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Effect of Salt Water on Compressive Strength, Flexural Strength and Durability of a Concrete

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Abstract - *In this thesis the study of compressive strength , flexural strength and durability of concrete and cement mortar cast and cured with Potable water, cast and cured with salt water is carried out. The present study is carried out in 2 phases .In first phase concrete cubes, concrete beam and mortar cubes cast and cured with Potable water for M30 grade and 1:3 cement mortar . In second phase concrete cubes, concrete beam and mortar cubes cast and cured with salt water M30 grade and 1:3 cement mortar*

For calculation purpose M-30 grade of concrete has been designed on basis of IS code 10262-2009 , by casting and curing of concrete using salt water in severe condition in grade M-30 of concrete. The mix design ratio for M-30 grade is - ***.45:1:1.84:3.39*** *(Cement = 363.16 kg/cu.m Water = 186.264 kg /cu.m, Fine aggregates (sand) = 669.683 kg /cu.m, Coarse aggregates = 1230.677 kg /cu.m) in which Water cement ratio = 0.45 similarly cement mortar (1:3) cubes were also prepared.*

For Compressive strength test of concrete 18 cubes were casted of size 150mm x 150mm x 150mm for 7, 14, and 28days. For flexural strength test 18 beams were casted of size 150mm x 150mm x 700mm for 7, 14, and 28 days. For Compressive strength test of cement mortar 18 cubes were casted of size 70.5mm x 70.5mm x 70.5mm for 3, 7, and 28days cubes of mortar. To find out the durability of concrete, carbonation depth test is also performed. The test for compressive strength flexural strength and durability has been done and results are shown in graph. Graphs are plotted between flexural strength, compressive strength and durability. The result obtained from this research has shown that compressive strength, flexural strength increases with the use of salt water and durability of concrete decreases.

Key Words: Compressive strength, Flexural strength, Durability, salt water, Potable water.

1. INTRODUCTION

This Cement concrete and mortar are the most widely used man made construction materials. It is difficult to find out another material of construction which is as versatile as concrete. The versatility of concrete is due to the fact that from the common ingredients, namely cement, aggregates, water and admixtures (sometimes), it is possible to achieve the properties of concrete so as to meet the demand of any particular situation.

Water is an significant element of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked very carefully. Compared to other ingredients the quality of water usually receives less attention. Since the strength of concrete is affected by the quality of water, therefore it is necessary to go in to the purity and quality of water.

Potable water is generally considered satisfactory for making concrete. This does not appear to be a true statement for all condition. Some waters containing a small amount of sugar would be suitable for drinking but not for making concrete. As per IS 456:2000 water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete and steel. The permissible limit of chloride (as C) is specified as 2000 mg/l for concrete not containing embedded steel and 500 mg/l for reinforced concrete work.

1.1 SALT WATER

Water is one of the important ingredients in making concrete. It was estimated that world's fresh water bodies is only 2.5 percent and balance constitutes sea water. UN predicted 5billion people will be in short of drinking water. Day by day the water levels are in depleting trend due to its abnormal usage and other environmental effects.

A popular yard-stick to the suitability of water for mixing of concrete is that if water is fit for drinking it is fit for making concrete. Due to storage of water, it is warranted to explore various alternative means to Potable water in the construction industry. Lot of marine infrastructure is going to establish along the coast, where sea water is available at least cost. The structures built in marine environment are directly in contact with sea water. Sea water, as its abundant availability along the coastal regions may be adopted for construction both for mixing and curing of concrete as a replacement to Potable water.

According to IS 456:2000, mixing or curing of concrete with sea water is not recommended because of presence of harmful salts. Under inevitable situation sea water may be used for mixing or curing in plain concrete with no embedded steel after having given due consideration

to possible disadvantages and precautions including use of appropriate cement system.

It is also stated that water found satisfactory for mixing is also suitable for curing. However water used for curing should not make any offensive stain or unsightly deposit on the concrete surface.

