Studies on the effect of seawater & Normal water intrusion in Sea sand on Concrete Cubes

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Abstract– The aim of this work is to study the Effects of Sea water encroachment in concrete cubes placed in Sea sand near costal zones. Paper inspects the influence of Normal water & Seawater curing in concrete cubes which is concealed on Sea sand. Cement concrete cubes of 150x150x150mm were cast using normal water and cured with seawater & normal water with two different mix proportions of M-20 & M-30 with 0.45 water cement ratio and compressive strength & NDT test were performed during 28th day and 84th day. Totally 72 specimen were cast with normal water. Cement in addition with fly ash class-C of 20% and 30% was also used for this investigation.

Key words: Compressive Strength, fly ash, Sea Sand, Seawater, NDT.

INTRODUCTION

Durability of Concrete structures in Costal Environment has been an issue for many years, due to the perception of sea water to concrete. In India, marine environment of soils are Subjected to major change in their index and Engineering Properties of soil. The strength of concrete mainly depends on the concrete mix, types of curing, water cement ratio, aggregates and cement types. Water is an important constituent of concrete as it participates in the chemical reaction with cement. The addition of fly ash class –C with cement in concrete mix is used in this investigation in Sea sand.

Md. Moinul Islam, Md. Saiful Islam, Md. Al-Amin and Md. Mydul Islam in 2012 examined that Suitability of sea water on curing and compressive strength of structural concrete as a part of durability study, this paper describes the effect of sea water on compressive strength of concrete when used as mixing and curing water. Concrete specimens were cast from four different grades and plain water as well as sea water was used as mixing water in making the test specimens. Test specimens were cured under sea water as well as plain water upto 180 days. Test results indicate that sea water is not suitable for mixing as well as curing of concrete. Concrete specimen made and cured with sea water exhibits compressive strength loss of about 10% compared to plain water mixed and cured concrete.

C.Marthong, T.P.Agrawal in 2012 examined the Effect of Fly Ash Additive on Concrete Properties. This paper reports a comparative study on effects of concrete properties when OPC of varying grades 33, 43, 53 were partially replaced by fly ash. The main variable investigated in this study is variation of fly ash dosage of 10%, 20%, 30% and 40%. The compressive strength, durability and shrinkage of concrete were mainly studied. Test results shows that, inclusion of fly ash generally improves the concrete properties upto certain percent or replacement in all grades of OPC.

Falah M. Wegian (2010) investigated the effects of mixing and curing concrete with sea water on the compressive strengths and reported that there are increases of strengths of concrete mixed and cured in sea water at early ages and a definite decrease for ages more than 28 days and up to 90 days.

Shetty, M. S. (3) in 2002 determined successful performance of a marine structure depends to a great extent on its durability against the aggressive marine environment. Disintegration of concretes in marine environments is mostly caused by chemical deterioration such as sulphate 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.

Dhuraria has recorded that earlier strengths could be achieved in fly ash concrete by adjusting the various ingredients in such a way that the quantity of cement and fly ash in the final mix is more than the quantity of cement replaced. Fly ash concrete mix appeared drier than normal concrete mix but gets satisfactorily compacted with adequate vibrations.

Preeti Tiwari et.al (2014) performed series of experiments on M-30 grade and said that there is marginal increase in the strength of cubes cast and cured in salt water as compared to those of cast and cured in fresh water at all ages of curing and concluded that there is no reduction in the strength if we use salt water casting and Curing the concrete.

1 MATERIALS USED

1.1 SEA SAND

Sea sand is obtained from locally available place Pondicherry was used for this study. The Specific gravity for sea sand is 2.51.

1.2 CEMENT

OPC- 43 confirming to IS 8112-1989 used in this project work. The specific gravity of cement is 3.15.

1.3 COARSE AGGREGATE

Coarse aggregate of size 20mm at 60% and 12mm at 40% is used in this work. The properties of coarse aggregate are determined as per IS 2386-1963 to have a specific gravity of coarse aggregate is 2.60

1.4 SEA WATER

To study the effect of seawater on geotechnical properties of Red soil in concrete cubes.

1.5 FLY ASH

Fly ash class – C was obtained from an industrial waste from thermal power stations. Fly ash is a by-product of burning pulverized coal in electric power plant.

2 METHODOLOGY

The general mix proportions are provided in IS: 10262-2009, for M20 and M30 grade of concrete was arrived as 1: 1.5: 3 and 1: 0.75: 1.5 with water-cement ratio of 0.45.

A total sample of 72 cube specimen of size 150mm x 150mm x 150mm were cast and tested the compressive strength at 28 & 84 days, Water absorption and Young's modulus were noted at 28 days. The various physical properties and chemical properties of Sea sand due to effects of sea water were investigated.

3 RESULTS AND DISCUSSIONS

3.1 SIEVE ANALYSIS

In order to obtain the gradation of sea sand sieve analysis test was performed.

