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Experimental Investigation on Partial Replacement of Cement by Glass Powder and Coarse Aggregate by Waste Plastics in M25 Grade Concrete

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Abstract – Now a days infrastructure is developing day to day which leads to consumption of concrete materials like cement, Fine aggregate, coarse aggregate increases. Cement play an important role in manufacturing of concrete. The global cement industry contributes about 7% of greenhouse gas emission to the earth's atmosphere. In order to address environmental effects associated with cement manufacturing, there is a need to develop alternative binders to make concrete. A Part from cement for manufacturing of concrete the coarse aggregate constitute 40 to 50 % by weight of the concrete. This lead to increase the cost of the concrete. To reduce the cost an alternate materials are used . A healthy and sustainable reuse of plastics and glass offers a host of advantages.. Tests will be conducted to determine the properties of plastic aggregate.

In this Study we have casted M25 Grade concrete replacing partially the cement with glass powder and a coarse plastic aggregate at a various percentages (2.5% +5% , 2.5%+10% , 2.5% + 15% , 5% +5% ,5%+10% ,5%+15% , 7.5%+5% ,7.5%+10%,7.5%+15%). The percentage substitution that gave higher compressive strength. Has been noted after testing M25 grade concrete samples under compressive and tensile loading condition.

Keywords –Coarse Aggregate, Plastic Aggregate, Partial Replacement, Grade Substitution Glass Powder.

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1. INTRODUCTION

Concrete is the most widely used man made construction material in the world and its second only to water as the most utilized substance in the planet. Seeking aggregates for concrete and to dispose of the waste from various commodities is the present concern. Today sustainability has got top priority in construction industry. In the present study the recycled plastics were used to prepare the coarse aggregates there by providing a sustainable option to deal with the plastic waste. There are many recycling plants across the world, but as plastics are recycled they lose their strength with the number of recycling. So these plastics will end up as earth fill. In this circumstance instead of recycling it repeatedly, if it is utilized to prepare aggregates for concrete, it will be a boon to the construction industry. Most of the failures in concrete structures occur due to the failure of concrete by crushing of aggregates. The plastic coarse aggregates(PCA) which have low crushing values will not be crushed as easily as the stone aggregates. These aggregates are also lighter in weight when compared to stone aggregates. Generation of plastic waste is one of the fastest growing areas. Every year more than 500 billion plastic bags are used (nearly one million bag per minute). Hundreds of thousands of sea turtles, whales and other marine mammals die every year from eating discarded plastic bag for mistaken food. On land many animals suffer from similar fate to marine life. Collection, hauling and disposal of Plastic bag waste create an additional environmental impact.

Fig 1.1 Waste Plastic

Fig 1.2 Waste Glass

2.MATERIALS USED

- Cement
- Fine Aggregate (FA)
- Coarse Aggregate (CA)
- Plastic coarse Aggregate (PCA)
- Glass Powder (GP)

Cement

Cement is one of the binding materials in this project. Cement is the important building material in today's construction world. 53 grade Ordinary Portland Cement (OPC) conforming to IS: 8112-1989 is used. Specific gravity of cement = 3.15

Description of test	Test results obtained	Requirements of IS: 8112 1989
Initial setting time	60 minutes	Min. 30minutes
Final setting time	300 minutes	Max. 600minutes

Table 2.1 Physical Properties of Cement.

Fine Aggregate

Locally available clean and dry man air river sand conforming to Grading zone II of IS: 383 –1970.has been used. The sand passing through IS 4.75mm Sieve has been used for casting all the specimens.

The specific gravity = (w2-w1)/(w2-w1) - (w3-w4)=2.6

Water absorption = 0.82%

Coarse Aggregate

The crushed 20 mm size aggregate were used

The specific gravity = 2.68

Water absorption = 1%

Fines modulus =6.52

Plastic Coarse Aggregate (PCA)

Plastics collected from the disposal area were sorted to get the superior one. These were crushed into small fraction and washed to remove the foreign particles. Then they are sieved to get 20mm size plastic aggregate.

