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Hypo Sludge and Steel Fiber as Partially Replacement of Cement and Sand in Concrete by Adding Superplasticizer: An Experimental Study

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Abstract: ***Based on laboratory experiments to identify mechanical parameters including compressive strength, split tensile strength, and flexural strength carried out after 7 days and 28 days of curing, conclusions were drawn. Utilizing pertinent Indian Standards, experiments and concrete mix design were carried out. The findings show that up to a certain point, adding both HS and SF increases the compressive, tensile, and flexural strength of concrete at all curing ages. The ideal ratio of 20% HS, 2% steel fibre, and 800 ml of super plasticizer to give concrete optimal strength and workability as well as an initial and final setting is 20% HS, 2% steel fibre, and concrete. At 7 and 28 days, compressive strength has been obtained 24.78 N/mm2 and 43.72 N/mm2. After seven and twenty-eight days, the split tensile strength is 7.66 N/mm2 and 5.87 N/mm2, respectively, while the flexural strength is 2.94 N/mm2 and 3.85 N/mm2. HS and SF mixed concrete is 6.51 percent less expensive than regular concrete.***

Keywords: super plasticizer, steel fibre, flexural strength, split tensile strength, compressive strength.

I. INTRODUCTION

Through the integration of industrial waste into concrete, the environment and energy can be saved. The use of these by-products offers environmental advantages like diversion of the material from the waste bodies, reduction of the energy used in processing virgin materials, usage of virgin materials and a decrease in pollution. For the production of ordinary Portland Cement (OPC), we use earth resources like limestone.

During the manufacturing of one tonne of OPC, an equal amount of carbon dioxide is released into the atmosphere, which is harmful to the environment. So, there is a need to choose an alternative. In urban cities, solid waste management is a very challenging task, which is a critical pollution problem. The reason is the generation of large quantities of solid waste. Also, at present, the cost of cement is increasing day by day.

It is necessary to use industrial waste products in an appropriate manner to reduce environmental problems and costs. Many research organizations are doing massive work on waste materials concerning Paper mill sludge is a major environmental and economic issue for the board and paper industry. The material is a by-product of the de- inking and re-pulping of paper mills. The paper industry is the primary source of hypo sludge, as it generates a large amount of waste hypo sludge. It is estimated that around 18% of waste (sludge) is generated during the production of pulp.

Hypo sludge contributes advantageous properties to the concrete while helping to maintain the economy. Therefore, numerous contemporary research works have focused on the application of hypo sludge in cement and concrete production to attain sustainable development. Many researchers have investigated the possibility of using the paper industry waste in concrete production. Disposal cost of paper industries can be reduced by using hypo sludge in concrete and produced the green concrete for construction.

II. LITERATURE REVIEW

Balamuruganand and Karthickraja (2018), studied an experimental investigation on strength of concrete with the optimum percentage of the partial replacement by replacing cement via 5%, 10%, 15%, and 20% of hypo sludge. The tests were carried out to evaluate the mechanical properties like compressive strength up to 28 days. Up to 10% of hypo sludge concrete, the compressive strength has been raised, so upto 10% cement has been replaced by hypo sludge. By replacement of cement by hypo sludge the cost of construction could be minimized. If silica is added, the strength will be considerably increased because of lack of silica in hypo sludge.

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Kumar and Murari (2018), experimental studies are carried out with addition of 0%, 0.5%, 0.75% and 1% polypropylene fibers in natural aggregate concrete (NAC) and recycled aggregate concrete (RAC). The recycled aggregate concrete is prepared with 100% replacement of recycled coarse aggregate with natural coarse aggregate. Compressive strength initially increases with fiber content up to 0.5% and then decreases with further use of fibers. The maximum value obtained in case of NAC is 3.68MPa for 0.5% fiber content, an increment of 18.01%.the maximum value obtained in case of RAC is 3.12MPa for 0.5% fiber content, an increment of 10.25% for split tensile strength. The maximum value obtained for NAC is 5.56MPa which is 17.15% increase. For RAC, the maximum value obtained is 3.86MPa, an increase of 12.26 % for flexural strength.

