Comparative Analysis of Nominal Concrete With Polymer Modified Concrete

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Abstract- *Transportation fulfills the basic need of human's. For the time immemorial every one travels either for food or leisure. There is a strong correlation between the quality of transportation facility and development of country, because of which everyone places a great expectation from transportation facilities.*

This paper emphasizes on POLYMER MODIFIED CONCRETE which is a recent advancement in the field of concrete pavement design. Polymer fibers which are added can avoid the voids in the concrete and may increase the durability of structure.

Among all transportation modes, economical road network plays a vital role for advancement in the economy of developing countries like India. Concrete pavements are mostly used in water logged areas and heavy rain fall areas to avoid the damage or failure of the road surface. A concrete pavement gives best results than bituminous layers.

In this study a series of compression tests, split tensile tests and flexural strength tests are conducted to obtain the result.

I. INTRODUCTION

Concrete is the preferred construction material for a wide range of building, bridges and any other civil engineering structures. It is the second most widely consumed substance on earth after water.

The concrete is a popular building material in the world for past 170 years and more. Though worldwide used concrete has biggest disadvantages such as delay in hardening, low tensile strength, large drying shrinkage and low chemical resistance. To overcome this disadvantages attempts is made by modifying cement concrete with polymer additives, such as thermoplastics, thermo sets like epoxy resins which hardens, elastomers or rubbers, naturals polymers cellulose, lignin and proteins. Polymers are preferred in the cement composites due to high performance, multi-functionality and sustainability compared to conventional cement concrete.

1. POLYMER MODIFIED CONCRETE

Locally available cement concrete is a better substitute to bitumen which is the by product in distillation of imported petroleum crude. It is a known fact that petroleum and its byproducts are dooming day by day. Whenever we think of a road construction in India it is taken for granted that it would be a bituminous pavement and there are very rare chances for thinking of an alternative like concrete pavements. Within two to three decades bituminous pavement would be a history and thus the need for an alternative is very essential. The perfect solution would be POLYMER MODIFIED CONCRETE , as it satisfies two of the much demanded requirements of pavement material in India, economy and reduced pollution. It also has several other advantages like longer life, low maintenance cost, fuel efficiency, good riding quality, increased load carrying capacity and impermeability to water.

2. OBJECTIVE OF STUDY

The objective of the project is to determine and compare the strengths of polymer modified concrete and conventional concrete such as compressive strength and split tensile strength.

3. SCOPE OF STUDY

Polymer modified concrete not only be used in pavements but also in construction of any civil engineering structures due to it's less weight, economical and abundant in availability. So that the entire scope of the project is based on it's mixing in concrete and curing.

The compatibility of polymer modified concrete in taking load coming on to the structure is being find out by testing the laboratory specimen of beams and columns.

II. EXPERIMENTAL DETAILS

In the present investigation, the following materials were used

- Ordinary Portland Cement of 53 Grade cement conforming to IS: 169-1989
- Fine aggregate conforming to IS: 2386-1963.
- Coarse aggregate
- Polymer
- Water

1. Cement

Cement is a material with adhesive and cohesive properties which is capable of bonding mineral fragments into a compact-solid whole. Ordinary Portland cement is the most common type of cement in general uses all around the world as a basic ingredient of concrete, mortar. Ordinary Portland Cement of 53 Grade of brand name KPC, available in the local market was used for the investigation. The physical properties of the cement are listed in Table 1

Table 1. Properties of Cement

S.NO	Characteristics	Values obtained	Standard values
1	Normal consistency	33mm	33 to 35 mm
2	Initial setting time	38min	Not be less than 30mins
3	Final setting time	450 min	Not be greater than 600min
4	Fineness Test	6%	Not more than 10%
5	Specific gravity	3.1	3.12 to 3.19

2. Fine Aggregate

Sand is an inorganic material. It consists of small angular or rounded or sharp grains of Silica. Sand is formed by decomposition of sand stone under the effect of weathering agencies. Various sizes or grades of sand are formed depending on the amount of wearing. The characteristics of sand is listed in Table 2.

