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Partial Replacement of Cement in Concrete by Hyposludge

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Abstract: **To save energy and to earn carbon credit is very much essential for the betterment of mankind. To produce 1 tons of Ordinary Portland Cement we use earth resources like limestone, etc & during manufacturing of 1 t of Ordinary Portland Cement an equal amount of carbon-dioxide are released into the atmosphere which is harmful to the environment. Energy plays an important role in era of developing countries like India. By earning carbon credit by using industrial waste (hypo sludge) for Building Materials like cement, the energy & environment can be saved.**

Keywords: **carboncredit, portlandcement, limestone, hyposludge.**

I. INTRODUCTION

Concrete is a composite construction material composed of cement, aggregate (generally a coarse aggregate made of gravels or crushed rocks such as limestone, or granite, plus a fine aggregate such as sand), water, and/or admixtures. Concrete is made by mixing: Cement, water, course fine aggregates and admixtures (if required). The objectives are to mix these materials traditionally to make concrete that is easy to: Transport, place, compact, finish and to give a strong and durable product. The proportionate quantity of each material (i.e. cement, water and aggregates) affects the properties of hardened concrete. All the inks, dyes, coatings, pigments, staples and "stickies" (tape, plastic films, etc.) are also washed off the recycled fibers to join the waste solids. The shiny finish on glossy magazine-type paper is produced using a fine kaolin clay coating, which also becomes solid waste during recycling. This hypo sludge consumes a large percentage of local landfill space for each and every year. Worse yet, some of the wastes are land spread on cropland as a disposal technique, raising concerns about trace contaminants building up in soil or running off into area lakes and streams. Some companies burn their sludge in incinerators, contributing to our serious air pollution problems. To reduce disposal and pollution problems emanating from these industrial wastes, it is most essential to develop profitable building materials from them. Keeping this in view, investigations were undertaken to produce low cost concrete by blending various ratios of cement with hypo sludge. Paper making generally produces a large amount of solid waste. Paper fibers can be recycled only a limited number of times before they become too short or weak to make high quality paper. It means that the broken, low- quality paper fibers are separated out to become waste sludge. All the inks, dyes, coatings, pigments, staples and “stickies” (tape, plastic films, etc.) are also washed off the recycled fibers to join the waste solids. The shiny finish on glossy magazine-type paper is produced using a fine kaolin clay coating, which also becomes solid waste during recycling. This paper mill sludge consumes a large percentage of local landfill space for each and every year. Worse yet, some of the wastes are land spread on cropland as a disposal technique, raising concerns about trace contaminants building up in soil or running off into area lakes and streams. Some companies burn their sludge in incinerators, contributing to our serious air pollution problems. To reduce disposal and pollution problems emanating from these industrial wastes, it is most essential to develop profitable building materials from them. In the context of low availability of non-renewable energy resources coupled with the requirements of large quantities of energy for Building Materials like cement, the importance of using industrial waste cannot be underestimated. The paper mill sludge consumes a large percentage of local landfill space for each and every year. Worse yet, some of the wastes are land spread

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on agricultural land or running off into area lakes and streams. Some companies burn their sludge in incinerators, contributing to our serious air pollution problems. To reduce disposal and pollution problems emanating from these industrial wastes, it is most desire to develop profitable materials from them. Keeping this in view, investigations were undertaken to produce low cost concrete by blending various ratios of cement with hypo sludge. So we take hypo sludge for comparing it with cement. **Hypo sludge** produced in a large amount as by product of paper industry and is usually used in concrete production as partial replacement of cement. It contains low calcium and minimum amount of silica and its due to presence of silica and magnesium properties, that it behaves like cement.

II. SCOPE OF THE PROJECT

- To provide a most economical concrete. It should be easily adopted in field. Using the wastes in useful manner.
- To reduce the cost of the construction. To promote the low cost housing to the E.W.S. group people.
- To find the optimum strength of the partial replacement of concrete. Minimize the maximum demand for cement.
- Minimize the maximum degradation in environment due to cement and safeguard the ozone layer from green house gases.
- To study the crack development in hardened concrete.
- To investigate the utilization of Hypo Sludge as Supplementary Cementitious Materials (SCM) and influence of these hypo sludge on the Strength on concretes made with different Cement replacement levels.

