International Journal of
Advanced Technology and Innovative Research

www.ijatir.org

ISSN 2348–2370
Vol.09,Issue.01,
January-2017,
Pages:0177-0185

Investigation on the Use of Sea Water on Strength Properties on Different Blended Cement Concretes

P. BALAKRISHNA[1], P. CHAMANTHI[2]

[1]PG Scholar, KMM Institute of Technology and Sciences, Tirupati, Andhrapradesh, India.

[2]Assistant Professor, KMM Institute of Technology and Sciences, Tirupati, Andhrapradesh, India.

Abstract: Construction engineering in coastal areas are facing the challenge of shortage of fresh water for mixing and curing. The quality of water places an important role in the setting and strength development of concrete structures. The present investigation is carried to identify the effect of mixing and curing of concrete with artificial sea water on the compressive strength, split tensile strength, density and water absorption of concrete cubes. The results indicate JSW and PENNA performed well. The 28 days compressive strength of PENNA, JSW, PANYAM, and LANCO cement concrete of M25 are: 40.3,38.96, 31.41 and 32.14 N/mm^2 similarly tested for M30 also results are 40.89, 41.03, 33.18 and 33.48respectively. there is not much difference in density value range 24.59 to 25.68kg/m^3. The water absorption values ranges 5.93 to 7.42% of all cement concretes. This is within the limits of as a standard of concrete.

Keywords: Curing with Sea Water, Compressive Strength, Split Tensile Strength, Workability.

I. INTRODUCTION

In concrete industry, several billion tons of fresh water is annually used, as mixing, curing and cleaning water, around the world. From the view point of saving fresh water, it is believe that the possibilities of using seawater as mixing water in concrete should be investigated seriously. Additionally, if the use of seawater as a concrete material is permitted, it will be very convenient and economical in the construction, especially in the coastal works. However, in most of the reinforced concrete standards, the use of seawater is not permitted due to the risk of early corrosion of reinforcement, induced by Nacl in seawater compounds. The quality of the water plays an important role in the preparation of concrete. Impurities in water may interfere with the setting of the cement and may adversely affect the strength and durability of the concrete also. The chemical constituents present in water may actively participate in the chemical reactions and thus affect the setting, hardening and strength development of concrete. There are various existing and new sources of water available which may be suitable for complete or partially replacement of potable water for concrete making. It includes reclaimed water, groundwater, treated water from sewer and water from ready mix concrete plant etc. Due to the shortage and scarcity of water in many part of the world and especially in arid regions like Qatar and Dubai, water authorities are moving towards identifying new sources of water.

In One of the facts in arid countries, desalinated water blended with brackish ground water used for concrete making purpose and for making concrete slurry also. About 80 percent of the surface of the earth are covered by oceans; therefore, a large number of structures are exposed to sea water with high salinity either directly, or indirectly when winds carries sea water spray up to a few miles inland from the coast. As a result, several coastal and offshore sea structures are exposed to the continuous action of physical and chemical deterioration processes. This challenge of building and maintaining durable concrete structures in coastal environs have long become a serious issue to the people living in this area. The IS: 456(2000) code stipulates the water quality standards for mixing and curing. In some arid areas, local drinking water is impure and may contain an excessive amount of salts due to contamination by industrial wastes. When chloride does not exceed 500 ppm or SO3 does not exceed 1000 PPM, the water is harmless, but water with even higher salt contents has been used Satisfactorily (Building research station11956). Building Research Station reported the success recorded in the use of water with higher salts contents such as chloride (higher than 500ppm) and trioxosulphate V (higher than 1000ppm).Chatveera et al4 utilised and recycled sludge water as mixing water for concrete production and found that concrete slump and strength reduced drastically.

Compressive strength, mineralogy, chloride ingress, and corrosion of steel bars embedded in concrete made with seawater and tap water were investigated based on the several long-term exposures under tidal environment. Seawater-mixed concrete showed earlier strength gain. After 20 years of exposure, no significant difference in the compressive strength of concrete was observed for concrete mixed with seawater and tap water. "The major objective of the present investigation is to assess the effect of sea water on strength development of various Portland slag cements manufactured by different agencies and compare the compressive strength, split tensile strength, density and water absorption properties of concrete made with different Portland slag cements".

. II.MIX DESIGN OF CONCRETE

A. Different mix design specifications

M10&M15–plain cement concrete (PCC): Levelling course, bedding for footing, concrete roads.

M20 – reinforced cement concrete (RCC): slabs, beams, footings (mild exposure).

M25 to M35 -- RCC: slabs, beams, columns and footing etc.

M40--Pre-stressed concrete slabs, beams, columns, footings etc.

M45 – Pre-stressed concrete girders.

M50 and M55—prestressed concrete girders, piers, and columns.

M60toM100 –RCC work when high compressive strength is required such as high rise buildings, long span bridges.

B. Mix design concrete in the present investigation

Indian standard recommended method of concrete mix design (IS 10262-1982) was first introduced during the year 1982. In the revision of IS 456-2000, a number of changes were introduced in IS 456 which necessitated the revision of IS 10262-1982. A committee was set up to review the method of mix design in conformity with IS 456-2000. The committee took long time and came up with new guidelines for concrete mix proportioning. The information given below is based on the guidelines given in Indian standard IS 10262:2009 for concrete mix proportioning.

