Scientific Journal of Impact Factor (SJIF): 4.72

e-ISSN (O): 2348-4470
p-ISSN (P): 2348-6406

International Journal of Advance Engineering and Research Development

Volume 4, Issue 5, May -2017

Comparative Study on Addition of Saw Dust Ash and Polypropylene Fibres to Concrete Using Destructive and Non Destructive Tests

Gibi Miriyam Mathew[1], Anju. V[2]

[1]Mtech student, Department of civil Engineering, Sree Narayana Institute of Technology, Adoor, Kerala
[2]Assistant professor, Department of civil Engineering, Sree Narayana Institute of Technology, Adoor, Kerala

Abstract — *Construction industry is one of the rapidly growing industries in the world. In this industry, concrete plays an important role and it is the most widely used man made construction material. Concrete consumes large quantities of natural resources. As per the present scenario, it is known that natural resources are depleting worldwide while at the same time the generated wastes from the industry are increasing substantially. So for the sustainable development of construction industry, methods like use of non-conventional innovative materials and recycling of waste materials should be adopted. Concrete 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 underutilized 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 in light weight concrete that has 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. In this paper cement has been partially replaced with SDA by its weight such as 2.5%, 5%, 7.5%, 10% and 12.5% in M25 grade concrete along with polypropylene fibres. Results showed that maximum increase in the compressive strength observed was 7.5% from both destructive and non destructive tests along with 1.2% of fibre content.*

Keywords- *saw dust ash; polypropylene fibres; light weight concrete; destructive tests; non destructive tests*

I. INTRODUCTION

Concrete is the most popularly used man made material in the world which is used for various construction works such as house construction, bridge construction, roads, pavements etc. It is known to be the most wide spread structural material, due to its property to shape up in various geometrical configurations. It is an assemblage of cement, fine and coarse aggregates and water. Concrete is an important part of the infrastructure of the society. Concrete has unlimited opportunities for advanced applications, design and construction techniques. It is the material of choice where strength, impermeability, durability, performance, fire resistance and abrasion resistance are required. Its high compressive strength and mouldability have made its widespread use. Dumping of these wastes on earth surface is causing the environment pollution. Saw dust ash (SDA) is a waste material, is a by-product obtained from the saw milling operations. It has high reactivity and pozzolonic property. To conserve resources, utilization of industrial and biogenic wastes as supplementary cementing materials has become an important part of concrete construction. Concrete has major disadvantages that it is brittle and weak in tension. Still concrete is better option than any other available materials for construction works. Concrete with advanced technologies such as reinforce cement concrete (R.C.C.) and fiber reinforced concrete (F.R.C.) provides extra strength and durability against sliding, cracking, buckling and overturning. Concrete properties can be improved by the use of industrial, agricultural and domestic wastes. Fibres are intended to improve impact strength, toughness, and strength of concrete and 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 successfully used one for commercial applications. Polypropylene is a synthetic hydrocarbon polymer, the fiber of which is made by extrusion processes by hot drawing the material through a die. Its use enables the reliable and effective utilization of intrinsic tensile and flexural strength of material along with significant reduction of plastic shrinkage cracking and minimizing of thermal cracking .The common forms of polypropylene fibres are smooth-monofilament and triangular shaped. These fibres have some unique properties that make them suitable for reinforcement in concrete.

II. OBJECTIVES OF THE STUDY

- To analyze the properties of the saw dust ash concrete compared to the portland cement concrete.
- To find the percentage of saw dust ash and polypropylene fibres that give maximum results
- To create a sustainable and pollution free environment
- To compare the results obtained from destructive and non destructive tests

III. SCOPE OF WORK

The purpose of this work is to determine the feasibility of using saw dust ash as a replacement of cement in concrete. Using a product such as SDA in concrete can influence the mechanical properties of concrete. This study will help to reduce the carbon emissions and cost of construction that would result from the usage of SDA. Also this work aims to compare the results obtained from destructive and non destructive tests.

IV. MATERIALS USED

The various materials used in this experimental study are cement, fine aggregate, coarse aggregate, saw dust ash (SDA), admixture, polypropylene fibre and water.

4.1. Cement

The cement used in this experimental work was 53 grade ordinary portland cement having specific gravity of 3.15 and normal consistency of 30%. All the tests were carried out in accordance with procedure specified in IS 12269 – 1987.

4.2. Fine aggregate

The fine aggregate used was M sand and it is collected from the locally available sites.

