USE OF ENGINEERED CEMENTIOUS COMPOSITE IN PAVEMENTS

Bilal Ahmad Wani[1], Dr. Sachit Vardhan[2]

M.Tech. Research Scholar (Transportation Engineering)[1], Associate Professor[2]
Department of Civil Engineering
CT University Ludhiana, Punjab.

***Abstract*: Although Concrete is one of the most resourceful and commonly used building material, the material's brittle nature remains a significant handicap for seismic and other applications where versatile behaviour is important. This might manifest as unnecessary deflections and cracking by poor output during service initialization. This feature restricts this material's utilisation and can be rescued by incorporating limited quantities of uniformly scattered fibres such as polypropylene fibres. This research aims to enhance traditional property of standard concrete used in pavement design. For the last five years, solid concrete overlays have been used to construct and restore buildings such as roads, bridge decks and airports. While rigid pavement overlays have advantages as long service life and strong longevity, there are problems with reflective cracking and bond products. High strength ductility and increased toughness properties indicate that Advanced Cementitious Composites (ECC) may be used as an enticing substitute to traditional concrete overlay products. To reduce environmental effects and enhance the durability of pavement overlay systems, a class of materials called Engineered Cementitious Composites (ECC) is developed to create more durable, long-lasting rigid pavement overlay. ECC ductility suppresses reflective cracking, a significant cause of premature overlay degradation, increasing longevity and reducing life-cycle maintenance. Ductile strength of regular concrete may be strengthened by having cementitious composites or Engineered Cementitious Composites (ECC Concrete) or more generally named Bendable Concrete. This concrete's micro-crack pattern reveals Bendable concrete's ductile nature. This composite displays considerably improved versatility. Fiber reinforced concrete has strong flexural and tensile power, increased ductility, and good energy absorption over standard concrete to support complex loads. The test outcome indicates that utilizing Polypropylene Fiber increases the beams' flexural strength and ductility. Based on the findings of the experimental test, it can be inferred that incorporating polypropylene 3.0 % or less by weight of cement has the greatest impact on ductility and flexural power.**

1. INTRODUCTION

Pavement is the natural substitute for surface covering on a geographical field meant for transport. The fundamental function of the floor structure is to disseminate roll loads over a wide region. Two forms of pavement typically occur, such as rigid and flexible paving, depending on surface load dissipation. While rigid concrete paves scatter the loads of the wheel very homogenously over the pavement's area, compact floors distribute the load under the wheel over a cone-shaped area. Whereas versatile pavements are used for all transportation system applications, for places subjected to mild or severe transport loads like bridge decks, carriages, airport flooring and industrial floor rehabilitation applications have become increasingly common with the use of rigid cement pavements because of their high flexibility and low maintenance. In recent decades, around the world, 100 000 km of rigid floors of concrete have been constructed. At present, several of the concrete floors touch or need to be fixed either at the end of their construction period. The most popular restoration approach is to put an overlay on the current landscape for pavements exposed to moderate to severe traffic. These systems have been used worldwide to protect paving, but in many cases premature delaminations and failures were observed, especially during the paving reconstruction process noticeable cracking and bonding strength problems. A next generation material is therefore required to prevent these problems from failingIn this study, a new composite, which has a quasi-ductile nature identical to that of steel and is classified as "engineered cementeous composites daemon," was implemented in polypropylene fiber manufacturing. The new composite was compiled. Bendable concrete classified as molded cement composites, abbreviated ECC, is a strong ductility and close crack width protection type of ultra-disposable fiber hardened cement composite composites. This material will display dramatically improved versatility. The so-called engineered cement composites or ECCs have been shown to be constructed with a lower load ability of approximately 3 % to 5% relative to the usual 0.01%. An ECC is therefore much more deformed than a standard concrete, albeit withoutracture. This stuff can be viewedEnhanced versatility considerably. The ECC consists of the same basic materials as traditional concrete but is needed to provide good workability with the addition of high-level water reduction (HRWR) agent. The multiple ingredients of ECC exchange the load added together. ECC proved 50 times more durable and 40 times stronger than standard concrete, which might also affect design decisions on floors. In addition, the excellent energy-absorbing properties of ECC render it highly ideal in seismic zones for essential bridge components.

1.1 Aims and objectives

The project intends to research and analyze the ductile conduct of concrete and crack resistance. In addition, the hardened property of ECC should be studied and contrasted with the traditional concrete architecture according to the Indian Standardization with the inclusion of Polypropylene Fibres. The priorities can be described as follows:

1. Comparison of the effects of the Bendable concrete's flexural actions with the traditional concrete and bending phenomena.
2. The tension hardening activity of ECCs should be studied.

3. To verify ECC's ductile behaviour.
4. To track the ECC-bounded concrete at various ages in UTM and equate it with standard concrete, under the flexural test (under four point loading).
5. to research the action of ECC-bending concrete design as defined by the Indian norms for the impact of Polypropylene fibers.
6. Create fiber experiments and build ECC technologies.