Step 1: Determination of target mean strength: The Formula for calculating target means strength as follow

$$Ft=fck + KS$$

Where Ft =target mean compressive at 28 days
fck = characteristics compressive strength at 28 days
K = statically value depending upon the accepted portions of flow results and the number of tests and
S= assumed standard deviation

Note: As per IS 456- 2000, the value of K is taken 1.65, assuming that characteristics strength is expected to fall not more than 5 percent of test results. And value of S is also taken from IS 456-2000 table. This is given for each grade of concrete. The value of S for M25, M30, and M35 is 5 Mpa.

Step 2: Water-cement ratio : The water- cement ratio is chosen from table no IS:456-2000 .which specify the minimum cement content, maximum water cement ratio and minimum grade of concrete for the different exposure condition with normal maximum size aggregate is 20mm. The value selected is compared with available relation in SP: 23-1982.for the determination of w/c ratio for the target mean compressive strength at 28 days.

It is noted here that w/c ratio for the determined target mean compressive strength at 28 days gives lower value than specified maximum value in table of IS 456-2000.

Step 3: Estimation of required water : The approximate water content is selected from the table 35 and 38 of SP: 23-1982, applied for normal concrete mix, which considers the aggregate type (whether crushed or uncrushed), maximum size of the aggregate and required slumps as a measure of level of workability.

Step4: Estimation of air content: The estimated entrapped air content is taken (2%) from table no 41 of SP 231982, based on nominal maximum size of the aggregate.

Step5: Determination of cement content: The cement content is calculated from the selected w/c ratio and estimated water content. The cement content calculated is compared with the minimum required cement content as per the durability consideration as stipulated in the IS456-2000 .The greater of the two value is adopted. It is noted that the quantity adopted is inclusive of the addition of part supplementary cementations materials.

Step6: Estimation of coarse aggregate Proportion: The percentage of sand in total aggregate depends upon the grading of sand to be incorporated in the mix. The general guideline is obtained from the figure 45 of SP 23-1982 (35). Aggregate of the same nominal maximum size, type, and grading will produce concrete of satisfactory workability. When a given volume of coarse aggregate is used, Approximate aggregate volume is given in table 3 in IS 10262-2009.for w/c ratio of 0.5. This aggregate volume may be adjusted for the w/c ratio in the following way. For every decrease of w/c by 0.05, the coarse aggregate volume may be increased by 1.0 percent to reduce the sand content and for every increase of w/c ratio by 0.05 the coarse aggregate volume may be decreased by 1.0 percent to increase the sand content.

Step7: Combination of different coarse aggregate fractions: Coarse aggregate of different sizes may be combined in different proportions so as to get overall grading confirming to grading given in table 2 of IS 383.

Step8: Estimation of fine aggregate proportion: From all above the steps, we have estimated the proportion of all the ingredients except coarse and fine aggregates. As a next step, find out the absolute volume of all the so far known ingredients. Deduct the sum of all the known absolute volume from unit volume (1m3), the result will be the absolute volume of coarse and fine aggregate put together. We know the volume of coarse aggregate and hence volume of fine aggregate can be calculated.

Step 9: Trial mixes: With the last step; the weight of all the ingredients in kg/m3 can be found out.

Mixing process: Though the mixing of the materials is essential for the purpose of uniform concrete, the mixing should ensure that the mass becomes homogeneous, uniform in colour and consistency. There are two methods adopted in mixing concrete. They are given below:

1. Hand mixing
2. Machine mixing

The physical and chemical characteristics of sea water

Seawater is a mixture of various salts and water. Most of the water in the ocean basins is believed to originate from the condensation of water found in the early atmosphere as the Earth cooled after its formation. This water was released from the lithosphere as the Earth's crust solidified. Additional water has also been added to the oceans over geologic time from periodic volcanic action. Most of the dissolved chemical constituents or salts found in seawater have a continental origin. It seems that these chemicals were released from continental rocks through weathering and then carried to the oceans by stream runoff .Over time, the concentration of these chemicals increased until equilibrium was met. Only six elements and compounds comprise about 99% of sea salts: chlorine (Cl-), sodium (Na+), sulfur (SO4-2), magnesium (Mg+2), calcium (Ca+2), and potassium (K+) (Figure 8p-1). The relative abundance of the major salts in seawater is constant regardless of the ocean. Only the amount of water in the mixture varies because of differences between ocean basins because of regional differences in freshwater loss (evaporation) and gain (runoff and precipitation). The chlorine ion makes up 55% of the salt in seawater. Calculations of seawater salinity are made of the parts per 1000 of the chlorine ion present in one kilogram of seawater. Typically, seawater has a salinity of 35 parts per thousand.

