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EFFECT OF ADDITION OF CRUMB RUBBER ON PHYSICAL AND MECHANICAL PROPERTIES OF M-40 GRADE CONCRETE

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Abstract – In present study, an attempt has been made to produce eco-friendly concrete so that it has less environmental effects and can also be produced in an economical manner. For this, the fine aggregates have been replaced with crumb rubber while preparing the M40 grade of concrete. Various proportions of crumb rubber i.e. 10%, 20%, 30% and 40% were used in present study. The behavior of crumb rubber on concrete was evaluated with the help of compressive strength test, split tensile strength and flexural strength test. Other properties of concrete were also evaluated such as thermal expansion and permeability of concrete. The results showed replacement of sand with crumb rubber slightly improves the permeability of concrete which ultimately improves the durability of concrete. The coefficient of thermal expansion is 30.35%, 47.32%, 62.5% and 69.6% for mix 10, mix20, mix30 and mix40 respectively. 28 days compressive strength of concrete for mix10, mix20, mix30 and mix40 was found to be 47MPa, 44.8 MPa, 42.2 MPa, 40.5 MPa and 39.7 MPa . Reduction in tensile strength in 28days was found to be 2.94%, 8.82%, 14.71% and 20.59% for mixes mix10, mix20, mix30 and mix40.

Keywords: Crumb rubber, Concrete Design Mix.

1. Introduction

Crumb rubber concrete is a composite product obtained by mixing cement, fine aggregate, coarse aggregate, crumb rubber and water. In crumb rubber concrete fine aggregates or coarse aggregates are partially replaced with crumb rubber depending on size of crumb rubber particles. Finding a way to utilize the rubber in concrete would enhance the understanding on how to incorporate crumb rubber in engineering usages.

Crumb rubber is a recycled rubber produced from automotive scrap tires. Steel wires and tyre cord are removed during recycling process and tyre rubber with a granular consistency is received. Processing continued with cracker mills by mechanical means and particular size reduce further.

Figure: 1. Used tyre waste in an open area

2. Objectives of the Study

The objectives of this study are:

- To carry out mix design of M40 grade concrete for different replacements of sand with crumb rubber.
- To determine the effect of crumb rubber on compressive strength, split tensile strength and flexural strength of concrete.
- To study the effect of crumb rubber on unit weight of concrete.
- To study the effect of crumb rubber on thermal expansion and permeability of concrete.

3. Mix Proportion

M40 Mix design was done as per the codal provisions of Indian standard method (IS: 10262-2009) (Annexure-III). Following are the quantities for various concrete mixes when M40 grade of concrete was prepared. The replacement of sand was done at different percentages i.e. 10%, 20%, 30% and 40%.

Table: 1. Total material quantity for various concrete mixes.

Mix	Cement (kg)	Sand (kg)	Crumb Rubber (kg)	Coarse Aggregate 10mm (kg)	Coarse aggregate 20mm (kg)	Water(ltr)	Super Plasticizer (ltr)
Mix0	350	752	0	494	742	140	5.25
Mix10	350	676.8	75.2	494	742	140	5.25
Mix20	350	601.6	150.4	494	742	140	5.25
Mix30	350	526.4	225.6	494	742	140	5.25
Mix40	350	451.2	300.8	494	742	140	5.25

4. Results and Discussion

COMPRESSIVE STRENGTH RESULTS:

Rate of reduction of compressive strength varies from 6.54% to 24.08%, 4.68% to 15.53%, 3.39% to 15.07%% in 7, 28 and 56 days with increase in contents of crumb rubber as replacement of sand. Rate of reduction in compressive strength also decreases with age.

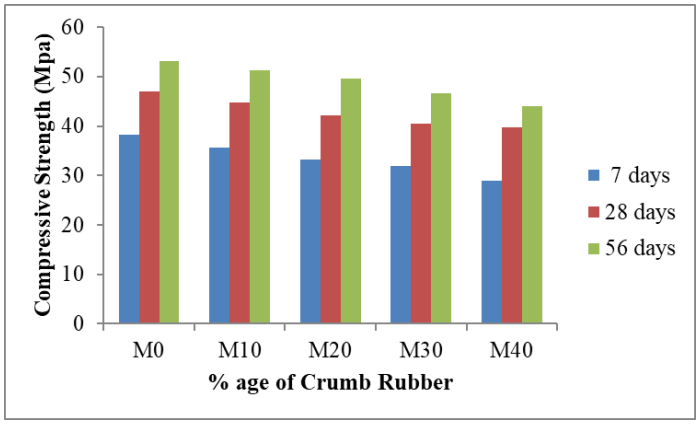

Figure: 2. Variation of Compressive Strength with Variation of Crumb Rubber % and age.