1.2 Scope of the Project Work

Composite is more durable than standard concrete, ECC behaves like metal rather than steel. Engineering the clay, fragile and hard conventional concrete is called. If stressed by an earthquake or normal wheel loads, it could be catastrophically failing. At tensile strains up to 5 percent, ECC remains unstable and healthy. Standard concrete fractures with a tensile strain of 0.01% cannot be mounted. Today, building firms are tightening concrete walls with steel bars so as to retain as minimal a crack as practicable. But the water and the sprinkling salts can penetrate the steel, causing corrosion that further weakens the metal, not small enough to repair. ECC concrete would not require a steel reinforcing to hold the width of the crack secure. Moreover, a structure's uctility is basically one of the key factors in its seismic efficiency.
Strong ductility and energy absorption are the core criteria of earthquake-resistant structures. The Indian IS 13920: 2003 code guarantees the overall structural ductility by offering additional reinforcing at crucial points including intersections of the system. It stressed no improvement in the ductility of the concrete used in houses.
Beton is a fractured substance that is of insufficient tensile power. Implementing different types of admixtures/ materials would serve as a groundbreaking approach in the field of floor construction in order to improve the properties of concrete including ductility, tensile strength and dissipation capability for electricity. A ductile cement can resist cracking with significant crack widths and maintain structural resilience. Structural stability and environmental protection can be accomplished by ductile concrete, which has a considerably higher ductility relative to standard concrete. The material's ductility property handles dynamic-load-induced shocks, minimizing the likelihood of earthquake loss and heavy wheel load. The harm resistance and underlying close crack width management ECC in the building and maintenance pavement is considered to be desirable by structural designers. ECC's compressive power is close to that of average and high resistance concrete. Normal concrete in nature is brittle when ECC is ductile in nature and has a wide range of applications and broad scope of potential in different areas, for example:-
1. Overlays in organic flooring. It may limit cracking and delamination of the surface and prevent fracturing.
2. In the building of jointless bridges, joints like the expansion or contraction joints are not required, because the ECC itself is capable of modifying its size.
3. Proof buildings and mobile concrete roads during earthquakes
4. Around broken floor boards, ECC overlays may be used

2. EXPERIMENTAL PROGRAMME

Concrete processing and processing is a typical phase in the process. During processing, samples are obtained and analyses on samples are then conducted. The research experiment contains plates, tubes and blocks.

TABLE 1: LIST OF ELEMENTS

Specimen	Number
Cubes	6
Beams	12
Cylinders	4
Total	22

TABLE 2: DETAILS OF ELEMENTS

Element	Size(cm)
Cube	15x15x15
Beam	10x10x50
Cylinders	D=15, H=30

2.1. MixtureProportioning

For job, the M25 nominal mix was used. All the components are recommended for this form of mix and their proportions are 1:1:2. It was using the water cement ratio of 0.4. The concrete's basic gravity was 3.15g / cm3. The following tables provide the quantity of the components included.

Table3: Quantities of materials used per unit element.

Specimen	Volume(cm^3)	Cement(Kg)	Sand(kg)	Aggregate(kg)	Water(Kg)
Beam	5000	4	4	8	1.6
Cube	3375	2.66	2.66	5.32	1.1
Cylinder	5301.44	4.2	4.2	8.4	1.68

B_1, B2, B3 represent three different beams with varying percentages of fiber and superplasticizer.

Table5: Quantity of fiber and super plasticizer used in different cylinders.

Cylinders	(%)fiber	Weight of fiber (Kg)	(%)super plasticizer	Weight of super plasticizer(Kg)
C_1	0.3	0.051	0.6	0.026
C_2	0.4	0.061	0.8	0.034
C_3	0.5	0.080	1.0	0.042

C_1, C_2 ,C_3 represent three different cylinders with varying percentages of fiber and superplasticizer.

Table 6: Quantity of fiber and super plasticizer used in different cubes.

Cubes	(%) fiber	Weight of fiber (Kg)	(%)super plasticizer	Weight of super plasticizer(Kg)
$(Cu)_1$	0.3	0.032	1.0	0.027
$(Cu)_2$	0.4	0.043	0.8	0.022
$(Cu)_3$	0.5	0.053	1.0	0.027
$(Cu)_4$	0.8	0.085	1.0	0.027
$(Cu)_5$	1.0	0.106	1.4	0.037

$(Cu)_1$,$(Cu)_2$,$(Cu)_3$,$(Cu)_4$,$(Cu)_5$ and $(Cu)_6$ represent cubes with varying percentages of fibers and super plasticizer respectively

2.2. CASTING PROCEDURE OF ECC-CONCRETE

The mixing affected the output of the ECC Concrete. This will lead to better performance and consistency of ECC concrete by a fair and effective mixing procedure. To reinforce cement & improved binding of cement with Polypropylene fibers is urged to have a good concrete blend. The mixing was done until the concrete mix design was finished. The ECC Concrete mixture was done by hand pouring.

2.3. Testing of Concrete

Degree of workability	Slump		Compacting Factor	Use for which concrete is suitable
	mm	In		
Very low	0-25	0-1	0.78	Very dry mixes; used in road making. Roads vibrated by power operated machines.
Low	25-50	1-2	0.85	Low workability mixes; used for foundations with light reinforcement. Roads vibrated by hand operated Machines.
Medium	50-100	2-4	0.92	Medium workability mixes; manually compacted flat slabs using crushed aggregates. Normal reinforced concrete manually compacted and heavily reinforced sections with vibrations.
High	100-175	4-7	0.95	High workability concrete; for sections with congested reinforcement. Not normally suitable for vibration

3.0 RESULTS AND DISCUSSION

After primary introduction and practical tasks such as planning of the components discussion on the job, casting and curing of the concrete, tests are conducted in the facility. Different aspects of the concrete with Polypropylene fibers have been identified from this project work. We have produced various polypropylene fiber percentages with a regular water cement ratio of 0.4. We have graphs centered on their reported values for all concrete blocks.