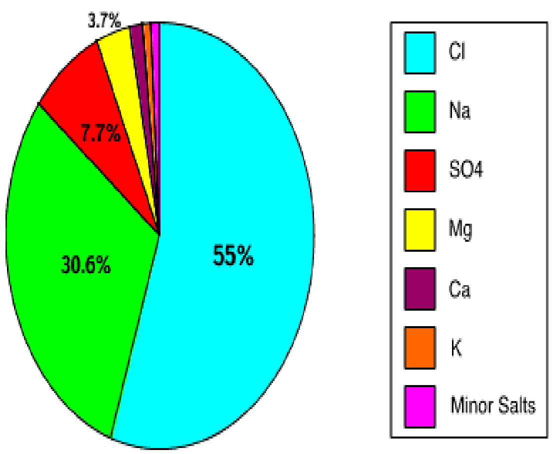

Fig1. Relative properties of dissolved salts in seawater.

The density of seawater generally increases with decreasing temperature, increasing salinity, and increasing depth in the ocean. The density of seawater at the surface of the ocean varies from 1,020 to 1,029 kilograms per cubic meter. Seawater also contains small amounts of dissolved gases. Many of these gases are added to seawater from the atmosphere through the constant stirring of the sea surface by wind and waves. Some of the important atmospheric gases found in seawater include: nitrogen, oxygen, carbon dioxide (in the form of bicarbonate HCO3), argon, helium, and neon. Compared to the other atmospheric gases, the amount of carbon dioxide dissolved in saturated seawater is unusually large. Some gases found within seawater are also involved in oceanic organic and inorganic processes that are indirectly related to the atmosphere. For example, oxygen and carbon dioxide may be temporally generated or depleted by such processes to varying concentrations at specific locations within the ocean.

III. MATERIALS AND METHODOLOGY

A. Materials

- Cement
- Fine aggregate
- Coarse aggregate
- Sea water

Cement: the cement used (PSC) is the investigation are port land slag cements manufactured and marketed by different cement companies, namely

- PENNA
- JSW
- PANYAM and
- LANCO.

Portland slag cement: PSC is blended cement. It is the most suitable cement for Infrastructure Projects because of its high flexural strength. Maximum strength, low risk of cracking, improved workability, and superior finish are the advantages of PSC.

Fig2. Portland slag cement.

Chemical requirements: Portland cement clinker used In the manufacture of Portland slag cement shall comply in all aspects with the chemical requirements specified for the 33 grade ordinary Portland cement in IS 269 : 1989, and the purchaser shall have the right, If he so desires, to obtain samples of the clinker used In the manufacture of Portland slag cement. The Portland slag cement shall comply with the following chemical requirements when tested In accordance With the methods given IS 4032: 1985.

Table1. Physical Characteristics of PSC Cement

Tests conducted	Cement companies			
	PANYAM	PENNA	LANCO	JSW
Normal consistency	30%	31.5%	31%	32%
Specific gravity	3.11	3.10	3.12	3.13
Initial setting time	70 minutes	90 minutes	120 minutes	40 minutes
Final setting time	210 minutes	200 minutes	240 minutes	180 minutes
Fineness	6%	4%	5%	5%
Soundness (Lechatlier method)	1.5mm	1.7mm	2mm	1 mm

Table2. Chemical Properties of Cements

Chemicals	PENNA CEMENT	JSW CEMENT	PANYAM CEMENT	LANCO CEMENT
Cao(lime)	47	45	46	49
Sio2(silica)	30	33	28	27
Al2o3(alumina)	8	10	8	9
Fe2o3(iron oxide)	4	1	6	4
Mgo(magnesia)	6	6	5	5
I/R(loss of ignition & in soluble residue)	5	5	7	6

Fine aggregate: The importance of using the right type and quality of aggregate cannot be overemphasized. The sand is used throughout the experiment work was obtained from the Muthirevullu near chittoor, chittoor district, Andhra Pradesh. Where concrete of high strength and good durability to any one of the four grading zones may be used, but the concrete mix should be properly designed. As the fine aggregate becomes progressively finer, that is from Grading Zones 1 to 1V, the ratio of the fine aggregate to coarse aggregate should be progressively reduced. It is recommended that the fine aggregate conforming to Grading Zone 1V should not be used in reinforced concrete unless tests have been made to ascertain the suitability of proposed mix proportions. It must be remembered that the grading of fine aggregates has much greater effect on workability of concrete than does the grading of coarse aggregate. Usually very coarse or very fine sand is unsatisfactory for concrete mixing. The coarse sand results in harshness bleeding and segregation.

Fig3. Fine aggregate

Naturally available sand is used as fine aggregate in the present work. The most common constituent of sand is silica, usually in the form of quartz, which is chemical inert and hard. The grading zone of fine aggregate was zone I as per IS specification. Fineness modulus is 3.1. The results of fine aggregate are presented

Table3. Grain size distribution of fine aggregate

Sieve size (mm)	Weight retained	%weight retained	Cumulative % weight retained	Cumulative Percentage passing(%)
4.75	2.3	23	2.3	97.7
2.36	52.5	5.25	7.55	92.45
1.18	322.5	32.25	39.8	60.2
0.6	349	34.9	74.7	25.3
0.3	129	12.9	87.6	12.4
0.15	114	11.4	99	1

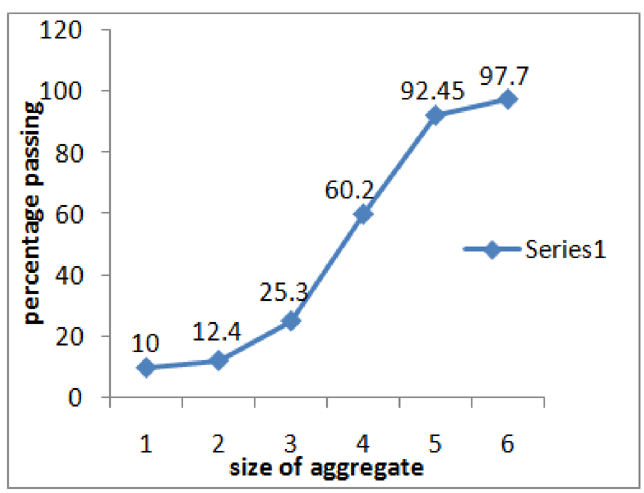

Fig4. Fineness Modulus of Fine Aggregate.

