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Effect of Sodium Chloride (NaCl) on Concrete Compressive Strength

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***Abstract*— In considering the effect of sodium chloride on the strength of concrete if added with the constituents of concrete during batching, a mix of 1:2:4 was used all through the test with sodium chloride as percentage to cement by weight from 0 to10. The zero percent of salt was used as the control, while fresh water sharp sand was used as fine aggregate and granite chippings as coarse aggregate.**

A total of sixteen cubes were cast for each percentage and their average compressive strengths at 7,14, 21 and 28 days were obtained. The average crushing strength for 7 days were 12.7 N/mm2 for 0%; 14.2 N/mm2 for 2%; 17.1 N/mm2 for 4%; 17.3 N/mm2 for 6%; 13.8 N/mm2 for 8% and 9.1 N/mm2 for 10%. While for 28 days 15.3 N/mm2 for 0%; 18.4 N/mm2 for 2%; 20.7 N/mm2 for 4%; 19.0 N/mm2 for 6%; 17.6 N/mm2 for 8% and 15.7 N/mm2 for 10%. The results show that common salt has the properties of additive when mixed with concrete constituents.

Keywords*— *Effect, Sodium Chloride, Concrete, Compressive Strehgth.

I. INTRODUCTION

The question of this paper is; what happens to concrete if sodium chloride (NaCL) is batched together with concrete constituents? Helmenstine

[1]noted sodium chloride damages concrete while Robertson [2] said sodium chloride accelerates the pigments in the surface of wet concrete immediately after placing. In his research work between 1993 and2005, Carter [3] observed that sodium chloride causes lots more damage to concrete, while Lee, Bonacci and Thomas [4] say that sodium chloride contaminates concrete. The aim of this paper is, if all these research findings were true, then what happens to concrete when some Nigerian Labourers carelessly/erroneously when batching and mixing, pour salt into the concrete directly or indirectly by pouring the water that had earlier been used in rinsing their hands after eating into the concrete constituents. The set up of this paper is as follows: Will the salt turn to be impurity to reduce the strength of the concrete or will it be an additive to improve on the strength of concrete? What will happen to the strength of concrete if the salt is varied in percentages of 2, 4, 6, 8 and 10 by weight of cement in the concrete, considering the zero percentage as the control, and which of these will be best allowed in concrete?

II. METHODOLOGY

A. Materials

To be of good quality, concrete must be free of impurities which may be from water, aggregates (fine/coarse) or from any other source (man error in handling concrete since impurity in concrete affects the strength of concrete)[5]. In this paper, Ordinary Portland Cement was used as the binder, fresh water sharp sand (which was free from salt) was used as fine, while quarry granite chips was used as coarse aggregates.

The water used for mixing the constituents was drinkable water free from organic matters and other impurities that may lead to weakness in concrete strength. Sodium Chloride was however introduced as a strange material in the concrete in proportion of the cement used as 0, 2, 4, 6, 8 and 10 percentages by weight. The mix ratio of cement: sand: gravel was 1: 2: 4.

B. Equipment/Apparatus

Concrete mixing machine was used to achieve a thorough mix of the constituents. Other equipment/apparatus used are weighing machine, cube moulds (150mm), tamping rod, compression testing machine (2000 KN control crushing machine), head pan, shovel, buckets and clean water storage tank for curing the concrete.

C. Casting and Curing

After a thorough mix of the constituents with the different percentages of salt, the wet concrete was cast into the moulds, filled in two layers and properly tamped with 25 blows of tamping rod on each layer thereby simulating the behavior of concrete on structure [6]. When the mould is full, the top was leveled with a trowel and the concrete allowed to settle well in the mould. About three hours after the initial setting, theconcrete cubes were properly identified by marking. They were stored to retain dampness and removed twenty-four hours after casting and submerged in the curing tank of clean water maintained at room temperature until they were removed for testing [6, 7].. A total of ninety-six cubes were prepared for test. Sixteen cubes each of the percentage of salt were cast.

D. Crushing

After the degree of compaction is simulated to that of concrete in structure as discussed above, the specimens were weighed and crushed in the laboratory with a loading rate of 120 KN/min on 2000KN control machine. Four cubes of each

percentage were crushed each testing day of 7, 14, 21 and 28 days and the average strength were as shown in Tables 1 and 2.

III. RESULTS AND DISCUSSION

Tables 1 and 2 are results of two different test carried out at different occasions to ascertain possible errors during mixing, placing and compaction of different percentages of salt.

The results show that concrete with sodium chloride in both Tables 1 and 2 have the behavior of concrete with additive in line with the findings of Cerra at aland Amodu[5, 8], this, the sodium chloride exhibit according to Tables 1 and 2 when used in plain concrete. From this research work, it was observed that if sodium chloride is mixed directly with wet concrete, it will exhibit a characteristic different from used on hardened concrete or during deicing processes in concrete.