Figure 2.1 Plastic Aggregate

Properties of Plastic

According to the Indian standard specifications the property of aggregates such as specific gravity, aggregate crushing value and density were determined. From Table ..... comparing the properties of aggregate for both NCA and PCA it is observed that the specific gravity and density for PCA is much lower than NCA which offers a light weight concrete. A lower crushing value indicates the complexity with which a PCA concrete could be crushed under compressive stresses.

Property	NCA	RPA
Specific gravity	2.64	0.9
Crushing value	28	2
Density	3.14	0.81
Melting point (0c)		75-100

Table 2.2 Properties of NCA & RPA

Glass powder

The glass waste available locally in shops has been collected and made into glass powder. Glass waste is very hard material. Before adding glass waste to the concrete it has to be powdered to the desired size. In the present studies glass waste was powdered by grinding in a ball/ mill .The glass waste pulverized for a period of 30 to 6o minutes which resulted powder of particle sizes ranging from 75 µm -150 µm.

Fig 2.2 glass powder

Properties of glass powder

S. No	Property	Glass Powder
1.	Specific gravity	2.6
2.	Fineness passing 150µm	99.4
3.	Fineness passing 90µm	98.1

Table 2.3 physical properties of glass powder

Constituent	Composition %	
	Glass Powder	OPC
Silica (SiO_2)	67.33	22.00
Calcium Oxide (CaO)	12.45	62
Aluminum Oxide (Al_2O_3)	2.62	5.05
Ferrous Oxide (Fe_2O_3)	1.42	4.64
Magnesium Oxide (MgO)	2.738	2.06
Sodium Oxide (Na_2O)	12.05	0.19
Potassium Oxide (K_2O)	0.638	0.40
Sulphite (SO_3^{2-})	0.751	1.43

Table 2.4 Chemical Composition of Glass Powder and OPC

3. EXPERIMENTAL PROCEDURE

In the present experimental work. First, the material, mix proportions, manufacturing and curing of the specimens are explained. This is then followed by description of types of specimens used, test parameters, and test procedures. Development of the process of making Plastic and Waste glass powder concrete. In this mix we are used only crushed plastic. To achieve the objectives of the investigation the experimental program was planned to cast around 27 cubes and cylinder with different percentages of RPA and GP.

Mix Design: The concrete mix design was proposed by using Indian Standard for control concrete. The grade was M25.The mix proportion of materials is 1:1:2 as per IS 10262-2009. Then natural fine aggregate was used. cement with glass powder and coarse aggregate with plastic at various percentage (2.5% +5% , 2.5%+10% , 2.5% + 15% , 5% +5% ,5%+10% ,5%+15% , 7.5%+5% ,7.5%+10%,7.5%+15%) were going to do. Chemical admixture is not used here.

Casting

The Plastic Waste and glass powder concrete is manufactured by as similar to the classical concrete. Initially the dry materials Cement, Aggregates & Sand are mixed. The liquid component of the mixture was then added to the dry materials and the mixing continued for further about 3-6 minutes to manufacture the fresh concrete. The fresh concrete was cast into the moulds immediately after mixing, in three layers for cube specimens. For compaction of the specimens, each layer was given 60 to 70 manual strokes using a tapping rod, and then

vibrated for 12 to 15 seconds on a vibrating table. Before the fresh concrete was cast into the moulds, the slump value of the fresh concrete was measured.

