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Experimental Studies on Cement Concrete by Partially Replacing Individually Cement by Hypo Sludge and Sand by M-Sand

E. Devakumar¹, C. Krishnaveni²

M. Tech, Department of Construction Engineering and Management, SRM University, Kattankulathur, India¹

Assistant Professor, Department of Civil Engineering, SRM University, Kattankulathur, India²

ABSTRACT: The rapid increase in construction activities leads to active shortage of conventional construction materials such as cement, fine aggregate and coarse aggregate. To meet this construction demand we are using Hypo sludge as an alternative to Cement and M-Sand for River Sand in certain percentage. In the world of concrete many artificial pozzolans are found by research such as fly ash, blastfurnace slag, silica fume, rice husk ash, etc.

Paper making generally produces a large amount of solid waste, these wastes are called as Hypo Sludge. Paper fibers can be recycled only a limited number of times before they become too short or weak to make high quality paper. Hypo sludge behaves like cement because of silica and magnesium properties.

The natural river sand was the cheapest resource of sand. However the excessive mining of river bed to meet the increasing demand for sand in construction industry has led to the ecological imbalance in the country. A few alternatives have come up for the industry to bank on of which manufactured sand or M-sand, as it is called, is found to be the most suitable one to replace river sand. Usage of M-Sand can overcome the defects occurring in concrete such as honey combing, segregation, voids, capillary, etc.

In this Experimental study we are replacing various quantity of Hypo sludge and M-Sand (10%, 15%, and 20%) individually in plain cement concrete of the grade M20, M25 and M30. And comparing the compressive strength of the concrete cubes with the conventional concrete cubes.

KEYWORDS: M-Sand, Hypo Sludge, Paper fibers, Compressive strength, Conventional Concrete Cubes.

I. INTRODUCTION

Concrete, is most widely used man made construction material and is the largest production of all the materials used in construction industry. Concrete is basically made of cementitious materials which have to properly bind themselves together, as well as with other materials to form a solid mass. Concrete or mortar is made up of cement, water and aggregates (Coarse and Fine Aggregate) and sometimes with necessary admixtures. Concrete has attained the status of a major building material in all the branches of modern construction. It is difficult to point out another material of construction which is as variable as concrete. Concrete is the best material of choice where strength, durability, impermeability, fire resistance and absorption resistance are required. Compressive strength is considered as an index to assess the overall quality of concrete and it is generally assumed that an improvement in the compressive strength results in improvement of all other properties. Hence strength investigations are generally centred on compressive strength. Even though concrete mixes are proportioned on the basis of achieving the desired compressive strength at the specified age, flexural strength often play a vital role in concrete making.

1.1 Hypo Sludge:

Hypo sludge (paper industry waste) has a tremendous potential in this context and it is well documented that the use of hypo sludge in concrete results in a significant improvement in the rheological properties. Hypo sludge is a recent arrival among cementitious materials. It was originally introduced as artificial pozzolana while producing paper the

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various wastes are comes out from the various processes in paper industries. From the preliminary waste named as hypo sludge due to its low calcium is taken out for our project to replace the cement utilization in concrete. Paper making industries generally produces a large amount of solid waste. Paper fibers can be recycled only a limited number of time before they become too short or weak to make high quality paper. From paper manufacturing process three types of sludge are obtained namely lime sludge (Hypo sludge), ETP sludge and De-Inking sludge. In our project we have utilized lime sludge as a replacement for cement. Lime sludge (Hypo sludge is a material obtained from the chemical recovery process of paper production. Hypo sludge is available abundantly worldwide, but its usage to date is very limited. In our project we have utilized lime sludge as a replacement for cement. Lime sludge (Hypo sludge is a material obtained from the chemical recovery process of paper production.

This value can be compared with the specific gravity of Portland cement which is 3.15.

Benefits of Hypo Sludge

1. Hypo sludge improves the properties of fresh and harden concrete.
2. Hypo sludge reduces degradation and bleeding.
3. Hypo sludge improves the durability of concrete.
4. Hypo sludge improves the setting of concrete due to presence of silica and magnesium.
5. Environmental friendly.
6. Lightweight compare to conventional concrete.
7. Hypo sludge is the cheaper substitute to OPC.

