Effect of Sawdust as a Partial Fine Aggregate Replacement on the Strength of Concrete

Yogendra Onkar Patil[1], Rakesh Amar More[2], Subhash Ramji Patil[3], Faizankhan Asgarkhan Pathan[4]
[1,2,3,4] *Asst.Professor, D.N.Patel College of Engineering*

***Abstract*—This research investigates the potential of utilizing sawdust as a waste material to partially replace sand, along with Alccofine 1203 as a supplementary cementitious material, to modify the properties of concrete. The study examines the impact of these modifications by substituting sand with sawdust by weight in concrete mixtures. Integrating sawdust into concrete not only provides a sustainable method for waste disposal but also helps in reducing the overall weight of the concrete. Alccofine 1203 is incorporated as a cement replacement in varying proportions of 0%, 4%, 8%, 12%, 16%, and 20%, while sawdust is used as a partial fine aggregate replacement at levels of 3%, 6%, 9%, and 12%. The mechanical properties of the modified concrete were evaluated through compressive and split tensile strength tests conducted at 7 and 28 days to assess the performance of different mix compositions.**

***Index Terms*—Alccofine (1203), compressive strength, sawdust, split tensile strength**

I. INTRODUCTION

Concrete is a composite material composed of coarse aggregate bonded together with a fluid cement that hardens over time. The most commonly used concrete types include those made with hydraulic cements or lime-based binders, such as Portland cement concrete. Advanced composite materials, including micro-fine concrete, have gained significance due to their enhanced workability and strength. Alccofine, a micro-fine admixture, is easy to integrate into cement and contributes to improved performance. Its ultrafine particles help achieve a smoother surface finish, and its optimized particle size distribution enhances both the fresh and hardened properties of concrete. In contrast, sawdust remains an underutilized material in the construction industry, primarily due to its limited availability compared to conventional aggregates like sand and gravel or a lack of awareness regarding its potential applications. However, there has been a growing push, especially in developing countries, to incorporate locally available resources to reduce construction costs. Sawdust, which consists of fine wood particles or chips generated as a byproduct of timber processing, presents an opportunity for sustainable material utilization in construction.

II. OBJECTIVES

a) To optimize the use of cement and Alccofine 1203 in concrete for maximum efficiency.
b) To effectively utilize fine aggregate and sawdust as partial replacements in concrete.
c) To evaluate the compressive and split tensile strength of the modified concrete.

III. MATERIALS

A. Cement
Properties of Cement are as follows
Table: Properties of Cement

Sr. No.	Property	Cement (53grade)
01	Specific Gravity	3.15
02	Fineness	9.8%

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B. Alccofine
Alccofine 1203 is a high-performance supplementary cementitious material that effectively replaces silica fume in concrete applications. It is derived from the byproducts of the iron ore industry, particularly utilizing materials rich in alumina and silica. These components are present in higher percentages in Alccofine 1203, enhancing its reactivity and ability to improve the performance of concrete. Its fine particle size and optimized chemical composition allow Alccofine 1203 to significantly reduce the water demand for a given workability, making it an

efficient material in achieving high strength and durability concrete.

One of the key benefits of Alccofine 1203 is its capacity to replace up to 70% of cement in concrete without compromising its mechanical properties. This makes it a sustainable and eco-friendly option for reducing cement consumption, which in turn lowers the carbon footprint of construction projects. Alccofine 1203 also contributes to the improved microstructure of concrete, resulting in enhanced resistance to chemical attacks, reduced permeability, and increased durability over time. Furthermore, its addition to concrete enhances early strength development and workability, making it ideal for both standard and high-strength concrete mixes.

This versatility makes Alccofine 1203 a valuable material in the construction industry, aligning with modern demands for high-performance, cost-effective, and environmentally responsible building materials.