Fig 3.1 Casting

4. TESTING PROCEDURE

An intensive experimental program is performed to study the effect of RPA and Glass Powder on Mechanical properties like compressive strength and tensile strength of concrete

Compressive Strength Test

At the time of testing, each specimen must keep in compressive testing machine. The maximum load at the breakage of concrete block has been noted. From the noted values, the compressive strength has been calculated by using formula:

Compressive Strength = Load / Area

Size of the test specimen = 150mm x 150mm x 150mm

TEST RESULT

Compressive strength

S. No	% Replacement		Compressive Strength N/MM^2		
	GP	PCA	7 Days	14 Days	28 Days
1	0%	0%	14.4	20.98	25.75
2	2.50%	5%	12.15	18.7	26.05
3	2.50%	10%	15.47	19.38	25.2
4	2.50%	15%	14.69	19.13	23.6
5	5%	5%	15.02	18.72	26.96
6	5%	10%	16.39	20.93	25.05
7	5%	15%	14.27	17.15	22.07
8	7.50%	5%	15.36	20.81	27.89
9	7.50%	10%	12.58	18.83	25.05
10	7.50%	15%	11.85	17.72	23.07

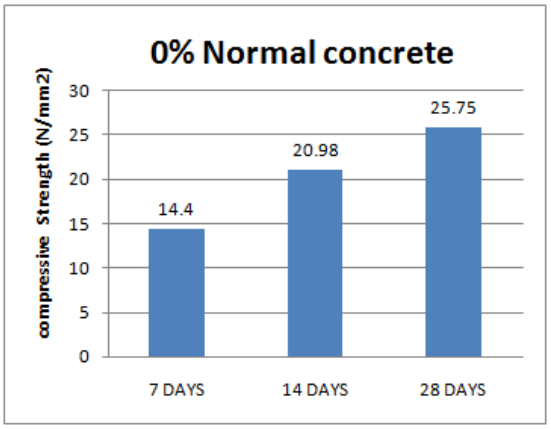
Table 4.1 Compressive Strength Test Result

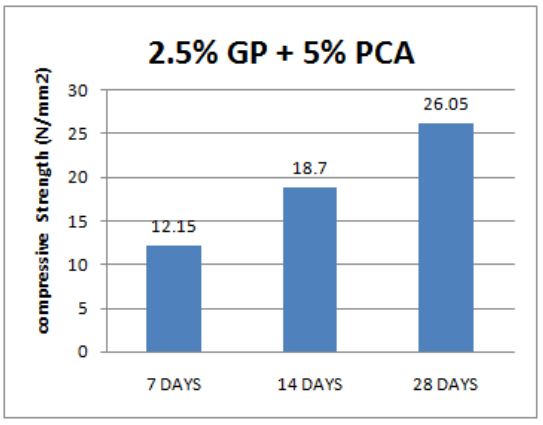
Tensile strength

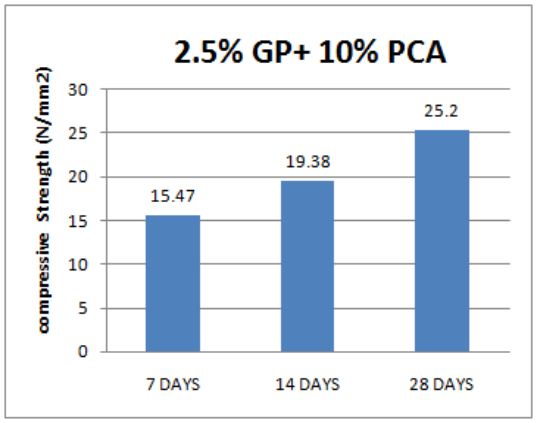
S. No	% Replacement		Tensile Strength N/MM^2		
	GP	PCA	7 Days	14 Days	28 Days
1	0%	0%	2.66	3.21	3.55
2	2.50 %	5%	2.44	3.03	3.57
3	2.50 %	10%	2.75	3.08	3.51
4	2.50 %	15%	2.68	3.06	3.40
5	5%	5%	2.71	3.03	3.63
6	5%	10%	2.83	3.20	3.50
7	5%	15%	2.64	2.90	3.29
8	7.50 %	5%	2.74	3.19	3.70
9	7.50 %	10%	2.48	3.04	3.50
10	7.50 %	15%	2.41	2.95	3.36