Pingle and Saraswat (2018), in this study the material obtained from the paper industry waste (hypo sludge) is partially replaced with Portland cement at different replacement levels. The properties of concrete were investigated which includes workability, setting time, compressive strength and optimum percentage of hypo sludge as supplementary cementations material (SCM) is also determined. This dissertation discusses various combination of cement with hypo sludge in concrete. Earlier study shows that hypo sludge is very rich in lime content and thus it works as a partial replacement material in concrete. Past studies also shows that the presence of silica, magnesium and calcium in hypo sludge makes it similar to that of cement and hence there is a possibility to replace cement with hypo sludge. The hypo sludge can minimize the demand for cement and reduce the construction cost. This dissertation deals with experimental investigations to evaluate the optimum percentage of hypo sludge to be used for manufacturing concrete. M30 and M40 grade of concrete were used in this study. Different percentage of hypo sludge i.e., 3%, 5%, 7%, 10% and 12% is replaced by OPC cement of 43 grades. The outcome demonstrates that the quality of the solid increments by adding hypo sludge up to 10%. Be that as it may, additionally increment in hypo sludge diminishes the compressive strength.

kaur et al. (2018) In developing countries like India, approach to sustainable development has become as important as economic development. Sustainability issues have grown with the increase in industrialization which has led to environmental pollution to the land as well as to water bodies. Industrial wastes such as fly ash (from thermal plant), hypo sludge (from paper mill industry) etc. which are purely inorganic, generated annually leading to the problem of their disposal. Also, cement production accounts in releasing carbon dioxide which is an alarming warning to the environment. To conserve the natural resources attempts have been made though concrete technology. So replacement with the industrial waste as supplementary material in the concrete will help out to solve the problems stated above. This paper deals with the experimental investigation of the concrete strength blended with hypo sludge. Hypo sludge with 0%, 5%, 10%, 15% and 20% percentage was used in M-20 concrete mix. The parameters such as workability, compressive strength, splitting tensile strength and flexural strength were tested. The strength was checked after 7, 14 and 28 days.

Vashistha et al. (2019) This review paper encompasses the inclusive approach of lime sludge valorization in construction materials. Research studies based on cement and aggregate replacement by lime sludge concludes that 10–30% lime sludge is gainfully utilized in sustainable concrete and mortar. Additional prospect for lime sludge application in construction material is the production of cement and ceramics. Significant use of lime sludge in combination with supplementary cementitious materials such as silica fume, nanosilica and fly ash is recommended for the production of cement components and ceramics. The recommendations are also suggested in accordance with the outcome of the study.

Naitam and khan (2019), explained in their paper innovative use of hypo sludge in concrete formulations as a supplementary that cementitious material was tested as an alternative to traditional concrete. These tests were carried out to evaluate the mechanical properties like compressive strength up to 28 days. This research work is concerned with experimental investigation on strength of mortar and optimum percentage of the partial replacement by replacing cement via 4% to 16% of Hypo Sludge. Keeping all this view, the aim of investigation is the behavior of mortar while adding of waste with different proportions of Hypo sludge in mortar by using tests like compression strength.

Kumar et al. (2019), in this study total five concrete mixes were made with steel fiber in dosages of 2.5%, 2%, 1.5%, 1% and polypropylene fibers are in dosage 0%, 0.5%, 1%, 1.5% of the weight of concrete mix. The specimens were casted and all the specimens are tested for 7days and 28 days strength. The results have depicted a gradual increase in the strength of the concrete as the fiber content increased. The compressive strength values obtained for mix1, mix2, mix3 and mix4 is 55.8mpa,56.2mpa, 58.6mpa, and 59.8mpa respectively. Results depict that 1.45%, increase in its strength for mix1, 2.18%, increase in its strength for mix2, 6.54%, increase in its strength for mix3 and 8.72%, increase in its strength for mix4.The split tensile strength obtained for conventional concrete at 28 days of curing is 3.42mpa, and the split tensile strength values obtained for mix1, mix2, mix3 and mix4 is 3.67mpa, 3.88mpa, 4.01mpa and 4.32mpa.Results depict that 7.3%, increase in its strength for mix1, 13.45%, increase in its strength for mix2, 17.25%, increase in its strength for mix3, and 26.31%, increase in its strength for mix4.when compared to conventional concrete.

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The flexural strength obtained for conventional concrete at 28 days of curing is 4.82mpa, and the flexural strength values obtained for mix1, mix2 mix3 and mix4 is 5.01mpa ,5.26mpa, 5.69mpa and 5.88mpa. Results depict that 4.2%, increase in its strength for mix1, 9.12%, increase in its strength for mix2, 18.04%, increase in its strength for mix3, 21.99%, increase in its strength for mix4. When compared to conventional concrete.