3.1. SlumpTestResults

A)For Specimen with 0.3% of fiber byweight

Plasticizer (%)	Slump (mm)	Workability
0.4	71	Medium
0.5	86	Medium
0.6	110	High

B)For Specimen with 0.4% of fiber byweight

Plasticizer (%)	Slump (mm)	Workability

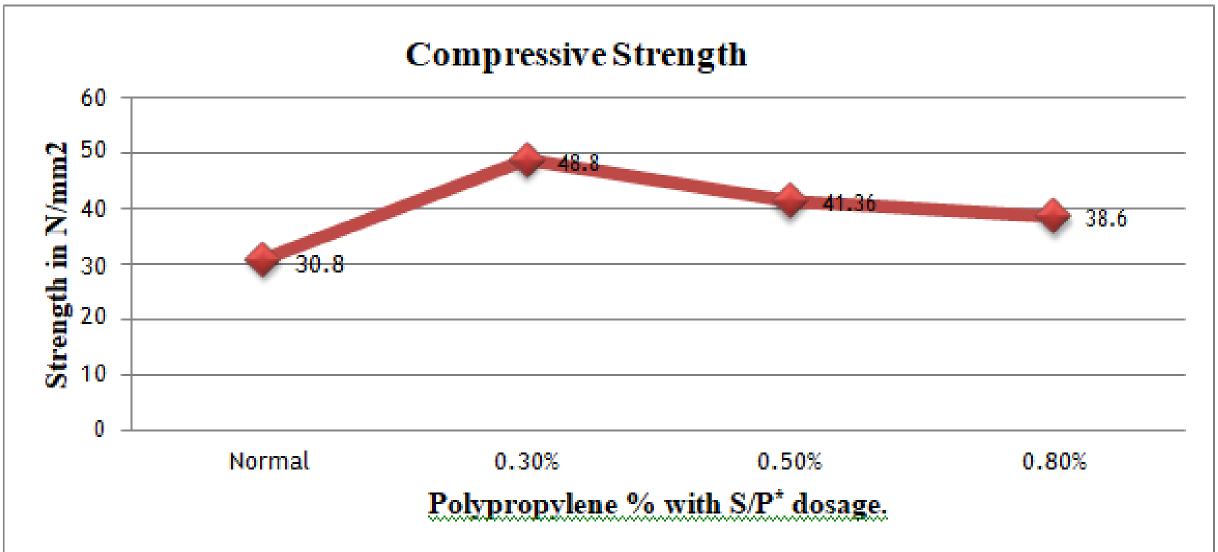
0.6	59	Medium
0.7	81	Medium
0.8	107	High

C)For Specimen with 0.5% of fiber byweight

Plasticizer (%)	**Slump (mm)**	**Workability**
0.8	47	Low
0.9	79	Medium
1.0	101	High

Graph for Compressive StrengthTest:
In X axis Polypropylene fibers percentage and in Y axis Compressive Strength is plotted.

S.NO.	Specimen	% Fiber	S/P* dosage (%)	Compressive Strength at 28 day (N/mm^2)
1.	Conventional Concrete.	Nil	Nil	30.8
2.	ECC	0.3	1	48.8
3.	ECC	0.5	1	41.36
4.	ECC	0.8	1	38.6

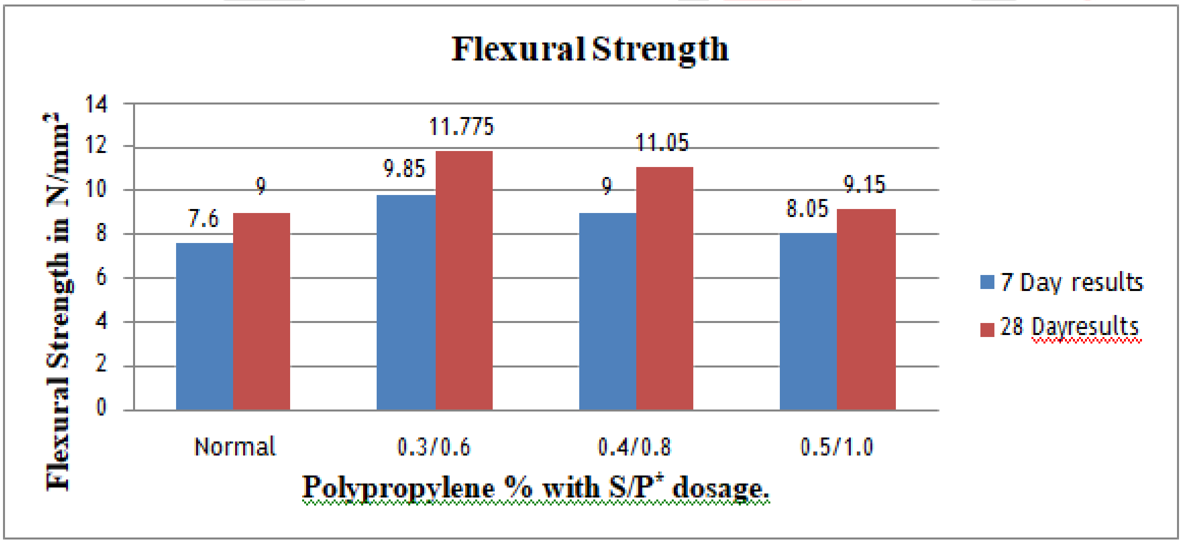


GRAPH 1: VARIATION OF COMPRESSIVE STRENGTH M_{25} GRADE CONCRETE FOR 28 DAYS WITH AND WITHOUT FIBER.

