A Study on Strength of Concrete with Partial Replacement of Cement with Saw Dust Ash and Steel Fibre

Ambika Nahak
M-Tech student, Department of Civil
College of Engineering & Technology
Bhubaneswar, Odisha

Mrs. Sabita Dash
Assistant Professor, Department of Civil
College of Engineering & Technology
Bhubaneswar, Odisha

***Abstract* - A study of mechanical strength of concrete made using Ordinary Portland Cement with a partial replacement of saw dust ash ranging from 5% to 20% and again by incorporating steel fibre of 0.5%, 1%, 1.5% with same SDA percent .The grade of concrete designed here was M_{25}. Slump and compacting factor tests were carried out for fresh concrete and compressive strength, split tensile strength, flexural strength tests for hardened concrete. The compressive strength and split tensile strength tests of normal and SDA concrete was done at the age of 3, 7, 28 and 56 days and SDA concrete containing steel fibre was tested at the age of 3, 7 and 28 days. The flexural strength of saw dust ash concrete with & without steel fibre was tested at the age of 28 days. From the experimental results, it was found that there is a reduction in strength with an increment of saw dust ash. But while adding steel fibre to SDA, it is observed that the fibre reinforced saw dust ash (FRSDA) concrete has an increase in strength twice than that of the SDA concrete at 3^{rd}, 7^{th} and 28^{th} days.**

Keywords: Saw dust ash concrete, saw dust ash, steel fibre, mix design

INTRODUCTION

Concrete is a very strong and versatile mouldable construction material. It is a composite material that consists essentially of a binding medium within which are embedded particles or fragments of aggregate. In the world of construction, one material is used above all others and that is "concrete". Concrete is absolutely indispensable in modern society's fascination with new roads, buildings and other constructions. The three basic ingredients of concrete are aggregate, cement, water. Cement is the fixture that binds the ingredients together, water gives the concrete viscosity in order to be moulded and react with the ingredients, and the aggregates are what adds bulk to the concrete, but are not involved in the chemical processes.

On its own, concrete have excellent resistance to compression (crushing), but is very poor in tension (stretching). To give it good load bearing capability when under tension, it has to be reinforced with steel bars (rebar), polymer strands or fibres.

Saw dust is very common due to the availability of saw mills in almost every township in the country. Sawdust is one of the major under utilized by-products from saw milling operations, generation of wood wastes in saw mill is unavoidable hence a great efforts are made from the utilization of such waste. Saw dust ash can be used as a light weight concrete that have already received attention over the past years. The implementation of waste sawdust can not only decrease environmental damage, but also can save the concrete materials.

Role of Fiber Reinforced Saw Dust Ash Concrete

Fibre reinforced saw dust concrete (FRSDAC) may be defined as a composite material made with Portland cement, aggregate, saw dust ash and incorporating discrete discontinuous fibres. The role of randomly distributed discontinuous fibres is to bridge across the cracks that develop some post-cracking "ductility". If the fibres are sufficiently strong, sufficiently bonded to material, it permits the FRC to carry significant stresses over a relatively large strain capacity in the post-cracking stage. To strengthen the SDA concrete and making it more durable steel fibre is being added, as it is an economically strong material, have excellent flexural strength, crack resistance and can also be used as an alternate material for concrete construction.

MATERIAL SPECIFICATION

Cement

The cement used in this experimental work was "Ramco 43 grade Ordinary Portland Cement", confirming IS 8112:89 (Specification for 43 grade Ordinary Portland Cement), having specific gravity-3.13 and normal consistency-35%.

Fine aggregate

The fine aggregate used was collected from the locally available sites and confirms to zone 3 of IS 383:1970, having specific gravity-2.67, fineness modulus-2.67 and water absorption-0.6%.

Coarse Aggregate

The coarse aggregate used here was collected from locally available places having size 20mm and down confirming IS 383:1970 having specific gravity-2.84, fineness modulus-7.94, water absorption-0.6% and aggregate impact value-11.74%.

Saw Dust Ash

Saw dust used in this study was collected from local mills, it was then converted into ash and grounded after cooling and was sieved by 300 µm sieve. The specific gravity and moisture content of saw dust ash obtained was 2.19 and 0.30. The fraction of saw dust ash taken was ranged from 5%-20%.

Steel Fibre

Crimped steel fibre was used in this experiment that was collected from Steel Wool Pvt. Ltd., Pune. It has an aspect ratio 45-80 having diameter 0.6-0.8 and width 2-2.5mm also having a tensile strength of 400 MPa-600 MPa. The volume fraction of steel fibre taken was 0.5%, 1% and 1.5%.

