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Study on Behaviour of Sea Water Concrete with Fly Ash and Sugar Solution

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Abstract – *Concrete is most popular building material in the world. Here, we conducted a study on suitability of sea water in concrete. It is common knowledge that using sea water is not a possibility when building concrete structures. The main problem with using sea water is doesn't lie with the concrete, the problem is with the steel reinforcing. The minute steel reinforcing comes in contact with the sea water, it begins to rust. Steel rusts, it expands and breaks up the surrounding concrete. This is not new knowledge, it is a simple fact that this will happen every time. One consideration during the construction process is the fact that sea water tends to speed up the setting time of concrete. To avoid these harmful effects, we should use good proportions of admixtures like fly ash and retarders in concrete mix that can make the concrete even more effective. The experimental finding in our studies would encourage the use of sea water in future construction works.*

Key Words: **Seawater, Fly ash, Sugar solution, Admixtures, Composition, Durability, Suitability, Normal concrete, Sea water concrete**

1. INTRODUCTION

Concrete is one of the major building materials use in modern day construction, because of its durability to cost ratio. Today's concrete is made using Portland cement, coarse and fine aggregates of stone and sand, and water.Admixtures are chemicals added to the concrete mix to control its setting properties and are used primarily when placing concrete during environmental extremes , such as high or low temperatures, windy conditions etc. It is difficult to find out alternate materials for construction which is suitable as that of such material from durability and economic of view. Out of that water plays an important role as in preparation of concrete. Water is a main ingredient of concrete as it actively participates in chemical reactions with cement. Today construction sector drinking water use in lot of amount. Sea water is a concrete mix with conventionally used raw materials alongside sea water instead of fresh water. Normally we use fresh water for the preparation of concrete. Billions of tons of fresh water are used in construction field. Recent studies show that, in a short future there will be shortage of fresh water. We all know that sea water exist in abundant all over the world. So, effective use of sea water in construction field would help to prevent the scarcity of fresh water. Hence as a social minded civil engineer, we can save our coming generation from this threatening issue. .Due to the presence of salt in sea water, it may affect the durability. To understand the effect of durability of concrete, we have done a study with different compositions of fly ash and retarder (sugar water). These admixtures are capable of enhancing some aspects of durability of concrete.

1.1 Materials used

1.1.1 Sea water

Sea water contains ions of Na, Mg, Ca and K. K, Mg forms K_2SO_4 and $MgSO_4$ which causes sulphate attack, react with calcium hydroxide in concrete mix which is formed by the hydration of dicalcium silicate (C_2S) and tri calcium silicate (C_3S). These ions especially chloride ions cause.

1.1.2 Fly ash

Fly ash also known as pulverized fuel ash. It is a coal combustion product that is composed of the particulates (fine particles of burned fuel) that are driven out of coal-fired boilers together with the flue gases. Fly ash is generally captured by electrostatic precipitators.

1.2 Need for study

In the past years there have been lots of development and new methods and techniques were arrived in the construction field. In the present study an attempt was made to develop a suitable mix design using M25 grade with sea water.We think it is very essential to the coming generation for their living.

1.3 Objectives

- To suggest the possibility of sea water for mixing and curing purpose in concrete
- To find the suitability of admixtures like fly ash and sugar solution in sea water concrete.
- To study the effect of durability with different composition of admixtures like fly ash and sugar solution.
- To determine the optimum composition of admixtures added up to 20%.
- To encourage economic and resource conservation methods of construction.

2. METHODOLOGY

2.1 Materials Collection

The primary step in our project methodology was to collect all the required raw materials for the study.

Table -1: Materials list

Sl. No.	Materials collected
1	Portland cement
2	M Sand
3	Coarse aggregate (20 mm)
4	Fresh water
5	Sea water
6	Fly ash
7	Sugar solution

2.2 Materials Testing

2.2.1 Cement

Table–2: Tests done on cement

Properties of Material	Obtained Value	Units as per IS specifications
Consistency	32%	26% -35%
Initial setting time	35 min	> 30 min
Final setting time	620 min	> 10 hours
Fineness	3%	< 10%

2.2.2 Fine aggregate

Table-2: Tests done on Fine aggregate

Properties of Material	Obtained Value	Units as per IS specifications
Specific gravity	2.631	2.6-2.8
Fineness Modulus	2.89	2.6-2.9

