International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 05 | May -2017 www.irjet.net p-ISSN: 2395-0072

"EFFECT OF SALT WATER ON COMPRESSIVE STRENGTH OF CONCRETE"

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Abstract – *In this research work, the effect of salt water and fresh water on the compressive strength of concrete is investigated. For this, the concrete cubes were casted for a mix design of M-40, 1:1.30:2.63 by weight and 0.50 water-cement ratio was considered. The salt of various proportions like (25, 30, 35, 40, 45) grams/ litre of water was mixed and cured with fresh water. Some of the cubes were casted and cured with fresh water and other cubes were casted and cured using sea water. The concrete cubes were cured for 3 and 7 days. The average compressive strength results obtained for 3 and 7 days using fresh water are 24.96 – 27.88 N/mm² and for sea water are 22.43 – 27.31 N/mm². The results obtained for various salt contents which were used for casting shows that there is increase in the compressive strength of concrete for low levels of salt content and there is decrease in compressive strength for high levels of salt content.*

Key Words: Concrete cubes, Fresh water, Salt water, Salt content, Compressive strength.

1. INTRODUCTION

Concrete is considered as one of the best material for construction all over the world. It is difficult to find out other alternate material for construction other than concrete from durability and economic point of view. [1]About 80 percent of the surface of the earth are covered by oceans; therefore, a large number of structures are exposed to sea water with high salinity either directly, or indirectly when winds carries sea water spray up to a few miles inland from the coast. The quantity of the water plays an important role in the preparation of concrete. Impurities in water may interfere the setting of the cement and it may adversely affect the strength properties of concrete. Sea water is the water from sea or ocean. Strength of concrete depends on the quality of water.

Concrete has an excellent structural performance and durability, but is affected by early deterioration when subjected to a marine environment[7]. The most common cause of deterioration is corrosion of the steel reinforcement, with subsequent sapling of concrete. Therefore the selection of materials, mix design, and proper detailing of reinforcement are essential parameters in producing a durable marine structure concrete. The durability of concrete is generally regarded as its ability to resist the effects and influences of the environment, while performing its desired function.

1.1 MARINE STRUCTURES

The successful performance of a marine structure depends to a great extend on its durability against the aggressive marine environment. Disintegration of concretes in marine environments is mostly caused by chemical deterioration such as sulfate attack, chloride attack and leaching. Physical deterioration from crystallization of soluble hydrated salts in pores of the concrete, erosion and abrasion promotes further disintegration. The overall results of these attacks on concrete are softening, cracking and partial removal of cover concrete. This in turn exposes a fresh surface for further attack [2]. Coastal and offshore sea structures are exposed to the simultaneous action of a number of physical and chemical deterioration processes, which provide an excellent opportunity of understand the complexity of concrete durability problems in practice. The need to use sea water for construction arises in such situations where no other source of fresh water is available or costly to transport. Although the existing literature and codes of practice reveal the effect of mixing and curing of sea water on durability of concrete, it still remains an area requiring further study and research for the use of structural concrete in marine environment.

1.2 SEA WATER

Sea water has a total salinity of about 3.5% (78% of the dissolved solids being NaCl and 15% $MgCl_2$ and $MgSO_4$)[3], and produces a slightly higher early strength but a lower long-term strength. Sea water (SW) is a complex solution of many salts containing living matter, suspended silt, dissolved gases and decaying organic material. The primary chemical constituents of seawater are the ions of chloride, sodium, magnesium, calcium and potassium. Sea water can be said to have a solution containing a great number of elements in different proportions. Water containing large quantities of chlorides (sea water) tends to cause persistent dampness and surface efflorescence. Such water should, therefore not be used where appearance is important, or where a plaster-finish is to be applied. The pH value of seawater varies between 7.4 and 8.4. Corrosion of the reinforcing steel occurs below a pH of 11. Therefore, in cases where concrete is subjected to a highly severe environment, then the cement must supply alkalinity.

2.MATERIALS AND METHODOLOGY

2.1 MATERIALS

The details of various materials used in the experimental investigation are as follows:-

(a) Coarse Aggregate- Crushed angular stone aggregate of maximum size 20mm confirming to Table- 2 of IS 383-1970 was used. The specific gravity was found to be 2.68 and water absorption was found to be 0.99%.