Table 2. Characteristics of Sand

S.NO	CHARACTERISTICS	VALUE
1.	Specific gravity	2.83
2.	Bulking of sand	24%
3.	Fineness modulus	2.835

3. COARSE AGGREGATES

The aggregates are used in concrete for very specific purposes. The use of coarse aggregate in concrete provides significant economic benefits for the final cost of concrete. Aggregates typically make up about 60 to 75% of the volume of concrete mixture. The aggregates of size 20mm and 12mm are used in project.

Table 3. Characteristics of coarse aggregates

S.NO	CHARACTERISTICS	VALUE
1.	Specific gravity	2.66
2.	Water absorption	1%
3.	Fineness modulus	2.9

4. Water

The water used for mixing and curing should be clean and free from injurious quantities of alkalis, acid, oils, salt, sugar, organic materials, vegetable growth and other substances that may be deleterious to bricks, stone, concrete or steel. Potable water is generally considered satisfactory for mixing. The pH value of water should be not less than 6.

5. Mix Proportions

In this project following are the mix proportions drawn by using ACI method

Nominal mix proportion

Volume of concrete = 1 m3
Volume of cement = 0.13m3
Volume of water = 0.16 lit
Volume of admixture = 0.0017 m3
Volume of all in aggregates = 0.708m3
Mass of Coarse aggregate = 1242.96 kg
Mass of Fine aggregate = 630.69kg
Mix ratio = 1 : 1.58 : 3.1

ADDING 1% OF POLYMER

Mix Proportions
Volume of concrete =1 m3
Volume of cement =0.13m3
Volume of water =0.16 lit
Volume of polymer =0.0044
Volume of all in aggregates =0.706m3
Mass of Coarse aggregate =1239.45kg
Mass of Fine aggregate = 628.9kg
Mix ratio =1 : 1.57 : 3.1

ADDING 2% OF POLYMER

Mix Proportions
Volume of concrete =1m3
Volume of cement =0.13m3
Volume of water =0.16m3
Volume of polymer =0.009m3
Volume of all in aggregates =0.701m3
Mass of Coarse aggregate =1230.68kg
Mass of Fine aggregate = 624.45kg
Mix ratio =1 : 1.56 : 3.1

ADDING 3% OF POLYMER

Mix Proportions
Volume of concrete = 1m3
Volume of cement = 0.13m3
Volume of water = 0.16 m3
Volume of polymer = 0.013
Volume of all in aggregates = 0.695
Mass of Coarse aggregate = 1220.14
Mass of Fine aggregate = 619.11
Mix ratio = 1 : 1.55 : 3.1

III. RESULTS AND DISCUSSION

1. Compressive strength test results

The following are the results for compression strength, split tensile strength and flexural strength tests.

Table 4. compression test results

Sr. No.	Age of concrete	Conventional concrete(N/mm²)	1% polymer (N/mm²)	2% polymer (N/mm²)	3% polymer (N/mm²)
1.	7 days	33.62	36.23	38.08	38.96
2.	28 days	49.85	52.95	53.80	55.48