Limitations of Hypo Sludge

1. Availability
2. Handling problem

1.2 Manufactured Sand:

For aggregate produces concrete aggregate are end products while for concrete manufacturers, aggregates are raw materials to be used for concrete production. The quality of aggregates can be influenced while raw materials, gravel or rock may have characteristics which can't be modified by the production process. One extremely important factor is consistent supply of course, fine aggregate. In this regard a course aggregate produced by crushing basaltic stone and river sand is the major natural source of fine aggregate in our country. However the intense construction activity is resulting in growing shortage and price increase of the natural sand in the country in addition the aggregate and concrete industry are presently facing a growing public awareness related to environmental threats.

Therefore, looking for a viable alternative for natural sand is a must. One alternative used as replacement is the use of M-sand. Due to the forecast shortfall in supply of natural sand and increased construction practices time will come when M-sand will play a significant role as an ingredient in concrete production.

M sand characteristics:

When rock is crushed and sized in quarry the main aim has generally been to produce course aggregate and road construction materials. M sand is defined as a purpose made crushed fine aggregate produced from suitable source materials. Manufactured sand has been produced by variety of crushing equipment's including cone crushers, impact crushers, roll crushers, road rollers etc., The raw material for M sand production is the parent mass of rock. It is based on the parent rock that the chemical, mineral properties, texture, composition of sand would change.

II. LITERATURE REVIEW

Jayraj et al (2013), has done experimental investigation on strength of concrete and optimum percentage of the partial replacement by preparing a mix M20 grade was designed as per Indian Standard method and the same was used to prepare the test samples. In the test performed, the optimum compressive stress obtained by utilizing paper waste was at 30% replacement. The compared values of cost show gradual decrement in total cost of per cubic meter concrete. When government implement the projects for temporary shelters for who those affected by natural disaster, this material can be used for economic feasibility.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

Jayesh kumar Pitroda et al (2013), they focused on investigation of strength of concrete and optimum percentage of the partial replacement by replacing cement via 10%, 20%, 30%, and 40% of Hypo Sludge. Keeping all this view, the aim of investigation is the behaviour of concrete while adding of waste with different proportions of Hypo sludge in concrete by using tests like compression strength and split strength.

Rushabh shah and J. Pitroda (2013), studied the results of the cement mortar of mix proportion 1:3 in which cement is partially replaced with Hypo Sludge as 0%, 10%, 30% and 50% by weight of cement. Test results indicate the decreases in the strength properties of mortar with Hypo Sludge for strength at 7 & 28 days as partial replacement with the cement in the cement mortar 1:3. So it can be used in non-structural elements in the low range compressive strength where strength is not required and low cost temporary structure is prepared.

Ritesh Patil and M.Jamnu (2014), study the various mechanical properties of concrete containing hypo sludge. Hypo sludge was used as a replacement to cement. Replacement percentages used during the present study were 10%, 15%, 20%, 25%. Compressive strength of cubes were found on 3days, 7days, and 28days. The 28th day flexural strength and split tensile strength of the specimens was found on the respectively beams and cylinders. It is found that replacement of hypo sludge have beneficial effects on the mechanical properties of concrete.

G.Balamurugan and Dr.P.Perumal (2014), study the Use of Quarry Dust to Replace Sand in Concrete – An Experimental Study his experimental study presents the variation in the strength of concrete when replacing sand by quarry dust from 0% to 100% in steps of 10%. M20 and M25 grades of concrete were taken for study keeping a constant slump of 60mm. The compressive strength of concrete cubes at the age of 7 and 28 days were obtained at room temperature. Also the temperature effect on concrete cubes at 100oC on 28th day of casting was carried out to check the loss of strength.

Michael Nirmal.X. (2015), Characteristic Study of Concrete by Replacing Conventional Natural Agreegrates with Recycled Coarse Aggregate and Manufactured sand (M-Sand).In this experiment results that strength about 50-50% replacements of RCA and M-sand reaches the maximum strength about 23.96 % than compared to the conventional concrete. Hence the usage of RCA and M-sand are recommended as an alternate material to achieve the Optimum strength with optimum percentages of quantity.

III. DESIGN MIX MATERIALS

The constituent materials used in this study are (i) Cement, (ii) Fine aggregate, (iii) Coarse aggregate, (iv)water,(v) Hypo sludge, (vi) M-sand.

