FIBRE REINFORCED CONCRETE-A REVIEW

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ABSTRACT
Fiber Reinforced Concrete (FRC) is a concrete containing fibrous material which can be in uniform distribution or random distribution. Fibers include steel fibers, glass fibers, synthetic fibers or natural fibers which will possess different actions according to their own properties. A number of papers have already been published on the use of steel fibers in concrete and a large amount of research had been taken in steel fiber reinforcement. In present study the detailed experimental investigation is carried out on plastic fiber reinforced concrete. Since, plastic is non-biodegradable and plastic waste can pollute the environment and also posses problem in dumping. Hence an attempt is made in the present investigation to study the effect of domestic waste plastic (polythene fibers) to concrete.

Keywords: Fiber reinforced concrete, domestic waste plastic, polythene fibers, compressive strength, flexural strength, split tensile strength.

I. INTRODUCTION
Due to its high compressive strength, long service life, easy availability and low cost, concrete is the most widely used construction material. But concrete also possess some disadvantages like low tensile strength and crack resistance. Due to its brittle behavior concrete shows sudden and accidental failure, especially during earthquakes, blasts or suddenly applied loads (impact). This serious disadvantage of concrete can partially be overcome by the addition of fibers. The addition of fiber can cause change in the failure mode under compressive deformation from brittle to pseudo-ductile, thereby providing toughness to concrete.
In India, domestic waste plastic are causing considerable damage to the environment and hence an attempt has been made to understand whether they can be successfully used in concrete to improve its properties like in case of steel fibers.

II. LITERATURE SURVEY

Workability: This paper reviews slump test and inverted slump test. Both these tests are helpful in determining the workability of fresh concrete, where inverted slump test is specifically used in case of fiber reinforced concrete. Slump and inverted slump cone tests were conducted to check the effects of addition of polypropylene on concrete. Their results state that inverted slump cone time increased, thus it can be Concluded that air entrainment becomes difficult and hence its use in corrosion prone structures should be avoided. Another result yields that fiber volume up to 0.3%, has Significant effect on fresh mix workability but it deteriorates as the fiber Volume increases. It is suggested to limit the fiber volume to 0.1-1% and add super plasticizers to improve workability.
Compressive strength: Experiments were conducted where waste fibers of metal and polypropylene were taken and tested. The results show that the addition of short fibers (<30mm) result in decrease of compressive strength and that of long fibers shows no change in compressive strength. Also addition of metal fibers shows no change in compression strength. It can be also be concluded that high fiber percentage may lead to high porosity and hence decreasing its compressive strength. Some performed experiments by adding waste polypropylene fibers to the concrete and included results of compressive strain at peak stress and compressive toughness index.
Compressive toughness index (CTI) is:
CTI = Total compressive energy absorbed/pre peak compressive energy absorbed.
It is concluded that long polypropylene fibers (19mm) reduce compressive strength but increase energy absorption capacity and toughness characteristics.
Previous researches also shows that at elevated temperatures the compressive strength of fiber reinforced concrete increases by 6%-10%
Flexural Strength: This test indirectly measures the tensile strength of concrete and how a concrete beam resists failure in bending. According to the experimental results, addition of short or long fibers of polypropylene in a mixture improves the flexural strength. The previous researches suggest the use of multi modal fibers rather than mono fiber system. Fiber volume and length also effect flexural performance and post cracking behavior. The experiments suggest that volume of fibers added is proportional to the ductility in FRC. The post cracking behavior analysis according to this suggests that mono fiber system does not affect this property as such. But addition of both short and long fibers tends to improve the crack resistance. Experiments on FRC from industrial waste were described in the concerned paper. The flexural strength for M20 grade concrete was found to be highest (~2times of control beam) with 1% galvanized wire and 2% lathe scrap. Waste metal fiber reinforcement tends to increase flexural strength till 3% volume.
Durability: Durability is the most important factor of concrete, and this paper aims to review durability and sustainability of fiber reinforced concrete. Researchers studied the effects of polypropylene fibers and results showed that these fibers did not show any reduction in tensile properties even when exposed to salt water conditions at various temperatures ranging from 70°C to -7°C for six months. They also concluded that plastic fibers are also resistant to alkali environment. Some performed experiment with Plastic fibers from post-consumer plastic

bottle and found that tensile strength was 87% after the attack. This implies that waste plastic fibers have good alkali and sulphide resistance.