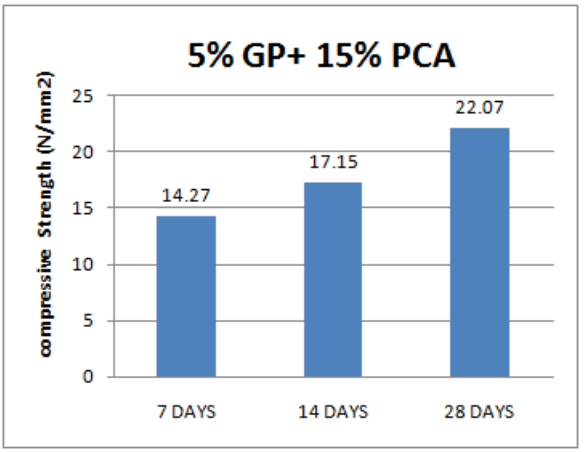
Table 4.2 Tensile strength of concrete

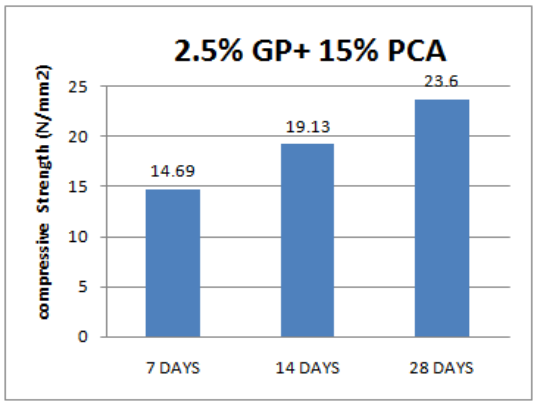
Graphs

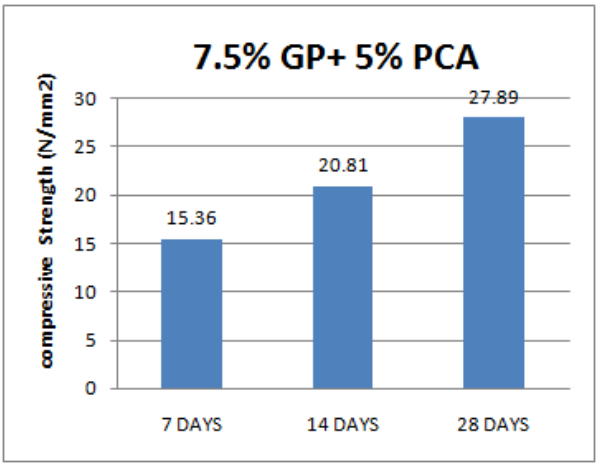


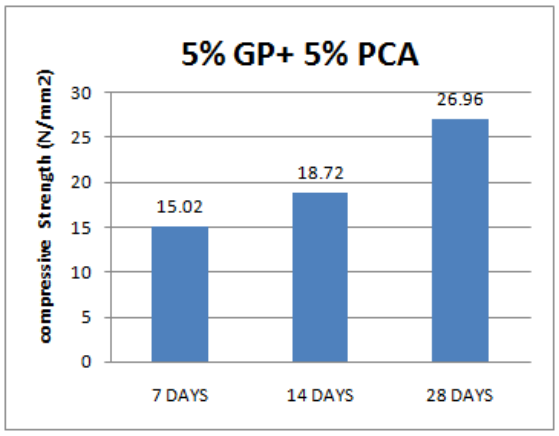


