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An Experimental Investigation on Partial Replacements of Fine Aggregate with Crumb Rubber and Cement with Fly Ash

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A B S T R A C T

As a primary source of raw materials for the construction sector, many researchers in the present day use either industrial or agricultural priceless goods. These waste materials are cost-effective, aid in creating a sustainable environment, and lessen environmental contamination. Before employing fly ash and crumb rubber in varying percentages, such as five percentages to fifteen percentages, as a partial replacement, concrete is subjected to compression strength tests for seven days, fourteen days, and twenty-eight days. It is suggested that cement and fine aggregate be studied with fly ash and crumb rubber as partial replacements for five to fifteen percent of the cement and five to fifteen percent of the fine aggregate, respectively. In this study, a total of [30] concrete samples (three conventional cubes and twenty-seven replacement cubes) were produced using concrete of the M30 grade and a water-to-cement ratio of 0.4. The cube samples are 150 mm x 150 mm x 150 mm in dimension. For seven days, fourteen days, and twenty-eight days, concrete cubes are maintained moist. This research study's primary goal was to evaluate the compressive strength and split tensile strength of concrete that was mixed with varying amounts of fly ash and crumb rubber.

Keywords: Fly ash, Crumb Rubber, Coarse aggregate, Fine aggregate, Cement, Compressive strength.

1. Introduction

A common building material because of rising demand is cement.Scientists and researchers are looking for an alternate binder. An environmentally friendly resource that is utilised to partially replace FA is agro waste from the crumb rubber industry.Good chemical and physical characteristics of crumb rubber include fineness, expansion, setting time, and compressive strength.This raises the standard and lowers the price of building materials.reduces landfill volume and harmful environmental effects.The vinyl polymer known as polyvinyl alcohol (PVA) is only connected by carbon-carbon bonds. However, it is rare and has qualities that are quite dissimilar from those of refined bitumen, therefore our goal is to use less natural resources overall. We can also reduce waste by using waste materials for daily use. The primary goal of this experiment was to use crumb rubber as an agent to modify bitumen, possibly improving the quality of the road pavement.

2. LITERATURE REVIEW

SM Dumme has investigated on **"M25 grade concrete partial replacement of crumb rubber [0%, 3%, 6%, 9% and 12%]"**. The result shows that there is a reduction in all type of strength for crumb rubber mixture, but crumb rubber content concrete become morelean due to increase in partial replacement of crumb rubber as fine aggregate ie.,3%, 6%, 9% and 1%. Flexural strength of concrete decreases with 3% replacement of sand and further decrease in strength with the increase in percentage of crumb rubber. For split tensile strength decreases with 3% replacement of sand and further decrease in strength with the increase in percentage of crumb rubber.

Dr.B.Krishna Rao has studied on **"M20 grade of concrete 5% and 10%" A Experimental tests on Split tensile and flexural strength.** The test results were done and noted that due to addition of rubber fibre, strength of concrete decreases, but as observing ductility is improving. Hence it is used for medium grade of concrete. The various rubberised concrete mixes were designed in accordance with standard mix design procedure for normal concrete with grade of M20. As exepected the target strength were not achieved for the mixes incorporating rubber fibre.

Mr. Prashant Charan had investigated on **"M25 grade of concrete partial replacement of fine aggregate as crumb rubber as 0.5%, 1%, 1.5% and 2%".** An experimental indicate that replacement of waste tyre crumb rubber particle to the fine aggregate in concrete at ratio 0.5% and 1% there is no effect on the concrete properties would occur, but there was a considerable change for 1.5% and 2% replacement ratio.

Dr. y. Robby had studied on **"concrete of M25 grade Replacing [5%, 10%, 15%, 20% and 25%]" A Experimental tests on compressive strength and flexural strength.** To studied the So they concluded that flexural strength decreases in concrete.In 7 days' flexure strength, there is not much variation seen between conventional and rubberized concrete.So there was not much difference in strength of rubberized and conventional concrete.

Dr.G.Portchejian has investigated on **"replacing fine aggregate with [5%, 10%, 15% and 20%] M20 grade concrete". In this experiment tests on compressive strength and split tensile strength.** so they founded that compressive strength decreases with the replacement of crumb rubber increased & 5%replacement of crumb rubber proves exceptionally well in compressive strength & tensile strength.It also gives more strength at 28^{th} days for 5%.Thus by replacing fine aggregate by crumb rubber safeguard the environment**.**

3. OBJECTIVES

• To gather raw materials such polyvinyl alcohol, fly ash cement, fine aggregate, and crumb rubber.

