International Journal of Technical Innovation in Modern Engineering & Science (IJTIMES),(UGC APPROVED)
Impact Factor: 5.22 (SJIF-2017),e-ISSN:2455-2585
National Conference on
Sustainable Practices & Advances in Civil Engineering (SPACE 2019)
Volume 5, Special Issue 06, June-2019.

EXPERIMENTAL STUDY ON BEHAVIOUR OF RIGID PAVEMENT USING SODIUM BENTONITE BY ROLLER COMPACTION METHOD

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Abstract: The increasing demands to recede the amount of CO_2 liberation from construction industries or fields has led to the development of various cementitious materials. These materials were incorporated in concrete making it inexpensive and eco-friendly without compromising on the mechanical properties of the concrete. Sodium Bentonite, a mineral admixture of this sort, is used as a replacement by weight of cement in designing a roller compacted concrete pavement. Soil compaction method is used to determine the optimum moisture content of various mix proportions. Cylinders were cast with cement percentages 10%, 15% and 20% varying with bentonite percentages of 0% and1% by using roller compaction. Compressive strength is evaluated for 3, 7 and 28 days. Test results stated that 15% of cement had achieved significant compressive strength for the conventional mix at 28 days. Though 20% of cement with 1% of bentonite and 15% of cement with 1% of bentonite has achieved significant strengths, 15% of cement with 1% of bentonite is considered as optimum mix proportion because of the rheology of this mix closer to a roller compacted concrete pavement.

Keywords: Sodium Bentonite, Rigid pavement, Roller compaction, Roller compacted concrete pavement, Compressive strength

I. INTRODUCTION

Over the last two decades, there have been revolutionary developments in relation to new materials for concrete production and to modifications and improvements in the behaviour of traditional materials. These developments are facilitated by increased knowledge of the atomic and molecular structure of materials, studies of long-term failures, the development of more powerful instrumental and monitoring techniques, a decrease in the cost-effectiveness of traditional materials, and better performing materials suitable for larger structures and longer spans, as well as for increased ductility.

The construction industry has advanced considerably in the last two or three decades with respect to the trials in the use of one or another cementitious material generally identified as pozzolans, for the composition of several cement-based products. This has not only resulted in the improvement of the value of the compressive strength achieved, but also in qualities such as the ability to set and harden under water.

Bentonite is a geological extract that is found freely in its natural state. Bentonite is formed from volcanic ash. It is a form of clay that consists of a primary mineral called montmorillonite that gives it its properties. Montmorillonite is a double-layer, two-dimensional mineral that has aluminium and silicate. These minerals give bentonite a layer of cards that look like crystalline packages and are called platelets. For industrial purposes, there are two main classes of bentonite: sodium bentonite and calcium. Sodium bentonite is used in this research.

Sodium Bentonite:

Sodium bentonite expands when wet, absorbing as much as several times its dry mass in water. Because of its excellent colloidal properties, it is often used in drilling mud for oil and gas wells and for geotechnical and environmental investigations.

The property of swelling also makes sodium bentonite useful as a sealant, especially for the sealing of subsurface disposal systems for spent nuclear fuel and for quarantining metal pollutants of groundwater. Similar uses include making slurry walls, waterproofing of below-grade walls, and forming other impermeable barriers, e.g., to seal off the annulus of water well, to plug old wells, or to line the base of landfills to prevent migration of leachate. Sodium bentonite can also be "sandwiched" between synthetic materials to create geo-synthetic clay liners (GCL) for the aforementioned purposes. This technique allows for more convenient transport and installation, and it greatly reduces the volume of sodium bentonite required.

II. LITERATURE REVIEW

Ali Memon etal. (2012) evaluated the feasibility of Bentonite as partial replacement of cement. The workability, density and water absorption decreased when bentonite % increased. In case of Strength activity Index, compressive strength and acid attack bentonite mixes showed higher strength than control mix. Low cost concrete can be produced by substituting bentonite as partial replacement of cement in concrete without compromising on strength parameters [16].

Junaid Akbar et al. (2013) introduced a major variable, sodium bentonite, as a partial replacement of cement by weight of cement.It was seen from the results that Bentonite resulted in poor early stage and good later stage Compressive strength when compared with Control samples.The main conclusions drawn from this research work is that Bentonite can be used in a place where later stage strength is required. And for durability purposes it gives good results at every stage[15].

M. Karthikeyan et al. (2015) investigated the potential use of Bentonite to evaluate its impact on various strength of ordinary Portland Concrete (OPC).Normal compressivetesting was performed for this purpose and the quality of concrete was checked. It was seen from the results that Bentonite resulted in poor early stage and good later stage Compressivestrength when compared with Conventional samples. The bentonite samples werecharacterized by the main variable proportion of bentonite in the natural and intercalatedforms (0, 25, 30, and 35 % by weight of cement for a mix of M25) in the replacement modewhiles the amount of cementations material. At 30% substitute of clay has achieved 19.55%, 2.72% and 8.07% in compressive, split tensile and flexural strength for 28days[12].

