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Research Paper

PERFORMANCE BASED STUDY ON EFFECT OF SEA WATER FOR MIXING, CURING & PLACING OF 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.

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.

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.

Using seawater for mixing and curing concrete increases early-age strength (up to 7–14 days) due to accelerated hydration, but often reduces later-age strength and durability over 28–90+ days while risking severe steel reinforcement corrosion. Standard construction codes generally restrict or prohibit seawater in reinforced structural concrete unless specific durability measures and non-corrosive reinforcement are used.

2. LITERATURE REVIEW

O. O. Akinkurolere (1) et.al in 2007 suggested that The compressive strength of concrete is shown to be increased by the presence of salt or ocean salt in the mixing & curing water. the rate of strength gain is also affected when the concrete is cast & cured with salt water & vice versa. Mixing concrete with salt water increases the compressive strength rapidly & the strength was still increasing at 28 days.

Preeti Tiwari (6) et.al In 2014 suggested that there was an marginal increase in the of concrete cubes which were casted and cured with salt water as compared with the concrete cubes cast and cured with fresh water. The rate of the strength gain in fresh water cubes is slow as compared with the salt water cubes. At 28 days, the rate of strength gain is still increasing in all the concrete cubes. The fresh water cubes also recorded its maximum strength at 28 days. Although, the compressive strength of the salt water concrete cubes was slightly higher than that of the fresh water concrete cubes.

P. Krishnam Raju(8) et.al In 2014 suggested that there is no quantitative reduction in compressive strength compared to target strength when the concrete is exposed to both "potable water mixing and sea water curing" and "mixing and curing by sea water". There is an increase in 7 days Split tensile strength of concrete for "Potable water mixing and sea water curing" in M30 and M35

Olutoge, F. Adeyemi (11) et.al In 2014 suggested that It was observed that concrete cast and cured with seawater increases gradually for all curing days beyond the strength of control cast (FF). The compressive strength of concrete batches FF agrees with the value of the compressive strength of 1:2:4 mix at 28days, of about 20N/mm2.The strength of concrete batches cast with salt water and cured with fresh water (SF) was also observed to have increased even at 28 days and 90days respectively.

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.



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



Sr.No. Weight of Cement

SampleWeight Cement Sample

Retained on 90µm Sieve Fineness of Cement

1	100 gm	4.65	4.65 %
2	100 gm	8.25	8.25 %
3	100 gm	7.95	7.95 %
		Average	6.95 %

Table No.1: Properties of Cement

Sr. No	Characteristics	Standard Values	Obtained Values
1	Fineness (%)	< 10	5.2
2	Standard Consistency (%)		28
3	Initial Setting Time(minutes)	Not less than 30 minutes	35
4	Final Setting Time(minutes	Not more than 600 minutes	560

COURSE AGGREGATE

Locally available coarse aggregates having the maximum size of 20 mm aggregate. Testing of coarse aggregate was done as per IS: 383-1970.

Table No.2: Properties of Coarse aggregate

Sr. No.	**Characteristic**	**Values**
1	Specific Gravity	3.2
2	Total Water	1.2

	Absorption (%)	
3	Total Crushing Value Test (%)	35
4	Grading Zone	II

Shape of the aggregate



SLUMP TEST – IS 1199



Destructive Testing of hardened concrete





- Concrete is strong in compression – Compressive Strength – as per IS 516 – 150 mm x 150 mm x 150 mm or 100 mm x 100 mm x 100 mm



- Compressive strength as per ACI – Cylinder of 150 mm dia & 300 mm height.
- Tensile strength – Indirect method – (1) Split tensile strength or (2) Modulus of rupture

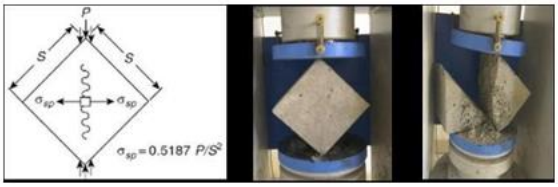




Split Tensile Strength

CYLINDER 150 mm DIA & 300 mm HEIGHT





2.4.2. MIX DESIGN

The various quantities of mix design for M30 grade of concrete are carried out by mix design as per IS 10262: 2009

- Volume of concrete = 1cum.
- Water Cement ratio =0.40
- Quantity of Cement = 369.675Kg.
- Quantity of Water = 147.87 Liter
- Quantity of fine aggregate =774 Kg.
- Quantity of coarse aggregate=1493 Kg.
- Quantity of admixture =1.84Kg. C: FA: CA= 1:2.093:4.038



2.5.EXPERIMENTAL PROCEDURE

To investigate the effect of salt water and fresh water on concrete specimen will determine, the concrete cubes, beams a were made, in which cubes, beams and cylinders were cast and cured with fresh water as well as also with salt water.