3.1 Cement

The cement used was ordinary Portland cement of 53- grade. The table below shows the properties of cement used.

Sl.no	Properties	Value
1.	Grade of cement	OPC 53
2.	Specific gravity	3.15
3.	Fineness	97.25
4.	Initial setting time	45 min
5.	Final setting time	385 min

Table-3.1 Properties of cement.

3.2 Fine aggregate

Fine aggregate is the inert or chemically inactive material, most of which passes through a 4.75 mm IS sieve and contains not more than 5 per cent coarser material. The fine aggregates serve the purpose of filling all the open spaces in between the coarse particles. Thus, it reduces the porosity of the final mass and considerably increases its strength. Usually, natural river sand is used as a fine aggregate.

3.3 Coarse aggregate

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

Construction aggregate, or simply "aggregate", is a broad category of coarse particulate material used in construction, including sand, gravel etc. Maximum coarse aggregate size used is 20 mm and the minimum coarse aggregate size used is 12 mm. coarse aggregates are particles greater than 4.75mm, but generally range between 9.5mm to 37.5mm in diameter. Coarse aggregate is produced by crushing quarry rock, boulders, cobbles, or large-size gravel. After harvesting, aggregate is processed: crushed, screened, and washed to obtain proper cleanliness and gradation.

3.4 Hypo sludge

Hypo sludge contains, low calcium and maximum calcium chloride and minimum amount of silica. Hypo sludge behaves like cement because of silica and magnesium properties. The bellow table and figure shows the properties and physical appearance of hypo sludge.

Sl.no	Constituent	Present in Hypo Sludge (%)
1.	Moisture	56.8
2.	Magnesium oxide (Mgo)	3.3
3.	Calcium Oxide (Cao)	46.2
4.	Loss on Ignescnt	27.00
5.	Acid Insoluble	11.1
6.	Silica (Sio2)	9.0

Table-3.2 Properties of raw hypo sludge.



Fig-1 the following image shows the physical appearance of Hypo sludge.

3.5 M-Sand

Fine aggregate used in this research is M- sand. Fine aggregates are the aggregates whose size is less than 4.75mm. The table and figure below shows the properties and physical appearance of M-Sand.

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 5, Issue 4, April 2016

Sl.no	Property	Value
1.	Specific gravity	2.68
2.	Fineness modulus	5.2
3.	Water absorption	7.0 %
4.	Surface texture	Smooth

Table-3.3 Properties of M-sand.



Fig-2 the following image shows the physical appearance of M-Sand.

3.6 Experimental investigation

Mix design was done for M20, M25 and M30 concrete as per the Indian standard code specifications (IS 10262-2007). Initial tests on all the ingredients of concrete were done. Fresh concrete tests such as slump cone test, flow table test etc., were also conducted. Testing of hardened concrete plays an important role in controlling and confirming the quality of cement concrete works. The experimental work involves the compressive test on cube involving various grades of replacement material of Hypo sludge and M-sand and hence a total no of 216 cubes were casted and tested.

Compressive Strength

Cubical specimens are placed on compression testing machine having a maximum capacity of 3000 KN and a constant rate of loading of 40 kg/m² per minute is applied on test specimen for curing days of 7, 14 and 28 days. Ultimate load at which the cubical specimen fails is noted down from dual gauge reading. This ultimate load divided by the area of specimen gives the compressive strength of each cube. The figure below shows the compressive strength testing of cubes in structural lab.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016



Fig no-3 Sample of Cubes casted.



Fig no-4 Cube tested for Compression strength.

III.RESULT AND DISCUSSIONS

Compressive Strength Results:

For cube compression tests on concrete, cube of size 150mm x150mm x 150mm were employed. All the cubes were tested in saturated condition after wiping out the surface moisture from the specimen. For this present investigation, cubes were tested by HEICO compression testing machine as per IS: 516 – 1959 at an age of 7 days, 14 days and 28 days. The tests were carried out at a uniform stress after the specimen has been centred in the testing machine. Loading was continued till the dial gauge needle just reverses its direction of motion. The reversal in the direction of motion of the needle indicates that the specimen has failed. The dial gauge reading at that instant was noted which is the ultimate load. The ultimate load divided by the cross sectional area of the specimen is equal to the ultimate cube compressive strength.

