

Studies on Tyre Aggregate Concrete with Fly Ash

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Abstract: For the construction works, concrete leads main role and a large quantum of concrete is being utilized. This inevitably led to a continuous and increasing demand of natural materials or alternative materials used for their production. At present the disposal of waste tyres is becoming a major waste management problem in the world. It is estimated that 1.2 billions of waste tyre rubber produced globally per annum. Only 11% of post consumer tyres are exported and 27% are sent to stockpiled, landfill or dumped illegally and 4% is used for civil engineering works. Fly ash is also a by-product from various industries. The utilization of fly ash in cement concrete as a partially replacement of fine aggregate is gaining immense importance today. In this research, our present aims to investigate the use of waste tyre rubber as coarse aggregate in concrete. A total of 36 Cubes, 36 Beams and 36 Cylinder are casted of M-25 grade of concrete by replacing 0%, 10 %, 20 % and 30 % of tyre aggregate with natural coarse aggregate. In addition fly ash is used as replacement of cement by 0%, 10 % and 20%. The fresh and hardened properties of concrete were identified. The test results were compared with the respective controlled concrete properties and show that there is a reduction in strength properties of the concrete due to the inclusion of rubber aggregates. It was observed that the Hardened properties of concrete is increased with increase in fly ash content and decreased with increase of tyre aggregate.

Keywords: Controlled concrete, Tyre aggregate concrete, Fly Ash (F.A), Workability, Compressive Strength, Flexural Strength, Split Tensile Strength.

1. Introduction

India has done a major leap on developing the infrastructure such as industrial structures, power projects and express highways etc, to meet the requirements of globalization. Concrete leads main role and a large quantum of concrete is being utilized for the construction of Civil Engineering works. The construction industry uses billion tons of raw material each year, is the largest user of natural resources in the world. Concrete is the most useful material in construction liable for the depletion of natural resources and increases the shortage of the ingredients such as steel, cement, and aggregates consequently there is a large demand for these materials in the commercial sector. In the backdrop, there is large demand for alternative materials from the wastes.

The scarcity and availability at acceptable rates of aggregate and sand are now giving anxiety to the construction industry. Over years, extraction and erosion of natural aggregates from water bodies like river beds; lakes etc. have resulted in huge environmental problem. Erosion of the existing profile results in flooding and landslides. Moreover, the filtrating of rain water conclude by deposits of natural sand is being lost, thereby causing contamination of water used for human utilization. Hence, to prevent pollution authorities are imposing more and more stringent restrictions on the extraction of aggregates and also it's crushing. The best way to overcome this problem is to find alternate aggregates for construction in place of natural aggregates. Rubber aggregates from discarded tyre rubber in sizes of 20 mm. As there is change in the industrial sectors, the power requirements of the country are also increasing rapidly. Thermal power is the main source of power in India (around 80% of the power produced is thermal power) resulting in the increase in production of quality of ash. The quality of coal relies open its rank and grade. The content of ash in Indian

coal ranges from 35% to 50%. Fly ash is very economical as its cost less than cement. Although, fly ash cannot be used as substitute of cement and it does not gain strength when mixed with water. But it is compliments cement is such a way that it uses by products of cement. Hence fly ash can be used to blend to with cement to attain a more cost effective cement solution.

2. Objective

The basic objective of this research was to evaluate the fresh and hardened properties of a concrete produced by replacing part of the natural coarse aggregates with an aggregate produced from locally available recycled waste tyre and subjected to local conditions, and replacing part of cement with fly ash, from the test results of the samples, as compared to the respective conventional concrete properties.