Coastal and offshore sea structures are exposed to the immediate action of a number of physical and chemical weakening processes. Oceans make up 80 percent of the surface of the earth, therefore, a large number of structures are exposed to seawater either directly or indirectly as winds can carry seawater send out up to a few miles local from the coast. Most sea waters are reasonably uniform in chemical composition, which is characterized by the attendance of about 3.5% soluble salts by weight.

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 tape 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. METHODOLOGY

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 CONCLUSIONS

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

Cube Size (mm)	Age of cube (days)	Average Test loads (tonnes)	Average compressive stength
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

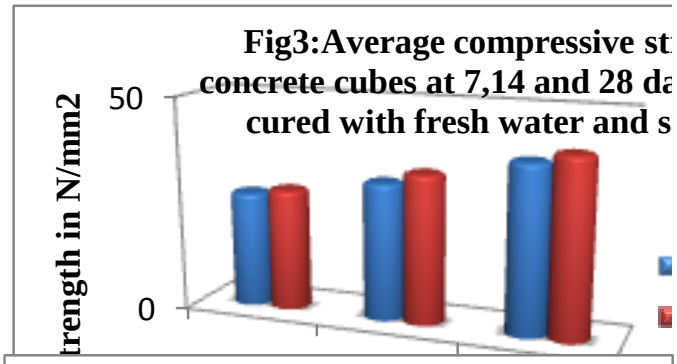
beam Size (mm)	Age of cube (days)	Average Test loads (tonnes)	Average Flexural Strength
700X150X150	7	11	4.64
700X150X150	14	12	4.79
700X150X150	28	14	5.37

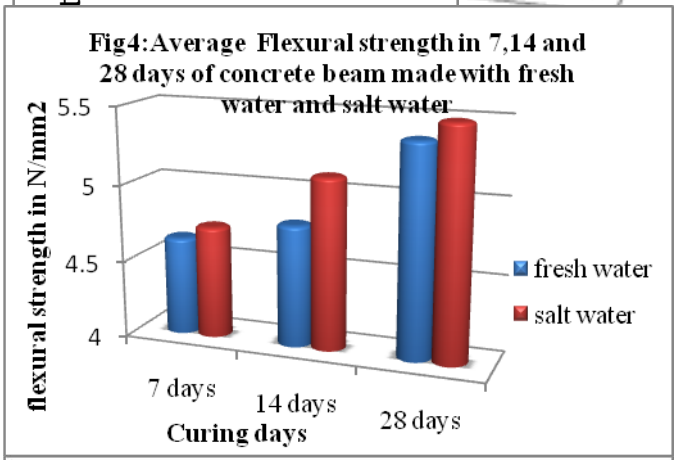
Table no.4: Flexural Strength of salt water

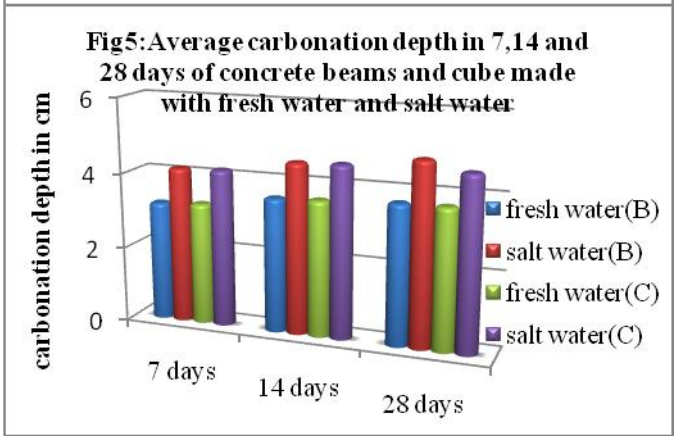
Beam Size (mm)	Age of cube (days)	Average Test loads (tonnes)	Average Flexural Strength
700X150X150	7	12	4.73
700X150X150	14	13	5.11
700X150X150	28	15	5.49

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
150X150 X150	700X150 X150	7	3.18	4.15	3.24	4.18
150X150 X150	700X150 X150	14	3.56	4.52	3.6	4.5
150X150 X150	700X150 X150	21	3.7	4.82	3.7	4.5







5. CONCLUSIONS

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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