International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-4, February 2020

Assessment of the Polypropylene Fiber Reinforced Concrete with Wastewater Lime Sludge

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Abstract*: The study investigated by the reuse of wastewater lime sludge is replaced for cement and addition of polypropylene fiber in the production of concrete for external use. The textile wastewater covers the cotton dyeing and printing operations. Nowadays the demand of cement has concern increased. This will contribute to increased cement production because of the cement industry is one of the major subscribers of carbon dioxide emission [15-18]. This work is directed towards developing low cost concrete from wastewater treatment plant. The study utilized in the sludge-cement replacement percentages of 10%, 20%, 30%, 40% and 50% by weight of cement. The test conducted on concrete examines were slump test, compaction factor test and then the mechanical properties on cube, cylinder, Beam and also NDT tests. Finally, the study concluded that the dry sludge can be used in as an improver to concrete mixture till up to 30%. Many more researches are needed to evaluate the durability of sludge concrete and the performance of reinforced sludge concrete.

Keywords: Sludge-Cement replacement, Polypropylene Fiber, Wastewater management, Concrete mix.

I. INTRODUCTION

Nowadays a building construction is done by based on the concrete utilization. Concrete is basically as a man-made construction materials[19-21] . High quantity of energy for which it takes a lot of oil resources requires by production of cement. And it will create a green house effects. The utilization of cement is increased day by day[22-26]. Low cost energy saving for replacement for cement by using industrial wastages(Acharya and Patro, 2016). Concrete is made by the addition of cement, water and aggregates and sometimes add by the admixtures. It is best material to choose construction to giving strength, impermeability, durability and fire resistance(R and Patil, 2014).

Revised Manuscript Received on February 28, 2020.
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The cost of disposal and treating of sludge contents is relatively high for wastewater treatment plants. The operating cost is high to developing the sludge treatment process. In each year 456 tones quantity of sludge is produced from treatment plants(Alqam, Jamrah and Daghlas, 2011).One of the biggest problems in our society is disposal of wastewater sludge. In nowadays the wastewater sludge is disposed by the use of land filling, ocean disposal and agricultural use. The recent researches has found by the sludge was used on the construction field(Ing et al., 2016).The compressive strength of concrete was decreased due to the use of sludge – cement replacement. The addition of polypropylene fiber has improved the tensile and flexural strength of the concrete. And it was prevention of growth of cracks in concrete(Abaeian, Behbahani and Moslem, 2018).Polypropylene fiber is to prevent the spalling of concrete and it was arrest the cracks and to give the high strength and durability. Monofilament or multifilament PP fibers type exposed a lower tendency for heat-induced concrete spalling relative to those cast list with fibrillated PP fibers(Maluk, Bisby and Terrasi, 2017).

II. MATERIALS AND METHODS

Cement

The cement produces less heat of hydration and offers greater resistance to the attack of aggressive waters than ordinary Portland cement(IS: 456-1978).This project was done by used only Ordinary Portland cement of 53 grades. Because of this is most important type of cement (IS: 12269-1987). It is used possible to develop the qualities of cement by using high quality limestone. Normally, high grade cement is used to offers many advantages of making in concrete. And it was little cost varied to use other low graded cement. It is the quickest rate development of the concrete(M.S. Shetty, 2006).

Fine Aggregate

Manufactured sand is an Eco friendly and economical alternative to river sand. The manufactured sand should be crushed proper gradation by using of suitable machines (M-sand particles size varies from 150 microns to 4.75 mm). Manufactured sand is very economical with comparison of river sand.(Yamei and Lihua, 2017)

Coarse Aggregate

The parts from 20 mm to 4.75 mm are utilized as coarse total. Coarse aggregates derived from partially crushed stones. So the workability is good.

The aggregate serves as reinforcement to act strength to the overall composite material. These aggregates are used as under foundations, roads, railroads.