(b) Sand (fine aggregate) -The fine aggregate used in this investigation was manufactured sand which is conforming to Zone-II of Table 4 of IS 383-1970[4]. The specific gravity was found to be 2.45 and water absorption was found to be 6%.

(c) Cement-: OPC 53 grade (Birla A1 cement) was used. The specific gravity was found to be 3.15.

(d) Water - Ordinary clean portable water free from suspended particles and chemical substances from laboratory was used for both mixing and curing of concrete cubes casted with fresh water. Some cubes were casted and cured using sea water.

(e) Salt water:- On average, seawater in the world's oceans has a salinity of about 3.5% (35 g/L). This means that every kilogram (roughly one litre by volume) of seawater has approximately 35 grams of dissolved salts (predominantly sodium (Na^+) and chloride (Cl^-) ions). The cubes were prepared using (25, 30, 35, 40, 45)gm of salts in one litre of water.

2.2 METHODOLOGY

Experimental system- To investigate the effect of salt water and fresh water on the compressive strength of concrete, concrete cubes were made, in which some of concrete cubes were casted and cured with fresh water and remaining concrete cubes were casted and cured with sea water. The amount of salt (NaCl) used in water was (25, 30, 35, 40, 45) grams/litre.

The concrete cube size measuring 150×150×150 mm in dimension were used. The batching of the concrete was carried out by weight. The mix design was calculated by referring the code book [5] [6] .The Cement, Fine aggregate and Coarse aggregate was added to the pan / paddle mixer and mixed. Various contents of salts like 25gm/l, 30gm/l, 35gm/l, 40gm/l and 45gm/l was mixed with fresh water and then added to the mixer. Some of the cubes were mixed using sea water. Then the required amount of water was added to the pan / paddle mixer and mixed well. Concrete was properly placed beneath and along the sides of the mould with the help of trowel and the concrete cube moulds were filled to one third of their height and compacted 25 times. The concrete cubes were demoulded after 24 hours of casting, and were cured in fresh water. Some of them were cured in sea water. The cubes were cured for 3 and 7 days respectively.

2.3 COMPRESSIVE STRENGTH

The test specimens for the determination of compressive strength of concrete were prepared using the standard metallic cube moulds adopting the procedure for the rodding and hard compactions. The concrete cubes moulds were lubricated with oil before the mixed concrete was placed inside it, in order to reduce friction between the concrete and the cubes.

The cubes are demoulded after 24 hour of casting, and cured in water having similar quality as used in the preparation of mix. The concrete cubes were cured for 3 and 7 days respectively. For each of the hydration period, cubes were tested and the average compressive strength recorded. The concrete cubes were tested in compression testing machine and the result were reported.

3. TEST RESULTS

After casting and demoulding, the cubes casted and cured in sea water had a darker surface than the normal concrete cubes, which were cured in fresh water. The concrete cubes were tested in "Compression Testing Machine" which has a capacity 3000 kN. The results are as follows-

Table-1: Compressive Strength of cubes for 3 days.

Cube Size	Content of Salt	Avg. Wt	Avg. Load	Avg. Comp. Strength
150*150*150	0 gm/l (F W)	8.13	561.67	24.96
150*150*150	25 gm/l	8.22	569.87	25.32
150*150*150	30 gm/l	8.00	564.60	25.08
150*150*150	35 gm/l	8.10	541.43	24.06
150*150*150	40 gm/l	8.13	529.67	23.54
150*150*150	45 gm/l	8.27	498.33	22.15
150*150*150	S W	8.31	504.80	22.43

Table-2: Compressive Strength of cubes for 7 days.

