Experimental Evaluation of Strength Properties of Concrete using Saw Dust Ash and Polypropylene Fibres

Gibi Miriyam Mathew
M Tech Scholar, Civil Engineering
Sree Narayana Institute of Technology
Adoor, Kerala

Sruthy B
M Tech Scholar, Civil Engineering
Sree Narayana Institute of Technology
Adoor, Kerala

Anju V
Assistant Professor,
Department of Civil Engineering
Sree Narayana Institute of Technology
Adoor, Kerala

Sruthi G Raj
M Tech Scholar, Civil Engineering
Sree Narayana Institute of Technology
Adoor, Kerala

***Abstract*— Globally concrete is the backbone for the development of infrastructure, buildings, industrial structures, bridges and highways etc. In today's situation concrete needs special combinations of performance and uniformity requirements that cannot be always achieved by using conventional constituents and normal mixing. It is weak in tension, has limited ductility and little resistance to cracking. This provided the motivation for exploring the benefits of saw dust ash (SDA) as a replacement material and the addition of polypropylene fibres. Sawdust is one of the major under utilized by-products from saw milling operations. The implementation of waste sawdust can not only decrease environmental damage, but also can save the concrete materials. Saw dust ash can be used as a light weight concrete that have already received attention over the past years. To strengthen the SDA concrete and making it more durable polypropylene fibre is being added. Polypropylene is a synthetic hydrocarbon polymer, the fiber of which is made using extrusion processes by hot drawing the material through a die. Polypropylene fibres may be effective in distributing impact stresses and providing some enhancement to frost resistance. They have also been shown to reduce the spalling of concrete in a fire. In this project SDA has been partially replaced with cement by its weight such as 2.5%, 5%, 7.5%, 10% and 12.5% in M25 grade concrete along with polypropylene fibres. The main objective of this study is to determine compressive strength of concrete at different replacement level.**

Keywords—Saw dust ash; Polypropylene fibres; Compressive strength; light weight concrete

I. INTRODUCTION

Concrete is the most popular building material in the world. Concrete is known to be the most wide spread structural material due to its quality to shape up in various geometrical configurations. It is an assemblage of cement, fine and coarse aggregates and water. Over 300 million tones of industrial wastes are being produced per annum by various industrial and agricultural processes. These materials possess problems of disposal, health hazards and aesthetic problems. The global consumption of cement is too high due to its extensive use in concrete. The advances in concrete technology has paved the way to make the best use of the locally available materials by judicious mix proportioning and proper workmanship, so as to result in a concrete satisfying the performance requirements. Cement industry contributes extensively in the emission of CO_2. It also consumes high levels of energy resources in cement production. By replacing cement with a waste material, such as saw dust, the cement and cement industry together can meet the demand in construction industry and also can help in reducing the environmental pollution. Saw dust is very common due to the availability of saw mills in almost every township in the country. It is one of the major under utilized by-products from saw milling operations. Saw dust ash (SDA) can be used as a light weight concrete that have already received attention over the past years. The implementation of waste saw dust can not only decrease environmental damage, but also can save the concrete materials.

Concrete is a brittle material with low tensile strength and low strain capacity that result in low resistance to cracking. To improve such properties, Fibre reinforced concrete (FRC) has been developed. Fibres are intended to improve strength, toughness and impact strength, to change failure mode by means of improving post-cracking ductility, and to control cracking. Among these fibres, polypropylene has been one of the most successful commercial applications. The common forms of these fibres are smooth-monofilament and have triangular shape. Polypropylene fibres have some unique properties that make them suitable for reinforcement in concrete.

II. SCOPE OF WORK

- To reduce the carbon emissions that would result from the use of saw dust ash as a partial replacement to cement.
- To reduce the cost of construction as well as to increase the strength of concrete
- To create a sustainable and pollution free environment
- To evaluate the suitability of agro waste as an alternative for cement

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III. OBJECTIVES OF THE STUDY

- To analyze the properties of the saw dust ash concrete as compared to the Portland cement concrete.
- To find the optimum percentage of Saw dust ash
- To provide an economical construction material
- Safeguard the environment by utilizing the agro waste properly

IV. MATERIAL USED

The various materials used in this experiment are Cement, Fine aggregate, Coarse aggregate, Saw dust ash (SDA), Chemical admixture, Polypropylene Fibre (PP) and Water

a) Cement

The cement used in this experimental work was "Dalmia 53 Grade Ordinary Portland Cement" having specific gravity-3.15 and normal consistency- 30%. All the tests were carried out in accordance with procedure specified in IS 12269 – 1987.

b) Fine aggregate

The fine aggregate used was M sand and it is collected from the locally available sites and confirms to zone 1. The specific gravity of fine aggaregate is 2.26.

c) Coarse Aggregate

The coarse aggregate used here was collected from locally available places having maximum size 20mm and specific gravity 2.6. The coarse aggregate is chosen by shape as per IS 2386 (Part I) 1963, surface texture characteristics of aggregate is classified as in IS 383-1970. The void ratio and porosity of coarse aggregate are 0.8 and 0.44 respectively.

d) Saw Dust Ash (SDA)

Sawdust is an organic waste resulting from the mechanical milling or processing of timber (wood) into various shapes and sizes. The dust is usually used as domestic fuel. The resulting ash known as saw-dust ash (SDA) is a form of pozzolana. The saw dust used for this project was collected from nearby sawmill. Samples were carefully collected to avoid mixing with sand by collecting the newly produced ones with shovel and packing into bags. The saw dust collected was sundried for 5 days to aid the burning process. The saw dust samples collected were burnt into ashes by open burning. The ash was then ground after cooling. Sawdust ash obtained is sieved through IS sieve of 300 micron. The specific gravity of saw dust ash obtained was 2.16.