4.3. 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.

4.4. Saw Dust Ash (SDA)

Sawdust is an organic waste resulting from the mechanical milling or processing of timber 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)

4.5. 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 plasticizer.

4.6. Polypropylene fibers

The fibres used were fine polypropylene monofilaments. The fibers were supplied by Jeetmull Jaichandlall Pvt Ltd, Chennai. Fig I shows the polypropylene fibres and Table I shows the physical characteristics of fibre.

Fig 2: Polypropylene fibre

Table I: Physical characteristics of polypropylene fibres

Specific gravity	0.91
Length	10-20mm
Melting range	162 – 164 ◦C
Thickness	35 – 40 micron
Elongation	15% - 18%
Strength	500 - 550 MPa
Diamond length	10 – 12 mm

4.7. Water

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

V. METHODOLOGY

The experiment was divided in to definite sequences of work.The sequences of works are represented in the form of a flow diagram presented in Fig 3.

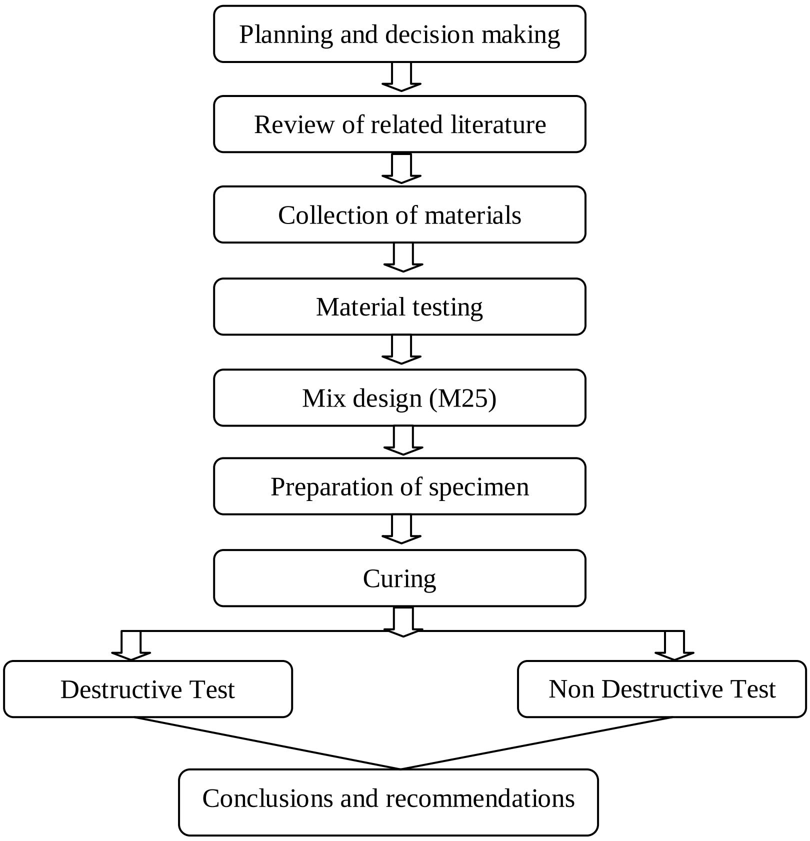

Fig 3: Methodology

5.1. 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.

5.2. Workability test on fresh concrete

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 slump test and compaction factor tests on fresh concrete as shown in Fig 4 as per IS 456:2000.

(a) *(b)*

Fig 4: Workability tests (a) Slump test (b) Compaction factor test

5.3. 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. Concrete cube specimens were cast in steel moulds using different percentages of polypropylene fibres. The different percentages of fibres used are 0%, 0.6%, 0.9%, 1.2%, 1.5%, 1.8%, and 2%. The optimum strength was observed at 1.2 % of fibre content, thereafter reductions in strength were observed. Then this percentage of fibre is kept as constant and cubes are prepared using different percentage of SDA. The various percentages of SDA replaced are 0%, 2.5%, 5%, 7.5%, 10% and 12.5%. 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.