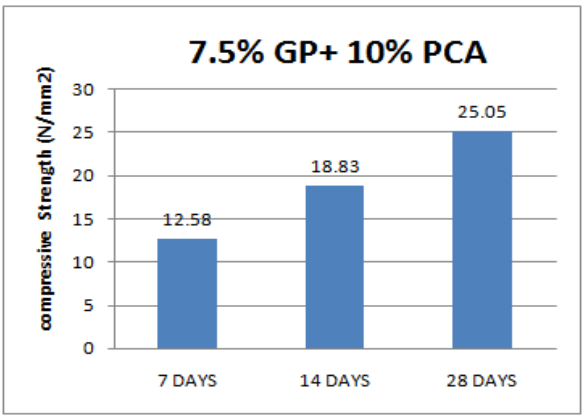


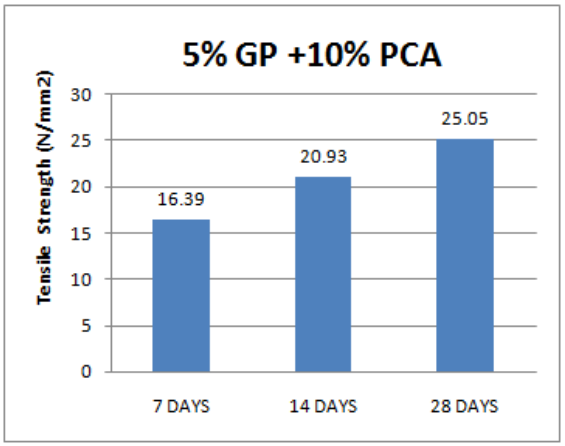


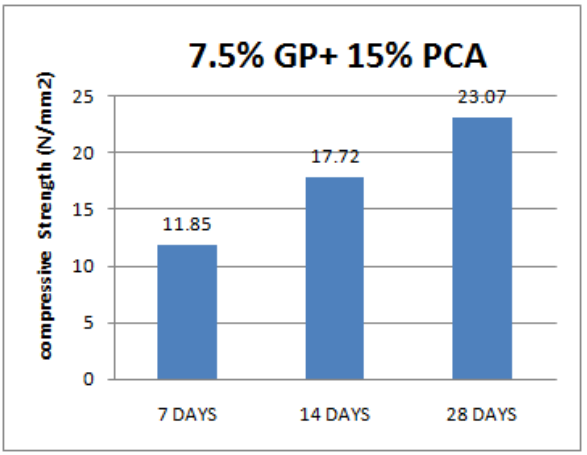












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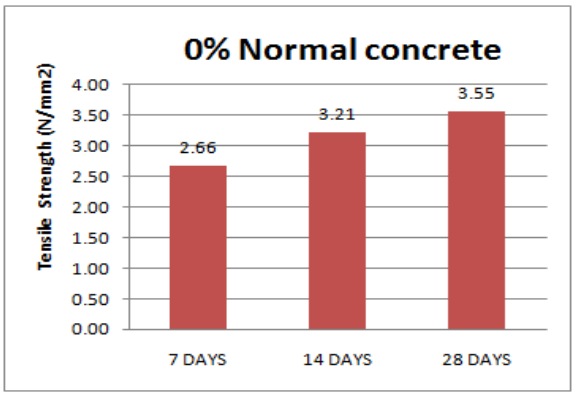