Cube Size	Content of Salt	Avg. Wt	Avg. Load	Avg. Comp. Strength
150*150*150	0 gm/l (F W)	8.25	627.33	27.88
150*150*150	25 gm/l	7.80	696.33	30.95
150*150*150	30 gm/l	8.13	698.33	31.03
150*150*150	35 gm/l	8.25	676.13	30.05
150*150*150	40 gm/l	8.14	671.67	29.84
150*150*150	45 gm/l	8.00	661.17	29.39
150*150*150	S W	8.14	614.63	27.31

*SW= Sea Water and FW= Fresh Water

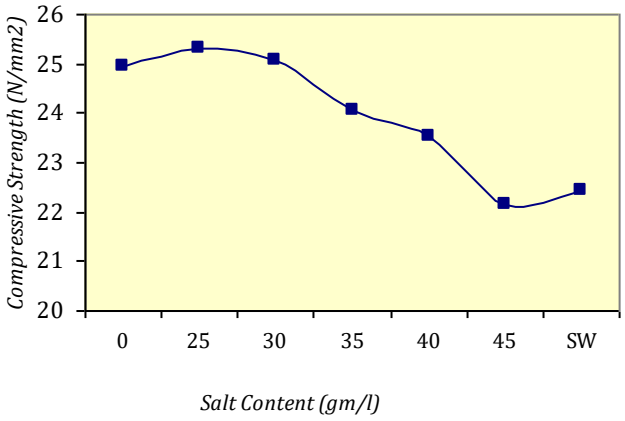

Fig - 1: Showing Average Compressive Strength of cubes at 3 Days Curing.

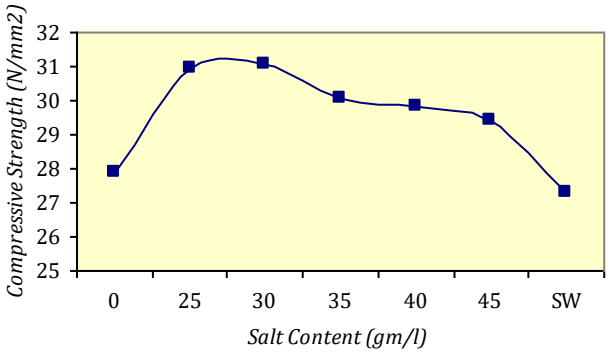

Fig - 2: Showing Average Compressive Strength of cubes at 7 Days Curing.

4. DISCUSSION

From the results it is clear that, there was an marginal increase in the of concrete cubes which were casted and cured with fresh water as compared with the concrete cubes casted and cured with sea water. The rate of the strength gain in fresh water cubes is slow as compared with the salt water cubes. Although, the compressive strength of the concrete cubes which were casted using various salt contents shows slightly higher values than the cubes casted with fresh water. The surfaces of cubes casted and cured using sea water are darker in color as compared to other cubes.

Fig- 3 and Fig- 4 shows concrete cubes immersed in fresh water and sea water respectively.

Fig: 3

Fig: 4

5. CONCLUSION

Series of experiments were conducted on M-40 grade (1:1.30:2.63) concrete. Cubes were casted and cured in fresh water and in sea water as per the relevant IS code of practice. The cubes were tested at different ages i.e. 3 and 7 days. Based on the result following conclusion can be drawn:-

1) The strength of concrete cubes casted and cured in fresh water at 3 and 7 days was found to be 24.96 N/mm^2 and 27.88 N /mm^2 respectively.

2) The strength of concrete cubes casted and cured in sea water at 3 and 7 days was found to be 22.43 N/mm^2, and 27.31 N/mm^2 respectively.

3) The strength of concrete cubes casted using 25 gm/l and cured in fresh water at 3 and 7 days was found to be 25.32 N/mm^2, and 30.95 N/mm^2 respectively.

4) The strength of concrete cubes casted using 30 gm/l and cured in fresh water at 3 and 7 days was found to be 25.08 N/mm^2, and 31.03 N/mm^2 respectively.

5) The strength of concrete cubes casted using 35 gm/l and cured in fresh water at 3 and 7 days was found to be 24.06 N/mm^2, and 30.05 N/mm^2 respectively.

6) The strength of concrete cubes casted using 40 gm/l and cured in fresh water at 3 and 7 days was found to be 23.54 N/mm^2, and 29.84 N/mm^2 respectively. And for 45 gm/l it was found to be 22.15 N/mm^2 and 29.39 N/mm^2 for 3 and 7 days respectively.

There is increase in strength of cubes casted using salt water and cured using fresh water as compared to those casted and cured in fresh water and sea water.

From the above research, we can conclude that if the water contains less amount of salts, then there is no reduction in strength. Hence, this water can be used for casting. If reinforcement is needed to be provided, then the structures should be provided with large cover to protect it from corrosion.

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