TABLE 1:RESULT OF AVERAGE CRUSHING STRENGTH OF VARIOUS PERCENTAGES OF COMMON SALT (SODIUM CHLORIDE) IN CONCRETE (CONDITION ONE)

CRUSHING STRENGTH								
PERCENTAGES OF SALT IN CONCRETE	7 DAYS		14 DAYS		21 DAYS		28 DAYS	
	Av. Wt. of cube (Kg)	Av. Conc. Strength (N/mm^2)	Av. Wt. of cube (Kg)	Av. Conc. Strength (N/mm^2)	Av. Wt. of cube (Kg)	Av. Conc. Strength (N/mm^2)	Av. Wt. of cube (Kg)	Av. Conc. Strength (N/mm^2)
0	7.60	12.00	7.65	12.40	7.70	13.30	7.80	14.40
2	7.70	14.40	7.85	15.00	7.90	16.50	7.90	17.40
4	7.85	17.00	7.90	17.60	7.95	20.40	8.50	21.00
6	7.85	17.60	7.90	17.80	7.95	17.90	8.60	18.70
8	7.90	13.90	7.95	15.30	8.00	16.70	8.65	17.50
10	7.92	7.30	7.97	9.70	8.50	12.60	8.75	15.00

TABLE 2: RESULT OF AVERAGE CRUSHING STRENGTH OF VARIOUS PERCENTAGES OF COMMON SALT (SODIUM CHLORIDE) IN CONCRETE (CONDITION TWO)

CRUSHING STRENGTH								
PERCENTAGES OF SALT IN CONCRETE	7 DAYS		14 DAYS		21 DAYS		28 DAYS	
	Av. Wt. of cube (Kg)	Av. Conc. Strength (N/mm^2)	Av. Wt. of cube (Kg)	Av. Conc. Strength (N/mm^2)	Av. Wt. of cube (Kg)	Av. Conc. Strength (N/mm^2)	Av. Wt. of cube (Kg)	Av. Conc. Strength (N/mm^2)
0	8.30	13.30	8.35	14.00	8.45	14.60	8.50	16.10
2	8.35	14.00	8.40	15.20	8.50	18.00	8.55	19.30
4	8.40	17.20	8.45	18.40	8.50	19.40	8.55	20.40
6	8.45	17.10	8.50	17.50	8.55	18.63	8.65	19.30
8	8.50	13.80	8.53	15.30	8.56	16.90	8.70	17.70
10	8.53	10.90	8.55	13.30	8.60	14.10	8.75	16.40

TABLE 3: RESULT OF AVERAGE CRUSHING STRENGTH OF ZERO PERCENTWITH VARIOUS PERCENTAGES OF COMMON SALT (SODIUM CHLORIDE) IN CONCRETE COMPARED WITH THE ZERO PERCENT (CONDITION ONE)

CRUSHING STRENGTH								
PERCENTAGES OF SALT IN CONCRETE	7 DAYS		14 DAYS		21 DAYS		28 DAYS	
	Av. Wt. of cube (Kg)	Av. Conc. Strength (N/mm^2)	Av. Wt. of cube (Kg)	Av. Conc. Strength (N/mm^2)	Av. Wt. of cube (Kg)	Av. Conc. Strength (N/mm^2)	Av. Wt. of cube (Kg)	Av. Conc. Strength (N/mm^2)
0	7.60	12.00	7.65	12.40	7.70	13.30	7.80	14.40
(0+2)/2		13.20		13.70		14.90		15.90
(0+4)/2		14.50		15.00		16.90		17.70
(0+6)/2		14.80		15.10		15.60		16.60
(0+8)/2		13.00		13.90		15.00		16.00
(0+10)/2		9.70		11.10		13.00		14.70

TABLE 4: RESULT OF AVERAGE CRUSHING STRENGTH OF ZERO PERCENT WITH VARIOUS PERCENTAGES OF COMMON SALT (SODIUM CHLORIDE) IN CONCRETE COMPARED WITH THE ZERO PERCENT(CONDITION TWO)

CRUSHING STRENGTH								
PERCENTAGES OF SALT IN CONCRETE	7 DAYS		14 DAYS		21 DAYS		28 DAYS	
	Av. Wt. of cube (Kg)	Av. Conc. Strength (N/mm^2)	Av. Wt. of cube (Kg)	Av. Conc. Strength (N/mm^2)	Av. Wt. of cube (Kg)	Av. Conc. Strength (N/mm^2)	Av. Wt. of cube (Kg)	Av. Conc. Strength (N/mm^2)
0	8.30	13.30	8.35	14.00	8.45	14.60	8.50	16.10
(0+2)/2		13.70		14.60		16.30		17.70
(0+4)/2		15.30		16.20		17.00		18.30
(0+6)/2		15.20		15.80		16.60		17.70
(0+8)/2		13.60		14.70		15.80		16.90
(0+10)/2		12.10		13.70		14.40		16.30

IV. CONCLUSION

From the result, sodium chloride could be used as additive in plain concrete work at between 2 and 6 percentages if there is need to improve/increase the compressive strength of concrete.

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