(a) *(b)* *(c)*

Fig 5: Various stages of preparation of specimen (a) Mixing of materials (b) Concrete mixed (c) Cubes cast

5.4. Tests on hardened concrete

5.4.1. Destructive tests

(i) Compressive strength test

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 6: Compression testing machine

5.4.2. Non destructive tests

The standard method of evaluating the quality of concrete in buildings or structures is to test specimens cast simultaneously for compressive, flexural and tensile strengths. The main disadvantages are that results are not obtained immediately; that concrete in specimens may differ from that in the actual structure as a result of different curing and compaction conditions; and that strength properties of a concrete specimen depend on its size and shape. Although there can be no direct measurement of the strength properties of structural concrete for the simple reason that strength determination involves destructive stresses, several non- destructive methods of assessment have been developed. Nondestructive testing (NDT) is a wide group of analysis techniques used in science and technology industry to evaluate the properties of a material, component or system without causing damage. These depend on the fact that certain physical properties of concrete can be related to strength and can be measured by non-destructive methods. Such properties include hardness, resistance to penetration by projectiles, rebound capacity and ability to transmit ultrasonic pulses and X- and Y-rays. These non-destructive methods may be categorized as penetration tests, rebound tests, pull-out techniques, dynamic tests, radioactive tests, maturity concept.

(i) Ultrasonic pulse velocity test

An ultrasonic pulse velocity test is an in-situ, nondestructive test to check the quality of concrete and natural rocks. In this test, the strength and quality of concrete or rock is assessed by measuring the velocity of an ultrasonic pulse passing through a concrete structure or natural rock formation. This test is conducted by passing a pulse of ultrasonic wave through concrete to be tested and measuring the time taken by pulse to get through the structure. Higher velocities indicate good quality and continuity of the material, while slower velocities may indicate concrete with many cracks or voids. This test is done to assess the quality of concrete by ultrasonic pulse velocity method as per IS: 13311 (Part 1) – 1992. The UPV apparatus and UPV test on cube specimen is shown in Fig 7.

(a) (b)

Fig 7: (a) UPV apparatus (b) UPV test on cube specimen

(ii) Rebound hammer test

Rebound hammer test (Schmidt hammer) is used to provide a convenient and rapid indication of the compressive strength of concrete. It consists of a spring controlled mass that slides on a plunger within a tubular housing. The operation of rebound hammer is shown in the Fig 8. When the plunger of rebound hammer is pressed against the surface of concrete, a spring controlled mass with a constant energy is made to hit concrete surface to rebound back. The extent of rebound, which is a measure of surface hardness, is measured on a graduated scale. This measured value is designated as rebound number (rebound index). A concrete with low strength and low stiffness will absorb more energy to yield in a lower rebound value.

Fig 8: Rebound hammer test on cube specimen

VI.RESULTS AND DISSCUSSION

6.1. Material testing

The tests were carried out to find out the physical properties of cement and aggregates used are tabulated in Table II and Table III respectively.

Table II: Physical properties of cement

Test	Result
Fineness	1.4%
Standard consistency	30%
Initial setting time	40 min
Final setting time	Beyond 40 min
Specific gravity	3.17

Table III: Physical properties of aggregates

Physical properties	Result
Specific gravityof fine aggregate	2.36
Specific gravity of coarse aggregate	2.67
Bulk density of coarse aggregate	1.574 g/cc
Void ratio of coarse aggregate	0.85
Porosity of coarse aggregate	0.445

6.2. Compressive strength test

The compressive strength obtained for various percentages of SDA and optimum of fibre (1.2%) is tabulated in Table IV and relation between compressive strength and different percentage of SDA is presented in Fig 9.

Table IV: Compressive strength obtained for various percentages of SDA and optimum of fibre

Percentage of SDA (%)	Strength obtained after		
	7 days (N/mm^2)	14 days (N/mm^2)	28 days (N/mm^2)
0	20.98	25.1	30.2
2.5	21.5	26.05	30.9
5	22.8	27.3	31.5
7.5	23.4	27.9	32.6
10	22.8	24.2	27.7
12.5	20.1	21.5	23.6

