International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

STUDY ON SEA SAND AS FINE AGGREGATE REPLACEMENT IN CONCRETE

Govind Sahu, Priyanka Dubey

PG Scholar, CED, Dr. APJ Abdul Kalam University Indore, M.P., India

Assistant Professor, CED, Dr. APJ Abdul Kalam University Indore, M.P., India

ABSTRACT

This research is concerned with the strength, deflection, ductility and durability investigation of a contemporary construction material named as This research is concerned with the strength, deflection, ductility and durability investigation of a contemporary construction material named as Sea Sand Concrete. An attempt is made to identify the potential use of sea sand as fine aggregate in concrete instead of natural fine aggregate. Sea sand was extracted from Nagoor, Nagapattinam District, Tamilnadu, India after getting the approval from concerned authorities.

Chloride content which leads to corrosion of steel reinforcement is the fundamental problem in incorporating sea sand as an aggregate in concrete. In this study, three different methods have been carried out for the removal of chloride content. Simulated rain test method was the first one tried and since it did not prove to be good, other two methods, Water wash and Hot water wash methods were adopted further. Concrete made after washing the Sea sand with water is termed as Water washed Sea Sand Concrete (SS) and the Concrete made after washing the sea sand with hot water (100 °C) is called as Hot Water washed Sea Sand Concrete (HSS).

Tests were conducted on fresh and hardened state of SS and HSS such as workability, compressive strength, split tensile strength and flexural strength with various fractions of sea sand aggregate starting from 10% to 100% with the increment of 10%. The results showed the comprehensive improvement in the slump value and the mechanical properties due to increase in sea sand content. Consequently the tests were carried out for durability characteristics and the results indicated the remarkable increment in durability characteristics of sea sand replaced concrete which provides better resistance against adverse environment. Further the study has been extended to

determine the flexural and ductility characteristics of concrete and results indicated that all the beams were failed in pure bending region and resulted with deflection more than the control beam with the influences of the ultimate moment. SS and HSS beams provided better ductility factor than control concrete. Hence this research has suggested that properly treated sea sand can be an effective alternative for river sand in concrete.. An attempt is made to identify the potential use of sea sand as fine aggregate in concrete instead of natural fine aggregate. Sea sand was extracted from Nagoor, Nagapattinam District, Tamilnadu, India after getting the approval from concerned authorities.

Key Words: Sea Sand, Aggregate, concrete, cement.

INTRODUCTION

Concrete is the second most consumed material after water and is the basis for the urban development. It can be roughly estimated that 30 billion tonnes of concretes are manufactured globally every year. Concrete is generally made from cement, fine aggregate (sand), coarse aggregate (stone and gravel) and water. ―Sand and gravel represent the highest volume of raw material used on earth after water. Their use greatly exceeds their natural renewal rates‖ (UNEP, 2014). Every year between 47 and 59 billion tonnes of material is mined globally (Steinberger et al. 2010), of which sand and gravel, hereafter known as aggregates, account for both the largest share (from 68% to 85%) and the fastest increase in extraction (Krausmann et al. 2009). Surprisingly, although more sand and gravel are mined than any other material, reliable data on their extraction in certain developed countries are available only for recent years (Krausmann et al. 2009). The absence of global data on aggregates mining makes environmental assessment very difficult and has contributed to the lack of awareness about this issue. One of the ways to estimate the global use of aggregates is through the production of cement for concrete. The production of cement is reported by 150 countries and reached 3.7 billion tonnes in 2012 (USGS, 2013a). For each tonne of cement, the building industry needs about six to seven times more tonnes of sand and gravel (USGS, 2013b). Thus, the world‘s use of aggregates for concrete can be estimated at 25.9 billion to 29.6 billion tonnes a year for 2012 alone. This represents

enough concrete to build a wall 27 metres high by 27 metres wide around the equator. Added to this are all the aggregates used in land reclamation, shoreline developments and road embankments (for which the global statistics are unavailable), plus the 180 million tonnes of sand used in industry (USGS, 2012). Aggregates also contribute to 90% of asphalt pavements and 80% of concrete roads (Robinson and Brown, 2002). China alone built 146,400 kilometres of road in one year,an indication of the world demand for aggregates.

