International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 04 Issue: 05 | May -2020 ISSN: 2582-3930

Partial Replacement of Cement with Bentonite Clay in addition with Coir fiber reinforcement

Atharva Tambolkar[1], Ram Modak[2], Pratiksha S. Pawar[3], Jayshree More[4]

Kailash Biradar[5]

[1,2,3,4](B.E. Students, Civil Engineering Department, D. Y. Patil College of Engineering,Akurdi, Pune)

[5](Assistant Professor, Civil Engineering Department ,D .Y .Patil college of engineering ,Akurdi, Pune)

Savitribai Phule Pune University

Abstract: Sustainability is a wide accepted concept in modern construction scenarioEven though the construction industry is revolutionizing in a significant manner in terms of both equipment and materials used, the cost of construction has skyrocketed along with the deteriorative impact on environment. This resulted in the adoption of a more balanced approach with the environment as its nerve centre to create a better world to live in. This has led to the adoption of a natural fiber like Coconut for the strength enhancement in concrete.

Coconut fiber is available in abundance at the test site, which makes it quite viable as a reinforcement material in concrete. It is an effective method for the disposal of coir mattress waste which will reduce the demand for additional waste disposal infrastructure and decrease the load on existing landfills and incinerators. The problem of high rate of water absorption of the fiber could be reduced by coating the fibers with bentonite. Moreover, the fibers being natural in origin is ecologically sustainable and can bring down the global carbon footprint quite effectively.

Bentonite is an absorbent aluminum phyllosilicate clay consisting mostly of montmorillonite.The different types of bentonite are each named after the respective dominant element, such as Potassium (K), Sodium (Na), calcium (Ca), and Aluminum .

A comparison of strength properties of fiber reinforced concrete is made with respect to conventional concrete and the influence of fibers on strength. The varying fiber contents of 0%,1%,2%,3% that of cement with replacement of 15% of bentonite clay. Material tests were carried out initially to determine the suitability of materials to be used in concrete. The cubes were cured for 7,14,28 days and were properly dried in sunlight before testing.

Keywords : Compressive Strength, Coir fiber, Bentonite clay, Split tensile strength, Flexural strength

I. INTRODUCTION

The advancement in high-performance construction materials, such as the introduction of high strength concrete. Among these high performance materials, fiber reinforced concrete (FRC) is gradually gaining acceptance from civil engineers. In recent years, research and development of fibers and matrix materials and fabrication process related to construction industry have grown rapidly.

A major roadblock towards development of high performance concrete using steel fibers is the high costs involved, availability and also problem of corrosion. Coconut fiber being the most ductile among all natural fibers (Majid Ali et al.,2012) has the potential to be used as a reinforcement material in concrete. It is biodegradable so the impact on environment will be minimal. This is also a way to dispose off the fibers which are derived as waste

materials from coir based manufacturing units to produce high strength materials .They are also non-abrasive in nature ,cheap and easily available.

Bentonite is type of clay that has an ability to swell and gel when dispersed in water which is used in construction mainly in excavation and foundation work.

There are basically two types of bentonite :

1) Sodium bentonite

2) Calcium bentonite

II. Past Investigations

The replacement ratios of Bentonite clay and Coir fiber and their corresponding Mix design strengths from previous experimental studies are given in Table 1.

Table 1 : Replacement ratios of Bentonite Clay& Coconut Fiber

Author	Grade of Concrete	Replacement Ratio	Type of Replacement
M.Aravindhraj & B.T.Sapna	M40	5%, 10%, 15%, 20%	Bentonite clay
Kshitija Nadgouda	M20	3%, 5%, 7%	Coconut Fiber
Shilpa P V & Mrs.Saritha Sasindran	M20	0%, 5%, 10%, 15%, 20% & 40%	Bentonite Clay &40% replacement of Fine aggregate with Steel slag
Parmeshwarlal Sahu, Pankaj Baghmare & Suryakant Pandey	M20	3%, 5%, 7%	Coconut Fiber