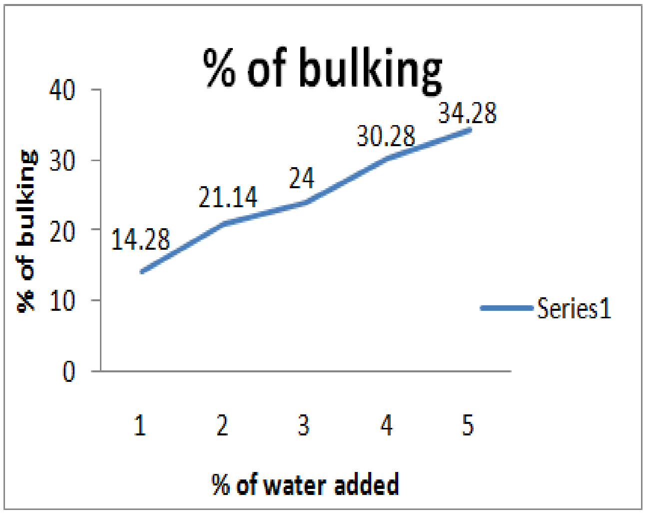

Fig5. Bulking of Sand.

The above graph clearly shows that the bulking of sand was maximum at 5% of percentage of water added by weight of sand. The bulking of sand at 1%, 2%, 3% and 4% are 14.28, 21.14, 24, 30.28 respectively

Coarse aggregate: Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. Earlier aggregates were considered as chemically inert materials but now it has been recognized that some of the aggregates are chemically active and also that certain aggregates exhibit chemical bond at the interface of aggregate and paste. The mere fact that the aggregates occupy 70-80 per cent of the volume of concrete, their impact on various characteristics and properties of concrete is undoubtedly considerable.

Fig6. Coarse Aggregate.

The coarse aggregate is free from clayey matter, silt and organic impurities etc. Coarse aggregate is tested for specific gravity, in accordance with IS: 2386-1963. The maximum size of 20 mm is used as coarse aggregate in concrete. For most of building constructions, the coarse aggregate consists of gravel or crushed stone up to maximum size 20 mm confirming to IS 383-1970 was used.

Water for Mixing And Curing: 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). This means that every kilogram (roughly one litre by volume) of seawater has approximately 35 grams of dissolved salts (predominantly sodium (Na+) and chloride (Cl−) ions). The cubes were prepared using 35g of salts in one litre of water. Here sea water is prepared artificially. The chemical composition of artificial (spiked) water is presented in table4.

Table4. Composition of artificial seawater

Salts	Amount	Units	Percentage
Nasio2	40	Mg/lit	0.115
Caco3	190	Mg/lit	0.548
Caso4	1180	Mg/lit	3.407
Mgso4	2450	Mg/lit	7.074
Mgcl2	3400	Mg/lit	9.818
Kcl	670	Mg/lit	1.934
Nacl	26700	Mg/lit	77.100
Total	34630	Mg/lit	100

Fig7. Sea water for mixing of concrete.

IV. RESULTS AND DISCUSSION

The results of the present investigation are represented both in tabular and graphical forms in order to facilitate the analysis, interpretation of the result is obtained is based on the current knowledge available in the literature as well as on the nature of results obtained. The significance of the results is assessed with reference to the standards specifies by the relevant IS codes.

Workability of different concretes: To enable the concrete to be fully compacted with given efforts. Normally higher water/cement ratio then that calculated by theoretical consideration may be required. That is to say the function of water is also to lubricate the concrete so that concrete can be compacted with specified effort forth coming at site of work. The lubrication required for handling concrete without segregation. For placing without loss of homogeneity, for compacting with amount of efforts forthcoming to finish it sufficiently easily, the presence of a certain quantity of water is of vital importance. The quality of concrete satisfying the above requirements is termed as workable concrete. The word "workability" or workable concrete signifies much wider and deeper meaning then the other terminology "consistency" often used loosely for workability.

Measurement of workability:

a) **Slump test**
b) **Compacting factor test**

Table5.