C. Sawdust

Sawdust is composed of fine wood particles produced during the processing of wood, such as when logs are cut, shaved, or sanded. These particles vary in size, ranging from fine dust to larger, irregular chips or small wood fragments, depending on the method and machinery used. Sawdust can be generated using hand tools, portable power tools, or industrial woodworking machinery. It is commonly produced when wood logs are sawn into smaller pieces or when wood is shaped and smoothed in various woodworking processes. Sawdust is often considered a byproduct in the timber industry, but it has various potential uses, including as a material for composite boards, animal bedding, and fuel. Additionally, sawdust has gained attention for its environmental benefits when used as a partial replacement in concrete or other building materials, offering a sustainable solution to waste disposal and resource conservation.

IV. EXPERIMENTAL INVESTIGATIONS

A. Compressive strength results

The compressive strength tests were conducted using a compression testing machine on the cast and cured specimens. The results are presented in Tables 2 to 4

Table 2: Compressive strength of concrete with Alccofine (1203)

Sr. No.	Alccofine	Compressive strength results, N/mm2	
		7 days	28 days
1	0%	34.54	49.63
2	4%	40.43	59.11
3	8%	44.91	64.26
4	12%	46.29	68.28
5	16%	51.47	72.44
6	20%	47.43	68.65

Table 3: Compressive strength of concrete with Sawdust

Sr. No.	Sawdust	Compressive strength results, N/mm2	
		7 days	28 days
1	0%	34.54	49.63
2	3%	30.01	31.12
3	6%	24.13	34.86
4	9%	22.08	32.14
5	12%	15.52	23.74

Table 4: Compressive strength of concrete with Alccofine (1203) and Sawdust

Sr. No.	Alccofine Plus Sawdust	Compressive strength results, N/mm2	
		7 days	28 days
1	0%	34.54	49.63
2	16%AF+6%SD	45.99	65.06

B. Split tensile strength results

The split tensile strength tests were conducted using a compression testing machine on the cast and cured specimens. The results are presented in Tables 5 to 7.

Table 5: Split tensile strength of concrete with Alccofine (1203)

Sr. No.	Alccofine	Split Tensile strength results, N/mm2	
		7 days	28 days
1	0%	3.38	4.85
2	4%	3.97	5.84
3	8%	4.41	6.36
4	12%	4.77	6.82
5	16%	5.12	7.78
6	20%	4.23	6.17

Table 6: Split tensile strength of concrete with sawdust

Sr. No.	Sawdust	Split tensile strength results, N/mm2	
		7 days	28 days
1	0%	3.38	4.85
2	3%	3.10	3.96
3	6%	2.40	3.44
4	9%	2.15	3.18
5	12%	1.56	2.34

Table 7: Split tensile strength of concrete with Alccofine &Sawdust

Sr. No.	Alccofine Plus Sawdust	Split tensile strength results, N/mm2	
		7 days	28 days
1	0%	3.38	4.85
2	16%AF+6%SD	5.17	7.41

V. CONCLUSION

A) When 16% of Alccofine (1203) is used as a partial replacement for cement, the compressive strength of the concrete at 7 and 28 days is 51.47 and 72.44 N/mm², respectively.

B) With 16% partial replacement of cement by Alccofine, the split tensile strength of the concrete at 7 and 28 days reaches 5.12 and 7.78 N/mm², respectively.

C) Replacing 6% of fine aggregate with sawdust results in a compressive strength of 24.13 N/mm² at 7 days and 34.86 N/mm² at 28 days.

D) The split tensile strength of concrete with 6% sawdust replacing fine aggregate is 2.40 N/mm² at 7 days and 3.44 N/mm² at 28 days.

E) When 16% Alccofine and 6% sawdust are combined as replacements for cement and fine aggregate, the compressive strength at 7 and 28 days is 45.99 and 65.06 N/mm², respectively.

F) The split tensile strength of concrete with 16% Alccofine and 6% sawdust as partial replacements for cement and fine aggregate is 5.17 N/mm² at 7 days and 7.41 N/mm² at 28 days.

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