III. Compressive Strength

Past investigations suggest that the increase in the quantity of bentonite and coconut fiber shows a reduction in the compressive strength. M.Aravindhraj& B.T.Sapna (2016) replaced Cement with Bentonite Clay with a replacement ratio varying from 5% to 20% and reported that a percentage replacement of 15% Bentonite Clay with Cement was found to have superior concrete compressive strength. On further increase in the quantity of bentonite shows a reduction in the compressive strength. The investigation carried out by KshitijaNadgouda(2015)was done by taking 3%, 5%, and 7 % (by the weight of cement) of coconut fiber in the concrete mix. Coconut fibers were obtained from local market. It was presumed that the compressive strength of concrete goes on decreasing with an increase in the fiber content of the concrete mix. This assumption was found to be correct based on the compressive strength test that was conducted on the cubes with varying fiber content (0%, 3%, 5% & 7%) . It was found that the results did not improve by addition of fibers beyond 5% of the weight of cement in the mix. Hence, the optimum increase in the strength of concrete by addition of fibers lies between addition of fibers between 0% and 3% of the weight of cement in the mix. The investigation of Shilpa P V &Mrs.SarithaSasindran (2018) shows compressive strength test results an increment of strength is observed for concrete with Calcium Bentonite and Steel Slag than plain concrete. Test results shows that 10% replacement of cement with CB and 40 % replacement of M-sand with steel slag gave 20.46% and 23.29% higher compressive strength than conventional concrete on 7th and 28th day. This mix has 6.43% and 1.2% strength reduction on 7th and 28th day respectively. It indicates the later age strength of concrete with CB and SS. The strength gets reduced on further increment of CB in mix. In experimental study of ParmeshwarlalSahu,Pankaj Baghmare& Suryakant Pandey (2017),the investigation was done by taking 3%, 5%, and 7 % (by the weight of cement) of coconut fiber in the concrete mix. At 3% addition of coconut fiber with a water cement ratio of 0.48, compressive strength tests yielded best results. However, the compressive strength decreased with increase in further amount of fibers in concrete.

IV. Split Tensile Strength

Past investigations suggest that the increase in the quantity of bentonite and coconut fiber shows a reduction in the tensile strength. M.Aravindhraj&B.T.Sapna (2016) suggestthat Split tensile strength too shows the replacement of B15% to a maximum an its levels are 38.26%,30.2% and 29.73% in 28,56 and 90 days respectively. On further increase in the quantity of bentonite shows a reduction in the split tensile strength. The investigation carried out by KshitijaNadgouda(2015) ,found that for 1% and 2% fiber content there was increase in tensile strength of concrete.Now, when the test was conducted on concrete with mix containing 3%, 5% & 7% fibers and a graph was plotted representing the variation in the tensilestrength of concrete with the change in fibercontent,it was observed that the tensile strength of concretegoes on decreasing with an increase in the fiber content of the concrete mix. The experimental studies carried out by Shilpa P V &Mrs.SarithaSasindran (2018) found that a slight increase in split tensile strength was observed with 15% Calcium Bentonite addition compared to plain concrete.

Further increment in percentage of CB results in reduction of strength. Split tensile strength of concrete having 0% CB and 40% Steel Slag found to be higher than mixes with 5%, 10%, 15%, 20% CB and 40% SS. The mix with 15% CB and 40% SS shows only 1.89% strength reduction as compared with 0% CB and 40% SS on 28th day. The optimum percentage of replacement of CB observed as 15% on comparison with plain concrete. The decrease in split tensile strength could be attributed to the same factors that reduce the compressive strength. 15% CB and 40% SS give good early age and later age tensile strength than plain concrete.The investigation of ParmeshwarlalSahu,Pankaj Baghmare& Suryakant Pandey (2017) found that the split tensile strength of concrete by taking 3%, 5%, and 7 % (by the weight of cement) of coconut fiber in the concrete mix 5% & 7 % fibers do not show favourable results, it can be concluded that fiber content should not be used beyond 3% .

