ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 5, Issue 6, June 2020

EFFECT OF SODIUM CHLORIDE SOLUTION ON THE STRENGTH OF CONCRETE CONTAINING SAWDUST AS ADMIXTURE

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Abstract:-- **The objective of this research is to explore the effect of sawdust as an admixture in concrete as well as that of sodium chloride solution as a curing medium of concrete. Most of the constructions in nearby sea areas utilize the sea water for curing concrete which contains a considerable amount of sodium chloride and also utilizing sawdust waste will be of great advantage due to the high rising cost of conventional building materials. The results show that the slump value of the concrete mix reduces as the amount of the sawdust (admixture) increases. also there is progressive loss of compressive strength of cubes cured in 5% sodium chloride having concentration of 50,000PPT with increase in sawdust content of 0%, 5%, 10% and 15% ranged 17.56 N/mm^2 to 16.22 N/mm^2 at 7days, 22.27N/mm^2 to 16.92 N/mm^2 at 14days, 22.77 N/mm^2 to 20.09 N/mm^2 at 21days and 24.34 N/mm^2 to 21.45 N/mm^2 at 28days respectively. The results show that Sodium Chloride has the properties of impurity reducing the strength of concrete and sawdust is not suitable to be used as admixture because it shows a progressive decrease in the compressive strength of concrete with a corresponding increase in its content.**

Index Terms:- Effect, Sodium Chloride, Concrete, Compressive Strength, sawdust, Admixture, workability.

INTRODUCTION

Utilizing waste products in concrete production will help in reducing the level of pollution and reserving some natural content of concrete as well as reducing all costs related to concrete production. This includes the use of sawdust as an admixture to upgrade the desired properties of concrete in both fresh or hardened form. The use of the sawdust as an admixture in concrete may enhance the economic standard of woodworkers by utilizing the waste material to generate assets and will also serve as a cheaper alternative to that of conventional admixtures, with a consequent reduction in the cost of construction and also as a means of addressing the environmental pollution caused by the accumulation of unmanageable waste. Sawdust (SD) is a waste material composed of fine particles of wood produced by timber industry. It is produced as timber is sown into planks at sawmills. This causes heaps of sawdust to be generated each day. The physical and chemical properties of sawdust vary significantly depending on several factors, especially the species of wood. Also, testing the concrete upon exposure of different conditions of weather, environment, acidic water is of utmost importance to find the effect of such conditions on concrete, therefore an optimized measure to these effects can be formulated.

II. PROBLEM STATEMENT

As there are major civil engineering constructions in riverine areas or close to the seas in some countries in the world which Nigeria is inclusive, in most cases water containing NaCl is used for mixing and as well in curing of concrete in civil engineering constructions. Hence there is a need to study and explore the experimental data and powerful statistical analyses regarding the effects of NaCl solution on compressive strength of concrete containing sawdust as additive.

III. AIM AND OBJECTIVES

1. Aim

This study aims to determine the effects of 5% Sodium chloride (NaCl) solution on the compressive strength of concrete containing sawdust as an admixture.

2. Objectives

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The following objectives will be adopted in the research;

a. To cast concrete cubes by replacing 0%, 5%, 10% and 15% of sawdust by weight of cement as an admixture
b. To determine the workability and compressive strength of concrete cubes at 7, 14, 21, and 28days.
c. To compare the above results with the control sample

IV. SCOPE AND LIMITATION

1. Scope

This analysis is based on knowing the effects of 5% sodium chloride (NaCl) solution having concentration of 50,000PPTon compressive strength of concrete containing a certain amount of sawdust used to replace the weight of cement as an admixture.

2. Limitation

The analysis work is limited to investigating the advantage or otherwise of sawdust as admixture, casting, curing for 28-days, testing and comparing the workability and compressive strength of the cured concrete with and without sodium chloride (NaCl) solution.

V. LITERATURE REVIEW

According to (ACI, 1999). Concrete is the most consumed artificial materials on the earth consists of coarse and fine aggregates and cement and sometimes with a certain amount of admixture. The aggregates occupy 60% to 75% of the concrete volume (70% to 85% by mass) which strongly influences the properties of freshly mixed and hardened concrete, mix proportions, and economy. (Kamran, 2013) view that from the last decade onward, the global concrete industry may require 8 to 12 billion metric tons of natural aggregates annually because over 2 billion tons of aggregates are consumed annually with about 40% of fine aggregates. According (Henry and Griffin, 1964) Presence of Sodium chloride in water use for mixing concrete increases the compressive strength of the concrete with less corrosion to the reinforced steel as well as the reduction in water vapour transmission. It has been known to be relatively being in on concrete compared to other salts (Cody et, al., 1996). But from the work of (Shi et al., 2011) containing NaCl indicates that NaCl causes substantial compressive strength loos in concrete.