III. MATERIAL SPECIFICATIONS

1. cement

OPC 43 grade cement is chosen according to the MORTH code.

Specific gravity	3.11
Fineness	5%
Initial setting time	65 mins
Standard consistency	31%

2. Fine aggregate

Specific gravity	2.46
Voids ratio	0.505
Porosity	34.56
Zone	II

3. Coarse aggregate

Specific gravity	2.66
Impact value	29.41%
Crushing value	32%

4. Sodium bentonite

Specific gravity	2.7
Fineness	10%

IV. MIX DESIGN

The soil compaction method is the most widely used mixture proportioning method for RCC pavements. This proportioning method involves establishing a relationship between the density and moisture content of an RCC mixture to obtain the maximum density by compacting samples over a range of moisture contents. Cement percentages are chosen as 10%, 15% and 20%.

Gradation of Coarse aggregate

Sieve Designation	Percentage by weight passing the Sieve
31.5mm	100
26.5mm	85-95
19.0mm	68-88
9.5mm	45-55
4.75mm	30-55

Gradation of fine aggregate

Sieve Designation	Percentage by weight passing the Sieve
600 microns	8-30
150 microns	5-15
75 microns	0-5

Results obtained from the moisture density plots of soil compaction method are as follows

Cement %	Optimum moisture content
10%	0.45
15%	0.45
20%	0.5

V. RESULTS

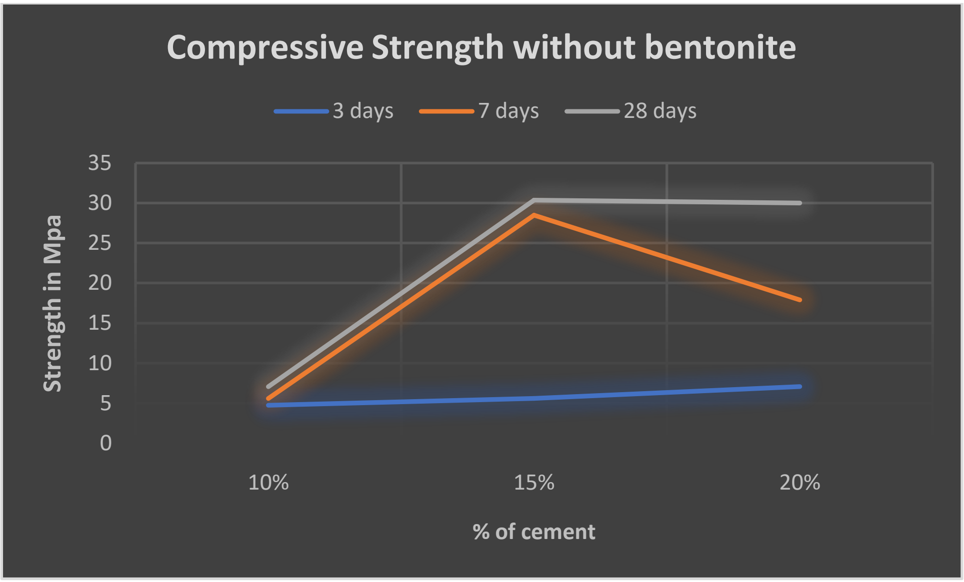

Fig 1: Compressive strength for 3,7 and 28 days without bentonite

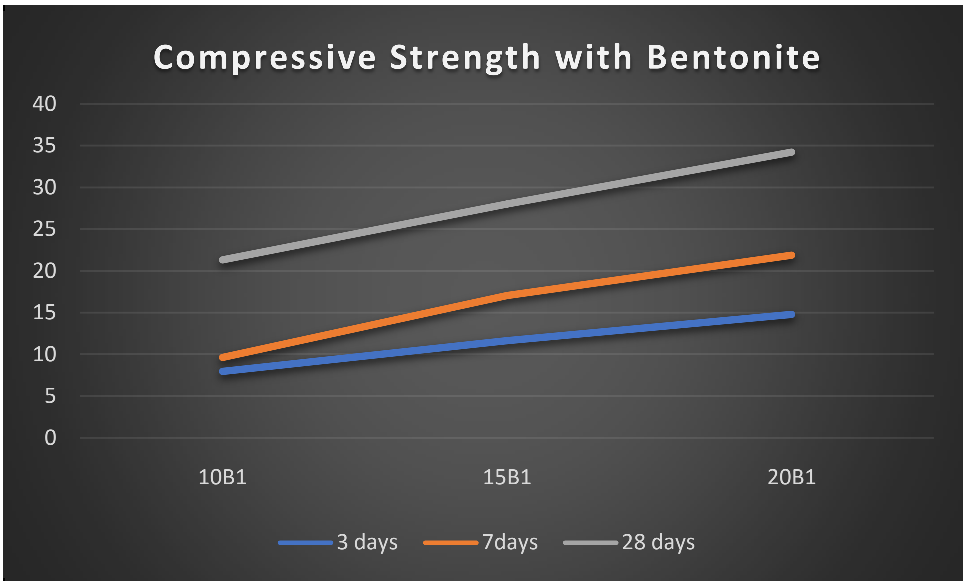

Fig 2: Compressive strength for 3,7 and 28 days with bentonite (B1 refers to 1% of bentonite)

