Strength Properties of Concrete by using Flyash, Quarry Dust and Crumb Rubber

U. Mahesh Kumar, Suraj Baraik, Venu Malagavelli

***Abstract:** As construction in India and other developing countries are increasing, the consumption of energy and resources are also increasing in same alarming way. Due to urbanization many industries are developed and the industrial wastage is also increasing day by day which is a serious concern to the environment. Many industries produce various end products, which may be used in construction industry at various places. So we focused on some of the waste materials which can be replaced in conventional concrete, and by then cost of construction can be reduced and is economical, also damage caused to the environment can also be reduced, at the same time landfills can also be reduced. So, we focused on reducing the virgin materials in concrete like cement, fine aggregate and coarse aggregate by replacing them with some waste materials which have same properties of cement, fine aggregate and coarse aggregate. The objective of the present work is to find out the effectiveness of fly ash, quarry dust and crumb rubber by replacing them in varied percentages. Here, cement is replaced by fly ash with percentages as 30%, 40%, 50%, 60% and quarry dust as fine aggregate with percentages of 20%, 30%, 40%, 50% along with crumb rubber as coarse aggregate with percentages as 5%, 10%, 15%, 20%. The results in this study have shown a gradual reduction of compressive strength as we kept on adding the crumbed rubber. Even though the strength obtained for 5% usage of crumbed rubber was quite satisfactory.*

***Keywords:** Fly ash, Quarry dust, Crumb Rubber, Compressive strength.*

I. INTRODUCTION

In present days concrete is one of the most widely used material and it plays a key role in developing structures in all countries. The development in infrastructure will have direct impact on the demand for concrete. The cost incurred in the construction mainly depends on the raw materials used for it, generally as we use all the natural conventional constituents the economy of the project will be high. In conventional concrete cement , river sand is used as fine aggregate, quarried stones are used as coarse aggregates, all these natural resources are available at their origin and using them at site would include all the transportation charges which ultimately make high costs in the project. Apart from increasing the construction cost, by using all the natural resources there is a ecological imbalance created and depletion of natural resources are at alarming stage.

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Replacing all the natural constituents by their near remedies. Say, using all the locally available resources and by using the end products obtained from various industries could be safe for construction as well as for the environment. By replacing of this we can provide most economical concrete, maximum usage of locally available materials provide low cost structures to the people and materials also easily adopted to the field.

Therefore we decided to partially replace some materials. Such as, fly ash as a replacement to cement , quarry dust as a replacement to fine aggregate and crumb rubber as a replacement to coarser aggregate. By using these materials, especially crumb rubber we can improve the quality such as light weight to the structures, high resistance to absorbing, durability, high ductility etc..

The dumping of waste material is one of the key issues in the whole world. The dumping of the waste tyres is a major matter because this material is very difficult to degrade even after a long time. Waste rubber is also used as raw material for rubber goods. Concrete is made by means of the composition of cement, coarse aggregate and fine aggregate. Among all kinds of construction materials concrete is the most frequently used material. Due to which there is decrease in the natural aggregates. There are several techniques which were proposed for the consumption of waste tyre, one of them is the use of crumb rubber in the concrete as full or partial replacement of coarse aggregates or fine aggregates .But only limited researches have been done till now on the use of waste tyre crumb rubber in concrete.

Alteration of building materials has an important role in the building sector. Various numbers of attempts have been thus made in the construction material field to get into use refused waste products like damaged used tyres, into valuable and gainful items. Success in this case will have a great contribution towards the decline of waste material dumping problems by utilization of the waste materials as a raw matter for other construction requirements. As dumping and burning of waste and discarded rubber tiers is a very difficult and pollution producing process.

Cement mixture consisted of rubber may be proved sensible to use for basic and nonstructural purpose, for example, lightweight concrete dividers, building exteriors and compositional parts. The consumption of crumb rubber in flimsy concrete is viewed as conceivably critical road. The use of crumb rubber with concrete will be advancement in the structuring of the wall as it will work as shock as well as sound absorber.

So in this study we made a concrete of using fly ash, quarry dust and added crumbed rubber to it, to investigate the special characters that we obtain by adding rubber to the concrete.

II. MATERIALS AND MIX PROPRTIONS

In This study materials used are cement, Fine Aggregates, Coarse Aggregates, Fly ash, Quarry Dust and Crumbed Rubber.

A. Cement

Ordinary Portland Cement (OPC) 53 grade was used which fulfill the requirements of IS 12269-19887. A few tests are conducted on the cement. The properties of cement were given in Table I.

Table I: cement test results

Physical Property	Values of OPC used	As per IS 12269-1987
Standard consistency	30.3%	---
Initial setting time	31minutes	Maximum of 30 minutes
Final setting time	9hours	Maximum of 600 minutes
Specific gravity	3.13	---

B. Aggregates

i. Fine Aggregate:

The Locally Available river sand passing through IS 4.75mm sieve is used which was coming under Zone II as per IS 383-1987. The properties of sand were given in Table II.