OBJECTIVE OF THE WORK

The objectives of the research are to determine the strength and durability properties of concrete of M30 grade concrete containing sea sand as replacement of fine aggregate and to find the optimum and safest percentage of replacement of sea sand in concrete. The replacement of sea sand with fine aggregate was varied between10% to 100% of aggregates (in steps of 10%) by weight fraction. The specific objectives are as follows:

1. To evaluate the suitability of sea sand for making concrete by determining the Physical properties and chemical composition of sea sand.
2. To evaluate the mechanical properties of processed sea sand concrete by determining the Compressive strength, split tensile strength and flexural strength.
3. To evaluate the durability properties by conducting acid resistance tests, sulphate attack resistance test, chloride attack resistance test, impressed voltage test and Rapid Chloride Penetration Test.
4. To evaluate the structural characteristics of reinforced concrete beam made with processed sea sand by determining the deflections, strains, moments, curvature and flexural rigidity.

International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

Result:-

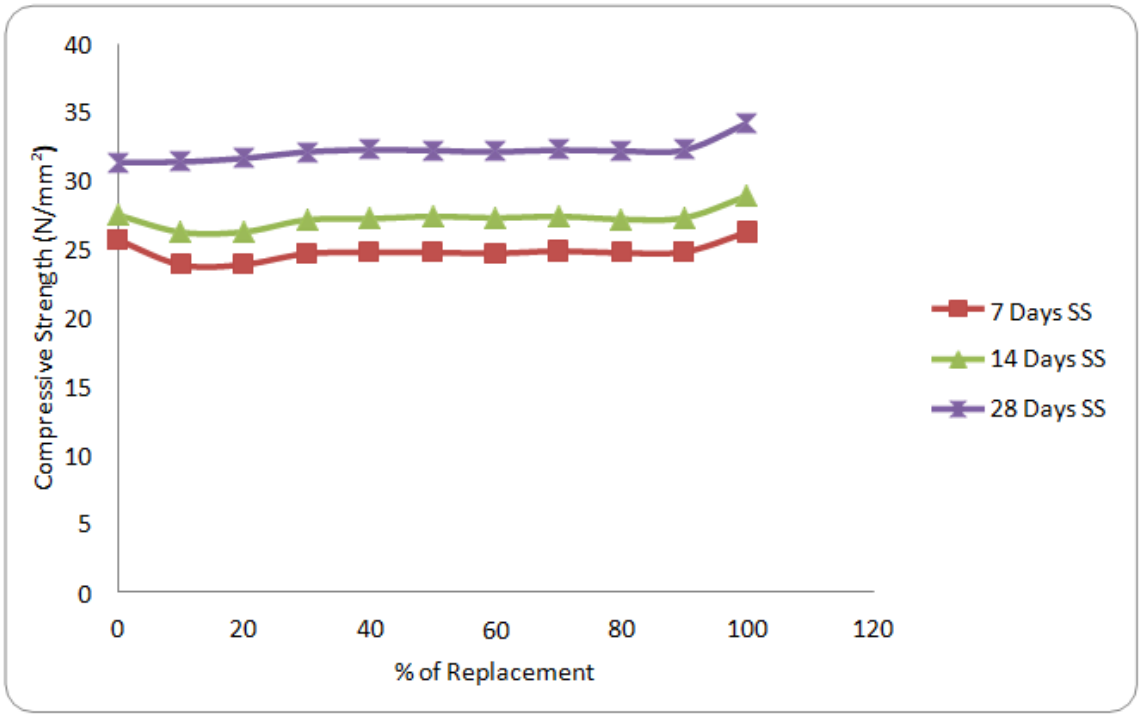


Figure 1 Influence of Water Washed Sea Sand in f_c

International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

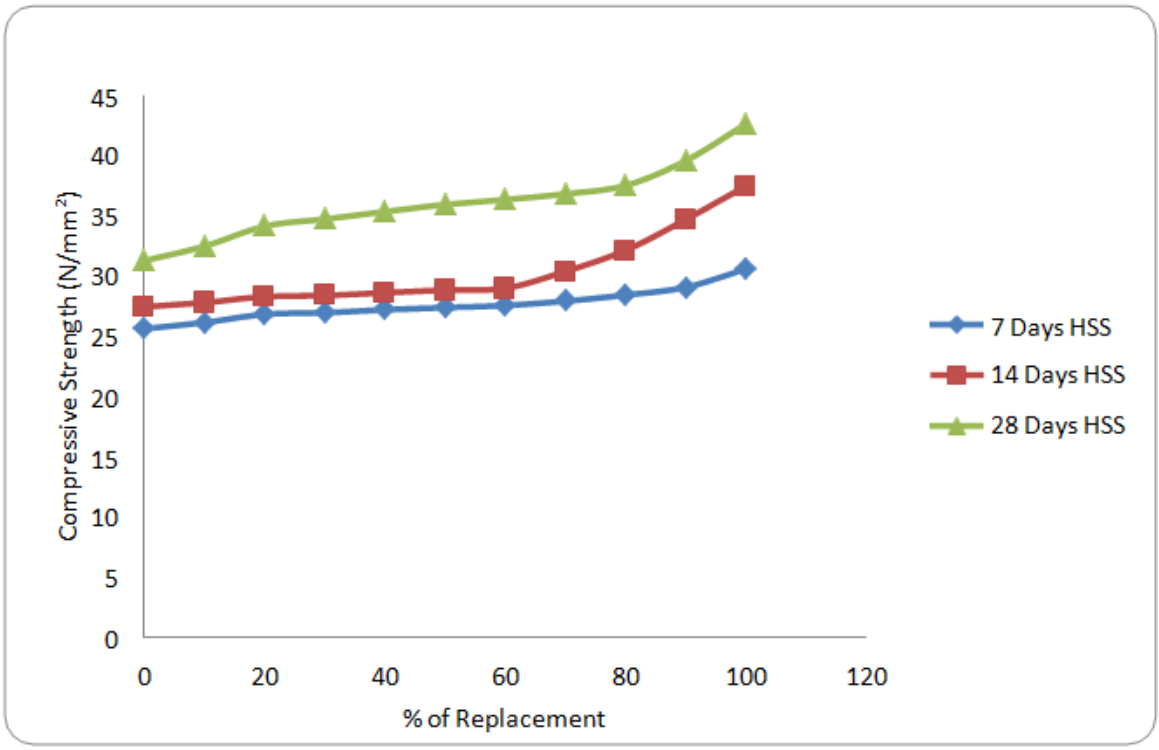
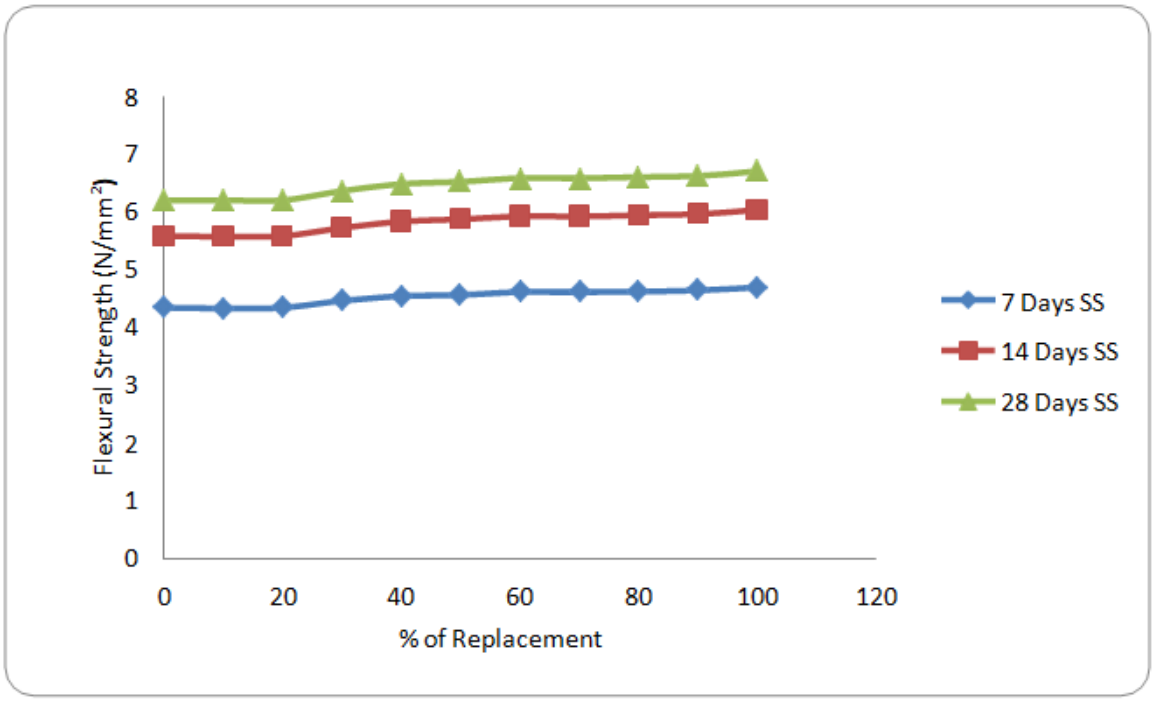