Cement companies	w/c ratio	Slump (mm)	Compacting factor	Degree of workability
PENNA	0.50	75	0.87	Low
JWS	0.50	80	0.92	Medium
PANYAM	0.50	70	0.85	Low
LANCO	0.50	65	0.80	Very low

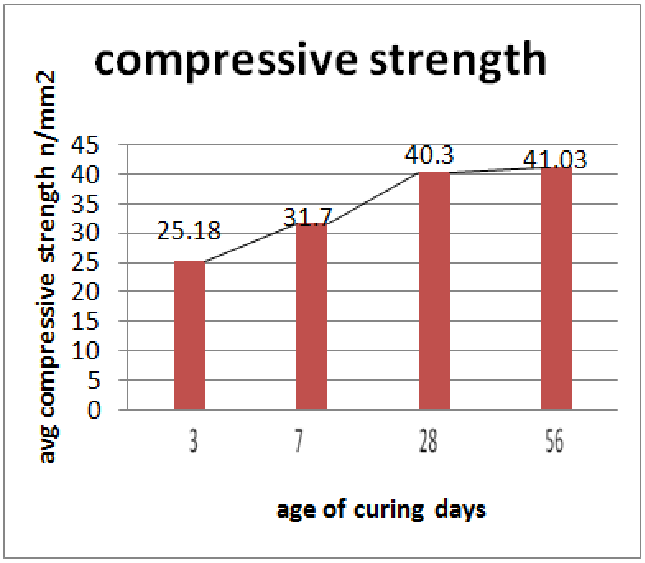

Fig8. Compressive strength of concrete for M25 mix of PENNA cement.

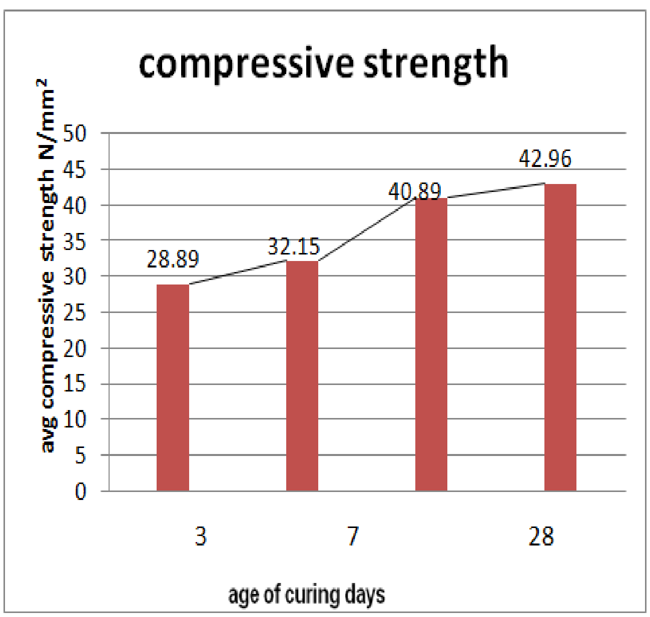

Fig9. Compressive strength of concrete for M30 mix of PENNA cement.

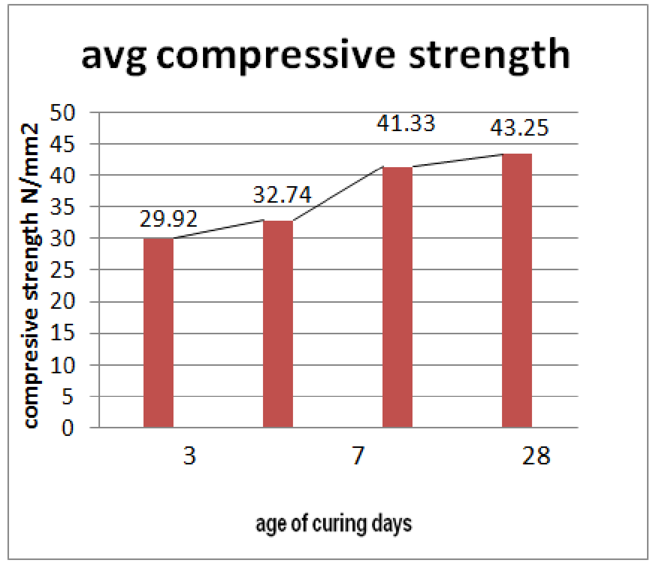

Fig10. Compressive strength of concrete for M35 mix of PENNA cement.

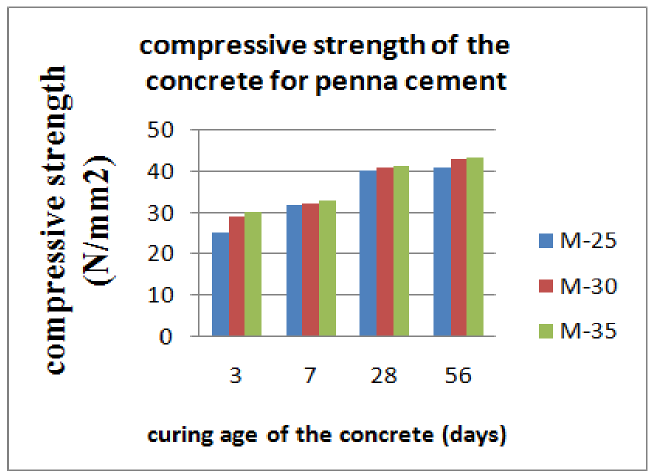

Fig11. Comparison of compressive strength for PENNA cement.