VI. CONCLUSIONS

- Additional water is needed when sodium bentonite is added in normal mix. But for roller compacted concrete, as the required amount of water is less, addition of sodium bentonite to a certain extent doesn't effect the workability of the mix.
- Test results stated that 15% of cement had achieved significant compressive strength for the conventional mix at 28 days.
- Though 20% of cement with 1% of bentonite and 15% of cement with 1% of bentonite has achieved significant strengths, 15% of cement with 1% of bentonite is considered as optimum mix proportion because of the rheology of this mix closer to a roller compacted concrete pavement.

REFERENCES

[1] Ministry Of Road Transport And Highways(MORTH) code (2013) – fifth revision

[2] IS:4031(part1):1996 - Method of physical tests for hydraulic cement, part1 determination of fineness of cement

[3]IS:4031(part 5):1996 - Method of physical tests for hydraulic cement, part5 determination of the initial and final setting time of cement.

[4]IS: 2386(Part 3):1963 - Methods of test for aggregates for concrete: Part 3 Specific gravity, density, voids, absorption and bulking

[5] ASTMC39- Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens

[6] Shah Faisal Saleh, Faisal Farooq Rather, Malik Jasif Jabbar, "Roller-Compacted Concrete (Rcc) And Its Application In Modern World Of Technology", International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395 -0056 Volume: 04 Issue: 04, p-ISSN: 2395-0072, Apr -2017, 87-91.

[7] S.Krishna Rao, P.Sarika, P.Sravana, T.ChandraSekhara Rao, "Evaluation Of Properties Of Roller Compacted Concrete Pavement (Rccp)", IJEAR Vol. 4, Issue Spl-2, ISSN: 2348-0033 (Online) ISSN : 2249-4944 (Print), Jan - June 2014, 88-90.

[8] Chamroeun Chhorn, Seong Jae Hong, Seung-Woo Lee, "A Study On Performance Of Roller-Compacted Concrete For Pavement", Construction and Building Materials 153, 2017 elsevier, 535–543.

[9] Mohammad Hashemi, Payam Shafigh, Mohamed Rehan Bin Karim, Cengiz Duran Atis, "The Effect Of Coarse To Fine Aggregate Ratio On The Fresh And Hardened Properties Of Roller-Compacted Concrete Pavement", Construction and Building Materials 169, 2018 elsevier, 553–566.

[10] Dipesh Vaidya, Jay Patel, Neel Patel, "Roller Compacted Concrete Pavement", International Journal of Advance Engineering and Research Development, e-ISSN : 2348-4470, p-ISSN : 2348-6406, Special Issue SIEICON-2017,April -2017, 1-4.

[11] R.Selvaraj and R.Priyanka, "Characteristics Study Of Bentonite Mortar With Replacement Of Cement", International Journal of Engineering Science Invention Research & Development; e-ISSN: 2349-6185, Vol. II Issue III September 2015, 178-185.

[12] M. Karthikeyan, P. Raja Ramachandran, A. Nandhini, R. Vinodha "Application On Partial Substitute Of Cement By Bentonite In Concrete", International Journal of ChemTech Research, ISSN: 0974-4290, Vol.8, No.11, 2015, 384-388.

[13]Amritha E.K and Neethu Paul , "Evaluation Of The Properties Of Bentonite Concrete With And Without Steel Fibre", International Journal of Scientific & Engineering Research, ISSN 2229-5518, Volume 7, Issue 10, October-2016, 162-166.

[14] Roobankumar, Niyas Ali, ShahulHameed.D.K, Shankar Raj, Syed Ayub, "Eco-Friendly Concrete By Partial Replacement Of Cement With Sodium Bentonite And Flyash", e-ISSN: 2395-0056, p-ISSN: 2395-0072, Volume: 05 Issue: 04 | Apr-2018, 406-408

[15] Junaid Akbar, Bashir Alam, Muhammad Ashraf, Salman Afzal, Asfandyar Ahmad, Khan Shahzada, "Evaluating The Effect Of Bentonite On Strength And Durability Of High Performance Concrete", International Journal of Advanced Structures and Geotechnical Engineering, ISSN 2319-5347, Vol. 02, No. 01, January 2013, 1-5.

[16] S.A.Memon, R.Arsalan, S. Khan, and T.Y.Lo. (2012). "Utilization Of Pakistani Bentonite As Partial Replacement Of Cement In Concrete." Construction and building materials., Vol-30, 237-242.