The following graph below shows the compressive strength test result of concrete cube containing Cement replaced by Hypo Sludge.

M20 grade Hypo Sludge as replacement material.

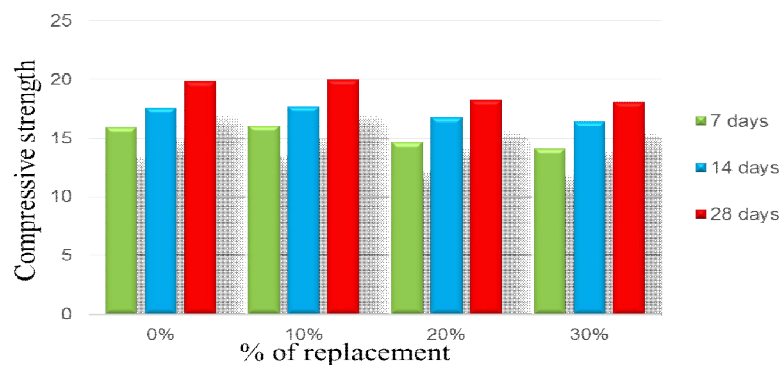


Fig-1 Compressive strength of M20 grade of Hypo Sludge as replacement material.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

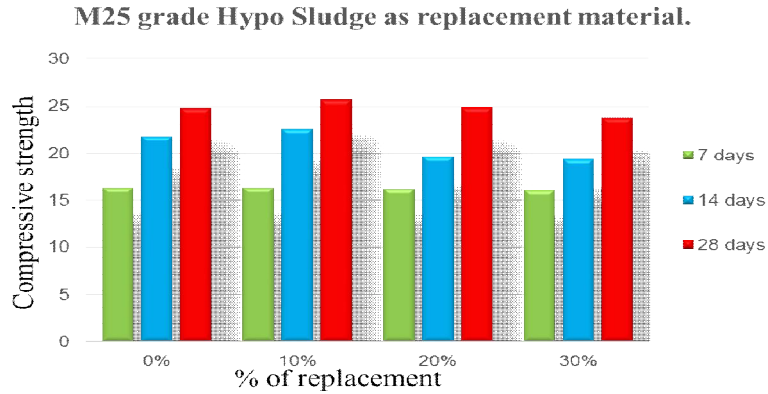


Fig-2 Compressive strength of M25 grade of Hypo Sludge as replacement material.

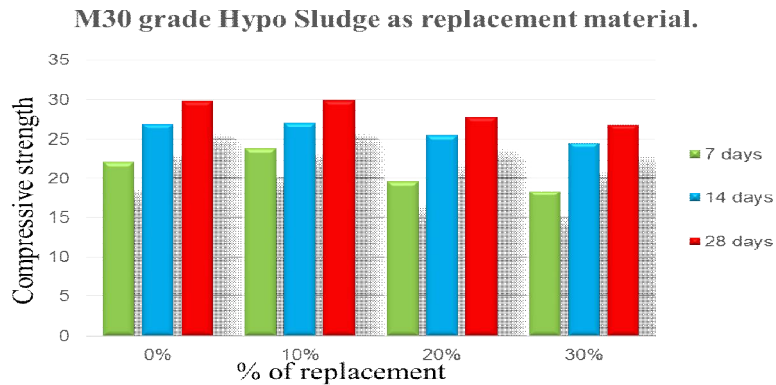


Fig-3 Compressive strength of M30 grade of Hypo Sludge as replacement material.

The following graphs below shows the compressive strength test results of concrete cube containing Sand replaced by M-sand.

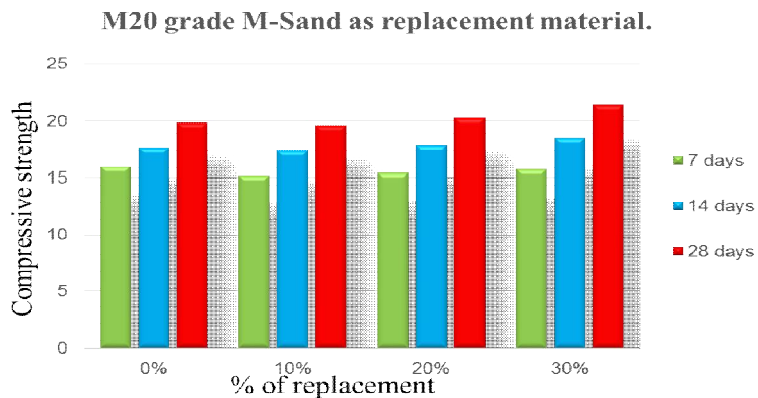


Fig-4 Compressive strength of M20 grade of M-sand as replacement material.