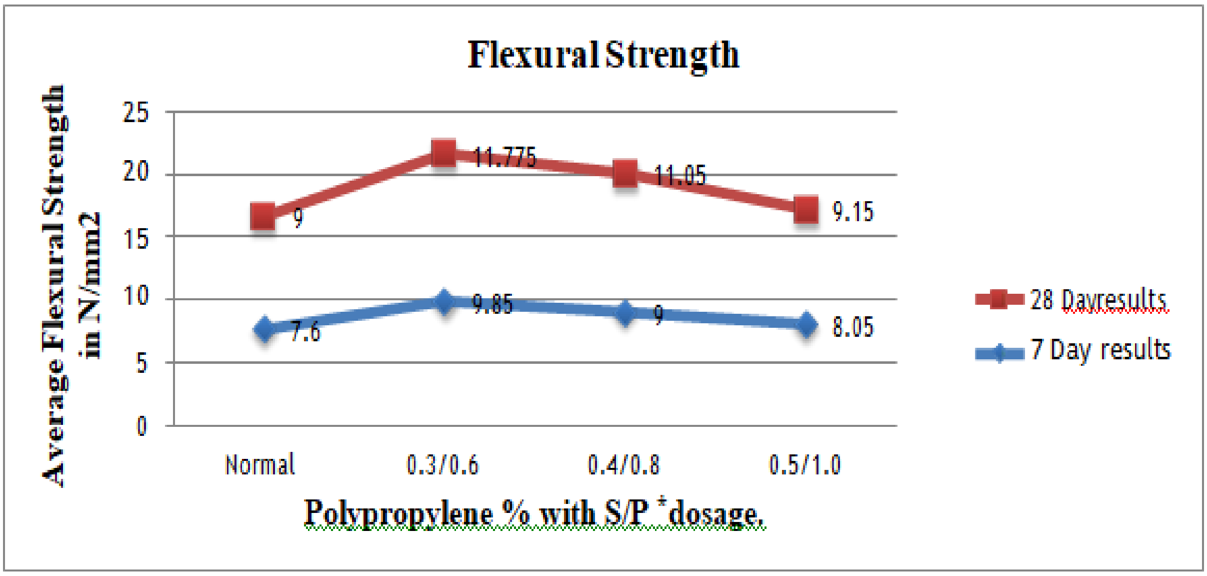
Graph for Flexure Strength Test:

In X axis, the percentage of polypropylene fibers and the average bending power in Y axis is calculated.

S.NO.	Specimen	% Fibre	S/P[*1] dosage (%)	Flexural Strength at 7 day 2 (N/mm)	Avg. Flexural Strength at 28 day 2 (N/mm)	Flexural Strength at 28 day 2 (N/mm) Sample 1	Flexural Strength at 28 day 2 (N/mm) Sample 2
1.	Conventional Concrete.	Nil	Nil	7.6	9	9.43	8.57
2.	ECC	0.3	1	9.85	11.775	11	12.55
3.	ECC	0.4	0.8	9	11.05	10.9	11.2
4.	ECC	0.5	1	x	9.15	9.15	x



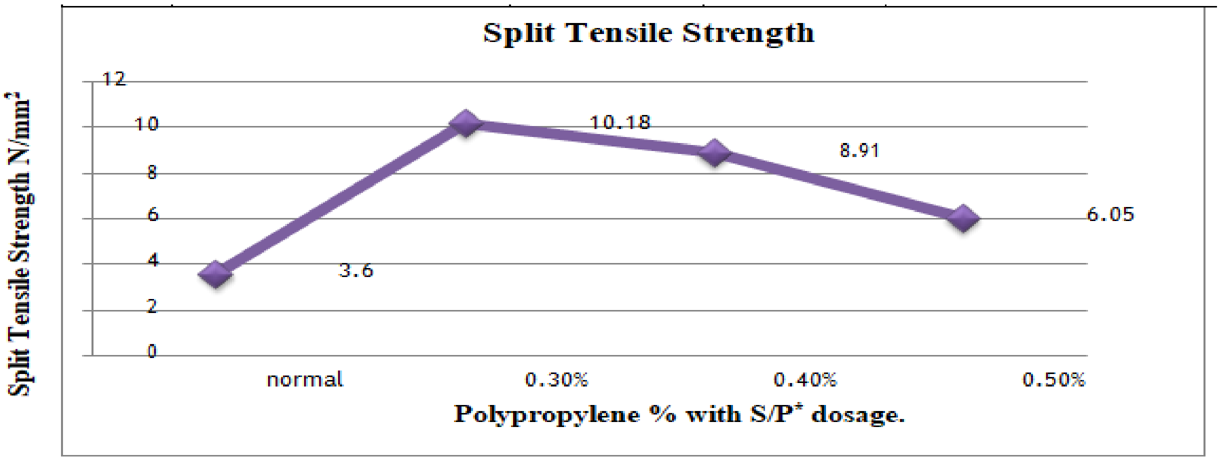
GRAPH 3 :VARIATION OF FLEXURAL STRENGTH M_{25} GRADE CONCRETE FOR 7 & 28 DAYS WITHAND WITHOUTFIBRE.