The concrete cube size measuring 150×150×150 mm, concrete beam size 700mm x 150mm x 150mm, in dimension will be used. The concrete cubes were cast and cu ys and will be tested ngth, flexural strengt



2.5.1 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

2.6. TEST RESULT

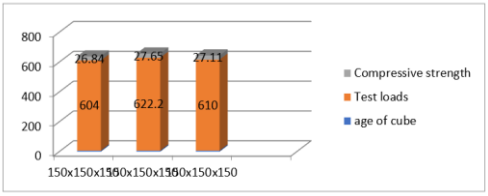
The test was carried out confirming to IS 516-1959 to obtain compressive strength, Flexural strength, and Split tensile strength of concrete at the age of 7, 28 days. The cubes using Compressive Testing Machine, Beams and cylinder were tested using Universal Testing Machine. The result of compressive strength, split tensile strength and flexural strength are tabulated in Table-4, 5, 6

2.6.1 Compressive Test

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

Cube test for 7 days

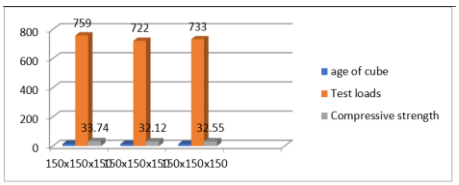
	Age of cube (days)	Test loads (KN)	compressive Strength
150X150X150	7	604	26.84
150X150X150	7	622.2	27.65
150X150X150	7	610	27.11



The average test results for 7 days cube strength is 27.20kn/m^2

Cube strength fot 14 days

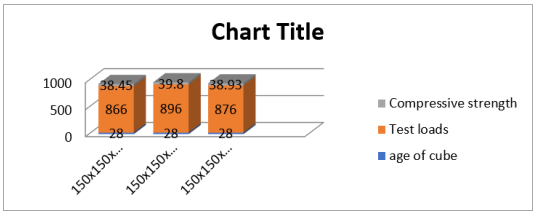
Cube Size (mm)	Age ofcube (days)	Test loads (KN)	compressive Strength
150X150X150	14	759	33.74
150X150X150	14	722	32.12
150X150X150	14	733	32.55



The average test results for 14 days cube strength is 32.8 kn/m^2

Cube strength for 28 days

Cube Size (mm)	Age	Test loads (KN)	compressive Strength
150X150X150	28	866	38.45
150X150X150	28	896	39.80
150X150X150	28	876	38.93



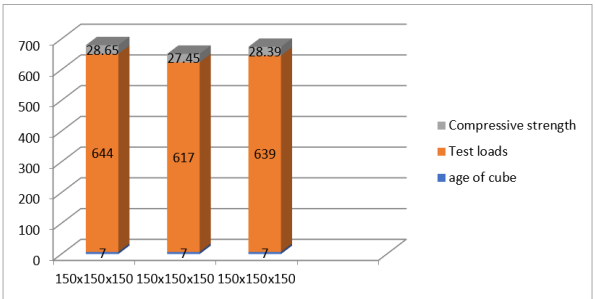
The average test results for 28 days cube strength is 39.06 kn/m^2

Table no 2:Compressive Strength result of salt water concrete

Test results for 7 days

Cube Size (mm)	Age	Test loads (KN)	compressive Strength

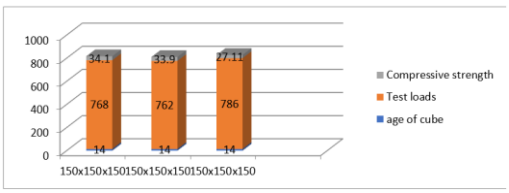
150X150X150	7	644	28.65
150X150X150	7	617	27.45
150X150X150	7	639	28.39



The average test results for 7 days cube strength is 28.16 kn/m^2

Test results for 14 days

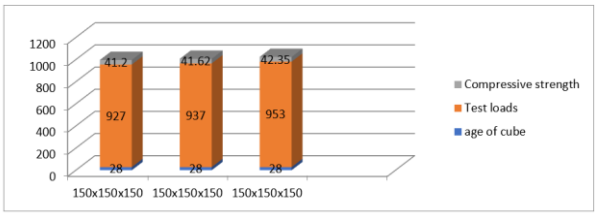
Cube Size (mm)	Age	Test loads (KN)	compressive Strength
150X150X150	14	768	34.1
150X150X150	14	762	33.90
150X150X150	14	786	34.92