Table II: Properties of F.A.

Physical property	values
Specific gravity	2.289
Fineness modulus	2.52
Water Absorption	1.74%

ii. Coarse aggregate:

The Locally Available crushed aggregate of 10mm maximum size retained on IS 4.75mm sieve has been used as per IS 2386 - 1963 The properties of aggregates were given in Table III.

TABLE III: PROPERTIES OF C.A.

Physical property	Values
Aggregate size	10
Specific gravity	2.72
Fineness modulus	2.61
Water Absorption	0.66%
Crushing value	0.47%
Impact value	12.7

C. Admixtures

i. Fly ash

Fly ash generally is the waste that we obtain from the power plants due to the burning of coal. Many studies have been done since past to evaluate the properties of fly ash and have concluded stating that, fly ash have siliceous and aluminous substances which make it a better substitute to cement.
Fly ash can be used as a partial replacement to cement using it in various percentages. In this study, we replaced cement with fly ash in percentages 30%, 40%, 50%, 60% respectively.

ii. Crumb Rubber

Aggregates as we all know are the main constituents of the concrete, they are the key members for imparting strength to the concrete. Generally, natural aggregates are obtained by quarrying rocks. As lots and tons of such aggregates are quarried every single day which is causing a severe ecological imbalance. We, in this study have made an effort to use crumbed rubber which is a waste obtained from automobiles. Crumb rubber landfills are increasing day by day and they release toxic organic chemicals when stored for long durations, and also polycyclic aromatic hydrocarbons are released when crumb rubber are exposed to temperatures which harm human. So, in this study we are replacing some amount of coarse aggregate in conventional concrete by crumb rubber. The size of the crumb rubber should be taken as same as coarse aggregate, crumb rubber is cut manually into the size of aggregate say 20mm i.e which passes from 20mm sieve. By using crumb rubber the weight of the conventional concrete also be reduced. this crumb rubber are obtained by vehicles such as trucks cars etc. By this process we can reduce some amount pollution, avoiding toxic chemicals and also the cost of construction be reduced. The rubber used in this study is shown in the fig.1.

Fig.1: Crumb Rubber used

III. MIX DESIGN

In This experimental study design for M30 grade is from IS 10262-2009.water cement ratio is 0.45. The mix ratio has done as 1:1.93:2.75. Mix proportions as given in Table IV.

Table IV: Mix proportions

Constituents	MIX 1	MIX 2	MIX 3	MIX 4
Cement	365	346	346	346
Water	187	181	181	181
Fine aggregate	637	632	632	632
Coarse aggregate	913	912	912	912
Fly ash	30%	40%	50%	60%
Rubber	5%	10%	15%	20%
Quarry dust	20%	30%	40%	50%

IV. METHODOLOGY

A. Experimental Program

Specimens of four mixes are casted with M30grade and mineral admixtures are added to the concrete with the mix proportions as given in the Table IV. Firstly place the coarse aggregates, fine aggregates cement in wet dry place, mix it for a time interval of five minutes, Then place the admixtures and mix it slowly, after completion of a mixing of materials. Then water is added slowly to the dry mixture, then Concrete is filled into the cubes of dimensions 150x150mm, Cylinders of the diameter 150 x 300mm, Beams of the diameter 150 x 150 x 720mm. To get full compaction of moulds .compact the moulds with the compaction rod to fill of gaps in a concrete. After the compaction, Place the moulds for the de moulded for 24 hrs. Then specimens are cured for 7days and 28days then the specimens are to be taken out for tests of Compressive strength, flexural strength, and split tensile strength.

Fig.2: Cylinders casted.

V. RESULTS AND DISCUSSIONS

A. Compressive strength

The Compressive strength results were given in Table V, and the fig.3 shows the strengths at 7day, 28 day. Fig.4 shows the crack pattern of the cube.

Table V: Compressive Strength Results.

Trial	7 Day (Mpa)	28 Day (Mpa)
30%fly ash+20%stone dust+5%rubber	17.9	26.8
40%fly ash+30%stone dust+10%rubber	16.53	26.2
50%fly ash+40%stone dust+15%rubber	15.12	25.3
60%fly ash+50%stone dust+20%rubber	14.6	24.8

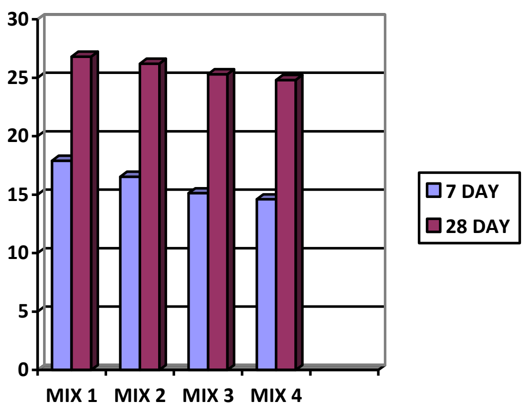

Fig.3: compressive strength of concrete.