FLEXURAL STRENGTH RESULTS:

Reduction in Flexural strength in 28days was found to be 10.86%, 28.26%, 39.13% and 69.56% for mixes M10, M20, M30 and M40. Rate of reduction in flexural strength decreases with age.

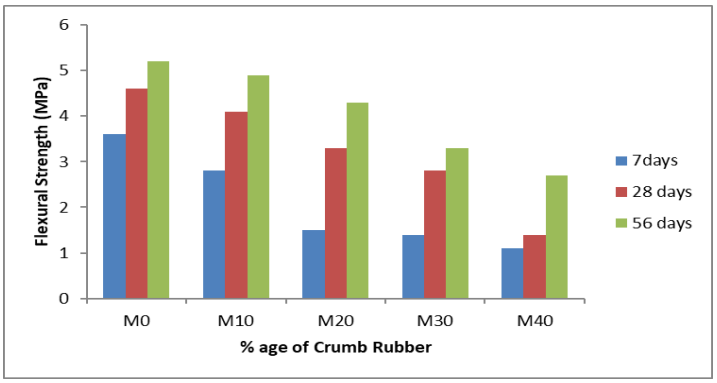

Figure: 3. Variation of Flexural Strength with Variation of Crumb Rubber Content% and age.

SPLIT TENSILE STRENGTH RESULTS:

Reduction in tensile strength in 28days was found to be 2.94%, 8.82%, 14.71% and 20.59% for mixes M10, M20, M30 and M40. Rate of reduction in split tensile strength decreases with age.

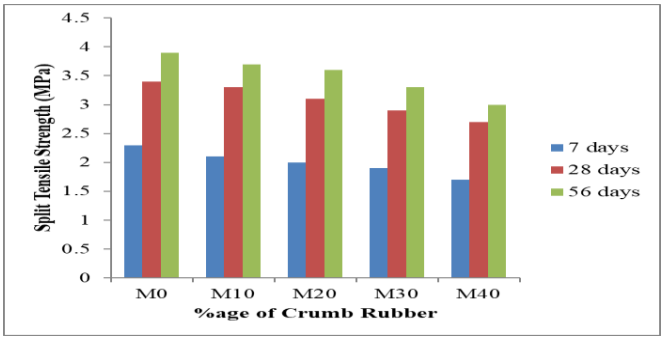

Figure: 4. Variation of Split Tensile Strength with Variation of Crumb Rubber% and Age

UNIT WEIGHT

The reduction in unit weight was found to be 7.44%, 15.06%, 21.28% and 27.70% for mixes Mix10, Mix20, Mix30 and Mix40.

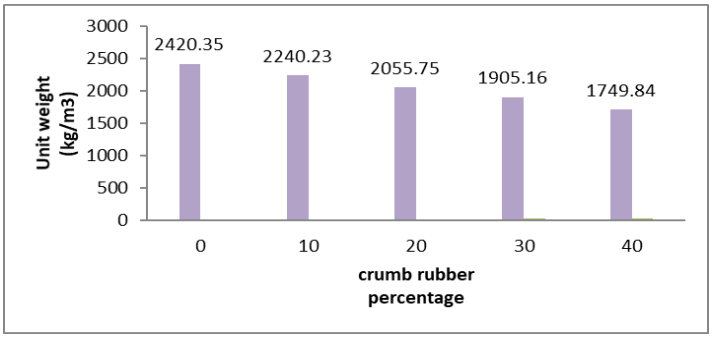

Figure: 5. Variation of Unit Weight with Variation of Crumb Rubber

PERMEABILITY

Test results showed the reduction of 5.7%, 13.30%, 20.9% and 23.5% in coefficient of permeability of mixes having crumb rubber content of 10%, 20%, 30% and 40% replaced with sand.

