

Effect of Salt Water on Compressive Strength, Flexural Strength & Durability of Concrete

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Abstract – In this research, the effect of salt water on the compressive strength, flexural strength & durability of concrete was investigated. This paper therefore presents the result and findings of an experimental research on the effect of salt water on compressive strength, flexural strength & durability of concrete. For this concrete cubes & beams were cast with fresh water and salt water for a design mix of M-30 1:1.84:3.39 by weight of concrete, and 0.45 water- cement ratio. Half of concrete cubes and beams were cast and cured with fresh water and remaining half cubes were cast and cured with salt water. The concrete cubes were cured for 7, 14 and 28 days respectively. The result of the average compressive strength, flexural strength of concrete obtained using fresh water ranges from 27.20 - 39.80 N/mm² and 4.64-5.37 MPa and using salt water ranges from 28.65 – 41.6 N/mm² and 4.73-5.49 MPa. Salt water concrete is less durable than portable water concrete

Index Terms – Salt Water, Fresh Water, Compressive Strength, Flexural Strength, Durability, Concrete Cubes & Beams.

1. INTRODUCTION

Concrete is the mostly used construction material all over the world. It is very difficult to find out alternate material for construction which is as suitable as that of such material from durability and economic, strength point of view. The quantity and quality of the water plays an important role in the preparation of concrete. Impurities present in water may affect the setting of the cement and may adversely affect the strength properties. The chemicals present in water may participate in the chemical reactions and thus affect the setting, hardening and strength development of mixture.

In IS: 456(2000) code stipulates the water quality standards for mixing and curing. In some areas, local drinking water is impure and excessive amount of salt water is present due to contamination by industrial wastes. When chloride does not exceed 500 ppm, or SO₃ does not exceed 1000 PPM, the water is harmless, So it is most important to examine whether the salt water can be used for making concrete.

2. MATERIALS

Following are the materials used which are:

Cement : Cement is a main element of concrete as it acts as a binding material, binds aggregates together. Cement is almost used in all construction works that involve use of concrete. Some cement based structure works like building work, railway sleepers, road work, tunnels and other weighty structure.

Coarse aggregates: Crushed broken stone angular in shape was used as coarse aggregates. Two fraction of coarse aggregates were used, 20mm size having specific gravity of 2.78, and 10mm size having specific gravity of 2.76. Fineness modulus was found to be 7.25 for 20mm size and 6.68 for 10mm size of aggregates

Sand (fine aggregates): Sand used in concrete was originally specified as roughly angular but rounded grains are now preferred. The fine aggregates use in this examination was Narmada river sand passing through 4.75 mm sieve with specific gravity of 2.64. The grading zone of fine aggregates was zone II as per Indian standard specification.

Water: Ordinary tap water clean, portable free from suspended particles and chemical substances was used for both mixing and curing of concrete

Salt water: Seawater is water from a sea or ocean. On average, seawater in the world's oceans has a salinity of about 3.5% (35 g/L, or 599 mm). This means that every kilogram (roughly one litre by volume) of seawater has around 35 grams of dissolved salts (predominantly sodium (Na⁺) and chloride (Cl⁻) ions). Salt water produced by dissolving 35 gm/l of NaCl in plain water was also used for mixing and curing of concrete and mortar cubes.

3. EXPERIMENTAL INVESTIGATIONS

To Find out the effect of salt water on compressive strength, flexural strength, durability of a concrete made with salt water and compare the result with concrete made with portable water

A. COMPRESSIVE STRENGTH

The test specimens for the determination of compressive strength of concrete were prepared using the standard metallic cube moulds adopting is 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 7, 14 and 28 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.



Fig1 Testing of cube in UTM machine

B. Flexural Strength

In this investigation, M30 mix concrete is considered to perform in order to find out the flexural strength of concrete made with salt water and portable water at 7,14,28days of curing. For Flexural strength test 18 beams were casted of size 700 x 150 x 150mm for 7,14,28 days for M30 grade. The ingredients of concrete were thoroughly mixed till uniform consistency was achieved.



Fig 2 Testing of beam specimen under three point loading in UTM machine

C. DURABILITY

The carbonation depth is assessed by using a solution of phenolphthalein indicator of 1% and ethyl alcohol of 70 %. Carbonation of concrete is caused due to the carbon-dioxide in atmosphere. The indicator solution is sprayed on freshly exposed surface of the concrete. The color of concrete is turned to pinkish color after sprayed.

4. RESULTS AND DISCUSSIONS

Table no.1: Compressive Strength result of fresh water concrete.

Cube Size (mm)	Age of cube (days)	Average Test loads (tonnes)	Average compressive strength
150X150X150	7	61	27.20
150X150X150	14	72	32.1
150X150X150	28	88	39.80

Table no 2:Compressive Strength result of salt water concrete

Cube Size (mm)	Age of cube (days)	Average Test loads (tonnes)	Average compressive Strength
150X150X150	7	64	28.65
150X150X150	14	78	34.1
150X150X150	28	93	41.6

Table no.3:Flexural Strength of fresh water

beam Size (mm)	Age of cube (days)	Average Test loads (tonnes)	Average Flexural Strength
700X150X150	7	11	4.64
700X150X150	14	12	4.79
700X150X150	28	14	5.37

