CHAPTER 7
CONCLUSION

7.1 GENERAL

The present study investigated the effectiveness of using Polypropylene Fibre in Geopolymer Concrete and varying fibre percentage in FRGP Concrete.

To produce and investigate different properties, parameters and behaviour of Geopolymer Concrete mixtures with Polypropylene Fibre additives with target compressive strength for the manufacture of all specimens.

7.2 CONCLUSION

Based on the investigations, the following conclusions were drawn and were presented in the following sections based on the required categories.

7.2.1 Research Findings Based on Results of Fresh Concrete

- The results indicated that the workability of fresh FRGP concrete decreases as the percentage addition of Polypropylene Fibre increases.
- The values of slump cone test on fresh concrete lies between 120 mm to 90 mm which there by ensures medium workability on all mix proportions
- The maximum percentage of flow of fresh concrete is observed in control specimen whereas lowest flow percentage is observed in FRGP-5 specimen.
• The loss in workability of the FRGP Concrete is due to the addition of Polypropylene Fibre which directly influences the flow in fresh Geopolymer Concrete.

7.2.2 Research Findings Based on Mechanical Properties

• The concrete mix prepared using up to 0.6% Polypropylene Fibre addition, shows increase in Compressive Strength of GPC.
• The results show that as the age’s increases the variation in strength gain decreases, and normalizes almost after 56 days.
• The effect of Polypropylene Fibre addition in binding material on splitting tensile strength shows higher strength than that of GP specimen.
• It is evident that the addition of Polypropylene Fibre increases the splitting tensile strength and this increment is more than that of Compressive Strength increment.
• The Polypropylene addition increases the flexural strength of plain GPC prisms and are substantially related to the bonding properties and the dispersion of Polypropylene Fibre

7.2.3 Research Findings Based on Durability Properties

• UPV results show all the specimen exhibit excellent quality in terms of pulse wave passed through the GPC.
• The UPV results also relate with the strength of GPC, higher the pulse velocity shows higher strength.
• From the UPV results it can be concluded that the quality of GPC is excellent for all mix proportions, especially for Polypropylene Fibre addition upto 0.6%, excellent.
- The water absorption test shows that FRGP-5 which is the superior specimen in terms of water absorption, the percentage of water absorption is 1.51% which is 4.13% higher than the control specimen.
- This increase in water absorption is due to higher voids in higher percentage of FRGP Concrete.
- Therefore it can be concluded that the addition of Polypropylene Fibre reduces the pores in FRGP Concrete.
- It is evident that the Polypropylene Fibre has a vast influence on its void structures.
- From shrinkage test on drying shrinkage it is concluded that the Polypropylene Fibre induces autogenous shrinkage because curing cannot reach the internal small pores produced by Polypropylene Fibre and thus results in internal drying which is called self-desiccation is observed.
- The drying shrinkage can be reduced by incorporating Polypropylene Fibre as an addition to cement
- From the RCPT it is evident that average penetration increases with increase in Polypropylene Fibre addition up to 0.6% and penetration increases for 0.8% addition.
- The values exceed the control specimen values at 1% addition of Polypropylene Fibre.
- From RCPT it can be concluded that the addition of polypropylene Fibre enhances the behaviour of GPC by resisting the chloride penetration thus giving the durability enhancement.
- The sulphate attack test results shows, there was no sign visibly for surface erosion, cracking or spalling of the specimens till 4 weeks of time, but after 8 weeks, a little erosion on the surface could be noticed.
• The sulphate attack test results show that Polypropylene Fibre incorporated FRGP Concrete cubes, invariably of strength, had marginal weight gain, which shall be due to the high absorption of exposed liquid. But the specimens are almost maintained in shape without any sign of severe external deteriorations.

• The sulphate attack results show that loss in Compressive Strength decreases with increase in Polypropylene Fibre addition up to a limit of 0.6% and this is due to the occupation of fibre in FRGP microstructure which restricts the penetration of sulphate solution, particularly in FRGP-3 the penetration is very low therefore increase in mass and loss in strength is very low in this specimen. But in case of FRGP-5 there was disintegration in its pore structure, hence this leads to higher increase in mass and higher loss in strength.