Figure 2 – Influence of hot water washed sea sand in fc



International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

Figure 3 –Influence of water washed sea sand in f_{cr}

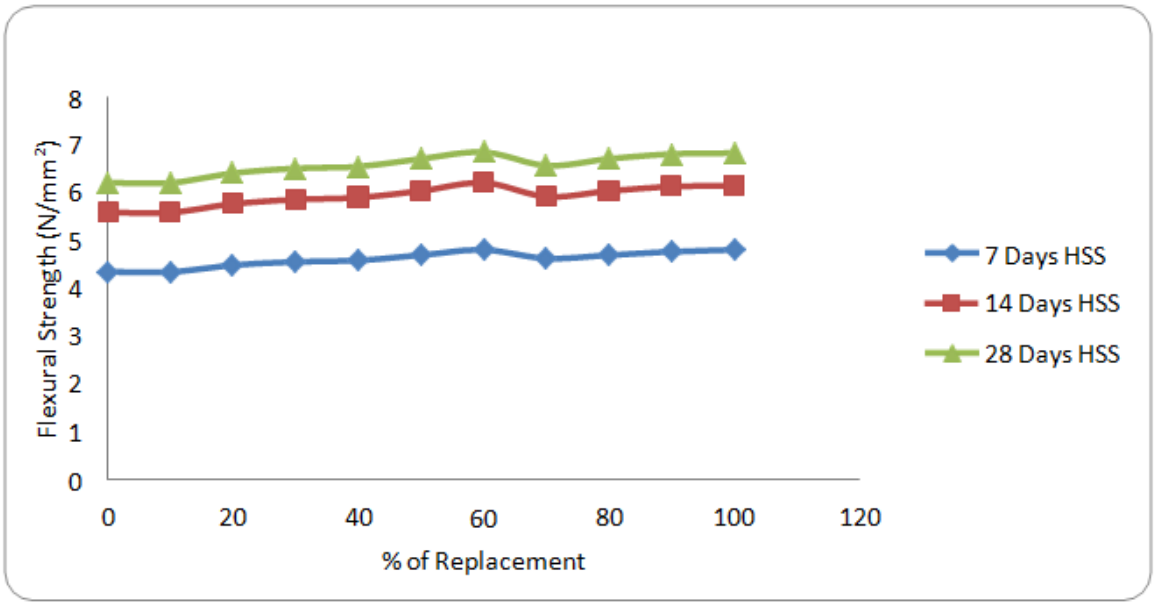


Figure 4 –Influence of water washed sea sand in f_{cr}

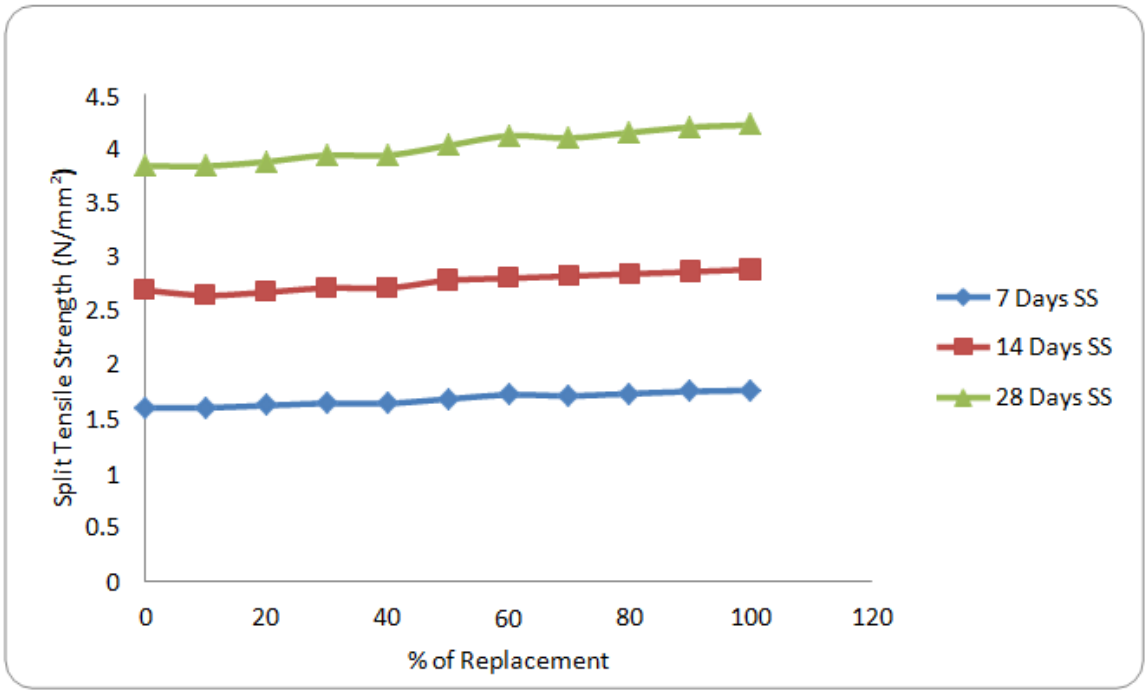


Figure 5 –Influence of water washed sea sand in f_t

International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

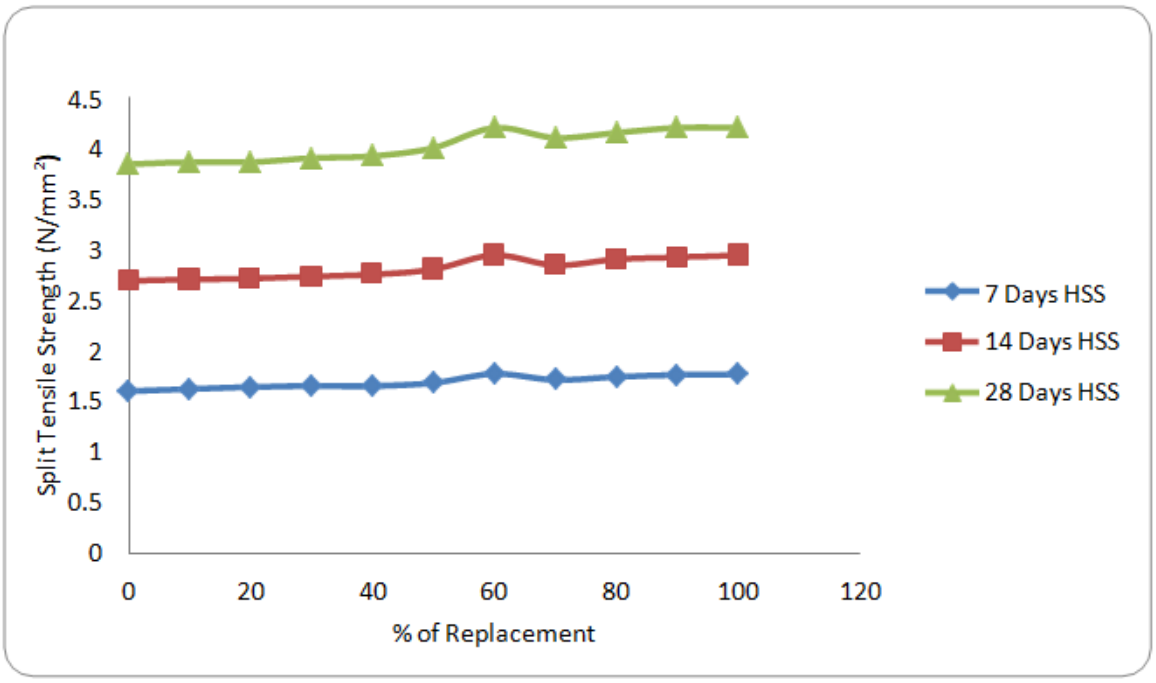


Figure 6 –Influence of water washed sea sand in f_t

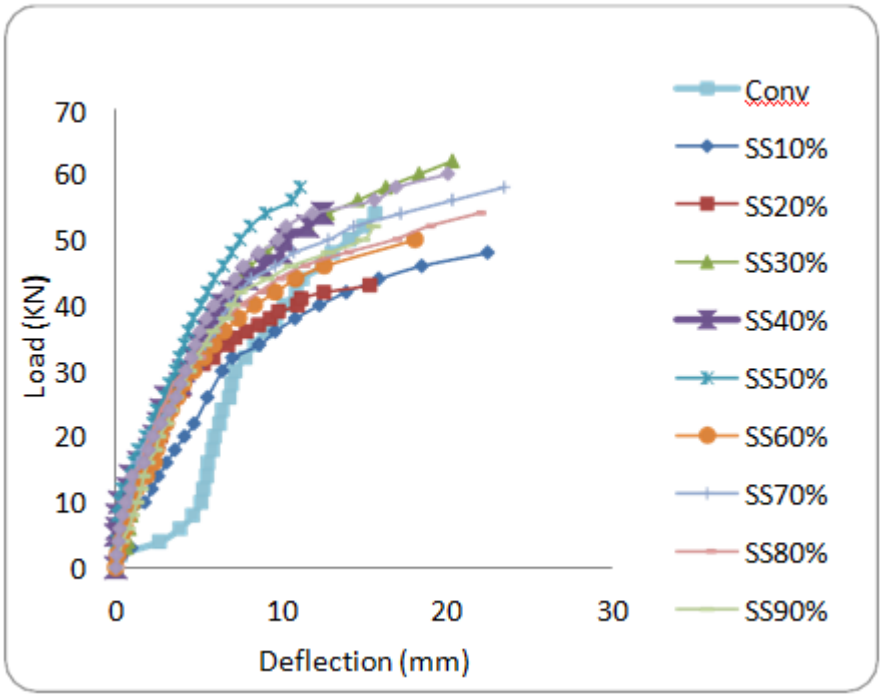


Figure 7 -Load Vs Deflection Response of SS Beams