• To execute numerous cement tests, including those for cement's fineness, consistency, and specific gravity.

• To perform different fine aggregate tests, such as sieve analysis, water absorption, and specific gravity.

• To perform different tests on coarse aggregates, such as the impact test and abrasion test, as well as tests for specific gravity,waterabsorption, flakiness index, and elongation index.

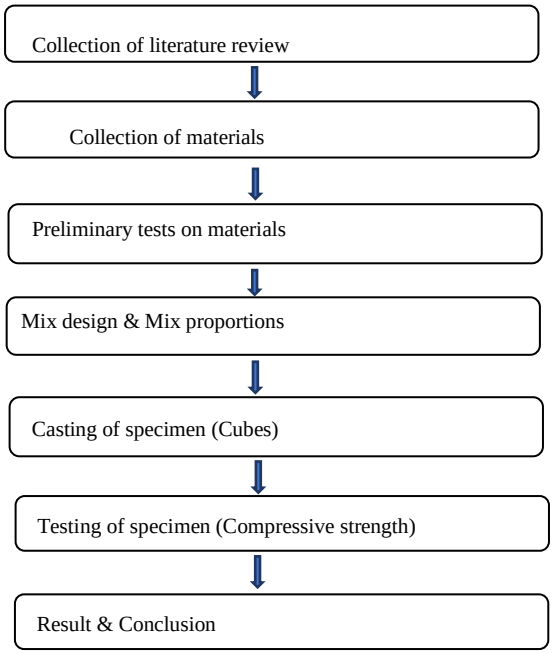
• Tests for crumb rubber and fly ash should be done, including ones for fly ash specific gravity and fineness.

• To utilise concrete of grade M30.

• To add crumb rubber to 5%, 10%, and 15% of the fine aggregate in concrete.

• To use 5%, 10%, and 15% fly ash and cement in concrete.To evaluate the costs of standard cement concrete with concrete with fly ash and crumb rubber replacing some of the fine aggregate and cement, respectively

4. METHODOLOGY



1.Cement

The primary component used to bond concrete was cementitious material of OPC 53 grade. Input of cement came from Puttaparthi. Other cement can be used, but it will depend on what is available where you live. Bagasse ash is used in place of cement at roughly 5%, 10%, and 15% of the total cementitious material. Initial setting time, final setting time, standard consistency, fineness, and specific gravity tests are all done on cement.

2.Fine Aggregates (F.A)

The fine aggregates were examined and found to be in compliance with Indian norms BIS: 383:1970. Concrete's compressive strength is increased with the use of fine aggregate. Better bonding or interlocking between fine and coarse particles is achieved when using fine aggregates. tests on fine aggregate include those for specific gravity and water absorption.

3.Coarse Aggregates (C.A)

The aggregates were tested in accordance with Indian standards and had a notional maximum size of 20 mm; the findings were within acceptable bounds (BIS: 10262, BIS: 383). On coarse aggregate, tests for specific gravity, water absorption, flakiness index, and elongation index were performed.

4.Flyash

Usually, lime and portland cement are coarser than fly ash. Fly ash is a finely separated byproduct of pulverised coal combustion that is carried away from the combustion chamber by exhaust gases. Depending on the intended usage, fly ash has different quality criteria.Sathya Sai district's Puttaparthi is where flyash was collected. Due to its different chemical qualities, flyash, which is produced by burning ash, can be used as a partial replacement for cement. The burned flyash is gathered and sieved in a 10 and 100 micron sieve before being used in concrete as a partial replacement for cement.

5.Crumb Rubber

The result of crushing, crumb rubber, is a concentrated material that can be used as aggregates for concreting, particularly as fine aggregates. Rubber has been broken down into different sizes during quarrying operations; the dust that is produced during this process is known as crumb rubber and it is created as waste. Crumb Rubber was gathered from a quarry that was close by in the Puttaparthi area.

4. CONCRETE MIX PROPORTION :

From table 3.1 According to mix design of IS 10262:2019, the amount of raw materials is estimated by calculating mean target strength as 31.6 N/mm2 and taking into account water cement ratio as 0.5. The results were 394 kg/m3 for cement, 791 kg/m3 for fine aggregate, 1141.5 kg/m3 for coarse aggregate, and 157.6 kg/m3 for water. Cubes and cylinders are cast taking into account the aforementioned quantities.