Wastewater Sludge

The lime sludge is an unavoidable by product of primary, secondary and advanced waste water treatment process. The most widely used final disposal method of sludge is putting it into landfills. The dewatering is act like gravitation setting and another treatment involves an incineration process it is available to treat the lime sludge(Barrera-Díaz et al., 2011). The material synthetic lime muck is produced high amount after physico-concoction treatment utilizing lime and ferrous sulfate in like manner gushing treatment plants using treating textile waste water. In recently it is either removal in landfills or is dumped with no appropriate treatment (Patel and Pandey, 2009).The textile lime sludge is a byproduct of wastewater treatment plant. In this system the higher amounts of lime system may affect the environment and surrounding peoples in current trends. In sludge disposal in handled the various ways in disposal of lime sludge in land is cheapest way as it enables crop to be grown on poor land.(Ing et al., 2016).

Polypropylene Fiber

The distribution of fibers into concrete is one of the techniques to improve building properties of concrete. Polypropylene Fiber is one of the synthetic fibers and it's received as a by-product from textile industry. There are available in the variable aspect ratios and cheap in cost. There are characterized by low specific gravity and low cost. In this fiber is used to the concrete in reduction of plastic shrinkage cracking and minimizing of thermal cracking. It is provides reinforcement and prevents spalling in case of fire and protects damage of concrete structures (Dharan and Lal, 2016).

III. RESULT AND DISCUSSION

Slump Cone test

The Slump cone test is to evaluate the workability of the concrete as per the IS code provisions . In this study, slump values are found to be true slump. The slump value differs of 2cm from the sludge mixed concrete to control concrete.The Slump cone value is shown in fig 1.

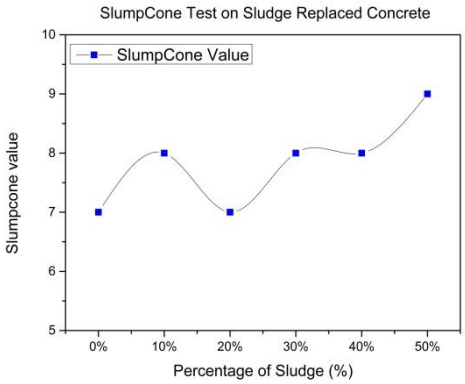


Fig 1.slump cone test

Compaction Factor

The compaction factor test is to evaluate the compaction capacity of the concrete without any application of external force. The Lime sludge mixed in concrete with various properties such as 10%, 20%, 30%, 40% and 50%. In this study, compared with other mix proportions, the most value reached in percentage of 30% of sludge replaced concrete. The compaction factor value is shown in fig 2.

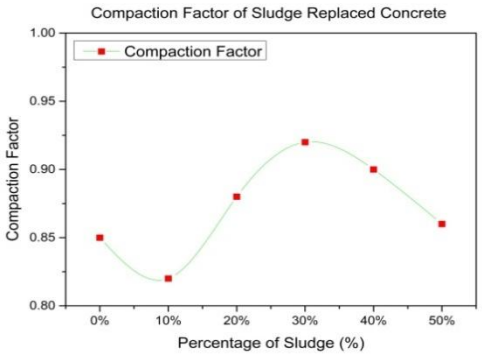


Fig 2.Compaction factor test

Compressive Strength Test

Compressive Strength tests were carried out on cubes of 150 mm size using a compression testing machine of 2000 KN capacity as per IS 516:1959. The testing water used for curing must be tested every 7days and also the temperature of water must be at 27±2oC. Remove the specimen from water after specified curing time and wipe out excess water from the surface. The compressive Strength value is shown in fig 3.

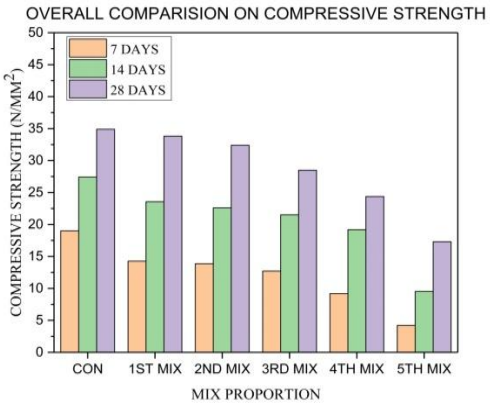


Fig 3.Compressive strength test

Split tensile Strength Test

Split tensile Strength tests were carried out on cylinders of 150 mm diameter and 300 mm height using a CTM of 2000 KN capacity as per IS 516:1959.Tensile strength decreased due to the addition of sludge in concrete. The Split tensile Strength value is shown in fig 4.