GRAPH 2: VARIATION OF FLEXURAL STRENGTH M_{25} GRADE CONCRETE FOR 7 & 28 DAYS WITH AND WITHOUTFIBRE.

Graph for Splitting Tensile StrengthTest:
Please remember the proportion of polypropylene fibers on the X axis and TensileStrength on the Y axisSplitting.

S.NO.	Specimen	% Fibre	S/P* dosage (%)	Splitting Tensile Strength at 28 day (N/mm^2)
1.	Conventional Concrete.	Nil	Nil	3.61
2.	ECC	0.3	1	10.18
3.	ECC	0.4	0.8	8.91
4.	ECC	0.5	1	6.05



GRAPH 4 : VARIATION OF COMPRESSIVE STRENGTH M_{25} GRADE CONCRETE FOR7 & 28 DAYS WITH AND WITHOUT FIBRE.

ANALYSIS OFRESULTS.

In contrast with standard concrete with no fibre reinforcement the fiber reinforcement inside the ECC will easily distribute the load if fiber composite strains. The strengthened polypropylene fiber ECC has greater tension strength and flexural force value in every chosen weight percentage of the fibre.

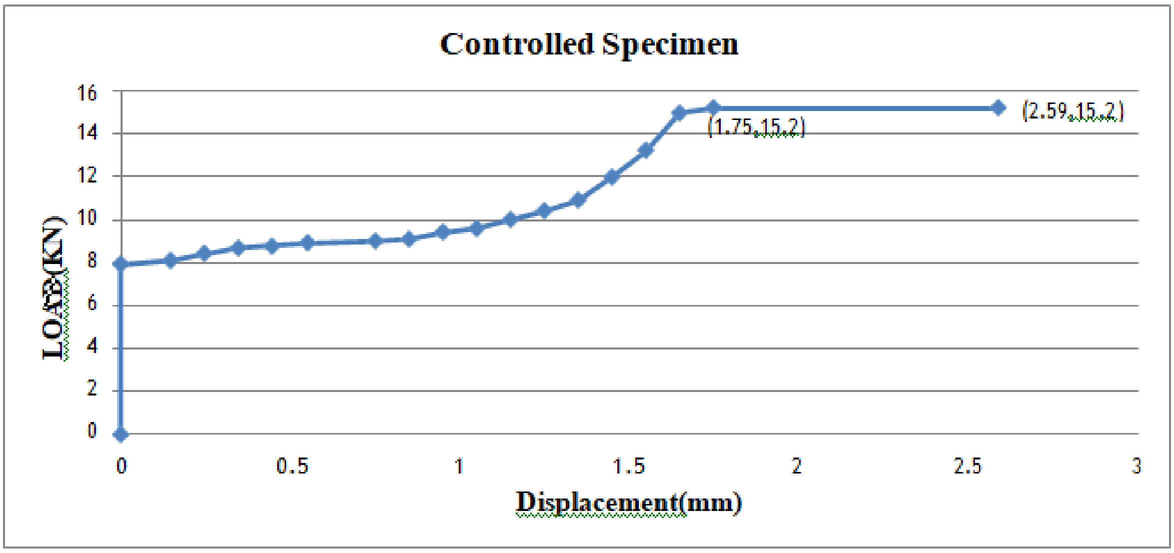
1. Compressor pressure and resistance is dramatically improved under 0.3Wt% stress, 0.5Wt% 0.8Wt% (s / p injection 1%) and 0.3Wt% flexure measure, 0.4Wt% 0.5Wt% 0.5Wt% polypropylene fabric. Compressive and flexural strength and tensile strength increased substantially. While the fiber-weight proportion was weaker, the tests were much better than standard concrete in density and flexural power. However, the power declined significantly at higher fiber weight levels. At a fiber content of 1Wt percent (super- plasticizer dosage of 1.4 percent), 20N / mm2 is found to be compressive. This may be because, as changes in weight, the fiber and matrix contact could be limited and the overall loade could not be moved from the matrix to the fiber.

2. In comparison, working power dropped above 0.5% and above 0.8% with higher fiber weight percentages. The use of additional super plasticizers was also a requirement that was detrimental to the efficiency of ECC. If concentrations below 0.3% of polymers are checked, their strengths may be much higher. So we can assume that the addition of small quantities of polypropylene fibers and little plasticisation, together with other patented modifications, will nhance both the compression strength and the flexural strength.

