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EFFECTS OF HARDWATER ON CEMENT AND CONCRETE PROPERTIES

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Abstract—
Presence of either temporary hardness or permanent hardness to the water is becoming almost inevitable in both surface and ground water. The water used in construction purpose, more so in the preparation of concrete knowingly or unknowingly is containing hardness. It is therefore necessary for researchers to study the effect of hardness on cement and concrete properties. In this work synthetic temporary hardwater at different proportions is prepared by dissolving $NaHCO_3$ is distilled water and such water is used to prepare concreate. It is observed that both cement and concrete properties are affected by temporary hardness. Normal consistency, initial and final setting times are increased in the presence of $NaHCO_3$ in water. Also, elasticity properties are affected by presence of temporary hardness in water.

Keywords— Effects, Concrete, Sodium Bicarbonate, Compressive Strength, Split Tensile Strength

I. INTRODUCTION

Various standards say that water of potable quality is to be used in the preparation of concrete. However due to shortage of water and ground water table containing minerals that impart hardness is forcing the construction industry to use water having hardness for its concreting purpose. Bicarbonates of sodium and calcium imparts temporary hardness and presence of chloride, sulphates and iron in water causes permanent hardness to the water. Now days it is rather difficult to get either surface or ground water that is free from hardness. Hence it is imperative to investigate and understand the likely changes in the both cement and concrete. In current endeavour the authors have resorted to prepare a hardwater by dissolving sodium bicarbonate in distilled water at different proportions and such water is used to study the properties of cement and concrete.

II. LITERATURE REVIEW

Many researchers as studied on the Sodium Bicarbonate (NaHCO3) effects on concrete properties. In many cases some authors also investigate this effects, important aspect is focused on evaluating the NaHCO3 concentrations in water. In this connection is mentioned some of the prominent research works that gives some significant insight into the NaHCO3 percentages.

V. Venkateswara Reddy (2005): In present study, the effect of strong alkaline substance is sodium bicarbonate (NaHCO3) on setting time and strengths. Comparison of results increases the NaHCO3 concentrations it decreases the compressive strength and split tensile strength.

I. V. Ramana Reddy (1996): Effect of alkalinity on strength, setting properties of cement and concrete.

III. MATERIALS & METHODOLOGY

3.1 Materials

The details of various materials used for the concrete in this work such as cement, fine aggregate and coarse aggregate along with their properties are as follows:
Cement: The cement used is Ordinary Portland cement (OPC) have the Grade as 53. The properties of cement are shown in Table 3.1 below:

Table 3.1: Properties of Cement

Property	**Result**
Normal consistency	30 %
Fineness of cement	4 %
Soundness of cement	2 mm
Specific gravity of cement	3.13
Initial setting time	30 min
Final setting time	270 min

Fine Aggregate: Is a granular material it containing soil more than 85 percent and it consisting natural sand or crushed stone with particle size is smaller than the 5 mm (materials passing through 4.75 mm IS sieve) with a specific gravity 2.64.
Coarse Aggregate: It consisting combination of gravels or crushed stone with particle size is larger than the 5 mm (usually between 10 mm and 40 mm) with specific gravity 2.91.
Water: It is an important ingredient for all sources, in these schematic conditions is an essential for life. In constructions water is needed to chemically react with cement and provide workability with the concrete it has Specific gravity of water is 1.
Sodium Bicarbonate: Sodium Bicarbonate is also known as baking soda it represents chemical formula (NaHCO3). It appears white crystalline solid is a fine powder, it is odourless, its density is 2.20 g/cm3 and it decomposes to melting point starts from 50 c. Where, sodium bicarbonate raise the pH level it should not be used to adjust the ph. The effect of soda is caused by thermal decomposition.

3.2 Methodology

A variety of tests can be conducted to characterize the engineering properties of cement and concrete. The properties include normal consistence, initial & final setting time, strength, compressive and tensile strength, and flexural strength. The present tests procedure can focus on evaluating the variations on strength properties with addition of sodium bicarbonate (NaHco3) at different percentages (0%, 1%, 2%, 3%, 4% and 5%). Where the tests are according to Indian Standards IS: 456 including the experiments are normal consistency, initial setting time & final setting time and compressive strength as per (IS 4031: 1988), In this experiment, specimens are casting is M20 grade mix design is used. The influence of sodium chloride at different concentrations was studied when the NaHco3 is spiked with drinking water, test samples were compared with the control samples. This comparison may in case of control samples made with locally available potable water.

This water was used for preparation of test samples for determining the Compressive strength, Split Tensile Strength and flexural strength of Concrete is also used for curing samples. For each batch of concrete mix has 3 cubes(150mm x150mm x 150mm) and 3 cylinders (150mm x 300 mm) are cast to calculate the compressive strength, split tensile strength and flexural strength respectively. Specimens are remoulded after 24 hours then they allowed chemical curing. The curing tank consists in water, which is used for mixing the concrete. The specimens are cured for 7 days and 28 days strength, where the cubes removed from the curing tank after they required period for allowed to dry at under shade.