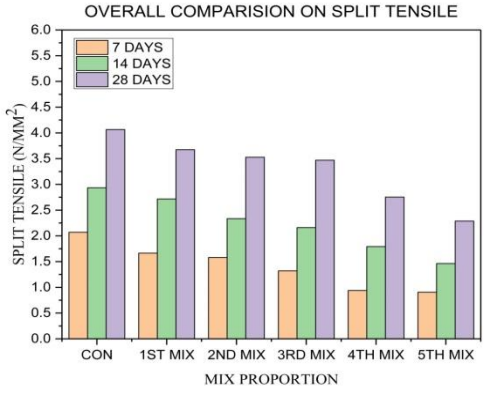


Fig 4. Split tensile strength test

Flexural Strength Test

To decide the Concretes Flexural Strength, which becomes an integral factor when a slab of the road with a deficient sub-grade is exposed to wheel loads and/or there are volume changes Because of temperature/shrinking (IS:516-1959). The consequence of the flexural quality of sludge concrete was shown in figure. In this graph, flexural strength of sludge concrete is constituted for 28 days test of beam. All beams casted are of same dimensions with variation in sludge replaced percentage. The size of the beams casted is of length 2000 mm, breadth 150 mm and depth 150 mm. The clear cover of 25 mm is provided on top and bottom of the beam. Beams are tested under two point load with aspect ratio (l/d) and comparing the flexural strength.(Fu, Wen and Wang, 2011)The beam Flexural Strength value is shown in fig 5.

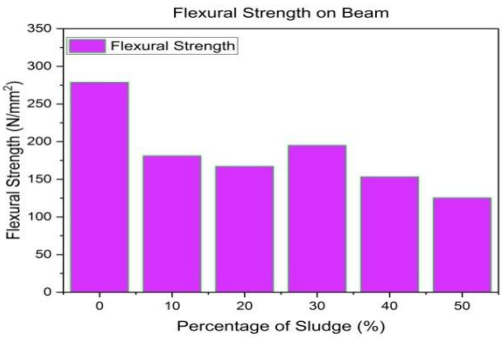


Fig 5.Flexural strength on beam

Non-Destructive Test (NDT)

The NDT test was conducting less time consuming and comparatively inexpensive. The concrete is one of the complicated materials so the efficiency and quality cannot be accomplished by conducting just one single test. Many tests which are conduct to determine all parameters of concrete and are following as Ultrasonic Pulse Velocity Method, Rebound Hammer test.(M.S. Shetty, 2006).

Rebound Hammer Test Rebound hammer is used to determine the surface hardness of the concrete material. The various types of Rebound hammer having different impact energy varies from 0.07 kg m to 3 kg m. Rebound hammer is applying the surface of the concrete and mentioning the rebound reading indicated by over a scales. The Rebound Hammer Strength value is shown in fig 6(a and b).

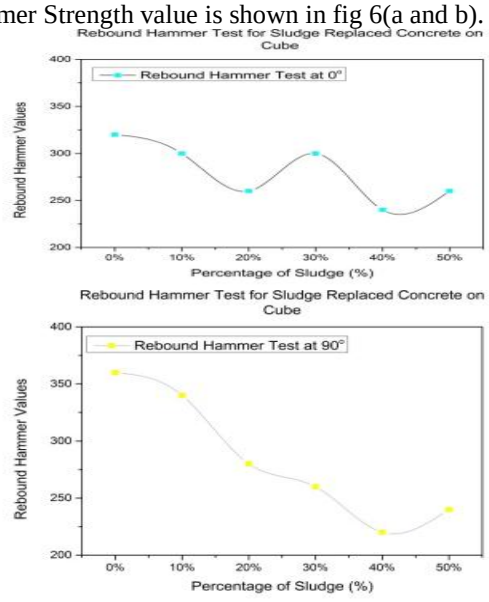


Fig 6.a.Rebound hammer at 00 test Fig 6.b.Rebound hammer at 900 test

Ultrasonic Pulse Velocity Method

The UPV test is used to determine the velocity of the pulses of longitudinal vibrations going through the concrete. The UPV method is normally accepted around the world and produced light weight equipment. The formula for UPV is V = L/T. Each specimen has been test made of direct, semi-direct and indirect method. In this study shows for both control and sludge replaced concrete. Fig (a, b and c) shows through graphical representation.