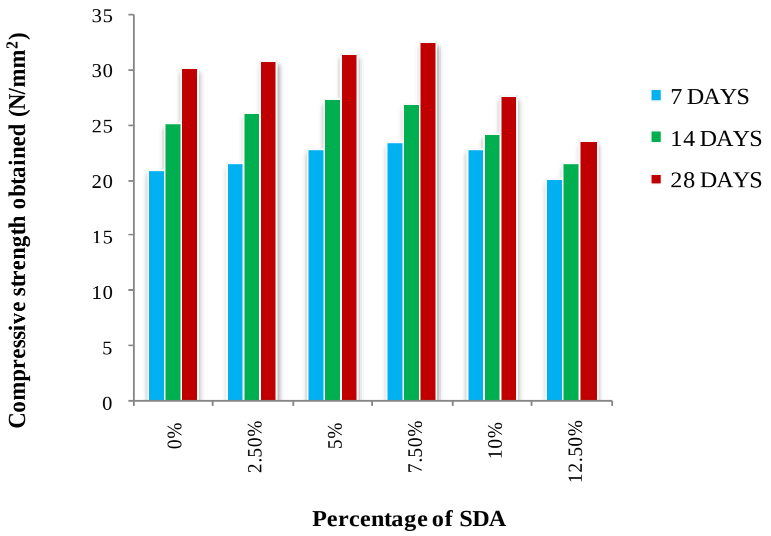

Fig 9: Relationship between compressive strength and various percentage of SDA

6.3. Non destructive test

6.3.1 Rebound hammer test

Results obtained from rebound hammer test on cube specimen after 28 days of curing are tabulated in Table V and the relationship between various percentage of SDA and compressive strength is shown in Fig.10.

Table V: Rebound hammer test results on cube specimen

Percentage of SDA (%)	Compressive strength for 28 days (N/mm^2)
0	27.6
2.5	28.1
5	29.5
7.5	31.4
10	25.6
12.5	23.8

Fig 10: Relationship between compressive strength obtained from rebund hammer test and percentage of SDA

6.3.2. Ultra sonic pulse velocity test

Results obtained from ulta sonic pulse velocity test on cube specimen after 28 days of curing are tabulated in Table VI.

Table VI: Ultra sonic pulse velocity test on cube specimen

Percentage of SDA (%)	Ultra sonic pulse velocity (km/sec)	Concrete quality (Grading)
0	3.99	Good
2.5	3.65	Good
5	3.82	Good
7.5	4.15	Good
10	3.91	Good
12.5	3.52	Good

VII. CONCLUSIONS

- The utilisation of SDA in concrete provides additional environmental as well as technical benefits for all related industries. Partial replacement of cement with SDA reduces the cost of making concrete.
- Saw dust ash concrete is light weight in nature and it proves to be environment friendly, thus paving way for green concrete.
- The results of compressive test have indicated that the strength of concrete decreases with respect to the percentage of SDA added.
- On addition of fibre to SDA, it is noticed that the strength of fibre reinforced saw dust ash concrete (FRSDAC) increases the strength of SDA concrete and has proximate strength compared to normal concrete.
- The maximum percentage of increase in compressive strength was observed 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.
- Usage of polypropylene fibre in concrete helps to reduce plastic shrinkage cracking.
- The results obtained from destructive tests and non destructive tests almost remain the same.

REFERENCES

[1] Ambika Nahak, Sabita Dash, "A Study on Strength of Concrete with Partial Replacement of Cement with Saw Dust Ash and Steel Fibre", International Journal of Engineering Research & Technology, Vol. 4, Issue 03, March, 2015
[2] Gopinath. K, Anuratha. K, Harisundar. R, Saravanan. M, "Utilization of Saw Dust in Cement Mortar & Cement Concrete", International journal of scientific & engineering research, Vol 6, 2015
[3] Kolli. Ramujee, "Strength properties of polypropylene fiber reinforced concrete", International Journal of Innovative Research in Science, Engineering and Technology, Vol.2, Issue 8, Aug, 2013
[4] Mohammad Iqbal Malik, Syed Rumysa Jan, Junaid Ahmad Peer, Syed AzharNazir, "Partial Replacement of Cement by Saw Dust Ash in Concrete A Sustainable Approach", International Journal of Engineering Research and Development, 2015
[5] Raheem. A. A, Olasunkanmi. B. S, Folorunso. C. S, "Saw Dust Ash as Partial Replacement for Cement in Concrete", Technology and management in construction, 2012
[6] Ratod Vinod Kumar, Shiva Rama Krishna. M, "A Case Study on Partial Replacement of Cement by Saw Dust Ash in Concrete", IJSR, 2015
[7] Sofi. A, Abhishek Saxena, Prateek Agrawal, Aryan Raj Sharma, Kamlesh Sharma, "Strength Predictions of Saw Dust and Steel Fibres in Concrete", International Journal of Innovative Research in Science, Engineering and Technology, Vol. 4, Issue 12, December 2015