III. PROCESS

- Collection of material.
- Material testing in various stages.
- Mix design.
- Tests performed.
- Conclusion

A. Collection of Material:

***Concrete*:**

Concrete is a composite material that consists of a cement paste within which various sizes of fine and course aggregates are embedded. It contains some amount of entrapped air and may contain purposely-entrained air by the use of air-entraining admixtures. Various types of chemical admixtures and/or finely divided mineral admixtures are frequently used in the production of concrete to improve or alter its properties or to obtain a more economical concrete.

Cement:

Ordinary Portland cement of Birla gold conforming to IS 269-1976 and IS 4031-1968 was adopted in this work. The cement used is 43 grade. Cement is a generic term that can apply to all binders. There is a wide variety of cements that are used to some extent in the construction and building industries, or to solve special problems. The chemical composition of these cements can be quite diverse, but by far the greatest amount of concrete used today is made with Portland cements.

***Coarse aggregate*:**

Aggregates generally occupy 70 to 80 percent of the volume of concrete and can therefore be expected to have an important influence on its properties. They are granular materials, derived for the most part from natural rock (crushed stone or natural gravels) and sands, although synthetic materials such as slag and expanded clay or shale are used to some extent, mostly in lightweight concretes. In addition to their use as economical filler, aggregates generally provide concrete with better dimensional stability and wear resistance. Aggregate classifications are made principally for the purpose of easier identification of particular aggregate lots, or to become familiar with the different types of aggregates. There are numerous ways of classifying aggregates. These classifications are made according to source of aggregate, specific

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gravity or unit weight of aggregate, size of aggregate particles, shape of aggregates, surface texture of aggregates, mode of preparation of aggregates, geological origin of aggregates, and mineral composition of aggregates and reactivity of aggregates. Aggregates are not generally classified by mineralogy; the simplest and most useful classifications are on the basis of source and specific gravity.

***Fine aggregate*:**

The sand which was locally available and passing through 4.75mm IS sieve is used. The specific gravity of fine aggregate was 2.60. Locally available river sand conforming to Grading zone I of IS: 383 –1970.Clean and dry river sand available locally will be used. Sand passing through IS 4.75mm Sieve will be used for casting all the specimens. Fine aggregate" is defined as material that will pass a No. 4 sieve and will, for the most part, be retained on a No. 200 sieve. For increased workability and for economy as reflected by use of less cement, the fine aggregate should have a rounded shape. The purpose of the fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent.

Water:

Water is a key ingredient in the manufacture of concrete. It is also material on its own right. Understanding its properties is helpful in gaining and understanding of its effects on concrete and other building materials. Although water is an important ingredient of concrete little needs to be written about water quality, since it has little to do with the quality of the concrete. However mixing water can cause problems by introducing impurities that have detrimental effects on concrete quality. Although satisfactory strength development is of primary concern, impurities contained in the mix water may also affect setting times, drying shrinkage, or durability, or they may cause efflorescence. The water used for experiments was potable water. Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. It should be free from organic matter and the pH value should be between 6 to 7.

Hypo-sludge:

Where, this 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. This silica and magnesium improve the setting of the concrete. While producing paper the 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. Due to the cement production green house gases are emitted in the atmosphere. For producing 4million tones of cement, they emit 1 million ton green house gases are emitted. Also, to reduce the environmental degradation, this sludge has been avoided in mass level disposal in land. To eliminate the ozone layer depletion, production of cement becomes reduced. For this, the hypo sludge is used as partial replacement in the concrete as high performance concrete. By utilizing this waste the strength will be increased and also cost reduction in the concrete is achieved.

***B.* Material Testing in various Stages:**

SPECIFIC GRAVITY TEST FOR AGGREGATES AND CEMENT:

Specific gravity test is used to determine the gravity value of cement, flyash, fine aggregate and coarse aggregate

i. Fine aggregate:

a) Apparatus required:

- pycnometer of about 1 litre capacity
- weighing balance
- glass rod
- Vacuum pump.

b) Specific gravity procedure for fine aggregates:

- Clean and dry the pycnometer. Tightly screw its cap. Take its mass (m1) to the nearest of 0.1g.
- Mark the cap and pycnometer with a vertical line parallel to the axis of the pycnometer to ensure that the cap is screwed to the same mark each time.