Water

The water used here was potable water and was clean and without having any visible impurities.

Chemical Admixture

Plastocrete Plus an admixture collected from Sika India Pvt. Ltd. was used here that acts both as a high efficient plasticizer and waterproofing compound. It conforms to both IS 2645-1975 and IS 9130-1979. It has a specific gravity approx. 1.08 and its dosage taken is 0.2% by weight of cement.

EXPERIMENTAL PROCEDURE

Mix Design

In this we have the selection of the constituent materials and its mix proportion that usually needed for a concrete mix. M_{25} grade of concrete was designed for this experiment with a mix proportion of 1:1.46:3.38 with water cement ratio 0.5. The concrete mix design has been designed based on IS 10262-1982. Modification was made for the constituents depending on the replacement done. Here the replacement is for cement by saw dust ash ranging from 5% - 20% and again replaced by adding steel fibre with 0.5%, 1% and 1.5% having the same percentage of SDA.

Batching, Mixing and Casting

The batching, mixing and casting was done with proper care and handling. The materials were weighed properly accordingly as required and was hand mixed thoroughly on a platform and then water was added as per the requirement. The addition of saw dust ash and steel fibre was added as ranged. The moulds (cubes, cylinders, beams) were then filled with the mix. The cubes were processed for vibration using the vibrating table and the cylinders and beams were tamped by tamping rod for around 25 times. The moulds were levelled properly. The specimens were kept for 24 hours, de- moulded and then were set for curing. The curing was allowed until the date of testing i.e., for 3rd, 7th, 28th, and 56th day.

RESULT AND DISCUSSION

The results and discussion done here are both about the fresh as well as for the hardened concrete. For fresh concrete the workability test i.e., the slump and compacting factor tests were done and for the hardened concrete the compressive strength, split tensile strength and flexural strength tests were conducted. The slump and compacting factor variation can be seen in Figure1 and Figure2.

Compressive Strength Test

The compressive strength test was done for 3rd, 7th, 28th and 56th day for normal and SDA concrete whereas tests done on 3rd, 7th, 28th day was for FRSDA concrete. The test results are shown in Figure 3, Figure 4.

Split Tensile Strength Test

The split tensile test for the concrete cylinders was done for 3, 7, 28 and 56 days for normal and SDA concrete whereas for FRSDA concrete it was done for 3, 7 and 28 days. The test results are shown in Figure 5, Figure 6.

Flexural Strength Test

For flexural strength test the beam testing was done for 28 days for normal, SDA concrete as well as for FRSDA concrete. The test results are shown in Figure 7.

CONCLUSION

The present study investigated the effectiveness of using Saw dust ash (a waste material obtained from different saw mills) for the partial replacement of cement.

Based on the investigations, the following conclusions were drawn.

- The utilisation of SDA in concrete provides additional environmental as well as technical benefits for all related industries. Partial replacement of SDA cement reduces the cost of making concrete.
- The workability of concrete decreases significantly with the increase of SDA content in concrete mixes.
- There is no change in the water content after addition of the admixture in the concrete materials.
- The results of compressive, split tensile strength and flexural strength test have indicated that the strength of concrete decreases with respect to the percentage of SDA added.
- On addition of steel fibre to SDA, it is noticed that the strength of Fibre reinforced saw dust ash concrete (FRSDAC) increases twice the strength of SDA concrete and have proximate strength compared to normal concrete.
- It is also seen that at 20% SDA + 1% SF the compressive strength increases & again it is decreased at 20% SDA + 1.5% SF.
- The split tensile strength of SDA concrete is slightly increased at 56th day as compared to the normal concrete. So there may be possibilities of increase in strength at later ages.

- There is an increase in flexural strength of FRSDAC as compared to normal as well as SDA concrete at 5%, 10% and 15% SDA.

Saw dust is a breathing hazard, and can also form a combustible mix with air (because it can burn). Even finer sawdust is created by sanding wood. Sawdust is recyclable, and easily composted instead of being discarded in the trash. Utilisation of SDA as cement replacement in concrete and as a cement raw material has the dual benefit of eliminating the costs of disposal and lowering the cost of the concrete. The SDA can be used for cement replacement to some extent.