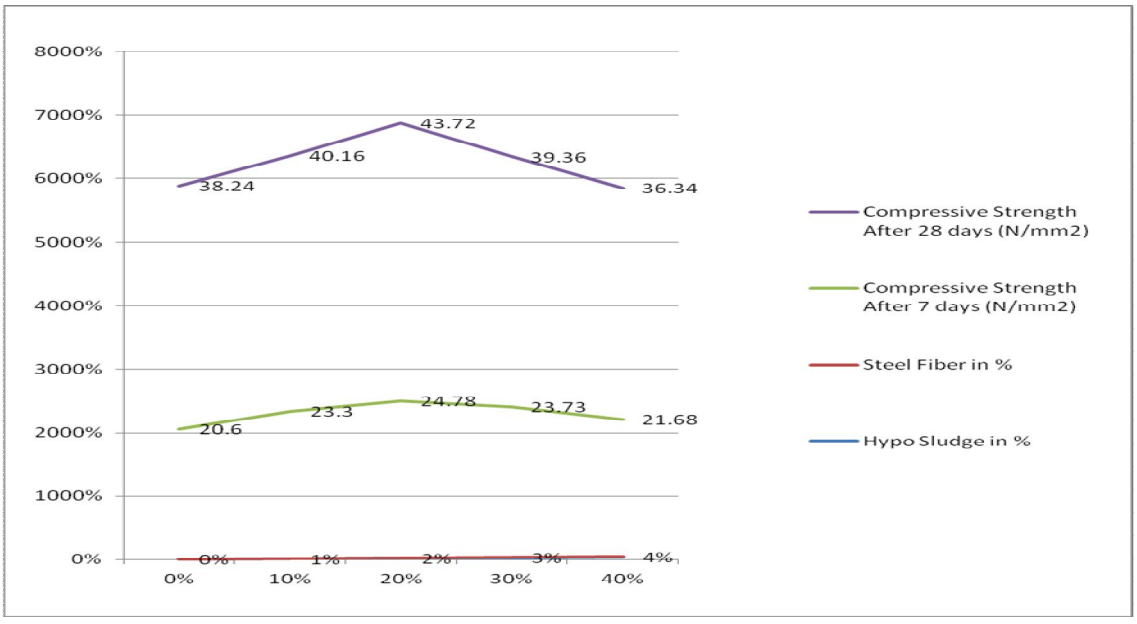
Naitam and Khan (2019), The innovative use of hypo sludge in concrete formulations as a supplementary cementation's material was tested as an alternative to traditional concrete. These tests were carried out to evaluate the mechanical properties like compressive strength up to 28 days. This research work is concerned with experimental investigation on strength of mortar and optimum percentage of the partial replacement by replacing cement via 4% to 16% of Hypo Sludge. Keeping all this view, the aim of investigation is the behavior of mortar while adding of waste with different proportions of Hypo sludge in mortar by using tests like compression strength.

III.CEMENT COMPOUNDS

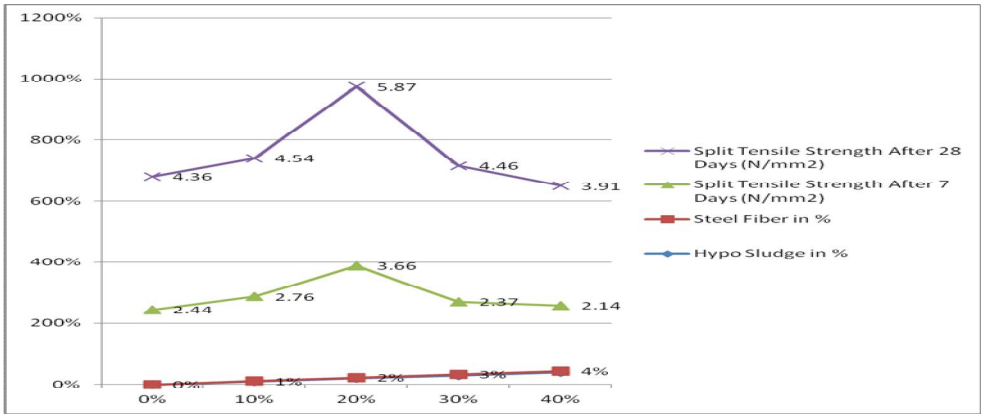
It has 4 principal compounds which known as clinker factors (C3S, C2S, C3S and C4AF) respectively. These compound present in the range of 45-60 %, 15-30%, 6-12% & 6-8 % respectively. The C3S and C2S compound are provide strength in the cement paste for that reason it is more important to another compound. These all compound responsible for strengthening of cement at different ages of water curing .



Figure 1 OPC Cement (43 Grade)



Graph 1. Combine Compressive strength in N/mm2 for all % of HS and SF with Superplasticizer at 7 days and 28 days



Graph 2 Combine split tensile strength in N/mm2 for all % of HD and SF with Super plasticizer at 7 days and 28 days

IV. CONCLUSION

Based on the above study following conclusions can be made

1) HS and SF waste material improves the compressive strength, split tensile strength and flexural strength of concrete.