Some industrial wastes have been studied for use as supplementary cementing materials such as steel slag, rice husk ash, eggshell ash marble slurry etc. but there is a scarcity of existing Literature on the use of sawdust as admixture however some of the researches related to it are as follows. According to (Sajjad et, al., 2017) a very little and inconclusive work has been done on the effect of the sawdust ash as partial replacement of cement on high-strength concrete durability, therefore there is need to have an advanced study to unveiled and affirmed such effects. The concrete samples were tested based on compressive strength, water absorption and density at different percentage replacement of cement with saw dust and only 10% is recommended to be used for the production of M25 concrete at 28days of curing (Mohammad, et, al., 2015). In research work of (Kamalakannan, et, al., 2019) they use both the sawdust ash and coir fiber to investigate their influence on the production of grade 20 concrete while the strength of concrete reinforced with Coire increase but there is a significant reduction of compressive with the increase of the sawdust. (Ugwu, 2019) made a full replacement with the sawdust in place of the fine aggregate in the production of lightweight aggregate in which resulted in a wider variation in reducing the strength with the control samples. Therefore, such replacement can be done only if partial replacement of some portion of fine aggregate is considered.

(Obilade, 2014) believed that Sawdust ash has less sustainability when it comes to compressive strength of concrete as they made up to 30% replacement but the values keep decreasing. he further stated that more work needs to be done to determine the actual effect of sawdust ash on concrete when cement was replaced with it. both workability and compressive strength of concrete decreases as the content of sawdust increases as partial replacement of cement but with a recommendation of 5% replacement at 90days as the optimal value to which can be adopted.

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Vol 5, Issue 6, June 2020

As opined by (Raheem, 2012).Also, (Dixson et, al., 2017) affirmed that only 5% of sawdust ash can be used as a replacement of fine aggregate in the production of lightweight concrete (M25) as an optimal value for the compressive and tensile strength of concrete.Also, From the work of (Tilak, 2018) to investigate the effect of sawdust as replacement of fine aggregate in concrete production using density and compressive strength, they found that both the properties decreased as the amount of the saw dust increases.But conversely, the research work made by (Muhammad, et, al., 2019) concluded that an improvement in both compressive and tensile strength was obtained up to 10% replacement with the mix ratio of 1: 1.52: 2.63 and design water-cement ratio of 0.56. only workability was reduced.

VI. MATERIALS

1. **Fine Aggregate:** The fine aggregate was obtained from Wudil river, it is very sharp river sand, free from clay and other form organic contents
2. **Coarse Aggregate**: The coarse aggregate was crushed rock of 20mm maximum aggregate sizes. Which was obtained from crushed rock industry
3. **Sodium Chloride**: The sodium chloride (NaCl) solution having concentration of 50,000PPT was obtained Sabon Gari market, Kano state, Nigeria.
4. **Water**: The water for mixing was sourced from a borehole within the Kano University of Science and Technology, Wudil, Kano, Nigeria. state which conformed to BS 3148 (1980) requirements.
5. **Cement**: Type 1 Ordinary Portland cement (i.e. a general-purpose Portland cement suitable for most uses) “Dangote Portland Cement” brand which conformed to BS 12 (1996) requirement was used.
6. **Saw Dust:** Thiswas also obtained from sawmills in Sabon Gari market in Kano state, Nigeria, it is containing both wastes of hardwoods and softwoods.

VII. RESEARCH METHODOLOGY

I. Concrete Mix Design

Mix design was carried out by weight. The amount of fine aggregate, coarse aggregate, water, cement and sawdust was calculated as shown in the table below.

TABLE 1: Quantities of Materials for 36 cubes

W/C ratio	Mass of cement kg	Mass of F.A kg	Mass of C.A kg	Mass of water kg
0.5	43.74	87.48	174.96	20.83

Sawdust was added to replace the mass of cement as an admixture in the proportion of 5%, 10% and 15% respectively, with 1:2:4 mix ratio from the mix designed above, the total mass of cement including 5% waste was calculated to be 43.74kg.

- ✓ 5% of 43.74 = 2.19kg
- ✓ 10% of 43.743 = 4.37kg
- ✓ 15% of 43.743 = 6.56kg

Total weight of saw dust required = 13.12kg.