International Research Journal of Education and Technology
Peer Reviewed Journal
ISSN 2581-7795

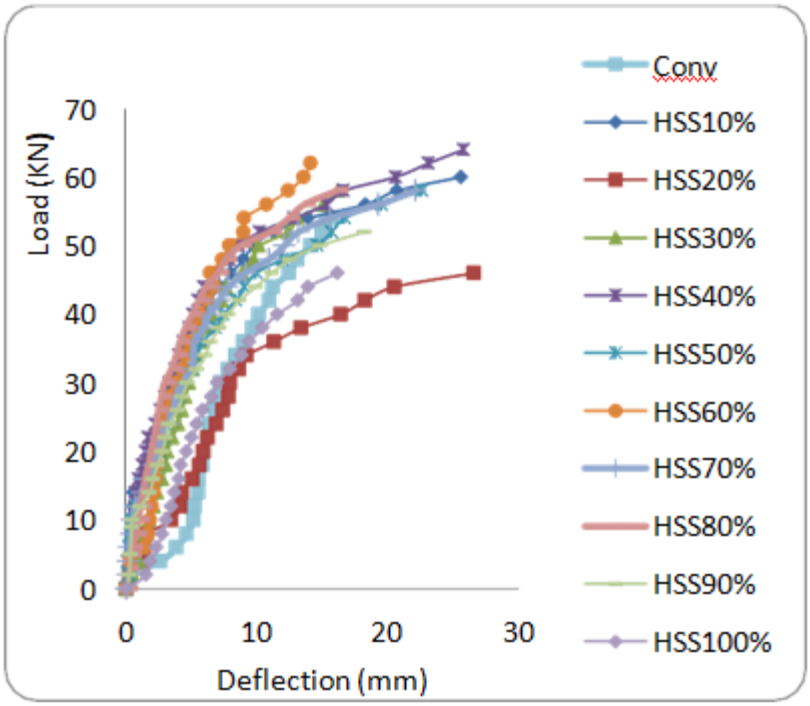


Figure 8 Load Vs Deflection Response of HSS Beams

Conclusion-

The present investigation on the flexural behavior and corrosionpotential of sea sand replaced concrete recommended the following:

i. The Water Washed Sea Sand will be the contemporary material to replace river sand in concrete which behaves better than river sand in all the mechanical, flexural and durability characteristics.

ii. The water wash method can be adopted for removal of chloride and the performance

of Hot Water washed Sea Sand Concrete is also quite mentionable which outright the control concrete in mechanical andflexural characteristics.

iii. The utilization of river sand will be reduced marginally by the usage of sea sand in concrete which protects the river bed, channels, regulates flood and increase the water table level more over it balance the ecology.

iv. It can be widely used for infrastructural development projects such as roadways and housing projects. It is an economical alternative material which will reduce extraction of sand and save in turn aids the environment.