IV. RESULTS & DISCUSSION

The effect of NaHco3 on consistence, initial and finial setting time results obtained in this investigation is based guidelines as per IS 456: (2009). The comparison of specimens if difference is less than 30 minutes it is negligible and the difference is greater than 30 minutes is considered by significant. Average compressive strength and split tensile strength is find to prepare at least 3 specimens prepared for comparison, here the strengths is obtained less than 10% is un sufficient for experiment and greater than 10% strength gains is considered to significant. Finally, the experimentation work in observed that where the sodium chloride concentration exceeded, the acceleration of initial and final setting time of cement and the compressive strength, split tensile strength is increases compared to NaHCO3 increased.

4.1 Cement properties:

Normal consistency Test results without and with NaHCO3 on M53 Grade cement as shown in below table 4.1.1:

Table 4.1.1 Normal consistency test results (without and with NaHCO3)

NORMAL CONSISTENCY (%) Vs NaHCO3 (%)	
$NaHCO_3$ (%)	Normal Consistency (%)
0	29
1	30
2	31
3	33
4	32
5	34
6	35

Initial Final setting times Test results for without and with NaHCO3 on M53 grade cement as shown below table 4.1.2:

Table 4.1.2 Initial & Final setting time test results (without and with NaHCO3)

INITIAL & FINAL SETTING TIME (Min) Vs NaHCO3 (%)		
$NaHCO_3$ (%)	**Initial Setting Time (min)**	**Final Setting Time (min)**
0	122	292
1	129	308
2	132	314
3	138	326
4	143	339
5	153	347
6	159	354

Compressive strength of cement test results (without and with NaHCO3) as shown below table 4.1.2:

Table 4.1.2 compressive strength of cement (without and with NaHCO3)

COMPRESSIVE STRENGTH (Mpa) Vs NaHCO3 (%)	
NaHCO3	**Compressive Strength of Cement (Mpa)**
0	52.43
2	50.69
4	49.69
6	48.62

4.2 Concrete properties:

Compressive strength of concrete test results for 7 & 28 days without and with NaHCO3 on M20 grade concrete as shown below table 4.2.1:

Table 4.2.1 compressive strength of concrete 7 & 28 days (without and with NaHCO3)

COMPRESSIVE STRENGTH (Mpa) Vs NaHCO3 (%)		
NaHCO3 (%)	**7 Days Compressive Strength of Concrete (Mpa)**	**28 Days Compressive Strength of Concrete (Mpa)**
0	13.20	22.56
1	13.01	22.22
2	12.87	21.87
3	12.71	21.57
4	12.52	21.16
5	12.19	20.74

Split tensile strength of concrete test results for 28 days without and with NaHCO3 on M20 grade concrete as shown below table 4.2.2:

Table 4.2.2 split tensile strength of concrete (without and with NaHCO3)

SPLI TENSILE STRENGTH (Mpa) Vs NaHCO3 (%)	
NaHCO3 (%)	**Spilt Tensile Strength (Mpa)**
0	3.23
1	3.10
2	3.08
3	3.03
4	2.92
5	2.91

Graphs: The graph plotted between normal consistency Vs NaHCO3 (%)

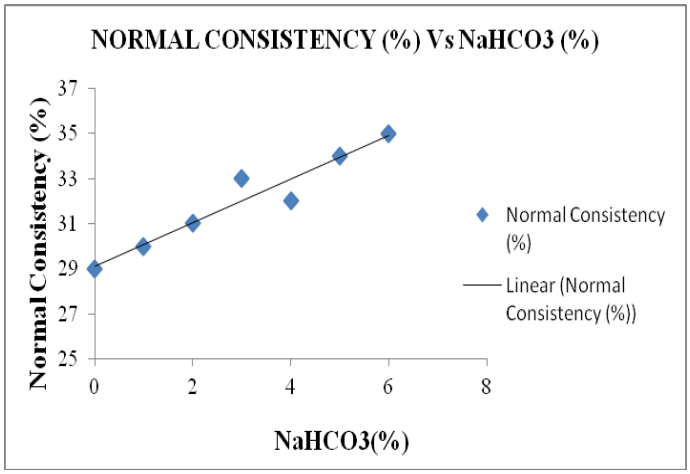

Fig. 1. Normal consistency vs NaHCO3

The graph plotted between Initial & Final setting time (min) Vs NaHCO3 (%)