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- Unscrew the cap and place about 200g of oven dried soil in the pycnometer. Screw the cap. Determine the mass (m2).
- Unscrew the cap and add sufficient amount of de-aired water to the pycnometer so as to cover the soil. Screw on the cap.
- Shake well the contents. Connect the pycnometer to a vacuum pump to remove the entrapped air, for about 20minutes for fine- grained soils and about 10 minutes for coarse-grained soils.
- Disconnect the vacuum pump. Fill the pycnometer with water, about three-fourths full. Reapply the vacuum for about 5minutes till air bubbles stop appearing on the surface of the water.
- Fill the pycnometer with water completely upto the mark. Dry it from outside. Take its mass (m3).
- Record the temperature of contents.
- Empty the pycnometer. Clean it and wipe it dry.
- 10.Fill the pycnometer with water only. Screw on the cap upto the mark.

Wipe it dry. Take its mass (m4).

G= (m2-m1)/[(m2-m1)-(m3-m4)]

Where,

(m1) - Mass of empty pycnometer

(m2) - Mass of pycnometer with dry soil

(m3) - Mass of pycnometer and soil and water

(m4) - Mass of pycnometer with water.

ii. Coarse aggregate:

a) Apparatus required:

- pycnometer of about 1 litre capacity
- weighing balance
- glass rod
- Vacuum pump.

b) Specific gravity procedure for coarse aggregates:

- Clean and dry the pycnometer. Tightly screw its cap. Take its mass (m1) to the nearest of 0.1g.
- Mark the cap and pycnometer with a vertical line parallel to the axis of the pycnometer to ensure that the cap is screwed to the same mark each time.
- Unscrew the cap and place about 200g of oven dried coarse aggregate in the pycnometer. Screw the cap. Determine the mass (m2).
- Unscrew the cap and add sufficient amount of de-aired water to the pycnometer so as to cover the coarse aggregate. Screw on the cap.
- Shake well the contents. Connect the pycnometer to a vacuum pump to remove the entrapped air, for about 20minutes for coarse aggregate.
- Disconnect the vacuum pump. Fill the pycnometer with water, about three-fourths full. Reapply the vacuum for about 5minutes till air bubbles stop appearing on the surface of the water.
- Fill the pycnometer with water completely upto the mark. Dry it from outside. Take its mass (m3).

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- Record the temperature of contents.
- Empty the pycnometer. Clean it and wipe it dry.
- 10.Fill the pycnometer with water only. Screw on the cap upto the mark.

Wipe it dry. Take its mass (m4).

G= (m2-m1)/[(m2-m1)-(m3-m4)]

Where,

(m1) - Mass of empty pycnometer

(m2) - Mass of pycnometer with dry coarse aggregate

(m3) - Mass of pycnometer and coarse aggregate and water

(m4) - Mass of pycnometer with water.

iii. Cement:

a) Apparatus required:

- density bottle
- weighing balance
- glass rod
- kerosene

b) Specific gravity procedure for Cement

- Clean and dry the density bottle. Tightly screw its cap. Take its mass (m1) to the nearest of 0.1g.
- Mark the cap and density bottle with a vertical line parallel to the axis of the density bottle to ensure that the cap is screwed to the same mark each time.
- Unscrew the cap and place about 200g of oven dried cement in the density bottle. Screw the cap. Determine the mass (m2).
- Unscrew the cap and add sufficient amount Kerosene to the density bottle so as to cover the soil. Screw on the cap.
- Shake well the contents. Connect the density bottle to a vacuum pump to remove the entrapped air, for about 20minutes for cement.
- Disconnect the vacuum pump. Fill the density bottle with kerosene, about three-fourths full. Reapply the vacuum for about 5minutes till air bubbles stop appearing on the surface of the kerosene.
- Fill the density bottle with water completely upto the mark. Dry it from outside. Take its mass (m3).
- Record the temperature of contents.
- Empty the density bottle. Clean it and wipe it dry.
- 10.Fill the density bottle with kerosene only. Screw on the cap upto the mark. Wipe it dry. Take its mass (m4).