Materials name	**Quantity**
Cement 3	394 Kg/m^3
Fine aggregate	791 kg/m^3
Coarse aggregate	1141.5 kg/m^3
water	157.6 lit

5. RESULT AND DISCUSSION

Table 4.1 : Cement Tests

Name of the tests	**Test result**
Normal consistency of cement	26%-38%
Specific gravity	3.1 – 3.6
Fineness	<10

Table 4.2 : Fine Aggregate Tests

S.NO	**Name of the test**	**Test Result**
1.	Specific gravity	2.78
2.	Water absorption	1.05%

Table 4.3 :Corase Aggregate Tests

Name of the tests	**Test results**
Specific gravity	2.77
Abrasion test	40%
Impact test	4%

Table 4.4 :Flyash Properties

Name of the tests	**Test results**
Fineness	2.516%
Colour	Black
Particle shape	Powder Form

Table 4.5 : Crumb Rubber Properties

Name of the tests	**Test results**
Specific gravity	2.32

Table 4.5: Compressive strength for 7 days

Experimental trails	S.no	Fly ash (%)	Polyvinyl alcohol	Crumb rubber	Compressive strength n/mm^2
Mix I	M1	5	2	5	20.86
	M2			10	22.43
	M3			15	20.77
Mix II	M4	10	4	5	20.11
	M5			10	16.0
	M6			15	22.77
Mix III	M7	15	6	5	21.10
	M8			10	18.0
	M9			15	20.11

From the above Concrete cubes that had been replaced for seven days were successfully given 65% of their compressive strength from the table. The results for M1 through M16 are listed in the table above. The greatest compressive strength for 7 days of curing cubes is reached at a value of 23 N/mm2 when utilising 5% CR and 20% fly ash, respectively.

Table 4.6: Compressive strength for 14 days

Experimental trails	S.no	Fly ash (%)	Polyvinyl alcohol	Crumb rubber	Compressive strength n/mm^2
Mix I	M1	5	2	5	20.22
	M2			10	25.66
	M3			15	24.0
Mix II	M4	10	4	5	20.44
	M5			10	21.33
	M6			15	21.00
Mix III	M7	15	6	5	20.11
	M8			10	23.55
	M9			15	23.44

The table above includes information for M1 through M9. The greatest compressive strength for cubes that have been cured for 14 days was measured at 25.66 N/mm2 utilising 5% Flyash, 2% PVA, and 10% CR, respectively.Compressive Strength for 14 Days of Replacement, Table 4.9 Concrete cubes effectively attained 65% of their strength. The results for M1 through M9 are listed in the table above. The greatest compressive strength for cubes that have been cured for 14 days was measured at 25.66 N/mm2 utilising 5% Flyash, 2% PVA, and 10% CR, respectively.

Table 4.7: Compressive strength for 28 days

Experimental trails	S.no	Flyash (%)	Polyvinyl alcohol	Crumb rubber	Compressive strength
Mix I	M1	5	2	5	20.33
	M2			10	21.77
	M3			15	22.0
Mix II	M4	10	4	5	20.44
	M5			10	24.88
	M6			15	31.0
Mix III	M7	15	6	5	20.11
	M8			10	23.66
	M9			15	20.21

From the above table Concrete cubes used as replacements for 28 days had successful acquisition of 70% of its compressive strength from the above. The results for M1 through M9 are listed in the table above. The greatest compressive strength for 28 days of curing cubes is obtained at a value of 23.10 N/mm2 using 15% Flyash and 6% PVA and 15% CR, respectively.

5. CONCLUSIONS

Observations based on test findings include the following:

1) Based on the results of the testing, it has been found that replacing the cement with fly ash and the fine aggregate with crumb rubber significantly improves the characteristics of concrete.

2) When Fly Ash and quarry dust were added to concrete and used to replace cement and fine aggregate up to 15% in M30 concrete, it was discovered that there was a significant boost in workability and increase in compressive strength when compared to plain cement concrete of the same grade.

3) It can be said that 5% to 15% of Flyash& CR replacement for cement & fine aggregate is ideal for M30 Concrete.

4) A considerable decrease in price is seen for one cubic metre of concrete when the costs of plain cement concrete of M30 grade and concrete with 5%-15% substitution of cement and fine aggregate by Fly ash & CR are compared.

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