3. Scope of the Work

As India is fast developing country in all over the world. With the growth of modern societies of industrial revolutions, the movability within automobile sector got momentum. About one crore 10 lakhs all types of new vehicles are added per annum on the Indian roads. The increase of about three crores discarded tyres each year poses a potential threat to the environment. An estimated 1000 million tyres reached the end of their lives per year. . Generally all the tyre waste is disposed by burning, during the process of burning very harmful gases are evolved and that polluted the environment. Besides the high temperature causes tyres to melt, thus producing oil that will contaminate water and solid. Still millions of automobile tyres are just being buried all over the world. The major advantage is for the environment. So by using the tyre as an aggregate in concrete we can minimize the environmental pollution.

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Fly ash particles are spherical in shape and are very small in size that cement which in turn helps them to fill the voids between cements particles in the concrete matrix, resulting in using less water to get concrete into workable state. Fly ash being a synthetic pozzolana in presence of calcium, hydrochloride and water form C-S-H (Calcium-Silicate-Hydrate) that gives fly ash based concrete the ability to enhance and develop strength over prolonged periods of time. The most important environmental benefit is that considerably less clinker is needed to produce one ton of finished cement producer will reduce its CO₂ emissions.

4. Methodology

In the present review an experimental program was carried out to test various cube specimens, beam specimens and cylindrical specimens of tyre aggregate concrete to determine material properties of tyre aggregate, natural aggregate, sand, cement and fly ash. Tests have been conducted on cubes, beams and cylindrical specimen to study tyre aggregate under loading. The experimental work was carried out into stages. In the first stage, properties of materials were determined and in second stages specimens were prepared and tested.

Specifications of materials

Natural Aggregates (N.A)

Natural coarse aggregate were obtained in crushed form were of granite-type. The natural coarse aggregate is of angular shaped crushed granite with maximum size of 20mm and its fineness modulus and specific gravity are 6.8 and 2.9 respectively. Crushed stone and sand gravel are the two primary sources of natural aggregate, which are used directly in construction or as a raw material for construction products such as concrete and bituminous road material.

Tyre Aggregates (T.A)

Tyre aggregate is the waste product which can be obtained by automobile waste tyre. tyre aggregates from discarded tyre rubber in maximum sizes of 20 mm. Recycled tyre aggregate concrete has good material potential. According to the council of environmental of the cement concrete organization, the recycled tyre aggregate concrete can be used for pavements , concrete shoulders, side walk, curbs, and residential driveways and structural fills.

Fly Ash (F.A)

Fly ash is very economical as its cost less than cement. Although, fly ash cannot be used as substitute of cement and it does not gain strength when mixed with water. But it is compliments cement is such a way that it uses by products of cement. Hence fly ash can be used to blend to with cement to attain a more cost effective cement solution.

Cement

Ordinary Portland cement (OPC) of 43-grade conforming to IS8112:1989 is used throughout this investigation. Cement is a most important constituent in concrete and well known binding material has occupied an indispensable place in the construction work.

Water

Water is very actively participated in the chemical action with cement. Potable fresh water with pH value of 7 available from local sources free from deleterious materials was used for mixing and curing of the mixes in this investigation.

Preparation of Specimen

For the preparation of Cube, Beam and Cylindrical Specimen firstly the control mix named as controlled concrete and 12 experimental combination of mixes named as tyre aggregate concrete were prepared in incorporating the tyre rubber aggregate and fly ash in concrete mix by partially replacement of coarse aggregate and cement respectively. For each combination three Cube, Beam and Cylindrical specimens were casted for the age of 28 days curing. The cube specimen were casted for compressive strength test of tyre aggregate concrete and the beam specimen were casted for the purpose of flexural strength of tyre aggregate concrete and similarly the cylindrical specimen were casted for split tensile strength for the tyre aggregate concrete. That means the 36 cube specimen, 36 beam specimen and 36 cylindrical specimens (33 modified concrete specimen + 3 normal controlled concrete specimen) were prepared for 28 days testing.

Mix proportion:- 1:1.17:2.15 is obtained by the Indian standard method of Mix design for M-25 grade of concrete.