• The Chloride Attack results show very little loss in mass in all specimens and the maximum loss percentage is observed as 1.67% in FRGP-5 specimen during 8 weeks of exposure which shows that there is very less effect of chloride solution on FRGP Concrete.

• The loss in compressive strength due to chloride attack is less in FRGP-3 specimen this is due to the resistance to penetration of chloride solution into the specimen.

• On the test on acid attack, erosion of surface was not observed in Polypropylene fibre added FRGP Concrete specimens even after 8 weeks of exposure in sulphuric acid solution and did not exhibit any noticeable colour change. Though the surface had become softer with the exposure time, the specimen remained structurally intact.

• The Polypropylene fibre gives more resistance to FRGP Concrete against acid attack to specimens in terms of weight loss. This also shows that resistance on surface erosion is made possible by incorporating Polypropylene fibre in FRGP Concrete.
7.2.4 Research Findings on Finite Element Analysis and Experimental Work of Conventional GPC Beams Subject to Varying Temperatures

- The FEM models for validation of plain Geopolymer Concrete and its respective analysis shows that the concentration of thermal stresses and its impact on the material structure is more for the control specimen when compared to that of Geopolymer specimen.

7.2.5 Research Findings on Behaviour of Reinforced GPC Beams and Slabs with and Without Polypropylene Fibre

- The test on specimens under elevated temperature shows the loss in weight goes on decreasing as the percentage of Polypropylene Fibre addition increases. This shows that resistance towards exposure to high temperature is made possible by incorporating Polypropylene fibre in FRGP Concrete.

- From the study carried out on fly ash based polymer RC beams and RC cement concrete beams, it can be concluded that the plain fly ash based polymer RC beams were structurally more resistive than control specimen due to its higher molarity(14 M) in this study. But when it comes to addition of Polypropylene Fibre there was no significant increase in load carrying capacity.

- The addition of fibre increases the flexural toughness of the beams. The volumetric fractional addition of Polypropylene Fibre gives the maximum load carrying capacity at 0.4%, but the toughness was high, attributed to the reduction in deflection. At 0.4% the failure was also sudden when compared to other specimens.

- Until 0.6% addition of Polypropylene Fibre addition, the load carrying capacity of beams was maintained not lesser than the control
specimen. The addition of Polypropylene Fibre gives more resistance toward bending by increasing its flexural resistance. The addition of Polypropylene Fibre also reduces the strain localization of the fly ash based RC beams. Hence the addition of Polypropylene Fibre should be maintained at 0.4% or lesser.

- From the test results it is observed that Geopolymer Slabs exhibited brittle failure. With the incorporation of Polypropylene Fibre in Geopolymer, the brittle behaviour of Geopolymer Concrete can be brought to ductile.

### 7.2.6 Research Findings on Microstructural Properties

- The micro structural study shows the enhanced performances and effective cost-benefit ratio made the use of Polypropylene Fibre in concrete structures recently.
- The advantage extended to Fibre Geopolymer Concrete also. Porosity is measured by means of BET techniques. In the case of both additives, the pores were found to be uniformly distributed throughout the samples.
- The results of BET and SEM have shown the difference in pore size for the samples with and without addition of Polypropylene Fibre. FRGP sample has low pore volume and surface area when compared to OPC and GPC.

### 7.2.7 General Conclusion

Based on results of the above experimental investigation it is concluded that Geopolymer concrete with Polypropylene Fibre as secondary reinforcement have superior properties and Structural behaviour than conventional GPC. The FRGP Concrete can be used as a substitute in place of conventional reinforced cement concrete.
7.3 **SCOPE FOR FUTURE WORKS**

- Polypropylene Fibre can be used in Self Compacting GPC and Special Concrete.
- Study on GPC with different additives like GGBS, silica fume along with polypropylene fibres.
- Polypropylene Fibre can be effectively added in making high performance Geopolymer blocks and porous Geopolymer Pavement Blocks.
- Study on performance of special structural elements like Deep beam, Corbel, Shear wall etc using Polypropylene fibre based GPC.
- Precast wall panels with Polypropylene fibre based GPC can be studied.
- Beam Slab Panels with Polypropylene fibre based GPC can be studied.