Fig.4: compressive strength of concrete.

B. Split Tensile strength

The Split tensile strength results were given in Table VI. these values are shown in fig.5, and fig.6 shows the cylinder placed for test.

Table VI: Split Tensile Strength Results.

Trial	7 Day (Mpa)	28 Day (Mpa)
30%fly ash+20%stone dust+5%rubber	1.68	3.90
40%fly ash+30%stone dust+10%rubber	1.60	3.41
50%fly ash+40%stone dust+15%rubber	1.54	3.01
60%fly ash+50%stone dust+20%rubber	1.49	2.83

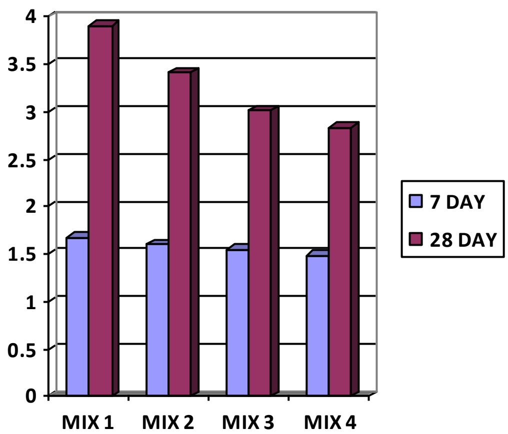

Fig.5: Split tensile strength of concrete.

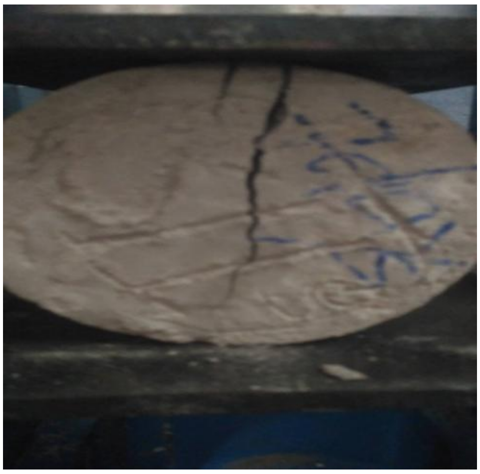

Fig.6: Split tensile strength of concrete.

C. Flexural strength

The Flexural strength results were given in Table VII. The fig.6 shows the strength values obtained at 7days and 28days of curing. Fig.7 shows the beam placed for testing.

Table VII: Flexural strength Results

Trial	7 Day (Mpa)	28 Day (Mpa)
30%fly ash+20%stone dust+5%rubber	1.70	4.03
40%fly ash+30%stone dust+10%rubber	1.63	3.87
50%fly ash+40%stone dust+15%rubber	1.60	3.76
60%fly ash+50%stone dust+20%rubber	1.46	3.2

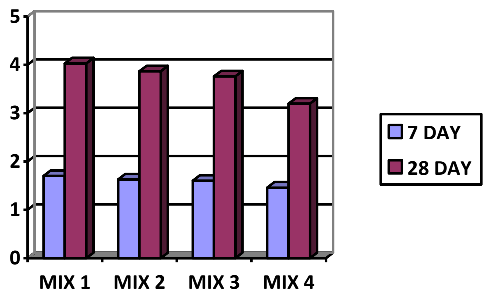

Fig.7: Flexural strength of concrete.

Fig.8: Flexural strength of concrete.

VI. CONCLUSION

The test results of this study indicate that there is great potential for the utilization of waste tyres in concrete mixes in different percentages, from this study it can be concluded that maximum strength is obtained for the conventional concrete, but as we add rubber to the concrete in various percentages the concrete gradually lost its strength and weight as well. But it can be said that, for those concretes where strength is not an important parameter this rubber induced concrete can be used, and also for low strength required structures this concrete would be preferred as it uses recycled rubber as coarse aggregate which would reduce the total cost of the structure.

- Placing of recycled rubber tyres into concrete mix leads to decrease in slump value and also effects the workability.
- Reduction in the unit weight of 14.33 % was observed corresponding to 15% by volume of coarse aggregates was replaced by rubber aggregate in sample.
- For rubberized concrete, test results show that addition of rubber aggregates resulting to significant reduction in compressive strength. Even then, the compressive strength is still in the reasonable range for the 5% replacement.
- Even the strength results have shown that the concrete having 5% rubber added to it have shown only 17% reduction in its actual strength.
- From all the studies conducted, we can state that use of rubber aggregates in the concrete could make it economical when compared to conventional concrete.
- We could also suggest to use this concrete for low load bearing structures and where strength is not a major issue.

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