Curing of Specimen

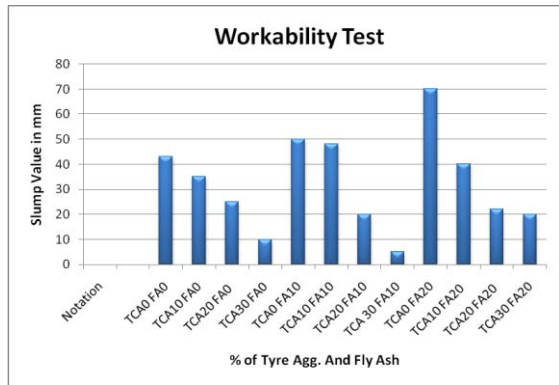
After 24 hours of casting period the specimens are removed from the steel mould and submerged in clean fresh water and kept there until taken out just prior to test. The water is renewed every seven days. The specimens are not too allowed become dry at any time on the curing period.

5. Results

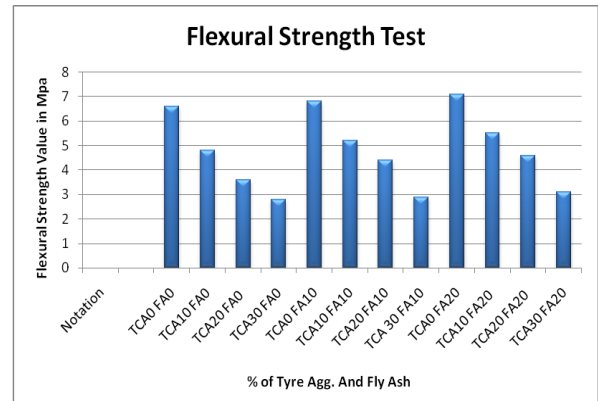
The test results carried out to investigate the various properties of tyre aggregate concrete with fly ash, mixes prepared in contrast with control mixes. The workability, compressive strength, flexural strength, and split tensile strength of grade of M-25 concrete and different replacement percentage of natural aggregate and cement by tyre coarse aggregate and fly ash respectively was studied.

Workability Test Result

S. No.	Notation	Fly Ash (%)	Tyre Aggregate (%)	Slump (mm)
1	TCA0 FA0	0	0	43
2	TCA10 FA0	0	10	35
3	TCA20 FA0	0	20	25
4	TCA30 FA0	0	30	10
5	TCA0 FA10	10	0	50
6	TCA10 FA10	10	10	48
7	TCA20 FA10	10	20	20
8	TCA 30 FA10	10	30	05
9	TCA0 FA20	20	0	70
10	TCA10 FA20	20	10	40
11	TCA20 FA20	20	20	22
12	TCA30 FA20	20	30	20



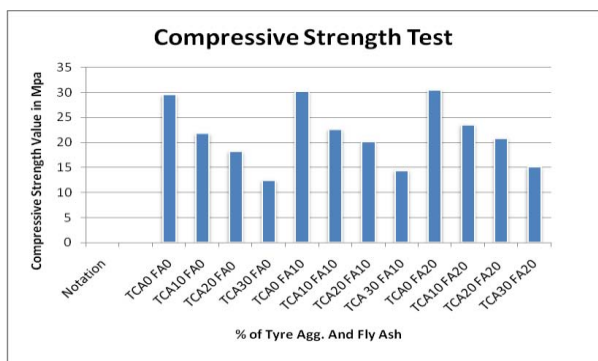
Workability of concrete for various mixes