3.2 Specific Gravity

Specific gravity of fine-grained soil was determined by density bottle method as per IS: 2720 (Part III/Sec 1).

3.3 Free Swell Index

As per IS 2720, the free swell index is an change in the volume of a soil without any external restriction, on submergence in ordinary water.

TABLE 1

Geotechnical properties in Sea sand for 28th day and 84th day

Description	Before placing concrete cubes	After placing concrete cubes	
		28th day	84th day
Specific gravity	2.65	2.61	2.60
Liquid limit	-	-	-
Plastic limit	-	-	-
Shrinkage limit	-	-	-

Plasticity index	-	-	-
Free Swell index	-	-	-
OMC	-	-	-
UCC	-	-	-
Direct Shear test	30^0 6′49.4″	25^0 18′32″	23^0 46′53″

The above table shows that the Specific gravity is decreased and direct shear value decreased after the effects of seawater intrusion in sea sand during 28th day & 84th day.

3.4 Compressive Strength

The standard mould of size 150mm × 150mm × 150mm is used for testing compressive strength during 28th day & 84th as per IS 516:1959 for ordinary mix and for the partial replacement of Fly ash class-C samples.

TABLE 4

Compressive strength of concrete with normal water and sea water curing in Sea.

Description	M-20		M-30	
	28th day	84th day	28th day	84th day
Normal water curing without fly ash	24.13	29.91	25.48	34.60
Normal water curing With fly ash 20%	25.94	20.60	39.61	31.85
Normal water curing With fly ash 30%	22.50	28.14	26.31	29.36
Sea water curing buried in sea sand without fly ash	35.46	19.65	27.82	31.65
Sea water curing buried in sea sand with fly ash 20%	20.38	17.77	21.64	33.76
Sea water curing buried in Sea sand (30%)	15.85	19.40	12.05	27.62

The above table values are calculated from (CTM) test of three samples from each description and average values is listed out in the table

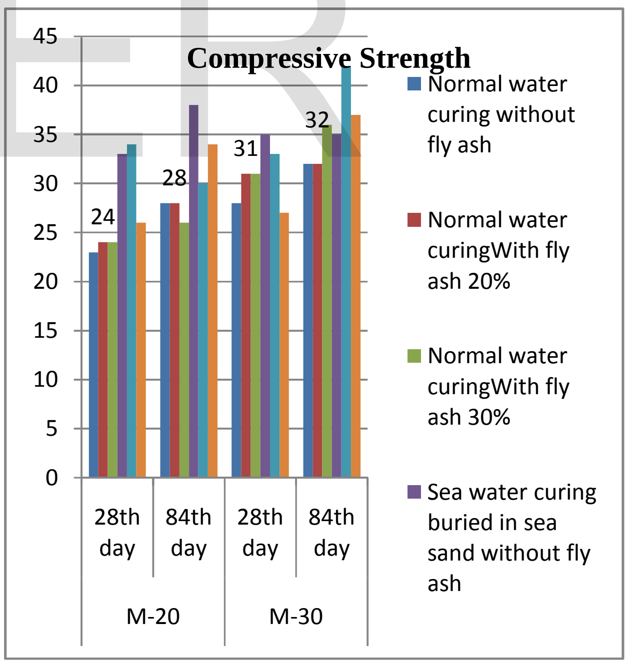

Fig 1: compressive strength of concrete with normal water and sea water

The above graph shows that M-30 with normal water curing has more strength compared with seawater during 84th day

3.5 Ultra-sonic pulse velocity.

An ultrasonic pulse velocity is an in-situ, non-destructive test to check the quality of concrete and its natural behaviour. Ultrasonic pulse velocity method, involves the measurement of the time travel of electrically generated pulses through the concrete. The pulses are applied to the concrete; three different waves are generated called longitudinal waves. Three different kinds of wave are generated. One is longitudinal or compression waves which travel twice as fast on other two types. Second one is shear or transverse waves are not so fast. Finally the surface waves are the slowest one.

if the pulsed velocity is greater than 4.5 its excellent, if its 3.5 to 4.5 are good in condition, if 3.0 to 3.5 it's a medium ,finally below 3.0 it's doubtful concrete to used.