SUGGESTIONS FOR FUTURE WORK

i) Further investigation can be carried out for impact, abrasion and attrition properties of Sea sand replaced concrete.

ii) Durability study may be carried out with the application of various corrosion inhibiting materials as coat in steel reinforcement bars.

iii) Different mineral and chemical admixtures can be tried to enhance the properties of Sea sand concrete.

iv) The role of Sea sand in the confined steel concrete composites and various fibers usage in Sea sand concrete may be investigated.

Since the Sea sand has finer particles which tend to flow easily, it can be tried for self compacting concrete also.

REFERENCES

1. Chandrakeerthy SRS 1994, 'Suitability of sea sand as a fine aggregate for concrete production‘, Transactions, Institute of Engineers, Sri Lanka, pp. 93–114.

2. Chapman, GP & Roeder, AR 1969, _Sea dredged sands and gravels‘, The Quarry

Managers' Journal, Institute of Quarrying Transactions, pp. 251 -263.

3. Chapman, GP & Roeder, AR 1970, _The effect of sea shells in concrete aggregates‘, Concrete, vol. 4, no.2, pp. 71-79.

4. Chapman GP 1968, _The sea-dredged sand and gravel industry of Great Britain. Seadredged aggregates for concrete‘, In Proceedings of a symposiu,.sand and gravel association of Great Britain. Buckinghamshire.

5. Cooper, KM 2013, _Setting limits for acceptable change in sediment particle size composition: Testing a new approach to managing marine aggregate dredging‘, Marine Pollution Bulletin, vol. 73, pp. 86-97.

6. Desprez, M, Pearce, B & Le Bot, S 2010, _The biological impact of overflowing sands around a marine aggregate extraction site: Dieppe (eastern English Channel)‘, ICES Journal of Marine Science, vol. 67, no. 2, pp. 270-277.

7. Dias, WPS, Seneviratne, GAPSN &Nanayakkara, SMA 2008, _Offshore sand for reinforced concrete‘, Construction and BuildingMaterials, vol. 22, pp. 1377-1384.

8. Donza, H & Cabrera, O 1996, _The influence of kinds of fine aggregate on mechanical properties of high strength concrete‘, In Proceedings of 4th international symposium of high-strength/high-performance concrete, vol. 2, pp. 153–60.

9. Donza, H, Cabrera, O &Irassar EF 2002,‘ High-strength concrete with different fine aggregate‘, CemConcr Res, vol. 32, pp. 1755–61.

10. EDE, 2013, Environment Data Explorer, Total road network, Source: International Road Federation, World Road Statistics, GRID-Geneva, United Nations Environment Programme.

11. EDE, 2014, Environment Data Explorer; Emissions of CO2 — from Cement Production (CDIAC), GRID-Geneva, United Nations Environment Programme.

12. Fliert, C 1968, _Experience with sea-dredged aggregates in the Netherlands. Seadredged aggregates for concrete‘, In: Proceedings of a symposium. Sand and gravel association of Great Britain. Buckinghamshire.

13. Fookes, PG &Higginbottom, IE 1980, _Some problems of construction aggregates in desert areas, with particular reference to the Arabian Peninsula: Part 1 - Occurrence and special characteristics‘, Proc. Institution of Civil Engineers, Part 1, pp. 39-67.

14. Gutt, W & Collins, RJ 1987, _Sea-dredged aggregates in concrete‘, Building Research Establishment, Watford, UK.

15. Hamer, K &Karius, V 2002, _Brick production with dredged harbour sediments. An

industrial-scale experiment', Waste Management, vol. 22, pp. 521–30.

16. Hussain, SE, Al-Gahtani, AS &Rasheeduzzafar, 1996, _Chloride threshold for corrosion of reinforcement in concrete', ACI Materials Journal, vol. 93, no. 6, pp. 534-538.

17. IPCC, 2013b. Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

18. Stocker, T.F., D. Qin, G.-K. Plattner, M. Tignor, S.K. Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex and P.M. Midgley (Eds.). Cambridge University Press, Cambridge and New York.