Therefore, a total of 13.12kg of sawdust will be added to the concrete as an admixture. to replace the mass of cement of 13.12kg

2. Laboratory Tests

fine and coarse aggregate was subjected to preliminary tests (water absorption, sieve analysis and specific gravity). while After the mixed design the materials were subjected to the following tests: slump test and compressive strength test.

Specifically, For the compressive strength test. A Concrete cube with a dimension of 150mm X 150mm X 150m was used in this research work. A series of 36 concrete cubes were cast. The cubes divided into 4 groups 9 per each. A compressive strength was carried out at 7, 14, 21 and 28days of curing. Taking 9 cubes with 0% sawdust content, 9 cubes with 5% sawdust content, 9 cubes with 10% sawdust content and 9 cubes with 15% sawdust content all cured in water containing 5% of sodium chloride solutions having concentration of 50,000PPT by volume as curing medium, the result was compared with the control sample of zero % replacement.

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
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VIII. RESULTS AND DISCUSSIONS

1. Specific Gravity and Water Absorption Test

The specific gravity and water absorption of fine aggregate and coarse aggregate is as follows:

Table 2: Specific Gravity and Water Absorption of Fine and Coarse Aggregate

Aggregate	Specific Gravity, Gs	Water Absorption (%)
Fine Aggregate	2.68	3%
Coarse Aggregate	2.70	3.14%

It was found that the specific gravity of fine and coarse aggregates are 2.68 and 2.7 respectively, which lies in the general range of specific gravity of aggregates from 2.5 to 3.0. (IS 2386-3(1963 PART 3) Water absorption value from the test conducted for both fine aggregate and coarse aggregate was found to be 3.0% and 3.14% respectively.

2: Sieve Analysis of Fine Aggregates

Total Weight of Fine Aggregates Sieved = 1000g

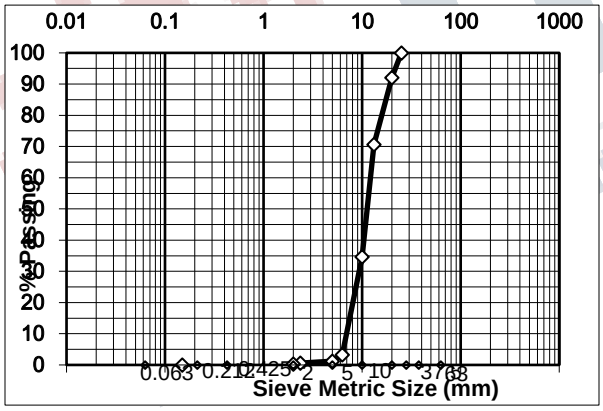

Figure 1: Sieve Analysis result of Fine Aggregates

The figure above is the particle size distribution curve of the fine aggregate sample. The curve indicates that the fine aggregate sample is well-graded containing a good representation of all particle sizes between maximum and minimum sizes

3. Sieve Analysis of Coarse Aggregates

Total weight of Coarse Aggregates sieved = 2000g

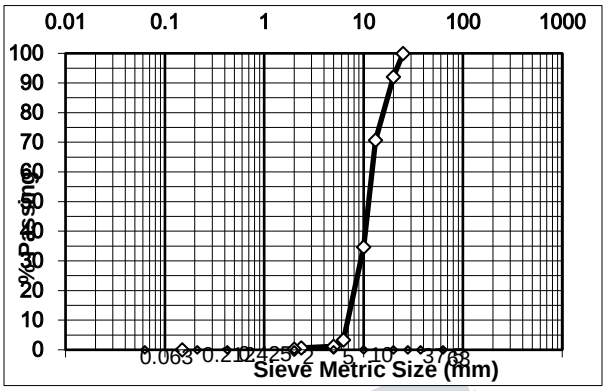

Figure2: Sieve Analysis result of CoarseAggregates

The figure above is the particle size distribution curve of the coarse aggregate sample. The curve depicts the various particle sizes present in the aggregates.

The results obtained in the sieve analysis test of fine aggregate and coarse aggregate indicated that the effective size was found to be 0.17mm and 7.09mm respectively. This effective size indicated that the maximum particle size of the smallest 10% of the soil sample. This value also indicated that 10 percent of the particles are finer and 90 percent of the particles are coarser than that particular particle size D10.