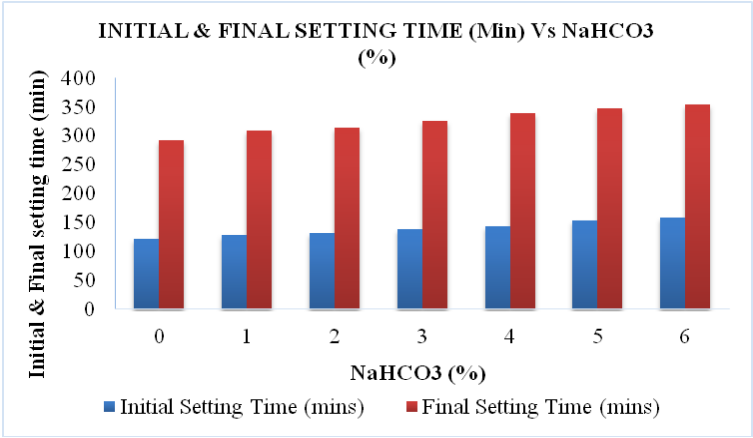

Fig.2. Initial setting & Final setting Vs NaHCO3

The graph plotted between compressive strength of cement Vs NaHCO3 (%)

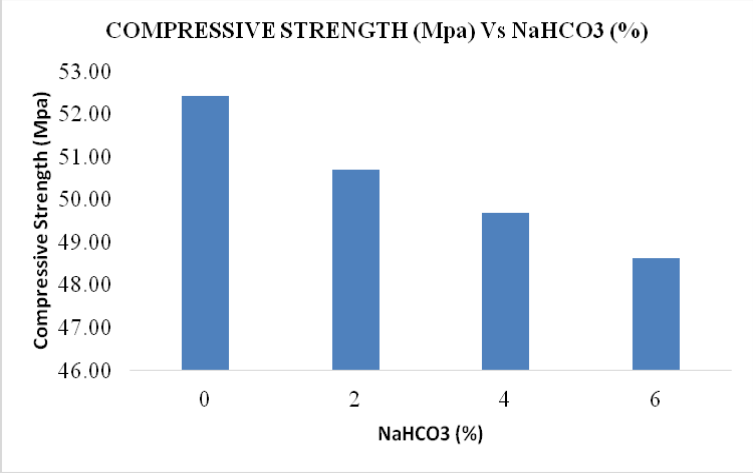

Fig. 3. Compressive strength Vs NaHCO3

The graph drawn between compressive strength of concrete Vs NaHCO3 (%)

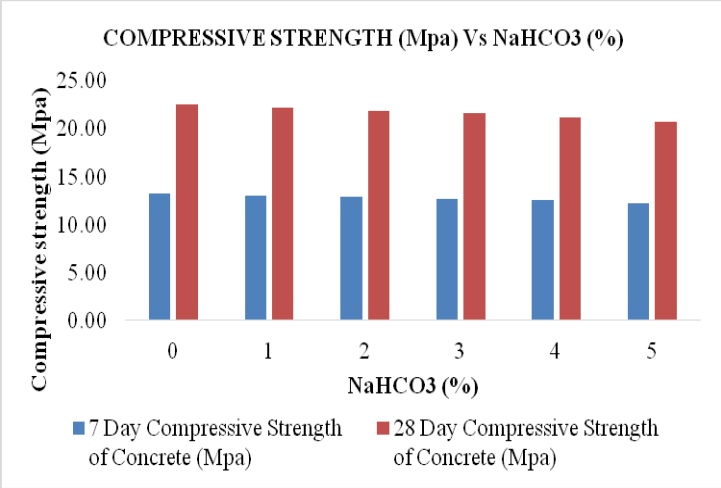

Fig.4. Compressive strength Vs NaHCO3

The graph plotted between split tensile strength of concrete Vs NaHCO3 (%)

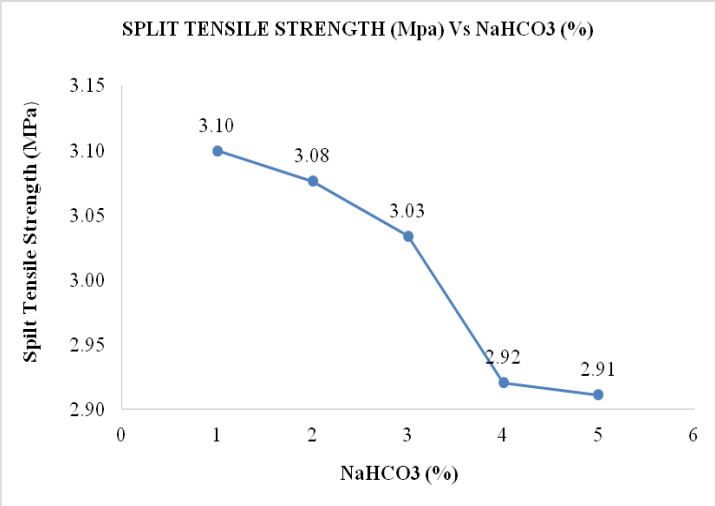

Fig.5. Split tensile strength Vs NaHCO3

V. CONCLUSION:

From the results of current study following conclusions can be drawn:

1. With the increase in the percentage of sodium bicarbonate in water the normal consistency value, initial and final setting time are increased.
2. Increased percentage of sodium bicarbonate decreases the compressive strength of cement.
3. Presence of sodium bicarbonate decreases the compressive and split tensile strength of concrete.

VI. REFERENCES:

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