2.2.3 Coarse aggregate

Table-3: Tests done on coarse aggregate

Properties of Material	Obtained Value	Units as per IS specifications
Bulk density	1.48	1.2-1.8 g/cc
Specific gravity	2.76	2.6-2.8
Fineness modulus	6.7	6.5-8

2.3 Casting of specimens

Based on designed mix proportion, concrete mix is prepared with seawater and M sand. Various steps involving in this are:

a) Batching
b) Mixing
c) Placing
d) Compacting

2.3.1 Batching

Measurement of materials for making concrete is known as batching. We casted three cubes (sea water), three cube (fresh water), three cylinders (sea water)

Fig -1: Batching

2.3.2 Mixing

Thorough mixing is required for uniformity of concrete mix. There are two methods for mixing of concrete, hand mixing and machine mixing. Here, hand mixing is adopted.

Fig -2: Mixing

2.3.3 Placing

Steel mould is prepared to cast specimens. Oil or grease is applied in the mould for easy remoulding. So properly mixed concrete is placed in the mould.

Fig -3: Placing

2.3.4 Compacting

Proper compaction is done while placing concrete mix into the mould for expelling entrapped air from the concrete.

Fig -4: Compacting

2.4 Curing

The most thorough method of curing with water consists of total immersion of the finished concrete element. Here, curing is done by immersing the casted specimens into seawater after 24 hours of casting. The specimens are then tested for 28 days.

Fig -5: Curing process

2.5 Compressive strength tests

In most of the structural applications, concrete is used primarily to resist compressive stresses. So Compressive Strength is used to denote the overall quality of concrete. Compression test on cube is the most common test conducted on hardened concrete because it is an easy test to perform and most of the desirable properties of concrete are comparatively related to its compressive strength. The compression test was carried out on a cubical specimen of size 100mm in a compression testing machine of capacity 2000KN at a loading rate of 14 N/mm^2 per minute. The compressive strength is calculated based on the maximum load taken by the specimen in N/mm^2.

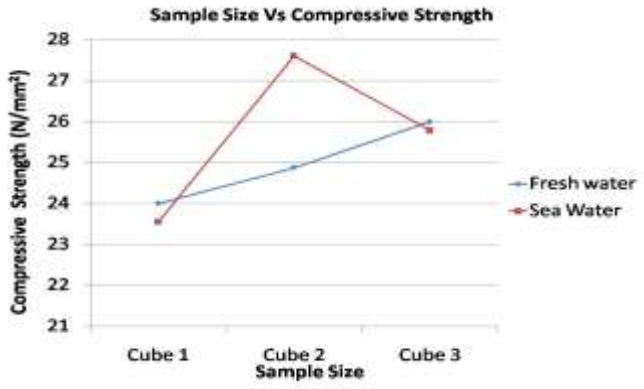
Fig -6: Compressive strength test

Table-4: Compressive strength of Fresh water concrete

Samples	Breaking Load (KN)	Compressive strength N/mm^2	Average N/mm^2
Cube 1	540	24	24.96
Cube 2	560	24.88	
Cube 3	585	26	

Table-5: Compressive strength of Sea water concrete

Samples	Breaking Load (KN)	Compressive strength N/mm^2	Average N/mm^2
Cube 1	510	23.55	25.64
Cube 2	620	27.6	
Cube 3	580	25.78	



2.5 Split tensile strength test

The concrete is very weak in tension due to its brittle nature. Hence. It is not expected to resist the direct tension. So, concrete develops cracks when tensile forces exceed its tensile strength. Therefore, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack. Furthermore, splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The procedure based on the ASTM C496 (Standard Test Method of Cylindrical Concrete Specimen) which similar to other codes like IS 5816 1999.