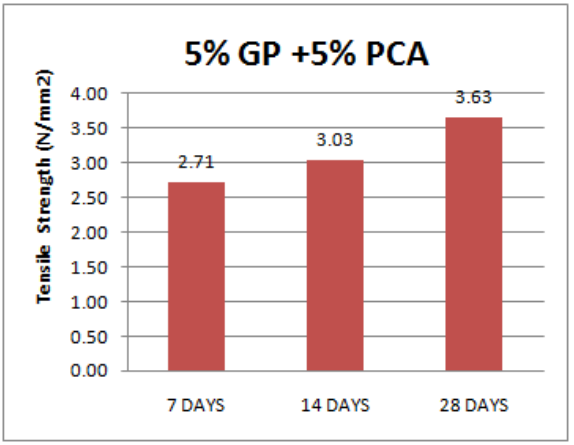
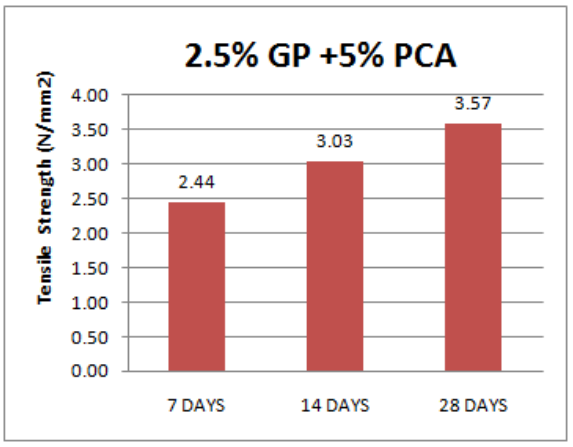
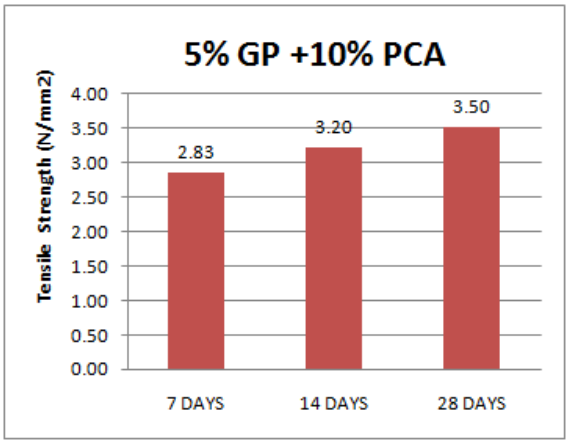
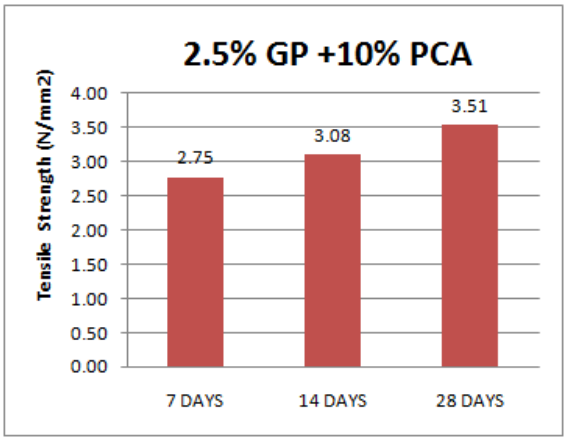
Tensile strength