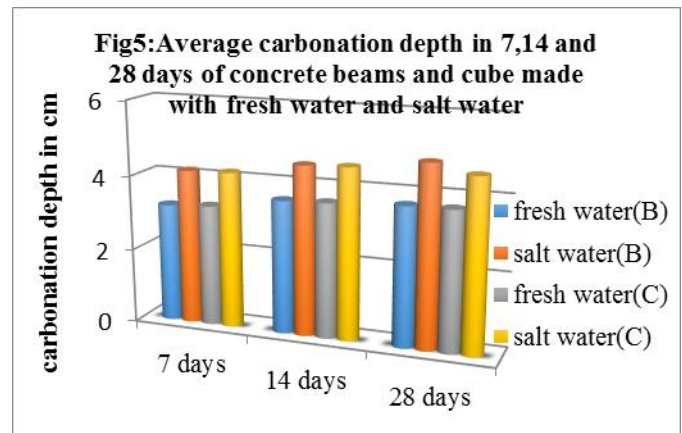
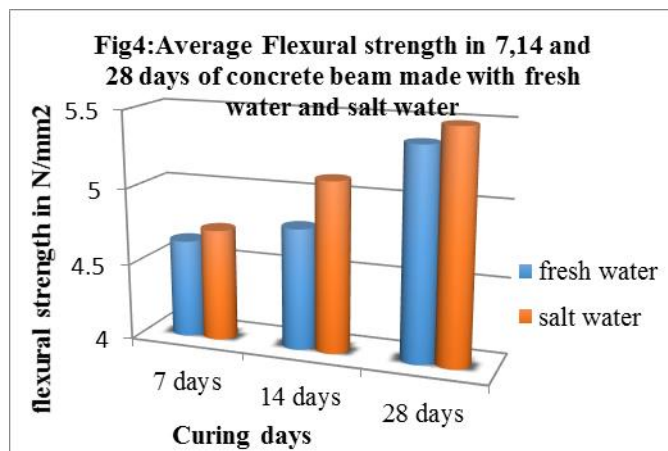
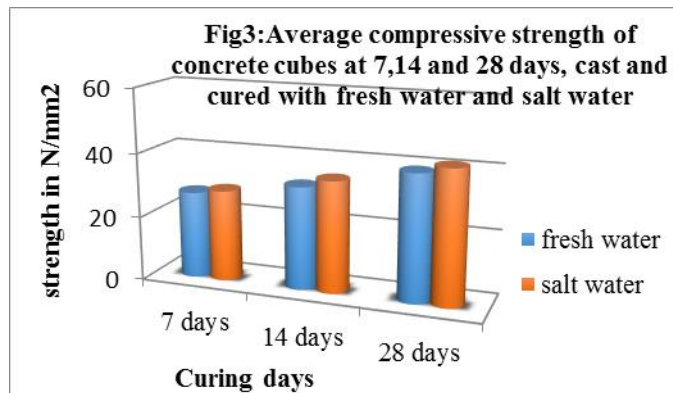
Table no.4:Flexural Strength of salt water

Beam Size (mm)	Age of cube (days)	Average Test loads (tonnes)	Average Flexural Strength
700X150X150	7	12	4.73

700X150X150	14	13	5.11
700X150X150	28	15	5.49

Table no.5:Durability of fresh water and salt water of concrete beam and concrete cubes

cube Size (mm)	Beam Size (mm)	Age of cube (days)	Average Carbonation depth of			
			Beams		cubes	
			F. w	S. W	F. W	S. W
150X150X150	700X150X150	7	3.18	4.15	3.24	4.18
150X150X150	700X150X150	14	3.56	4.52	3.6cm	4.5cm
150X150X150	700X150X150	21	3.7	4.82	3.7cm	4.82cm



5. CONCLUSION

Series of experiments were conducted on M-30 grade (1:1.84:3.39) concrete. Cubes and beams were cast and cured in fresh water and in salt water as per the relevant IS code of practice. The cubes and beams were tested at different ages i.e. 7,14 and 28 days. Based on the result following conclusion can be drawn:-

1. The compressive strength of concrete cubes cast and cured in fresh water at 7,14 and 28 days was found as 27.20N/mm², 32.1N/mm² and 39.8N /mm² respectively.
2. The compressive strength of concrete cubes cast and cured in salt water at 7,14 and 28 days was found as 28.65N/mm², 34.5N/mm² and 41.6N /mm² respectively.
3. The flexural strength of concrete cubes cast and cured in fresh water at 7, 14 and 28 days was found as 4.64N/mm², 4.79N/mm² and 5.37N /mm² respectively.
4. The flexural strength of concrete cubes cast and cured in salt water at 7,14 and 28 days was found as 4.73N/mm², 5.11N/mm² and 5.49N /mm² respectively.
- 5.The average carbonation depth of concrete cube and beams cast and cured with portable water at 7,14,28days are 3.24cm,3.6cm, 3.71cm and 3.18cm,3.56cm,3.7cm Respectively
6. The average carbonation depth of concrete cube and beams cast and cured with salt water at 7,14,28days are 4.18cm,4.56cm, 4.58cm and 4.15cm,4.52cm,4.82cm Respectively
7. There is marginal increase in the compressive strength and flexural strength of concrete cube and beam cast and cured in salt water as compared to those of cast and cured in fresh water at all ages of curing.
8. Durability of concrete cast and cured with salt water is lesser than concrete cast and cured with portable water.

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