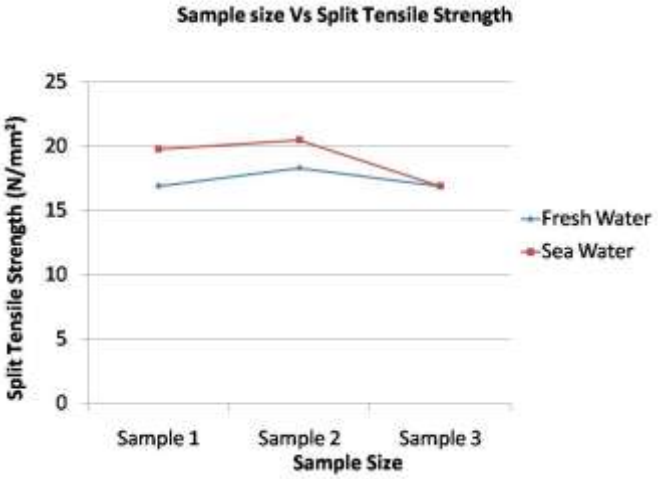
Fig -7: Split tensile strength

Table-6: Split tensile strength of fresh water concrete

Samples	Breaking Load (KN)	Compressive strength N/mm²	Average N/mm²
Sample 1	120	16.9	17.36
Sample 2	130	18.3	
Sample 3	120	16.9	

Table-7: Split tensile strength of sea water concrete

Samples	Breaking Load (KN)	Compressive strength N/mm²	Average N/mm²
Sample 1	140	19.8	20.03
Sample 2	145	20.5	
Sample 3	140	19.8	



2.6 Studies with different compositions of fly ash & retarder

For enhancing the durability, we have done a study with different compositions of fly ash and sugar solution. Fly ash is the byproduct of coal-fired electric and steam generating plants. Different proportions of fly ash and sugar solution respectively (15% & 5%, 10% &10%, 5% & 15%) are used to make concrete and increased the durability. The strength for these concrete blocks was tested on 7th and 28th day.

2.7 Casting of specimens

Based on designed mix proportion, concrete mix is prepared with seawater, fly ash and sugar solution. Various steps involving in this are:

e) Batching
f) Mixing
g) Placing
h) Compacting

2.7.1 Batching

The measurement of materials for making concrete is known as batching.18 cubes were casted in the sense 6

cubes for each proportion (15% Fly ash & 5% Sugar solution, 10% Fly ash & 10% Sugar solution, 5% Fly ash & 15% Sugar solution)

2.7.2 Mixing

Thorough mixing is required for uniformity of concrete mix. There are two methods for mixing of concrete, hand mixing and machine mixing. Here, hand mixing is adopted.

2.7.3 Placing

Steel mould is prepared to cast specimens. Oil or grease is applied in the mould for easy remoulding. So properly mixed concrete is placed in the mould.

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Proper compaction is done while placing concrete mix into the mould for expelling entrapped air from the concrete.

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2.9 Compressive strength tests

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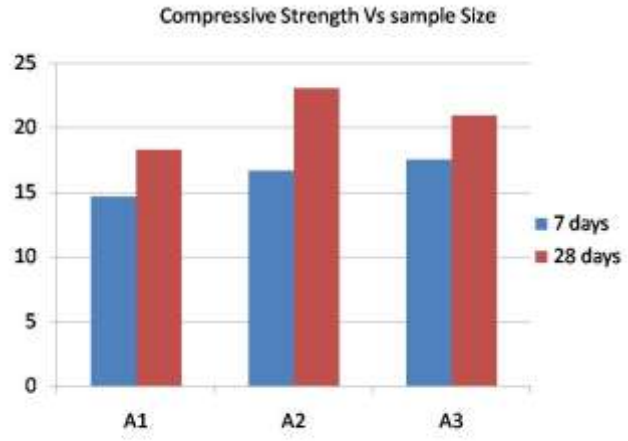
Table-8: 7th day Compressive strength result

	Load (KN)	Compressive strength N/mm^2	Average
A1	310	13.77	14.66
	330	14.66	
	350	15.55	
A2	390	17.33	16.66
	360	16	
	375	16.66	
A3	410	18.22	17.55
	395	17.55	
	380	16.88	

Table-9: 28th day Compressive strength result

	Load (KN)	Compressive strength N/mm^2	Average
A1	425	18.99	18.29
	410	18.33	
	395	17.55	
A2	520	23.11	23.03
	550	22.88	
	520	23.11	
A3	475	21.11	20.96
	460	20.44	
	480	21.33	



3. CONCLUSIONS

- Sea water can be used for mixing and curing purpose of concrete.
- Admixtures like fly ash and sugar solution in sea water concrete improves the quality of concrete.
- When comparing the 7th day compressive strength of sea water concrete containing admixtures, the 28th day compressive strength has increased by 4%
- The optimum composition of admixtures obtained is 10% of fly ash and 10% of sugar solution,

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