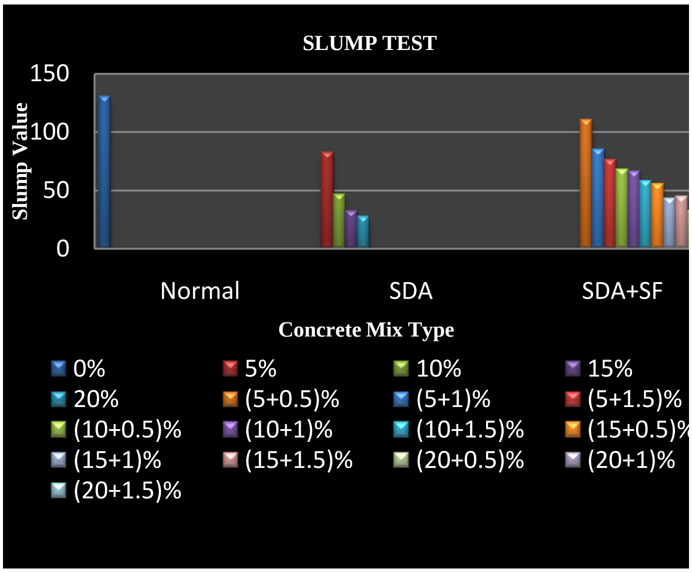

Figure-1: Slump value for percentage of SDA

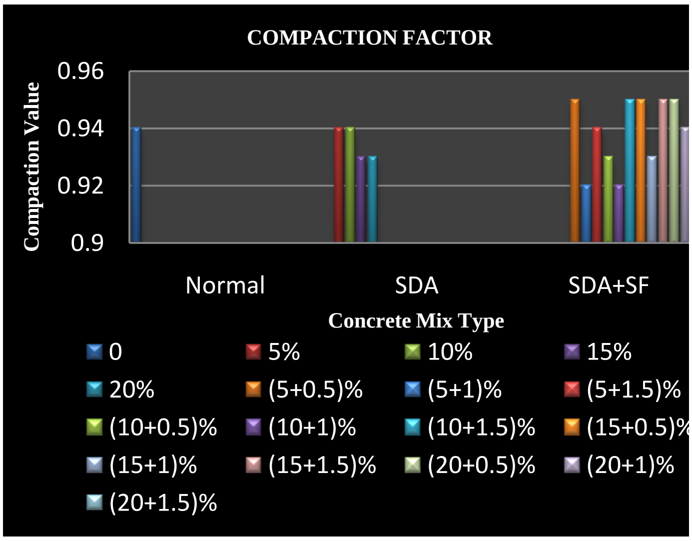

Figure-2: Compaction value for different percentage of SDA

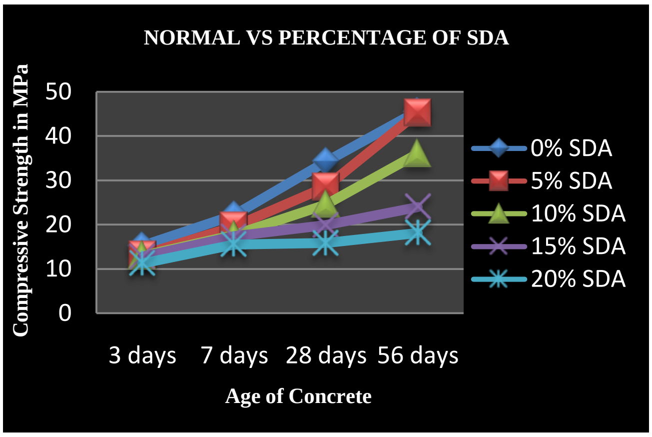

Figure-3: Variation of compressive strength at different ages for normal and various SDA %

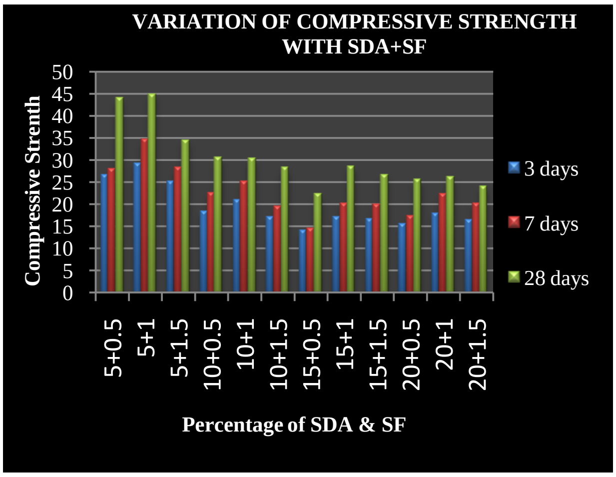

Figure-4: Variation of compressive strength at No. of ages for various percent of SDA and SF