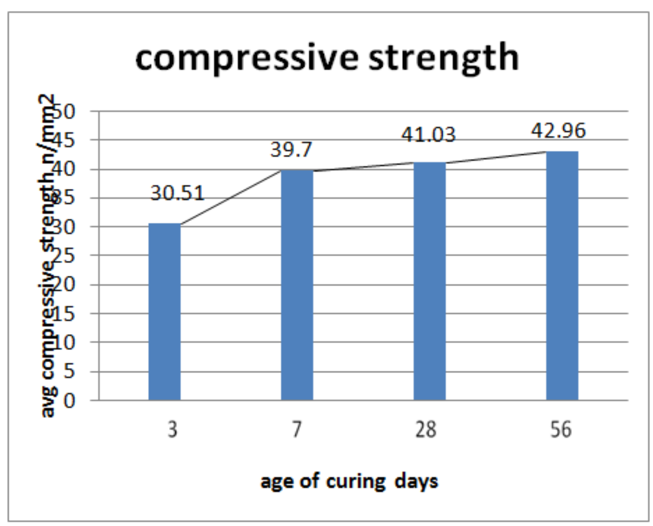

Fig12. Compressive strength of concrete for M30 mix of JSW cement.

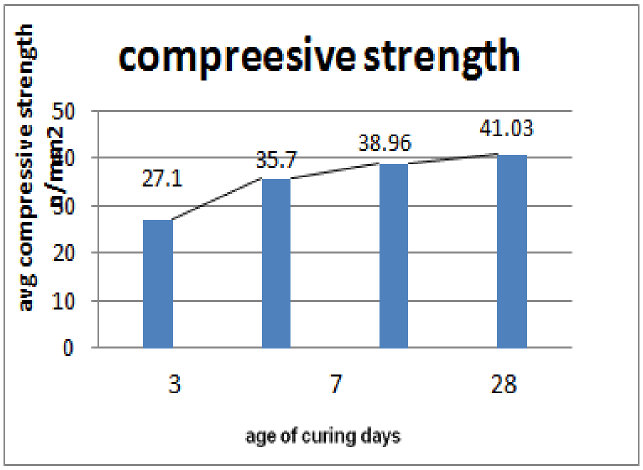

Fig13. Compressive strength of concrete for M25 mix of JSW cement.

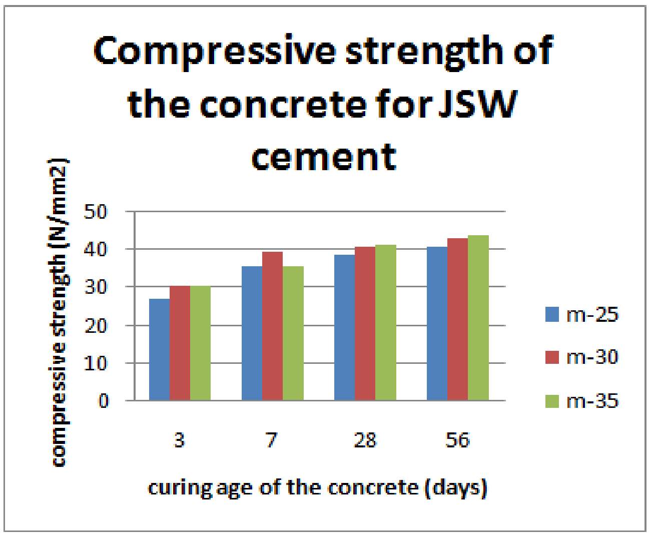

Fig14.Comparison compressive strength of concrete for JSW cement

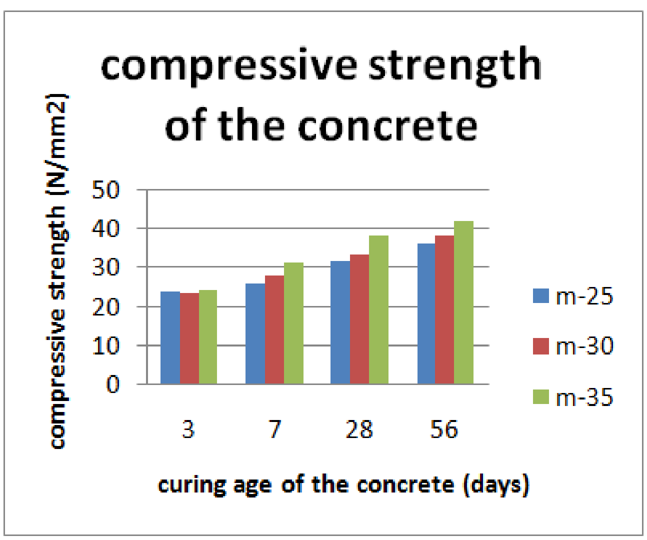

Fig15. Comparison on compressive strength of concrete of PANYAM cement.