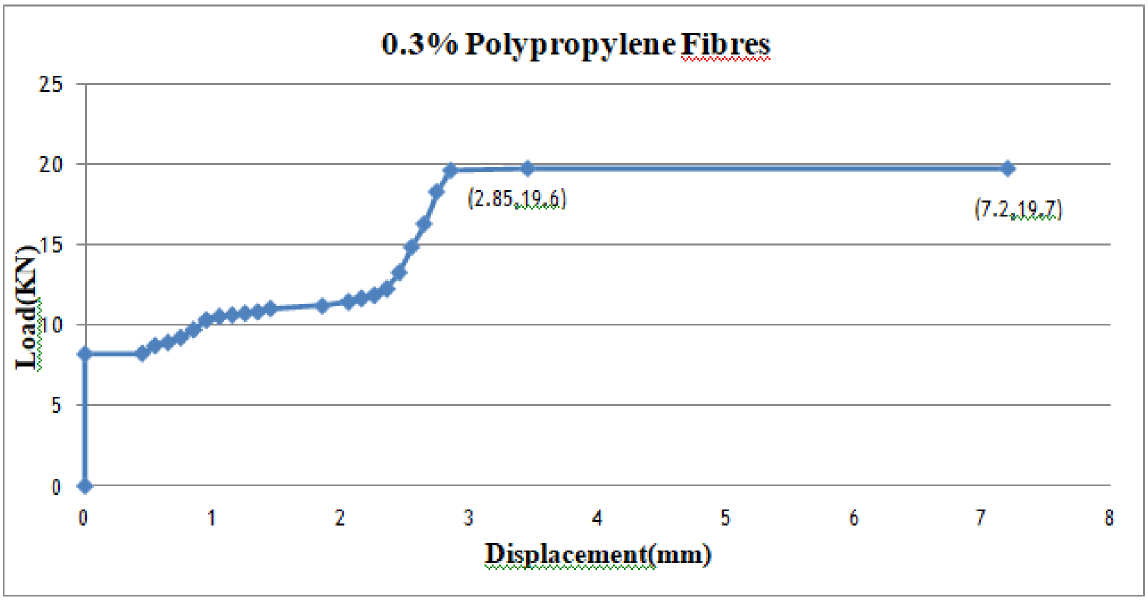
Load vs. DeflectionGraphs:

In X axis displacement and in Y axis corresponding load is plotted.

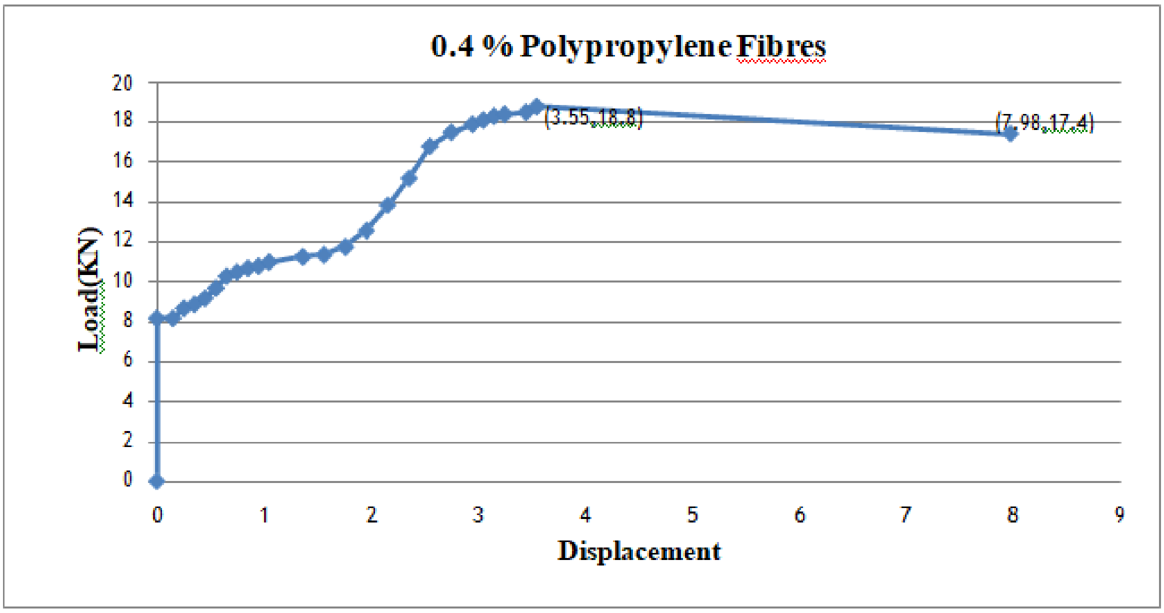
4.6.1 For 7 DayTests:



GRAPH 5: LOAD VS DISPLACEMENT FOR COVENTIONAL CONCRETE.