Fig 1: Saw dust ash (SDA)

e) Chemical Admixture

Cera - Chem Pvt Ltd, Chennai has developed "Ceraplast 300" which is compatible with blended cements, especially with slag cements. Ceraplast 300 M is a new generation, high grade, and high-performance retarding super plasticiser specially designed for concrete with replacement of cement upto 70-80 percent by slag. The super plasticizer was added 0.5 to 0.7 % by weight of cement to all mixes. Ceraplast 300 M is a new generation, high grade and superior performance retarding super plasticizer.

f) Polypropylene fibers (PP)

The fibres used were fine polypropylene monofilaments. The fibers were supplied by Jeetmull Jaichandlall Pvt Ltd, Chennai .The length of fibre range from 10mm to 20mm. Polypropylene fibres are Synthetic hydrocarbon polymer. They are formed by extrusion processes by hot drawing material through a die. Table I shows the physical characteristics of polypropylene fibre.

TABLE I: PHYSICAL CHARACTERISTICS OF POLYPROPYLENE FIBRES

Specific gravity	0.91
Melting range	162 – 164 °C
Thickness	35 – 40 micron
Elongation	15% - 18%
Strength	500 - 550 MPa
Diamond length	10 – 12 mm

Fig 2: Polypropylene fibre

g) Water

Fresh, colourless, odourless and tasteless potable water that is free from organic matter of any kind was used for mixing.

V. EXPERIMENTAL PROCEDURE

a) Mix proportion

Mix design is calculated as per IS 10262:2009 specifications. The concrete mix of M25 grade concrete is adopted with a water cement ratio of 0.5.

b) Workability test

Workability of concrete defined as 'that property of freshly mixed concrete which determines the ease and homogeneity with which it can be mixed, placed, consolidated and finished'. It is determined by performing the following tests on fresh concrete as per IS 456:2000.

1. Slump Test
2. Compaction factor test

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c) Batching, Mixing and Casting

The batching, mixing and casting was done with proper care and handling. The materials were weighed properly as required and hand mixed thoroughly on a platform and then water was added as per the requirement. The addition of SDA and fibre was added as ranged. The cube moulds of size 150mmx150mmx150mm were then filled with the mix. The cubes were tamped by tamping rod for around 25 time and the surface of moulds were levelled

properly. The specimens were kept for 24 hours; de-moulded and then set for curing. The curing was allowed until the date of testing i.e., for 7th, 14th, and 28th. Then after the days of curing, the cube specimens were taken out and tested under compression testing machine.

d) Compressive strength tests

The aim of this test is to determine the compressive strength of concrete specimens. The cube specimen was taken out from the curing tank after specified curing time and were allowed for dry and the weight of each specimen as well as measure the dimension of the specimen were noted. The specimens were placed in the machine such that load shall be applied to the opposite sides of the specimen, and the specimens were aligned centrally on the base plate of the machine. The movable portion was rotated gently by hand so that it touches the top surface of the specimen. The load was applied gradually till the specimens failed and the maximum load at failure of specimen were recorded. The compressive strength of the specimen was calculated by dividing the failure load by the cross-sectional area of the specimen. Compressive strength of the cubes was determined at curing periods of 7 days, 14 days and 28 days.

Fig 3: Compression testing machine

VI. RESULTS AND DISSCUSSION

a) Workability results

The workability test results for various percentages of SDA are shown in the table below.

TABLE II: WORKABILITY RESULTS

Sl. No	Percentage of fibre (%)	Percentage of SDA (%)	Workability tests	
			Slump test	Compaction factor test
1	0	0	80	0.91
2	1.2	2.5	79	0.9
3		5	77	0.89
4		7.5	76	0.89
5		10	75	0.88
6		12.5	73	0.87

b) Compression test

Table III shows the results of compression test for a curing period of 7 days and 28 day

TABLE III: COMPRESSIVE STRENGTH RESULTS

Percentage of ash (%)	Percentage of fibre(%)	Strength obtained after 7day (N/mm^2)	Strength obtained after 14day(N/mm^2)	Strength obtained after 28day(N/mm^2)
0	0	23	24.1	27
2.5	1.2	20	21.77	25
5		21.1	23	27.6
7.5		22	24.3	29.33
10		18	20.44	21.6
12.5		15	19.6	20.3

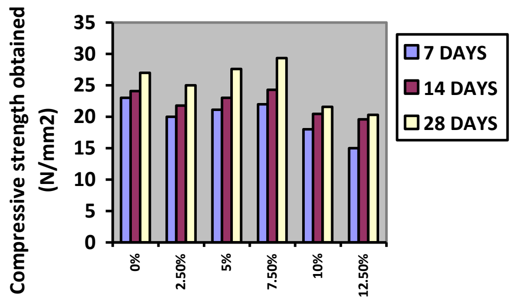

Fig 4: Relationship between compressive strength and various percentage of SDA

VII. CONCLUSIONS

Based on the investigations, the following conclusions were drawn.

- The addition of SDA in concrete provides environmental as well as technical benefits.
- The partial replacement of SDA cement reduces the cost of making concrete.
- Saw dust ash concrete is light weight in nature and it prove to be environment friendly thus paving way for green concrete.
- The workability of concrete decreases significantly with the increase of SDA content in concrete mixes.
- The compressive test results have indicated that the strength of concrete decreases with respect to the percentage of SDA added.
- The significant improvements in strengths were observed with inclusion of polypropylene fibres in concrete. The optimum strength was observed at 1.2 % of fibre content there after reductions in strength were observed.
- The maximum percentage of increase in compressive strength observed was at 7.5 % of SDA with 1.2% of fibre content. So a combination of 7.5% SDA + 1.2% PF will give the maximum compressive strength results.

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