4. Slump Test Results

The results of the concrete slump tests were shown Table:4.7 in below;

Table 3.Workability Test Results

S/N	Amount of sawdust used (%)	Slump (mm)
1	0%	35
2	5%	25
3	10%	19
4	15%	11

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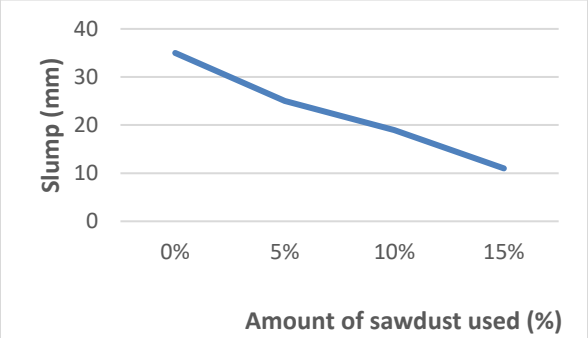

Figure 3: Workability Tests Results

The workability result presented in the figure above shows that the control mix has the highest slump values of 35mm. and reduces subsequently to the lowest value of percent 11mm at 15% replacement. Therefore, the workability of the concrete mix reduces as the amount of the sawdust (admixture) increases.

5: Compressive Strengths of Test Samples:

Table 2 shows the result of a combined compressive strength after 28days

Table 2: Mean Compressive strength test result

Age Days	**Control N/mm^2**	**5% SD N/mm^2**	**10% SD N/mm^2**	**15% SD N/mm^2**
7	17.56	17.41	17.07	16.22
14	22.27	18.96	17.45	16.92
21	22.77	20.43	21.48	20.09
28	24.34	22.15	21.84	21.45

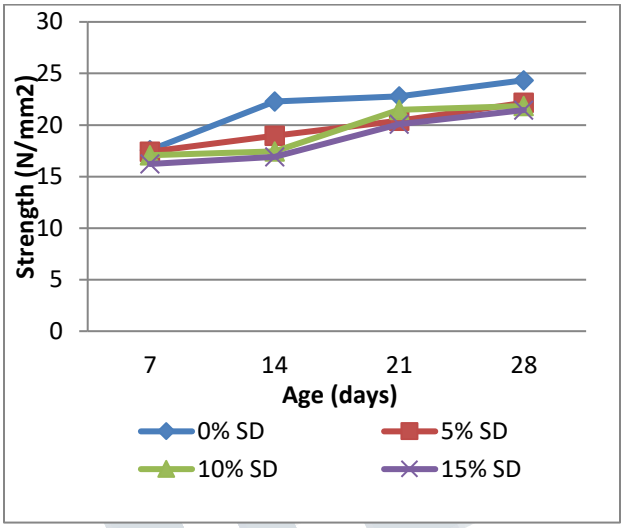

Figure 4: Mean Compressive strength test result

The results of the mean compressive strengths test were presented in the above figure at various curing ages of concrete Specimens with replacement of cement with saw-dust at different level of 5%, 10% and 15% were tested for compressive strength test which was performed at the ages of 7, 14, 21 and 28-days. It was observed that with the increase in the amount of sawdust as an admixture to the concrete, the compressive strength of concrete decreases in comparison with the control having 0% replacement. Therefore, both the addition of sawdust and the 5% of sodium chloride having concentration of 50,000PPT as curing medium contributed to the process of this decrease. Also, the longer the age of curing, theh igher the compressive strength.

IX. CONCLUSIONS

The main conclusions derived from the research work are;

1. Concrete cubes were cast with 0%SD content as control, 5%SD content, 10%SD content and with 15%SD content. The workability result indicated that the control mix has the highest workability values of 35mm. and a lowest value of 11mm at 15%replacement.
2. The result also shows that 5% of Sodium Chloride (NaCl) having concentration of 50,000PPT is deleterious to concrete and the rate of deterioration will depend on the amount of NaCl used. Therefore, lower percentages of it as a curing medium should be tried to access its impact to the concrete.
3. From the results, we can also conclude that the longer the age of curing, the higher the compressive strength. Also, the higher the amounts of sawdust present in the mix the lower the compressive strength.

ISSN (Online) 2456-1290

International Journal of Engineering Research in Mechanical and Civil Engineering (IJERMCE)
Vol 5, Issue 6, June 2020

X. Recommendations

In view of what has been observed in this research, the following recommendations were made:

1. A comparison of the effect of Sodium Chloride (NaCl) should be made on concrete samples with different mix ratios, lower percentages ranging of 0.5, 1, 2, 3, and 4% replacement of cement with the sawdust in the production of concrete should be made.
2. Different types of cement and varied sizes of aggregates should be employed to observe whether they are effective in the compressive strength of concrete adulterated with sawdust as admixtures.
3. It was also suggested that other parameters regarding the concrete strength such as tensile strength and modulus of elasticity should be checked.

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