Table 4

UPV of concrete with normal water curing and sea water curing in Sea sand with & without fly ash

Description	M-20		M-30	
	28th day	84th day	28th day	84th day
Normal water curing without fly ash	4637	4657	4533	4860
Normal water curing With fly ash 20%	4747	4357	4734	4460
Normal water curing With fly ash 30%	4564	4364	4684	4584
Sea water curing buried in sea sand without fly ash	4687	4704	4617	4647
Sea water curing buried in sea sand with fly ash 20%	4224	4344	4323	4337
Sea water curing buried in Sea sand (30%)	4324	4664	4114	4714

The above table values are calculated from UPV test of three samples from each description and average values is listed out in the table

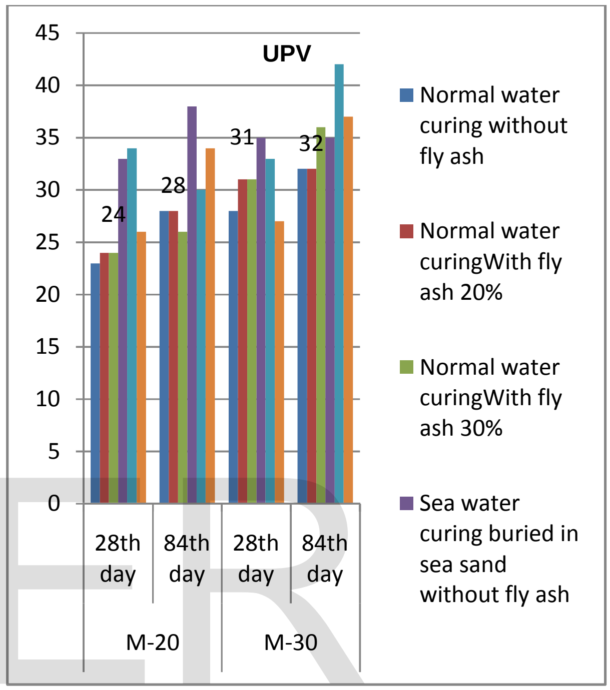

Fig 2: UPV of concrete with normal water and sea water

The above graph shows that M-30 with normal water curing without fly ash has more strength compared with seawater during 84th day.

3.6 Rebound hammer test

Schmidt's rebound hammer is one of the non-destructive testing methods for concrete to measure the surface hardness. It consists of a spring hammer that side on a plunger within the tubular. When the plunger is pressed against the surface of concrete the mass hit from the plunger it reacts to the force against the spring, that impact against the concrete and spring controlled the action of mass, taking the rider with it guide scale. The rider on top of the tubular just above mass rebound to allow the reading to be taken. The distance travelled along the concrete is called rebound number. This test can be done both horizontally and vertically manner.

TABLE 4

Rebound hammer test of concrete with normal water curing and sea water curing in Sea sand with & without fly ash.

Description	M-20		M-30	
	28th day	84th day	28th day	84th day
Normal water curing without fly ash	23	28	28	32
Normal water curing With fly ash 20%	24	28	31	32
Normal water curing With fly ash 30%	24	26	31	36
Sea water curing buried in sea sand without fly ash	33	38	35	35
Sea water curing buried in sea sand with fly ash 20%	34	30	33	35
Sea water curing buried in Sea sand (30%)	26	34	27	37

The above table values are calculated from Rebound hammer test of three samples from each description and average values is listed out in the table.

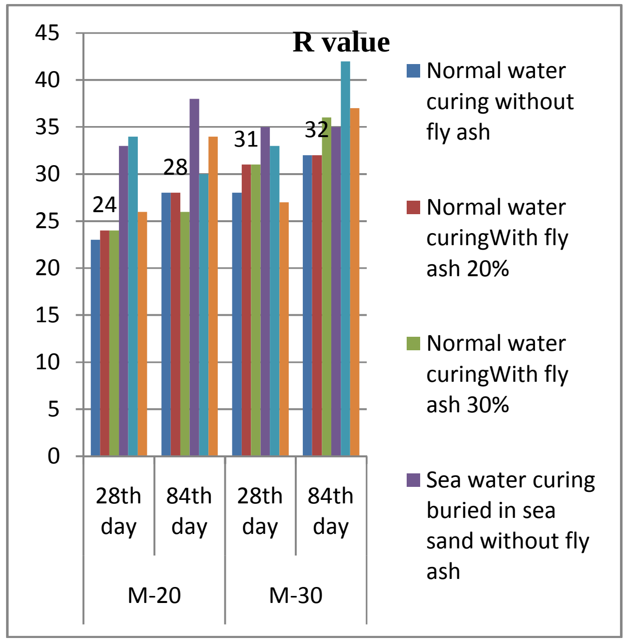

Fig 3: R value of concrete with normal water and sea water

The above graph shows that M-30 with normal water curing without fly ash has more strength compared with seawater during 84th day.

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4 CONCLUSIONS

Based on the test results, it is concluded that:

1. When compared with normal water curing and sea water curing without fly ash the compressive strength for sea water curing is decreased by 11.33 N/Sq.mm and 10.26 N/Sq.mm for M-20 during 28^{Th} day and 84^{th} day respectively.

2. When compared with normal water curing and sea water curing with fly ash class–C for 20% and 30%. The compressive strength for 30% fly ash is decreased with seawater curing.

3. The ultra-sonic pulse velocity results show that normal water curing of concrete have

better quality when compared to sea water curing.

4. The Rebound hammer test value of concrete is increased during normal water curing without fly ash when compared with sea water without fly ash.

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