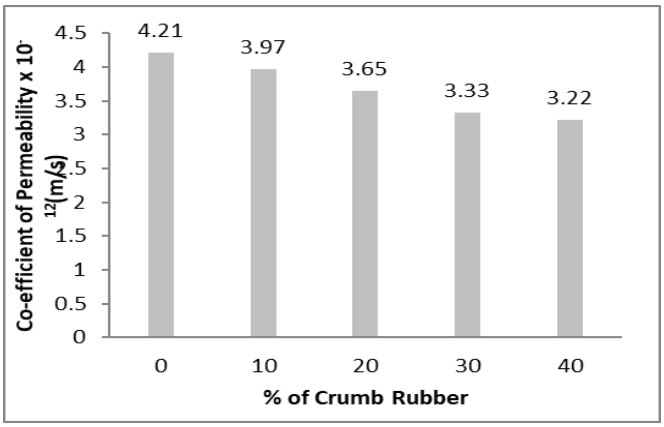

Figure: 6. Variation of Permeability with variation of crumb rubber

THERMAL EXPANSION

Results were showed that the value of coefficient of thermal expansion were reduced by about 0.35%, 47.32%, 62.5% and 69.6% for mixes mix10, mix20, mix30, and mix40.

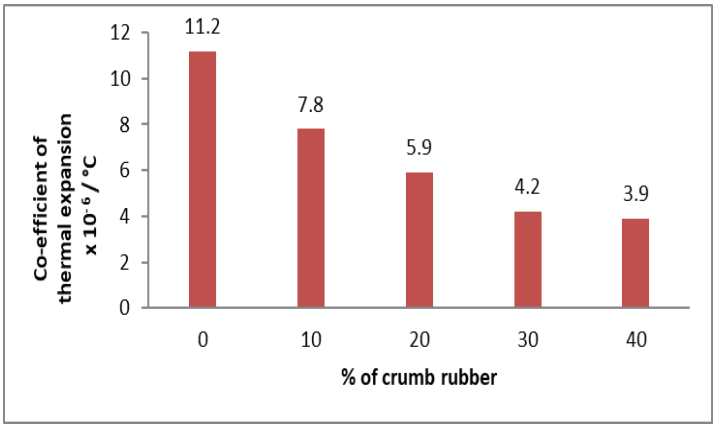

Figure: 7. Variation of coefficient of thermal expansion with variation of crumb rubber

5. Conclusions

After evaluating the performance of normal and replacement concrete, the final conclusions drawn for the present experimental study are mentioned below:

1. Workability of concrete in terms of slump increases with increase in contents of crumb rubber with replacement of sand. Increase in slump was found to be in the range from 3.92 % to 17.64%, when sand was replaced with crumb rubber from 0 to 40%.
2. The unit weight of crumb rubber concrete decreased about 8% for every 10% replacement of sand with crumb rubber, which shows that light weight concrete may be obtained by using crumb rubber.
3. The replacement of sand with crumb rubber slightly improves the permeability of concrete which improves the durability of concrete.

4. The coefficient of thermal expansion reduced with the increase in crumb rubber content and rate of reduction decreases with crumb rubber content. The coefficient of thermal expansion is 30.35%, 47.32%, 62.5% and 69.6% for mix 10, mix20, mix30 and mix40 respectively. Results indicate that crumb rubber improve the resistance of concrete to thermal changes.
5. In all strength testes crumb rubber concrete specimens did not shatter which indicates that the rubber particles absorb forces acting upon it and improve the impact resistance of concrete.
6. The Compressive strength of concrete is increased with age and reduced with an increase in the rubber content. 28 days compressive strength of concrete for mix10, mix20, mix30 and mix40 was found to be 47MPa, 44.8 MPa, 42.2 MPa, 40.5 MPa and 39.7 MPa .
7. Rate of reduction of compressive strength varies from 6.54% to 24.08%, 4.68% to 15.53%, 3.39% to 15.07% in 7, 28 and 56 days with increase in contents of crumb rubber as replacement of sand.
8. Rate of reduction in compressive strength also decreases with age.
9. Failure of plain and rubberized concrete in compression and split tension shows that rubberized concrete has higher toughness.
10. The split tensile strength showed increase for different percentage replacements at 7, 28 and 56 days with crumb rubber as a replacement of sand. Reduction in tensile strength in 28days was found to be 2.94%, 8.82%, 14.71% and 20.59% for mixes mix10, mix20, mix30 and mix40.
11. Rate of reduction in split tensile strength also decreases with age follow similar pattern as that of compressive strength.
12. The flexural strength showed rise with age for different percentage replacements and reduction in flexural strength with increase in contents of crumb rubber used as a replacement of sand. Reduction in Flexural strength in 28days was found to be 10.86%, 28.26%, 39.13% and 69.56% for mixes mix10, mix20, mix30 and mix40.
13. Rate of reduction in flexural strength decreases with age.

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