19. IS 10262 2009, Concrete Mix Proportioning - Guidelines, Bureau of Indian Standards, India.

20. IS 2386 1997, Methods of Tests for Aggregates for Concrete, Bureau of Indian Standards, India.

21. IS 383 1970, Specification of Course and Fine Aggregates from Natural Sources for Concrete, Bureau of Indian Standards, India.

22. IS 456 2000, Code of Practice for the Structural use of Concrete, Bureau of Indian Standards, India.

23. IS 8112 1989, Ordinary Portland Cement, 43 Grade - Specification, Bureau of Indian Standards, India.

24. John, E 2009, _The impacts of sand mining in Kallada river (PathanapuramTaluk), Kerala', Journal of basic and applied biology, vol. 3, no. 1&2, pp. 108-113.

25. Katwan, MJ 2001, _Corrosion of steel reinforcement in hot countries, an acute case study', Materials and Structures, vol. 34, pp. 360-366.

26. Kayyali, OA &Haque, MN 1995, _The C1-/OH- ratio in chloride- contaminated concrete – a most important criterion', Magazine of Concrete Research, vol. 47, no. 172, pp. 235-242.

27. Kondolf, GM 1994, _Geomorphic and environmental effects of instream gravel mining', Landscape and Urban Planning, vol. 28, pp. 225–243.

28. Kondolf, GM 1997, _Hungry water: effects of dams and gravel mining on river channels', Environmental Management, vol. 21, no. 4, pp. 553-551.

29. Krausmann, F, Gingrich, S, Eisenmenger, N, Erb, KH, Haber, H & Fischer-Kowalski, M 2009, _Growth in global materials use', GDP and population during the 20th century, Ecological Economics, vol. 68, pp. 2696-2705.

30. Limeira J, Agulló, L &Etxeberria M 2010, _Dredged sea in concrete: an experimental section of a harbor pavement', Construction Building Materials, vol. 24, pp. 863–70.

31. Limeira J, Etxeberria, M Agulló, L & Molina, D 2011, _Mechanical and durability properties of concrete made with dredged sea', Construction and Building Materials, vol. 25, pp. 4165-4174.

32. Mahasenan, N, Smith, S & Humphreys, K 2003, _The Cement Industry and Global Climate Change: Current and Potential Future Cement Industry CO2 Emissions', in: Gale, J., Kaya, Y. (Eds.), Greenhouse Gas Control Technologies. Proceedings of the 6th International Conference on Greenhouse Gas Control Technologies, Kyoto Japan. Elsevier Science 2, pp. 995–1000.

33. Milliman, D &Syvitski, M 1992. _Geomorphic/Tectonic Control of Sediment Discharge to the Ocean: The Importance of Small Mountainous Rivers', Journal of Geology, vol. 100, no. 5, pp. 525-544.

34. Myers, N, Mittermeier, A, Mittermeier, G, da Fonseca, B & Kent, J 2000, _Biodiversity hotspots for conservation priorities', Nature, vol. 403, pp. 853-858.

35. Newman, K 1968, _Aspects of workability, strength, shrinkage and creep', Proceedings of a Symposium, Sea-dredged aggregates for concrete, Buckinghamshire.

36. Padmalal, D, Maya, K, Sreebha, S &Streeja, R 2008, _Environmental effects of river sand mining: a case from the river catchments of Vembanad Lake', Southwest coast of India.

37. Radford, T 2005, _It's the way you tell them, Environment & Poverty Times, 3', Special Edition for the World Conference on Disaster Reduction, Kobe, Japan, UNEP/GRID-Arendal.

38. Rasheeduzzafar, Dakhil, FH &Gahtani, AS 1985, _Corrosion of reinforcement in concrete structures in the Middle East', Concrete International, pp. 48-55.

39. Roeder, AR 1968, _Some technical data on sea-dredged aggregates. Sea-dredged aggregates for concrete', In: Proceedings of a symposium, Sand and gravel association of Great Britain. Buckinghamshire.

40. Saviour, N 2012, Environmental impact of soil and sand mining: a review', International Journal of Science, Environment and Technology, vol. 1, no. 3, pp. 125-134.

41. Sonak, S, Pangam, P, Sonak, M &Mayekar, D 2006, _Impact of sand mining on local ecology in multiple dimension of global environmental change', The Energy and Resources Institute, New Delhi.