2) The addition of waste HS and SF increases the strength of concrete for all curing ages up to a certain point. After that there is an abrupt reduction in the strength of the HS and SF mixed concrete. Because at higher dosage, concrete loses its ability to make a proper bond.

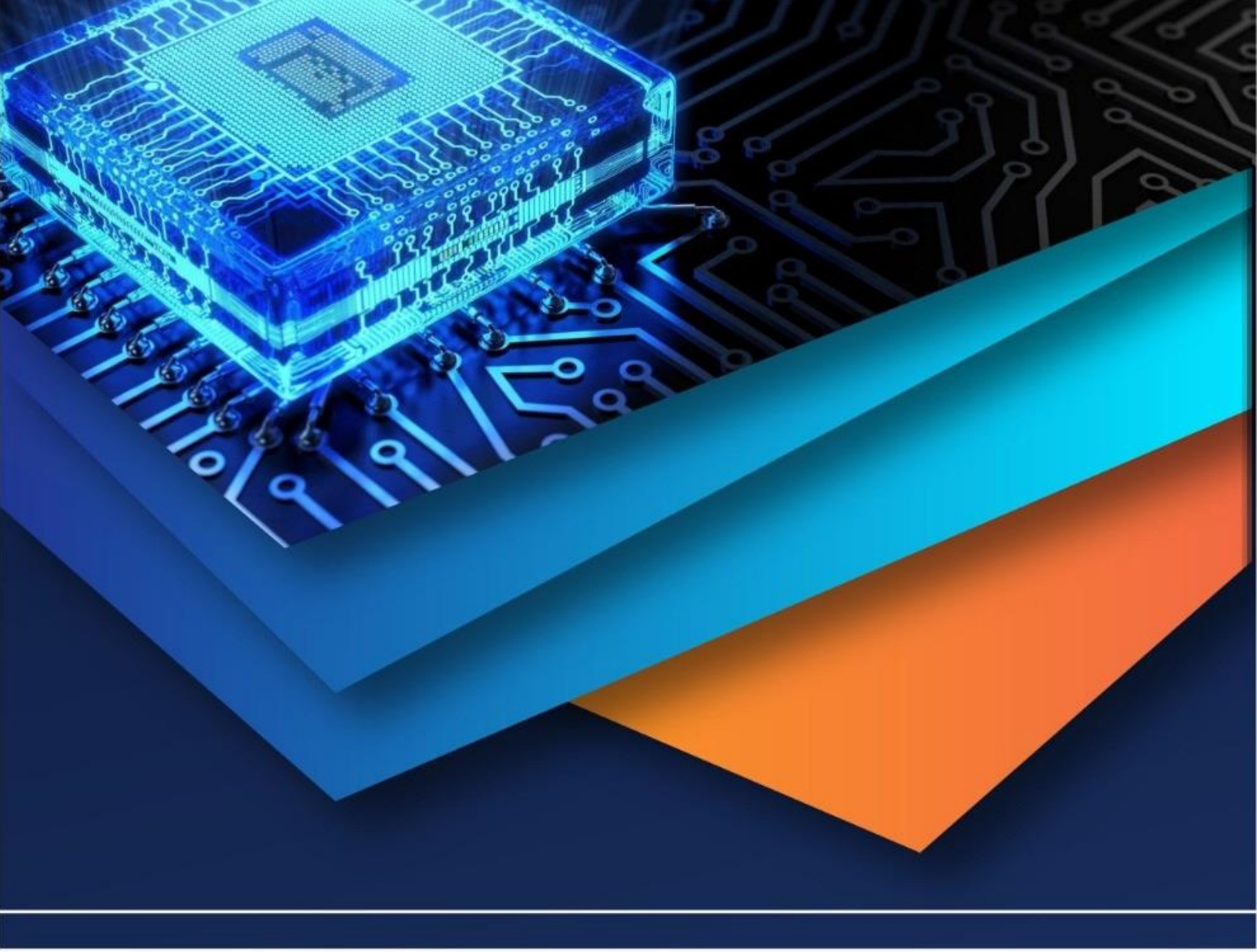
3) The gradual increase is seen in the compressive strength of Hypo Sludge and Steel Fiber mixed concrete at 7 days and 28 days of curing with 20% addition of HS and 1% addition of SF in the amount of 43.72 N/mm2, but after that it starts reducing the compressive strength with an increase of HS and SF addition and the mix which gives the maximum compressive strength is Mix 3.

V. ACKNOWLEDGMENT

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