V. Flexural Strength

Literatures found that the increase in the quantity of bentonite and coconut fiber shows a reduction in the flexural strength. According to M.Aravindhraj&B.T.Sapna (2016) the Flexural strength also shows a increase in strength for B15% of replacement of Bentonite in cement and its levels are 27.44%,27.44% and 31.57% in 28,56 and 90 days respectively. KshitijaNadgouda(2015)shows the variation of the flexural strength of concrete with the change in the fiber content, it was found that the 28th day flexural strength of concrete goes on increasing with an increase in the fiber content of the concrete mix. But, a considerable increase in the strength is observed only in the concrete mix with 3% fibers. After that the 28th day flexural strength of the concrete with the mix having 5% fiber content turns out to be less than that of the concrete mix with 0% fiber content. Flexural strength increases in case of 3% fiber mix. Thus, economy can be achieved in construction. The investigation of Shilpa P V &Mrs.SarithaSasindran (2018) an increase in flexural

strength was observed with Calcium Bentonite addition compared to plain concrete. The concrete having 0% CB and 40% Steel Slag shows high flexural strength of 6.55 N/mm2. With the addition of 5% CB flexural strength reduced to 6.2 N/mm2. The optimum percentage of CB replacement observed as 10% as compared with plain concrete. A flexural strength of 6.5 N/mm2 obtained which is nearly in the same range of concrete having 40% SS. It indicates that less than 1% strength reduction occurred in concrete with 10% CB. Further addition of CB results in reduction of strength.

Conclusion

1. At 3% addition of coconut fiber with a water cement ratio of 0.5, compressive strength tests yielded best results. However, the compressive strength decreased on further fiber addition. This must be due to the fact that when the fibers are initially added to concrete, the finer sized fine aggregates enter into the surface pores in the fiber creating a better bonding between the fiber and mix, however further addition of fibers resulted in formation of bulk fiber in the mix which will lead to decrease in bonding. Hence there is an optimum value of fiber to cement ratio, beyond which the compressive strength decreases. Hence 0.5 was taken as the optimum water cement ratio and optimum fiber content was taken as 3%. Literatures concluded that a percentage replacement of 15% Bentonite Clay with Cement was found to have superior concrete compressive strength.
2. When the fiber content is increased there is an increase in split tensile strength with a maximum at 3%. However when the fiber content is increased beyond this value a reduction in tensile strength is observed. This is due to the fact that tensile failure occurs due to the dislocation of atoms and molecules present in the concrete. However when the fiber is added it acts as a binder holding them together. Literatures found that further increase in the quantity of bentonite beyond 15% shows a reduction in the split tensile strength.
3. When fiber content is increased there is an increase in flexural strength with a maximum at 3% of fiber. However when the fiber content is increased beyond this value a downward slope of the graph is observed. This is also due to the binding properties of coconut fiber owing to its high tensile strength.When Bentonite content is increased there is an increase in flexural strength with a maximum at 15% of bentonite.Further increase in content reduces flexural strength.
4. Due to its relatively higher strength and ductility, It can be a good replacement for asbestos fibers in roofing sheets, which being natural in origin pose zero threat to the environment .
5. From the results obtained it can be concluded that Bentonite can be used in structural concrete as a partial replacement, by weight of cement, to produce durable and reliable concrete.

References

1) Neeraj Agarwal, Research on Coir Fiber Reinforced Cement Concrete, International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056

2) Parmeshwar lalSahu , Pankaj Baghmare, USE OF COCONUT FIBER IN FIBER REINFORCED CONCRETE, IJAERD- International Journal of Advance Engineering & Research Development

3) Yalley, P. P. and Kwan, A.S K., USE OF COCONUT FIBERS AS AN ENHANCEMENT OF CONCRETE, International Journal of Advance Engineering & Research Development

4) M.Aravindhraj, B.T.Sapna, Influence of Bentonite in Strength and Durability of High Performance Concrete, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056

5) Rakesh Kumar, Pankaj Goel, Suitability of Synthetic Fiber for the Construction of Concrete Pavements, Journal of Scientific & Industrial Research Vol. 73, July 2014, pp. 448-452

6) S. Nallusamy a, R. Suganthini Rekha, Investigation on Mechanical Properties of Coir Fiber Reinforced Polymer Resin Composites Saturated with Different Filling Agents, IOP Conf. Series: Materials Science and Engineering 225 (2017) 012283 doi:10.1088/1757-899X/225/1/012283

7) U.S. Bongarde, V.D. Shinde, Review on natural fiber reinforcement polymer composites, ISSN: 2319-5967 ISO 9001:2008 Certified International Journal of Engineering Science and Innovative Technology (IJESIT) Volume 3, Issue 2, March 2014