The average test results for 14 days cube strength is 34.33 kn/m^2

Test results for 28 days

Cube Size (mm)	Age	Test loads (KN)	compressive Strength
150X150X150	28	927	41.20
150X150X150	28	937	41.62
150X150X150	28	953	42.35



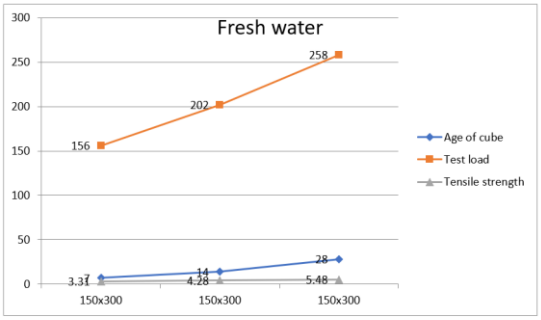
The average test results for 28 days cube strength is 41.71 kn/m^2

SPLIT TENSILE STRENGTH TEST

Split tensile strength of fresh water

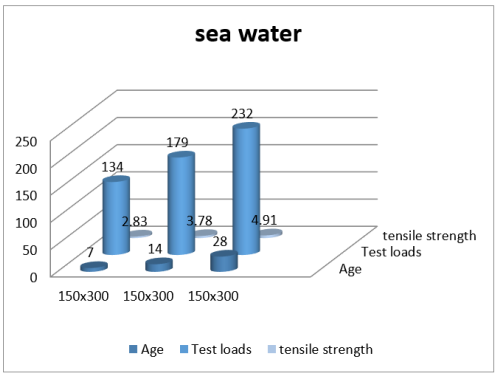
cylinder size	Age of cube	Test loads (KN)	tensile stength

	(days)		
150X300	7	156	3.31
150X300	14	202	4.28
150X300	28	258	5.48



Split tensile strength for sea water

cylinder size	Age of cube (days)	Test loads (KN)	tensile stength
150X300	7	134	2.83
150X300	14	179	3.78
150X300	28	232	4.91



CONCLUSION

Based on this study, the following conclusions may be drawn:

- Concretes mixed and cured in seawater have higher compressive, tensile, than concretes mixed and cured in fresh water in the early ages at 7 and 14 days. The strengths after 28 days for concrete mixes mixed and cured in fresh water increase in a gradual manner.
- Cement content in concrete mixes has a great effect on concrete strengths and durability. Higher cement content produces strength five times higher, especially for low water–cement ratios.
- Strengths are also affected by the aggregate type and properties and cement type, age and curing conditions but with a lower rate than the effect of cement content. The use

of SRCs may help resist damage of concrete exposed to seawater.

- The increase of cement content and the use of SRC in concrete improve the resistance of concrete for deterioration against seawater and salty solutions.
- Care should be taken in the manufacturing of concrete to produce impermeable dense concrete in order to resist the attack of seawater.

• Series of experiment were conducted on M30 grade of concrete by this project work , the effect of salt water on compressive strength, and split tensile strength of concrete was investigated

• Four alternative design conditions are developed on water for mixing & curing of concrete.

• There is higher in the strength of concrete specimen cast & cured with salt water as compared to those of cast & cured in fresh water. The rate of the strength gain in fresh water cubes is slow as compared with salt water.

• From the above finding we can conclude that there is no reduction in the strength if we use salt water casting & curing the concrete. This concept can be used for region having more salty water, rural area having salty bore water

A meaningful test method is needed for evaluating the effect of seawater under continuous and alternating exposures.

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 27.20kN/m2, 32.8kN/m2 and 39.06kN /m2 respectively.
2. The compressive strength of concrete cubes cast and cured in salt water at 7,14 and 28 days was found as 28.16kN/m2, 34.33kN/m2 and 41.71kN /m2 respectively.
3. The tensile strength of concrete cylinder cast and cured with fresh water at 7,14, and 28 was found as 3.31kn/m,4.28kn/m and 5.48kn/m.
4. The tensile strength of concrete cylinder cast and cured with salt water at 7,14, and 28 days was found as 2.83kn/m,3.78kn/m and 4.91kn/m.
5. Durability of concrete cast and cured with salt water is lesser

than concrete cast and cured with portable wate.

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