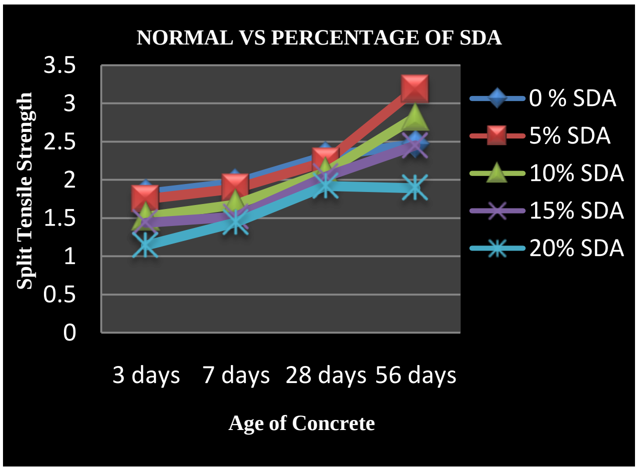

Figure-5: Variation of split tensile strength at different ages for normal and SDA %

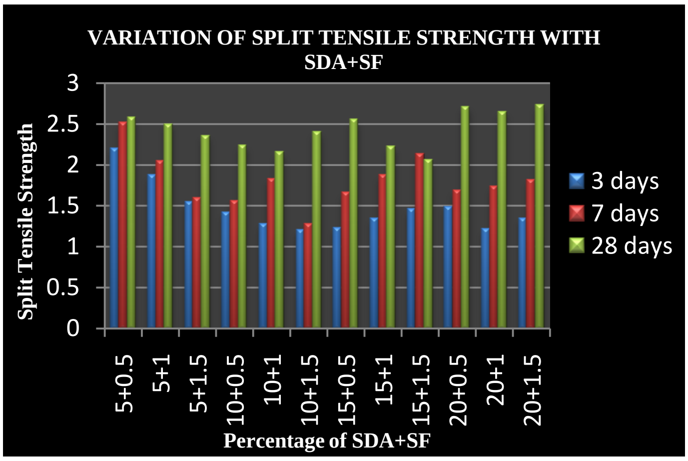

Figure-6: Variation of split tensile strength at No. of ages for various percent of SDA and SF

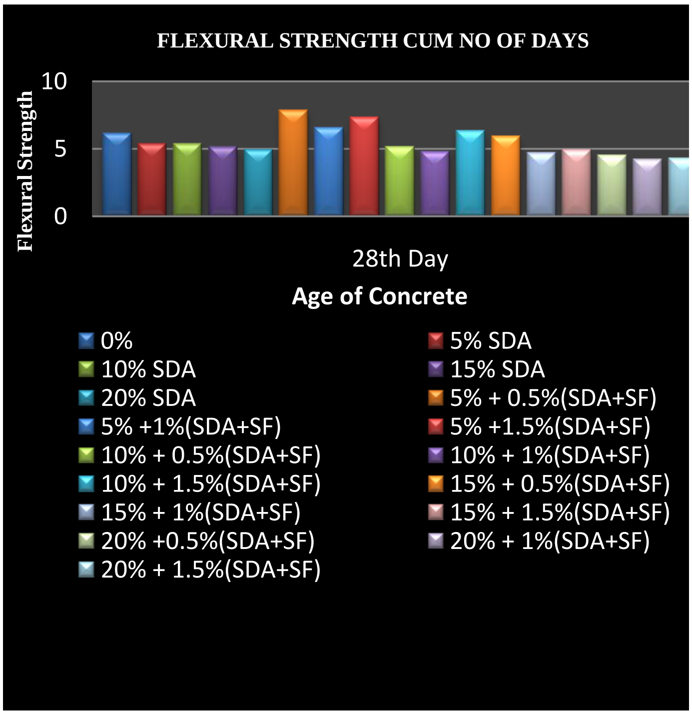

Figure-23: Variation of flexural strength at 28 days for various percent of SDA, SDA+SF and normal concrete.

ACKNOWLEDGEMENT

I would like express my sincere thanks my Guide Mrs. Sabita Dash and all those who have co-operated me with my work for which this paper has been completed.