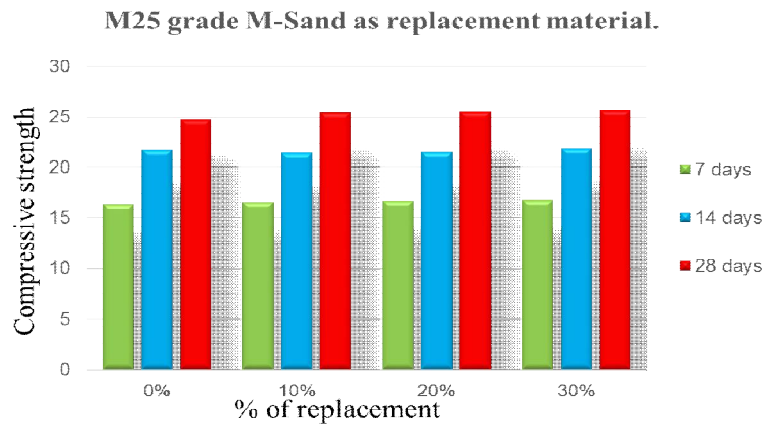


Fig-5 Compressive strength of M25 grade of M-sand as replacement material.

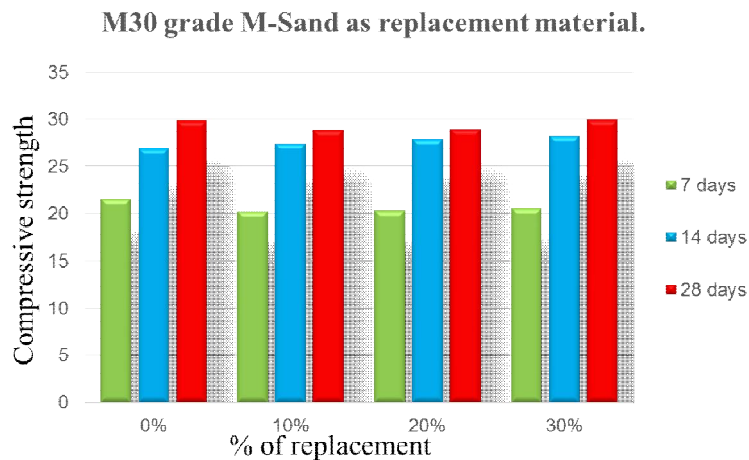


Fig-6 Compressive strength of M30 grade of M-sand as replacement material.

V. CONCLUSION

1. Hyposludge was done individually by 10, 20 and 30 at each replacements strength of concrete increased gradually.
2. The percentage increase in strength with replacement of Hyposludge for cement is 1.006, 1.47 and 1.95 respectively for 10%,20%, and 30% of replacement of cement for M20 grade of concrete.
3. The percentage increase in strength with replacement of Hyposludge for cement is 1.15, 1.6 and 1.98 respectively for 10%,20%, and 30% of replacement of cement for M25 grade of concrete.
4. The percentage increase in strength with replacement of for cement is 1.44, 1.85 and 1.99 respectively for 10%,20%, and 30% of replacement of cement for M30 grade of concrete.
5. M-Sand replacement with natural river sand was showing promising results with increase in strength by 1.1, 1.25 and 1.85 with 10%,20%, and 30% of replacement of river sand for M20 grade of concrete.
6. M-Sand replacement with natural river sand was showing promising results with increase in strength by 1.35, 1.75 and 1.90 with 10%,20%, and 30% of replacement of river sand for M25 grade of concrete.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Vol. 5, Issue 4, April 2016

7. M-Sand replacement with natural river sand was showing promising results with increase in strength by 1.21, 1.99 and 1.95 with 10%,20%, and 30% of replacement of river sand for M30 grade of concrete.

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