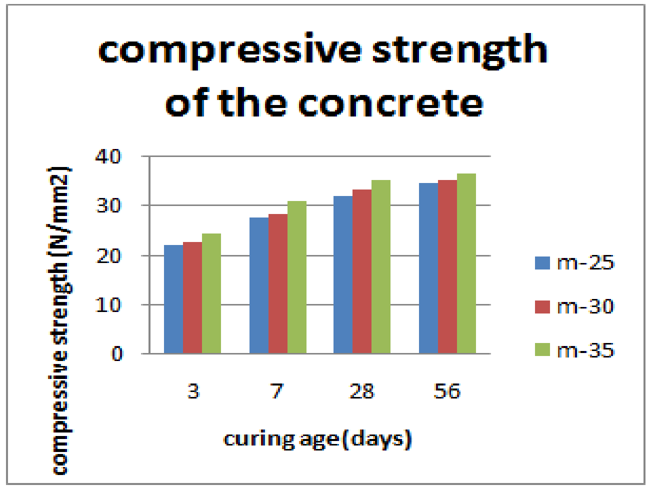

Fig16. Comparison on compressive strength of concrete of LANCO cement.

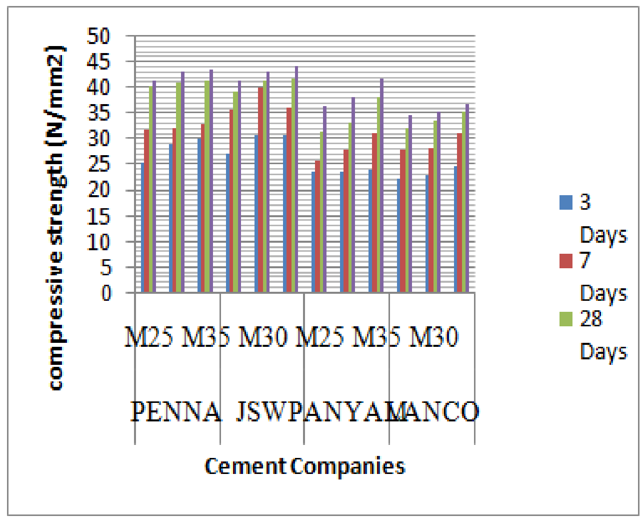

Fig17. comparison on compressive strength of concrete for different cement.

V. CONCLUSION

- The effect of sea water on strength properties of concrete made with Portland Slag cement (PENNA, JSW, PANYAM AND LANCO), were investigated.
- M25, M30, and M35 cements mixes were used in the investigation.
- In this project curing of 3,7,28 and 56 days concrete strength were determined.
- Artificial sea water (spiked) with various salts to simulate sea water characteristics was used both for mixing and curing of concrete.
- The durability parameters of concrete (compressive strength, split tensile strength, density and water absorption) these are characteristics of permeability and slump , compacting factor which describe the characteristics of workability of concrete was investigated.

- The rate of strength of concrete (compressive strength, split tensile strength) were increased with age of concrete, made with all Portland slag cement.
- It seems that irrespective of mixes of concrete on early strength is gazed relative to the conventional concrete.
- M25 and M30 mix concrete are generally have relative more compressive strength than the target mean strength.
- All concrete made with (PENNA, JSW,) cements (M25, M30, and M35), has exhibited more compressive strength than the PANYAM and LANCO. These may be due to the high fineness and exact quantum of Cao and Sio2 ingredients.
- The M25 for 28 days mix concrete of different brands are 40.3 (PENNA), 38.96 (JSW), 31.41(PANYAM), 32.14(LANCO) N/mm2.
- The M30 for 28 days mix concrete of different brands are 40.89 (PENNA), 41.03 (JSW), 33.18(PANYAM), 33.48(LANCO) N/mm2.
- The M35 for 28 days mix concrete of different brands are 41.33 (PENNA), 41.58(JSW), 38.07(PANYAM), 35.26(LANCO) N/mm2.
- The split tensile strength of M25 mix concrete of different brands are 2.63 (PENNA), 2.72 (JSW), 2.30(PANYAM), 2.44(LANCO) N/mm2.
- The split tensile strength of M30 mix concrete of different brands are 2.72 (PENNA), 2.63 (JSW), 2.26(PANYAM), 2.26(LANCO) N/mm2.
- The split tensile strength of M35 mix concrete of different brands are 2.68 (PENNA), 2.35 (JSW), 2.30(PANYAM), 2.30(LANCO) N/mm2.
- The density of all concrete of made with different brands of cement ranges 24.5 to 25, 72 Kg/m3.
- The water absorption of all cement made with different brands of cement ranges 5.93 to 7.42 % (W/W).

VI. REFERENCES

[1] Adebakin, H. I. (2003). “Effect of Salinity on Compressive Strength on Concrete.”

[2] Akinkurolere O.O. et.al. (2007). “The Influence of Salt Water on Compressive Strength of Concrete”, Journal of Engineering and Applied Sciences 2(2). Medwell Journals, pp 412-415.

[3] Akinsola Olufemi Emmanuel., Fatokun Ajibola Oladipo & Ogunsanmi Olabode E., (2012) “Investigation of salinity effect on compressive strength of reinforced Concrete”, Journal of Sustainable Development; Vol.5, No. 6; Published by Canadian Center of Science and Education.

[4] Bryant, M. (1964). Effects of Seawater on Concrete. Miscellaneous paper no 6-690, U.S. Army Engineers, Waterways experiment station, Corps of Engineers, Vicks berg, Mississippi. U.S.A.

[5] Dimiri,A, J.K.varshney,and v.k. varma (2015), A Review on strength of concrete in sea water ,International Journal of Engineering Research & Technology,vol 4(3), pp. 844-847.