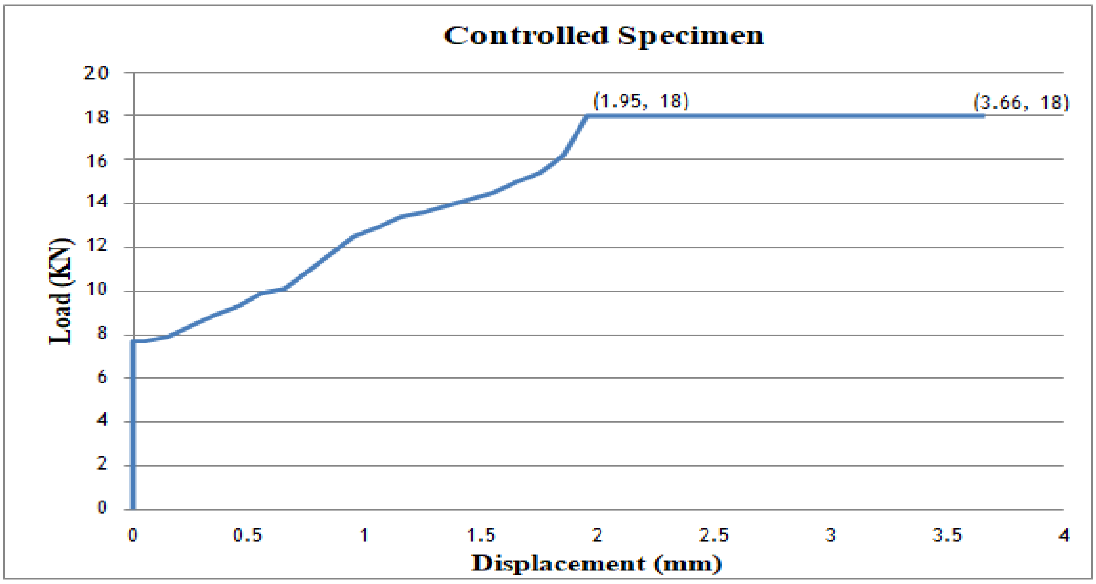


GRAPH 6: LOAD VS DISPLACEMENT FOR ECC (0.3% FIBRE) CONCRETE.

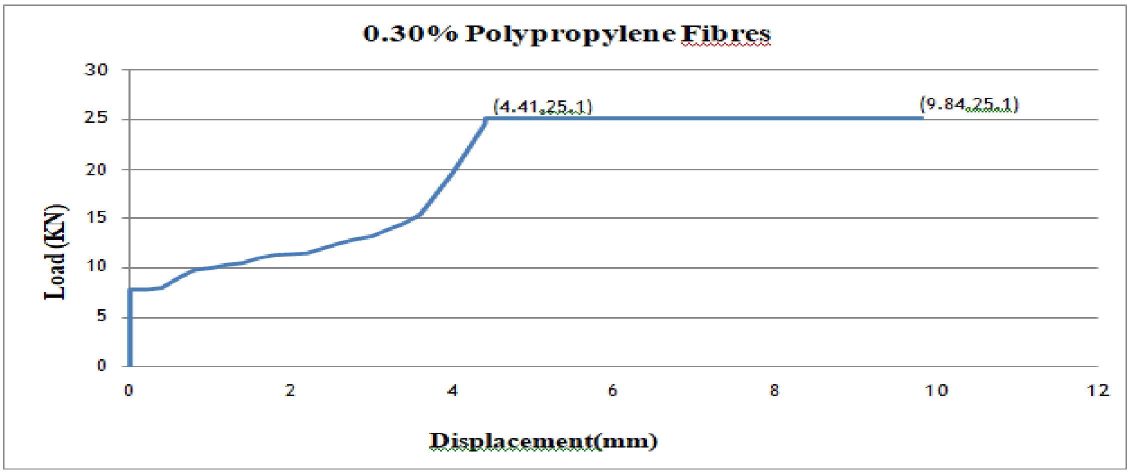


GRAPH 7 : LOAD VS DISPLACEMENT FOR ECC (0.4% FIBRE) CONCRETE

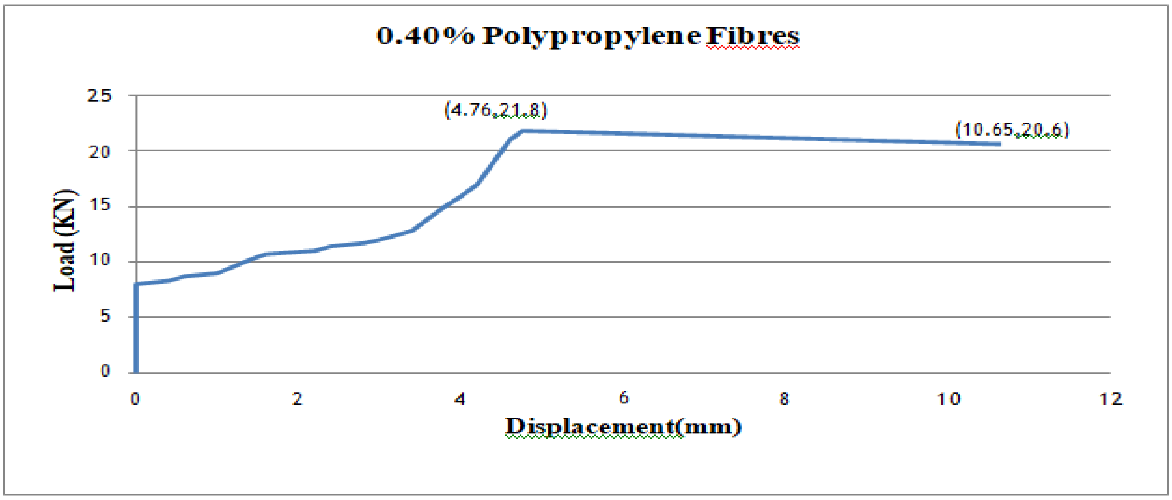
4.6.2 For 28 DayTests:



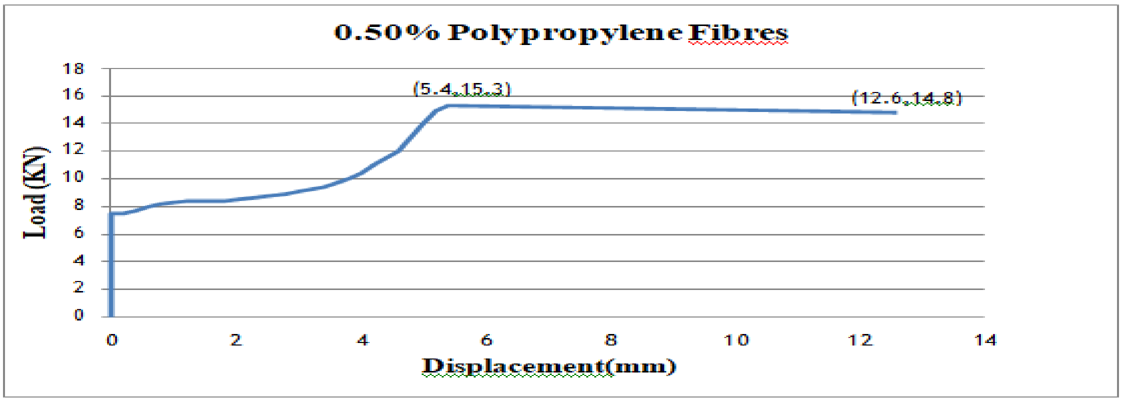
GRAPH 8 : LOAD VS DISPLACEMENT FOR COVENTIONAL CONCRETE.



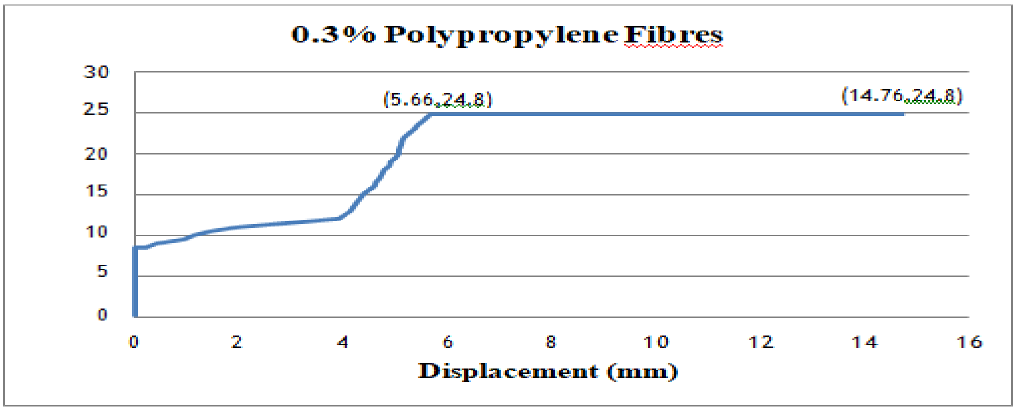
GRAPH 9: LOAD VS DISPLACEMENT FOR ECC (0.3% FIBRE) CONCRETE.



GRAPH 10: LOAD VS DISPLACEMENT FOR ECC (0.4% Fibre) CONCRETE.



GRAPH 11: LOAD VS DISPLACEMENT FOR ECC (0.5% FIBRE) CONCRETE.



GRAPH 12 : LOAD VS DISPLACEMENT FOR NO AGGREGATE ECC (0.3% FIBRE) CONCRETE.

4.0. CONCLUSIONS

Conclusion

1. Engineered cement composites (ECC) provide all of the qualities suitable for high-performance flooring applications, including outstanding longevity, good ductility and cracking resistance.
2. Compared to regular concrete, ECC composite measurements indicate greater results in splitting, tiredness and bond inspection, freezing thaw damage, checking for abrasion and degradation, long-term structural durability, and speeding up environmental

monitoring.
3. A well-designed ECC overlay system was lower than a concrete and HMA overlay device over a 40-year operating period.
4. The ECC overlay device decreases overall life-cycle resources by 14%, GHG pollution by 32% and the expense by 40 percent relative to traditional overlays by improving service life and reducing maintenance frequency.
5. The load carrying potential of the ECC / concrete overlay samples was double the load carrying capacity of the PC / concrete overlays of the study and the ECC / concrete deformability was considerably higher and the life period of the fatigue improved
6. Compared with the control panel, the ECC fault mode was more ductile in design. It indicates that the beam's overall carrying ability was greater than control experiments and other differing percentage by up to thirty percent of polypropylene. It is observed that the ECC beams ductility beats traditional concrete beams from the measurement of the ductility ratio.
7. In contrast to Plain cement concrete beams and SFRC (Steel Fiber Enhanced Beton) composite beams with the same geometry and flexural loading conditions, the ECC beams layered have considerably the both load bearing and deforming capability and have strengthened crack width power.

Future Scope

External ECC Concrete experiments and studies are suggested to show the ECC Concrete's additional functionality for their implementations. Some guidelines for further studies are provided below:
1. There will be further experimental testing to evaluate the tolerance potential of the concrete to corrosion in future. It is also advised that ECC Concrete Beams with steel reinforcement bars be installed for research.
2. Further tests and experiments are needed to assess the shear strength of the concrete in order to evaluate the application of concrete in earthquake-resistant structures.
3. Further analysis and measurements are required to evaluate the ratio of Poisson. The examination of concrete cylinders is advised.
4. Further studies and analyzes are required to build a basic model in which steel, polypropylene and hybrid fiber absorption energy is measured.
5. More study is expected in beams wrapped with fiber enhanced polymer sheets to ascertain the effects of special hybrid fiber mixing of steel and polypropylene fiber on ductility, stability, break tensile strength and flexure strength.

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