Permeability: Permeability of concrete is a major contributor to its durability. Researchers suggested that more the fiber length and characteristics, more air voids will be formed. This increase in porosity tends to increase permeability also. Thus, resisting its usage in marine construction. Experiments investigate the effect of waste fibrillated polypropylene fibers of lengths 19mm and 12.7mm, where 19mm showed an increase in permeability and no effect on permeable voids. In contrast, 12.7mm long fibers denote a slight increase in permeability and decrease in volume of permeable voids.

Toughness and Impact resistance: Considering the experiment conducted by Mohammed Seddik Meddah, Mohamed Bencheikh, we find that the Toughness of FRC is considered as its ability to absorb energy across the crack and is found in their experiment by using area under load displacement curve. By finding toughness indices, it was concluded that waste polypropylene fibers provided more toughness than metallic fibers. One more possible reason for poor performance of metallic fibers may be their random orientation and geometry (since they were directly used as waste itself).

Impact resistance is said to be increased with addition of fibers. According to Bayasi and Zeng, Impact resistance significantly improves with addition of short fibers than long fibers till the volume of fibers added does not affect workability of FRC. Similarly Soroushian investigated the effects of adding recycled fibers and suggested that there was a sheer increase in impact resistance of FRC for discrete reinforcement distribution. S.Aravindam suggests that there is a 23.7% increase in impact resistance as recorded by falling weight method.

SUMMARY

This paper covers current state of usage of industrial waste fibers and focuses on waste plastic fibers. This paper covers effect of addition of fibers and their volume on mechanical properties on fresh and hardened concrete according to various experiments, given as:

- Recycled polypropylene fibers reduce air content in FRC, and may be used in the use of structures in marine environment. It can be implied that air content will increase even more for the addition of waste metal fibers, due to their highly crimped structure. An optimum volume of 3% of fibers is considered not to have adverse effect on air content, and higher amount than this is avoidable
- It is observed that the workability of FRC decreases as the volume of PP fibers increases, especially when more volume is more than 1%. This is due to the large surface area of uneven waste fibers, absorbing cement paste and making the matrix more viscous. The decrease in workability is seen more due to the addition of long fibers. So, short fibers should be added for better workability otherwise super plasticizers can be added.
- Experiments suggest that there is almost a 41.25% increase in the compressive strength when waste metal fibers are used. Using long polypropylene fibers reduces the compressive strength but improves its CTI and toughness characteristics, unlike short fibers which increase compressive performance up to 0.3% and then start to affect it adversely.
- The addition of fibers usually doesn't enhance flexural strength of concrete, but long fibers contribute to quasi ductile behavior during post cracking period.
- Durability of FRC with addition of plastic fibers results in a good resistance to salts, alkaline environment in various extreme temperatures and conditions, whereas metal fibers are highly susceptible to corrosion.
- Longer fibers and better fiber characteristics would tend to increase the permeability of FRC. Polypropylene fibers have higher tendency to increase permeability due to their higher surface area rather than metal fibers. In case polypropylene fibers are used, short fibers should be preferred as they showed a decrease in permeability voids in experiments. It is good to avoid usage of PP fibers where impermeability is one of the most important factors of construction. Eg. Water tanks, swimming pools and so on.
- Impact resistance of FRC is proportional to the amount of fibers added, until they do not affect workability of the fresh mix.
- Using FRC from industrial waste products would have following benefits:
  - More use of recycled steel, post-consumer plastic and metal waste.
  - Reduce disposal problem.
  - Sustainable, durable and economical.
  - Reduction in slab thickness up to 30%.
  - Ideal for joint free design.

III. SCOPE AND CONCLUSION

This paper primarily reviews the various effects of addition of fibers in concrete with regard to compression, durability, flexure, impact energy, permeability, fresh concrete properties and toughness. Apart from checking the strength variation, comparison between the percentages of fiber with respect to the concrete volume is presented. And hence the optimum amount of percentage of fibers with respect to maximizing strength, durability and utility are to be noted. In future, FRC design fundamentals for waste, macro and crimped fibers can be established for both metal and plastic fibers. This has a great future and can give us economical, sustainable and durable concrete.

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