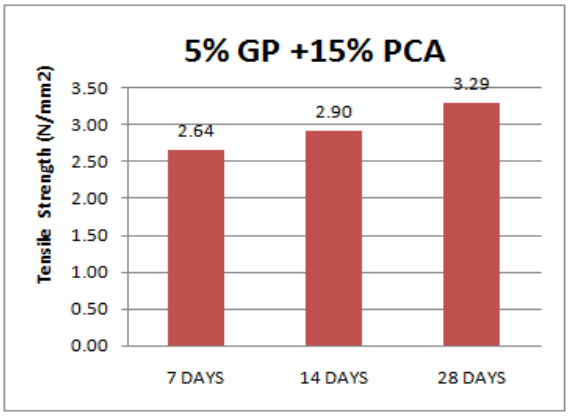


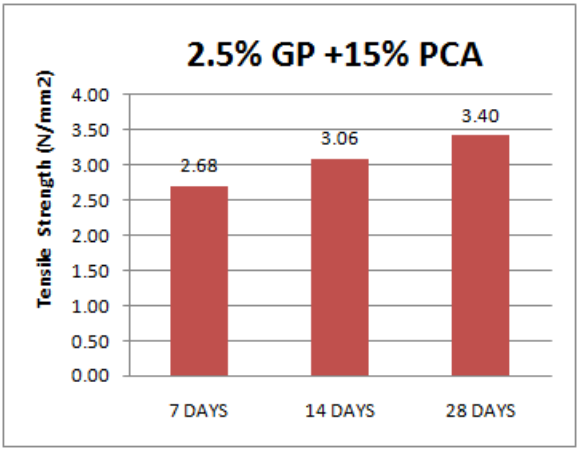


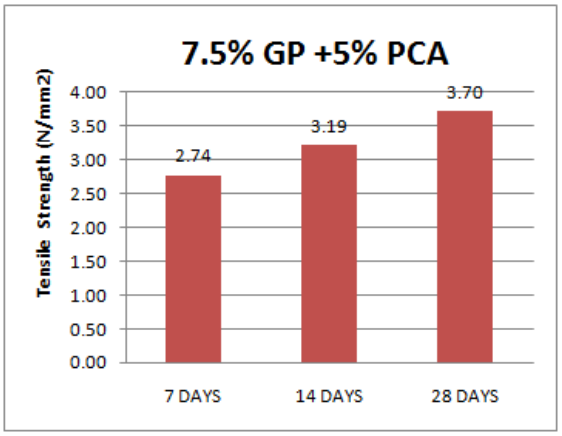


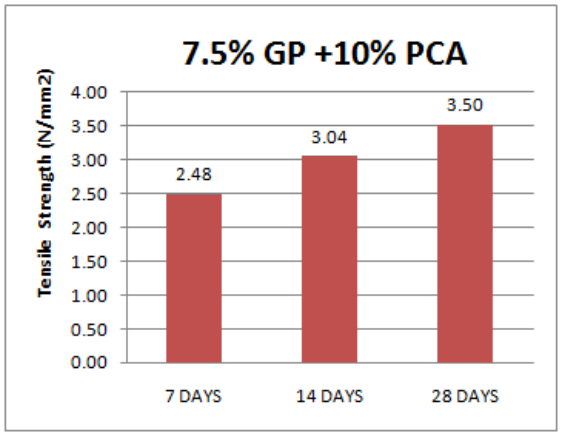


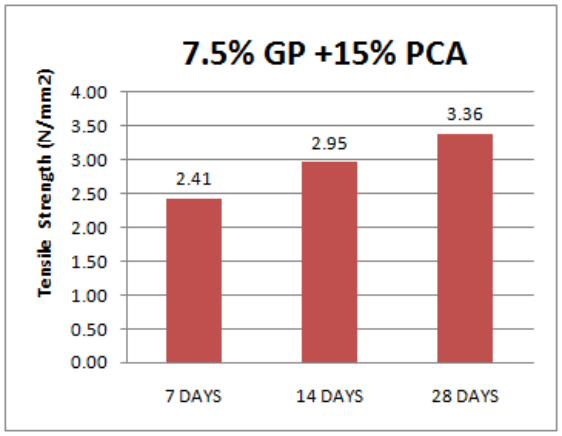












CONCLUSION

From the above test results we conclude that the increasing percentage of PCA results in decreasing in percentage of compressive strength.

By replacement of Cement and Coarse aggregate with Glass powder (GP) and Plastic Coarse Aggregate (PCA) i.e., G2.5 +PCA5 ,G5+PCA5 and G7.5+PC5 in concrete shows the increasing in compressive strength and tensile strength by 26.05N/mm^2 , 26.96 N/mm^2 and 27.89 N/mm^2, and 3.57 N/mm^2, 3.63 N/mm^2 and 3.70 N/mm^2

By seeing the results analysis it is observed that the increasing in Percentage of PCA Result the decreasing in compressive strength and tensile strength. Therefore the increasing percentage of glass powder as partial replacement of cement in concrete for PCA with 5% Which shows higher strength compared to Normal concrete (M25) for 28 days.

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