Flexural Strength of concrete for various combinations after 28-days of curing

Compressive Strength Test Result

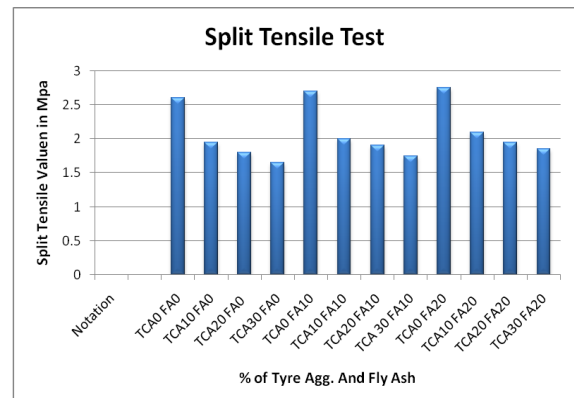
S. No	Notation	Fly Ash (%)	Tyre Aggregate (%)	Compressive Strength (Mpa)
1	TCA0 FA0	0	0	29.55
2	TCA10 FA0	0	10	21.83
3	TCA20 FA0	0	20	18.22
4	TCA30 FA0	0	30	12.44
5	TCA0 FA10	10	0	30.22
6	TCA10 FA10	10	10	22.66
7	TCA20 FA10	10	20	20.22
8	TCA 30 FA10	10	30	14.44
9	TCA0 FA20	20	0	30.50
10	TCA10 FA20	20	10	23.55
11	TCA20 FA20	20	20	20.80
12	TCA30 FA20	20	30	15.11



Compressive Strength of concrete for various combinations after 28-days of curing

Split Tensile Strength Test Result

S. No	Notation	Fly Ash (%)	Tyre Aggregate (%)	Split tensile Strength (Mpa)
1	TCA0 FA0	0	0	2.60
2	TCA10 FA0	0	10	1.95
3	TCA20 FA0	0	20	1.80
4	TCA30 FA0	0	30	1.65
5	TCA0 FA10	10	0	2.70
6	TCA10 FA10	10	10	2.00
7	TCA20 FA10	10	20	1.90
8	TCA 30 FA10	10	30	1.75
9	TCA0 FA20	20	0	2.75
10	TCA10 FA20	20	10	2.10
11	TCA20 FA20	20	20	1.95
12	TCA30 FA20	20	30	1.85



Flexural Strength of concrete for various combinations after 28-days of curing

Flexural Strength Test Result

S. No	Notation	Fly Ash (%)	Tyre Aggregate (%)	Flexural Strength (Mpa)
1	TCA0 FA0	0	0	6.60
2	TCA10 FA0	0	10	4.80
3	TCA20 FA0	0	20	3.60
4	TCA30 FA0	0	30	2.80
5	TCA0 FA10	10	0	6.80
6	TCA10 FA10	10	10	5.20
7	TCA20 FA10	10	20	4.40
8	TCA 30 FA10	10	30	2.90
9	TCA0 FA20	20	0	7.10
10	TCA10 FA20	20	10	5.50
11	TCA20 FA20	20	20	4.60
12	TCA30 FA20	20	30	3.10

6. Conclusion

The fresh and hardened properties of concrete like workability, compressive strength, flexural strength and split tensile strength of tyre aggregate concrete with fly ash are established. The introduction of recycled rubber tyres into concrete significantly increased the slump and decreases the workability of concrete. For rubberized concrete, the test results show that the addition of rubber aggregate resulted in a significant reduction in concrete compressive strength compared with the controlled concrete. Concrete attained its optimum strength of 30.50 N/mm² for M25 grade of concrete at fly ash replacement of 20%. Tyre aggregate concrete

Shows maximum compressive strength is 23.55N/mm² for M25 grade of concrete with 10% replacement of natural aggregate by tyre aggregate and 20% replacement of cement by fly ash.

Maximum flexural strength of tyre aggregate concrete is observed as 5.50 Mpa for 10 % replacement natural aggregate by tyre aggregate and 20 % replacement of cement by fly ash. Maximum Split tensile strength for tyre aggregate concrete is observed as 2.10 Mpa with 10% replacement of natural coarse aggregate by the tyre aggregate and 20 % replacement of cement with fly ash. Our experimental study basis 10% tyre aggregate and 20% fly ash gives the maximum strength (compressive, flexural and split tensile strength) of tyre aggregate concrete.

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