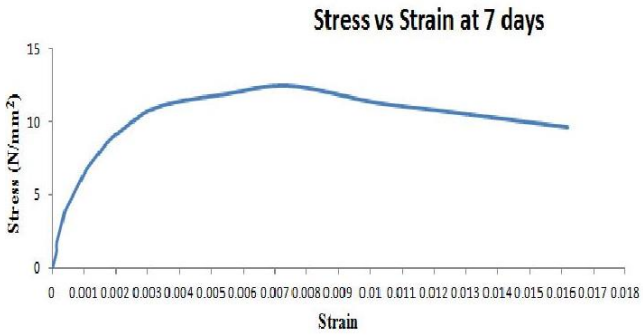

Figure 24. Stress Strain Behaviour of Plastic concrete with Polythene sheets 1.5% at 7 Days

Peak Stress = 12.99 N/mm^2
At Peak Stress, Strain = 0.007

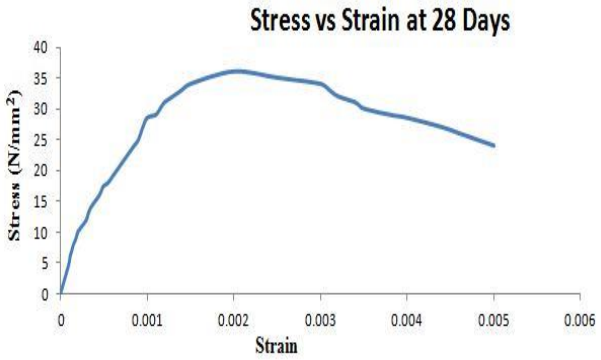

Figure 25. Stress Strain Behaviour of Plastic concrete with Polythene sheets 1.5% at 28 Days

Peak Stress = 35.10N/mm^2
At Peak Stress, Strain = 0.0023

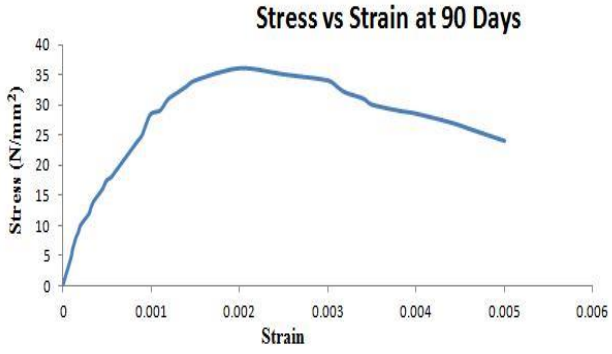

Figure 26 Stress Strain Behaviour of Plastic concrete with Polythene sheets 1.5% at 90 Days

Peak Stress = 35.80N/mm^2
At Peak Stress, Strain = 0.0022

DISCUSSIONS

1) The relationship between stress and strain is important in understanding the basic elastic behaviour of concrete in hardened state which is useful in design of concrete Structures
2) From the values of stresses and strains, average stress-strain curve for each mix is plotted, taking the average values of the results of the three cylinders. The stress-strain curves for conventional and plastic concrete mixes at 7 days, 28 days, 90 days for Conventional concrete and plastic concrete are shown in Figures
3) Strain values at Peak Stress for conventional concrete is 0.0023 at 90Days,whereas for plastic straws of 0.5%,1.0% & 1.5% the strain values at peak stress are 0.0024,0.0028 & 0.0026 respectively

IV. CONCLUSION

1) Strain values at Peak Stress for conventional concrete is 0.0023 at 90Days,whereas for polythene sheets of 0.5%,1.0% & 1.5% the strain values at peak stress are 0.0025,0.0029& 0.0025 respectively
2) From the observations made from stress-strain curves of all the conventional and plastic concrete mixes, the stress-strain behaviour is observed to be almost similar.
3) The only difference is that plastic concrete mixes have shown improved stress values for the same strain levels compared to that of conventional concrete mixes

V. REFERENCES

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