REFERENCES

[1]. A.A. Raheem et al. (2002), Saw Dust Ash as Partial Replacement for Cement in Concrete", Organization, Technology and Management in Construction, An International Journal, 4(2).
[2]. Amit Rana (2013), "Some Studies on Steel Fibre Reinforced Concrete", International Journal of Emerging Technology and Advanced Engineering, Volume 3, Issue 1.
[3]. C.Marthong (2012), Sawdust Ash (SDA) as Partial Replacement of Cement", International Journal of Engineering Research and Applications, Vol. 2, Issue4, pp.1980-1985.
[4]. Cengiz Duran Atis, Okan Karahan (2009), Properties of Steel Fibre reinforced Fly Ash Concrete", Construction and Building Materials, Vol. 23, pp. 392-399.
[5]. Elinwa, A.U., Ejeh, S.P., & Mamuda, M.A. (2008), "Assessing of Fresh Concrete properties of Self-Compacting Concrete containing Saw Dust Ash", Construction and Building Materials Journal, 22: 1178 – 1182.
[6]. Elinwa, A.U., Abdulkadir, S. (2011), "Characterizing Saw Dust Ash for use as an Inhibitor for Reinforcement Corrosion", New Clues in Sciences, 1: 1-10.
[7]. Felix F. Udoeyo and Philibus U. Dashibil (2006), "Sawdust Ash as Concrete Material", Journal of Materials in Civil Engineering.
[8]. J.Parvesh (2014), "Concrete Added with Manufactured Sand, Coconut Shell, Steel and Sisal Fibres", International Journal of Latest Trends in Engineering and Technology, Vol. 3 Issue 3.
[9]. Kishor S. Sable, Madhuri K. Rathi (2012), "Effect of Different Type of Steel Fibre and Aspect Ratio on Mechanical Properties of Self-Compacted Concrete", International Journal of Engineering and Innovative Technology, Volume 2, Issue 1.
[10]. Khadake S.N., Konapure C.G. (2013), "An Experimental Study of Steel Fibre Reinforced Concrete with Fly Ash for M35 Grade", International Journal of Engineering Research and Applications, Vol. 3, Issue 1.
[11]. Layla Muhsan Hasan Bdeir (2012), "Study Some Mechanical Properties of Mortar with Sawdust as a Partially Replacement of Sand", Anbar Journal for Engineering Sciences, Vol.5, No.1.
[12]. L. O. Ettu1 et al. (2013), "Variation of Strength of OPC-Saw Dust Ash Cement Composites with Water-Cement Ratio", International Refereed Journal of Engineering and Science, 2319-1821 Volume 2, Issue 7 (July 2013), PP. 09-13.
[13]. M. Mageswari and B. Vidivelli (2009), "The Use of Sawdust Ash as Fine Aggregate Replacement in Concrete", Journal of Environmental Research & Development Vol. 3 No. 3.
[14]. Muntadher Ali Challoob, Vikas Srivastava (2013), "Effect of Fly Ash and Steel Fibre on Portland Pozzolana Cement Concrete", International Journal of Engineering Trends and Technology, Volume 5, Number 3.
[15]. Osman Gencel et al. (2011), "Workability and Mechanical Performance of Steel Fibre Reinforced Self-Compacting Concrete with Fly Ash", Composite Interfaces 18 (2011).
[16]. R. S. Deotale, S. H. Sathawane, A.R. Narde (2012), "Effect of Partial Replacement of Cement by Fly Ash, Rice Husk Ash with Using Steel Fibre in Concrete", International Journal of Scientific & Engineering Research, Volume 3, Issue 6.
[17]. Rajeev Chandak et al. (2014), "A Study of Strength of Steel Fiber Reinforced Concrete with Fly Ash", ISSN 2319 – 6009, Vol. 3, No. 1.
[18]. Saravana Raja Mohan. K, Parthiban. K (2011), "Strength and behaviour of Fly Ash based Steel Fibre Reinforced Concrete Composite", International Journal of Civil and Structural Eengineering, Volume 2, No 1.

Books
[19]. M.L.Gambhir, Concrete Technology.
[20]. A.M. Neville, J.J. Brooks, Concrete Technology (2010), Concrete Technology, 2nd ed. London: Pearson Education Ltd.

Codes
[21]. IS 456:2000, Plain and Reinforced Concrete Code of Practice.
[22]. IS 10262:1982, Recommended Guidelines for Concrete Mix Design.
[23]. IS 383:1970, Specification for Coarse and Fine Aggregates from Natural Sources for Concrete.
[24]. IS 8112:1989, 43 Grade Ordinary Portland Cement- Specification.
[25]. IS 2645-1975, Specification for Integral Cement Water Proofing Compounds.