Based on the results the graph is drawn as shown below

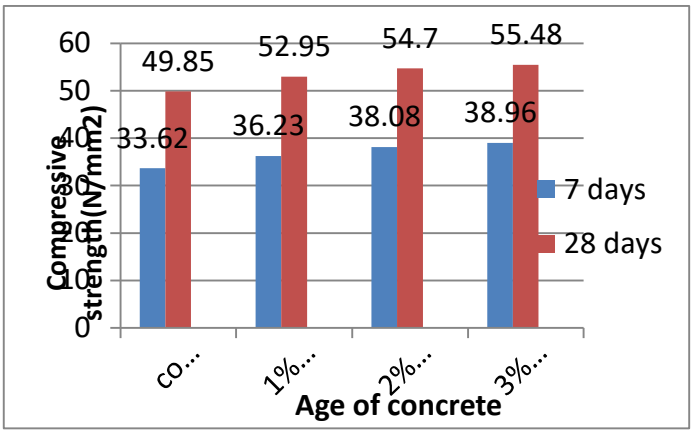

Figure 1. compressive strength graph

DISCUSSION ON COMPRESSIVE STRENGTH

1) In conventional as well as polymer modified concrete the compressive strength at 7 days and 28 days are found out and results are tabulated.
2) It is observed that with the addition of 1%, 2% and 3% of polymers the average compressive strength is increased.
3) This increment in strength may be due to the filling of voids with the polypropylene in concrete mix.
4) The compressive strength is increased by 7.76%, 13.26 % , 15.88% with the addition of 1% , 2% and 3% of polymer respectively at 7 days.
5) The compressive strength is increased by 6.21%, 9.72 % , 11.29% with the addition of 1% , 2% and 3% of polymer respectively at 28 days.
6) The compressive strength of polymer modified concrete is increased effectively at 7 days and 28 days by adding of polypropylene.

2. Spilt tensile strength test results

Table 5. split tensile test results

Sr. No.	Age of concrete	Conventional concrete(N/mm²)	1% polymer (N/mm²)	2% polymer (N/mm²)	3% polymer (N/mm²)
1.	7 days	1.98	2.28	2.52	2.79
2.	28 days	2.35	2.68	2.89	3.12

Based on the results obtained from the test the graph is plotted as shown in fig.

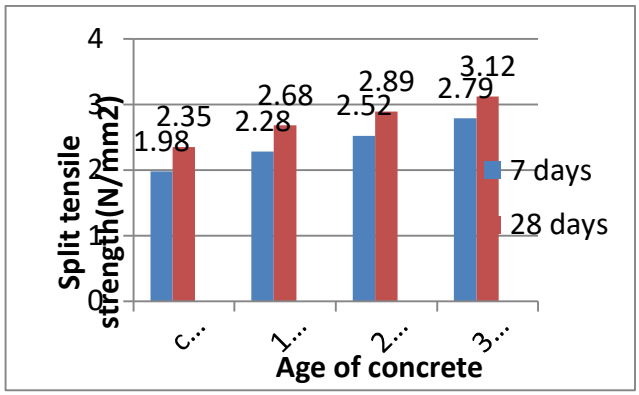

Figure 2. split tensile strength graph

DISCUSSION ON SPILT TENSILE STRENGTH

1. In conventional as well as polymer modified concrete the split tensile strength at 7 days and 28 days are found out and results are tabulated.
2. It is observed that with the addition of 1% , 2% and 3% of polymers the average split tensile strength is increased.
3. This increment in strength may be due to the filling of voids with the polypropylene in concrete mix.
4. The split tensile strength of polymer modified concrete is increased effectively at 7 days and 28 days by adding of polypropylene.
5. The split tensile strength is increased by 15.15%, 27.27 % , 40.19% with the addition of 1% , 2% and 3% of polymer respectively at 7 days.
6. The split tensile strength is increased by 14.04%, 22.97 % , 32.76% with the addition of 1% , 2% and 3% of polymer respectively at 28 days.

IV. OVERALL CONCLUSION

- The compressive strength of polymer modified concrete is increased by 11.29% when compared to conventional concrete of M40 grade with addition of 1% of polypropylene.
- The above increment in strength is because of addition of polypropylene, which reduces the air voids.
- Therefore, due to addition of small amount of polypropylene to the conventional concrete increment of compressive and split tensile strengths are observed. This is mainly due to the filling of small voids present in the concrete mix.
- However, among the different percentages(1% , 2%, 3%) of polypropylene to the concrete mix 3% gives the best results of compressive and split tensile strengths tests comparatively.
- The main advantage of polymer modified concrete is that the durability of the construction can be increased because the voids are filled with polymer. Hence the deterioration of the structure is decreased.
- This polymer modified concrete can be used mostly at pavements or any other heavy constructions.

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