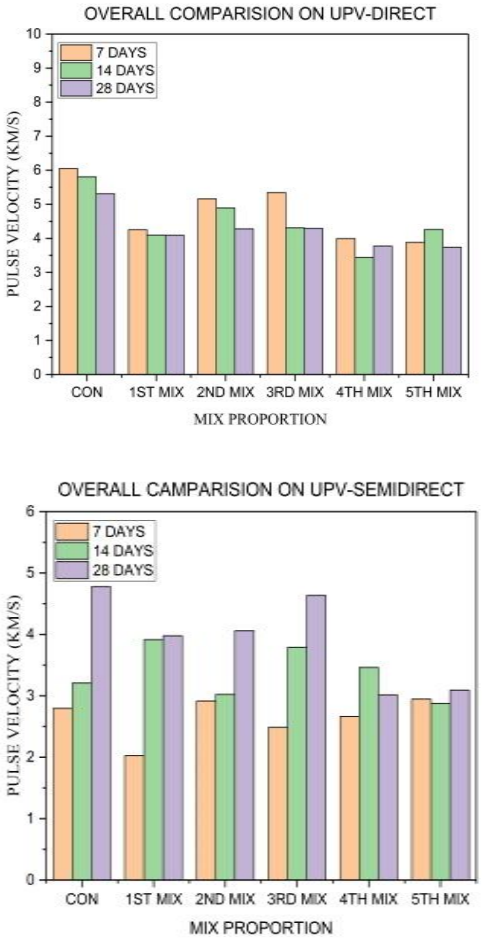
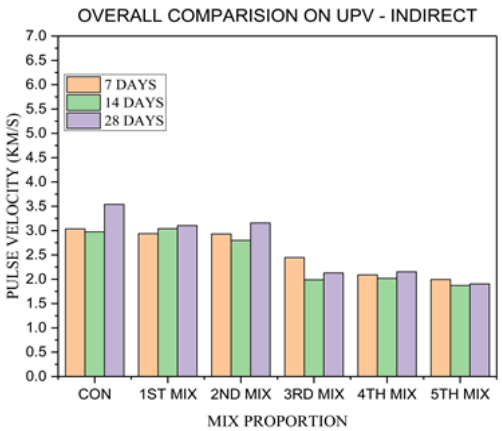


Fig 7. a. UPV- Direct transmission b. UPV- Semi-Direct transmission



c. UPV- InDirect transmission

IV. CONCLUSION

The study is attained sustainability in construction industries. This study is programmed to replace the lime sludge in concrete as 10%, 20%, 30%, 40%, and 50%. The optimum of the above 30% is given best results when compared to all other proportions. In addition to the sludge the polypropylene fiber is added with varying proportion from 0.5 to 2.5% with the weight of cement. In which the concrete is casted with 0.5 to 2.5% of polypropylene fiber with weight of cement. While comparing the results of all the proportion lime sludge reduces the strength of the concrete.

The addition of sludge decreases the strength of concrete. The workability is reduced and with addition of fibers. The surface area of polypropylene fiber is more. The experimental study is indicate the concrete is 0.5% to 2.5% of the polypropylene fiber by volume of concrete exhibit convincing behavior under the compression and flexural. The marginal enhancement in compression strength recorded due to fiber inclusion the maximum percentage of improvement in compressive strength compared to the conventional concrete. Considerable amount of flexural and split tensile strength the percentage is increased with the tension by incorporating the polypropylene fiber is respectively compared to the conventional concrete. The toughness of the FRC specimen was increased since the fiber performance as crack resisters. The separate mix proportion is required to attain maximum strength. The efflorescence of the fresh concrete should be minimized.

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