[6] Falah M. Wegian (2010). “Effects of sea water for mixing and curing on structural concrete Studies”, The IES Journal Part A: Civil & Structural Engineering, Vol. 3, No. 4, and November 2010, pp 112-115.

[7] Gracemodupeolaamusan and Festusadeyemiolutoge (2014)” The effect of sea water on shrinkage properties of concrete”(IJRET) VOL 2(10),pp.2347-4599.

[8] Is 10262-1982- Recommended guide line for concrete mix design

[9] Is 383-1970 - Specification for coarse aggregate and fine aggregate from natural sources for concrete.

[10] IS 4031:1988- Methods of physical tests for hydraulic cement.

[11] IS 455:1989 -Specifications for portland slag cement

[12] IS456-2000-Code of practice for plain and reinforced cement concrete

[13] IS 516- 1959- Method of test for strength of concrete

[14] IS 5816:1999 -Method of testing for splitting tensile strength of concrete

[15] IS 2386 (part-3)-Method of test for aggregate for concrete–specific gravity,density,voids, absorption and bulking

[16] Kaushik, S. K. and Islam S. (1995), "Suitability of seawater for mixing structural concrete exposed to a marine environment", Cement & concrete composites, Vol.17, No.3, pp.177-185

[17] Krishnam Raju .P, V. Ravindra and M. Bhanusingh (2014). “A Study on Strengths of Ordinary Portland Cement Concrete Under Marine Water”, International Journal of Engineering Science and Technology (IJEST), Vol. 6 No.3 Mar 2014, pp 6-11.

[18] Kumar Mehta .P & Paulo J.M. Monteiro. “Concrete in Sea Water”, Concrete Microstructure, Properties and Materials.

[19]Mbadike E.M. (2011),“Effect of salt water in the production of concrete”, Nigerian Journal of Technology, Vol. 30(2), P.P. 105-110.

[20] Michael A.T. and Adam Kuwairi, (1978).Effect of ocean salts on the compressive strength of concrete and concrete Res.,Pergamon Press Inc.(USA) pp:491-500.

[21]Moinual Islam Md, Md. Saiful Islam, Md. Al-Amin and Md. Mydul Islam (2012) “Suitability of sea water on curing and compressive strength ofstructural concrete”,Journal of Civil Engineering (IEB), vol.40 (I) p.p 37 – 45.

[22]Mokhtar M. A. and Swarmy, R. N. (2008) “Influence of Salt Weathering on the Properties of Concrete”,Arabian Journal for Science and Engineering, Volume 33, Number 1b, pp. 501.

[23]Neville, A. (2001),"Seawater in the Mixture",Concrete international, Vol.23,No.1,pp.48-51.

[24]Olutoge,F et.al,(2014). The effect of sea water on compressive strength of concrete , International Journal of Engineering science Invention ,vol.3(7),pp 23-31.

[25]Otsuki, N. et. al. (2011), “Possibility of sea water as mixing water in concrete”, 36th Conference on Our World in Concrete & Structures, Singapore, Vol.36, pp.131-138.

[26]Preeti Tiwari, Rajiv Chandak, R.K. Yadav (2014), “Effect Of Salt Water On Compressive Strength Of Concrete”, Int. Journal of Engineering and Application, Volume 4, Issue 4, April 2014, pp 38- 42.

[27]Retno Susilorini M.I., Kristina Retno Dewi W, and Tri Wibowo , (2005), “The performance of early – age concrete with sea water curing”, Journal of Coastal Department, Vol. 8, No. 2, 85 – 95.

[28]S. O. Osuji and E. Nwankwo (2015)”Marine water effect on compressive strength of concrete: a case study of escravos area of nigerian delta” nigerian journal of technology (nijotech)vol. 34 no. 2, pp. 240 – 244

[29]Shetty, M. S. (2002). Concrete Technology, Theory and Practice, Fifths Revised Edition, S. Chand &Company Ltd, New Delhi.

[30]Swathi maniyal and Ash tosh patil (2015), An experimental review of effect of seawater on compressive strength of concrete,vol.5(3),pp 155-159

[31]T. Fukute, K. Yamamoto and H. Hamada, (1990) “Study on the durability of concrete mixed with sea water”, Report of the Port and Harbor Research Institute 29 (3) 57–93.(in Japanese)

[32]Takahiro Nishida1, Nobuaki Otsuki, Hiroki Ohara, Zoulkanel Moussa Garba and Tomohiro Nagata, “Some Considerations for the Applicability of Seawater as Mixing Water in Concrete”, Third International Conference of Sustainable Environment

[33]Tarek, T. U. and Hamada H. (2004)."Long-term performance of alumina cement concrete mixed with tap water and seawater" ACI materials journal, Vol.101, No.3, pp.226-232

[34]Tibbetts, D. C. (1968) “Performance of Concrete in Seawater”, Canadian Building Series, No.2, pp. 159 – 180.

Author’s Profile:

P Balakrishna, is a post graduate(PG) student in structural Engineering in KMM institute of technology and sciences, Tirupati, AP, India.

P Chamanthi, is assistant professor in KMM institute of technology and sciences, Tirupati. She completed her M.tech in MJR institute of technology, Pileru. She has 1 Year experience in teaching.