Where,

(m1) - Mass of empty density bottle

(m2) - Mass of density bottle with dry cement

(m3) - Mass of density bottle and cement and kerosene

(m4) - Mass of density bottle with kerosene.

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WATER ABSORPTION TEST:

Water absorption test is used to determine the absorption content of water by fine aggregate and coarse aggregate.

i) Fine Aggregate:

a) Apparatus required:

- Container
- Balance
- Electric Oven.

b) Water absorption test procedure for fine aggregate:

- The fine or coarse aggregate passing through sieve is taken about 200g.
- They are dried in an oven at a temperature of 110o ±5oC for 24 hours.
- The fine or coarse aggregate is cooled to room temperature.
- Its weight is taken as (W1g)
- The dried fine or coarse aggregate is immersed in clean water at a temperature 27o ±2oC for 24 hours.
- The fine or coarse aggregate is removed from water and wiped out of traces of water with a cloth
- Within three minutes from the removal of water, the weight of fine or coarse aggregate W2 is found out

The above procedure is repeated for various samples

ii) coarse aggregate

a) Apparatus required:

- Container
- Balance
- Electric oven

Water absorption test procedure for coarse aggregate:

- The fine or coarse aggregate passing through sieve is taken about 200g.
- They are dried in an oven at a temperature of 110o ±5oC for 24 hours.
- The fine or coarse aggregate is cooled to room temperature.
- Its weight is taken as (W1g)
- The dried fine or coarse aggregate is immersed in clean water at a temperature 27o ±2oC for 24 hours.
- The fine or coarse aggregate is removed from water and wiped out of traces of water with a cloth
- Within three minutes from the removal of water, the weight of fine or coarse aggregate W2 is found out
- The above procedure is repeated for various samples.

The test results obtained are:

- Water absorption of the coarse aggregate is 9%
- Water absorption of the fine aggregate is 28%

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C. Mix Design:

Concrete:

Stipulations for proportioning:

1	Grade Designation	M30
2	Type of cement	Opc 43 grade IS-8112
3	Max. nominal agg. Size	20 mm
4	Min. cement content	320 kg/m3
5	Max.water cement ratio	0.45
6	Workability	100 mm
7	Exposure condition	severe
8	Degree of supervision	good
9	Type of aggregate	Crushed angular agg.
10	Max. cement content	450 kg/m3
11	Chemical admixture type	Superplasticiser IS 9103

Test data for materials:

1	Cement used	Opc 43 grade IS 8112
2	Sp.gravity of cement	3.15
3	Sp.gravity of water	1.00
4	Chemical admixture	Super plasticicer
5	Sp.gravity of 20mm agg.	2.74
6	Sp.gravity of sand	2.74
7	Water absorption of 20mm aggregate	9%
8	Water absorption of sand	28%
9	Free moisture of agg.	nil
10	Free moisture of sand	Nil
11	Sieve analysis of C.agg	Separate analysis done
12	Sieve analysis of F.agg	Separate analysis done

D. Supply of Oxygen rich air to the intake manifold:

The oxygen rich air is now forced into the combustion chamber through the intake manifold. The purity of Oxygen will be about 75 – 85 %. The amount of fuel injected must be reduced as too much temperature will be produced inside the combustion chamber due to Oxygen rich supply. If not, it might damage the piston, valves and other parts inside the chamber.

IV. COMPARISONS

In this chapter, the strength between the conventional concrete and partially replaced hypo sludge concrete is compared with suitable graphs.

COMPRESSIVE STRENGTH:

- For 10% replacement of cement, the compressive strength has increased to about 41.86 N/mm^2 from 40.70 N/mm^2 when compared to conventional concrete.
- For 20% replacement of cement, the compressive strength has decreased to about 38.41 N/mm^2 from 40.70 N/mm^2 when compared to conventional concrete.
- For 30% replacement of cement, the compressive strength has decrease to about 26.5 N/mm^2 from 40.70 N/mm^2 when compared to conventional concrete.

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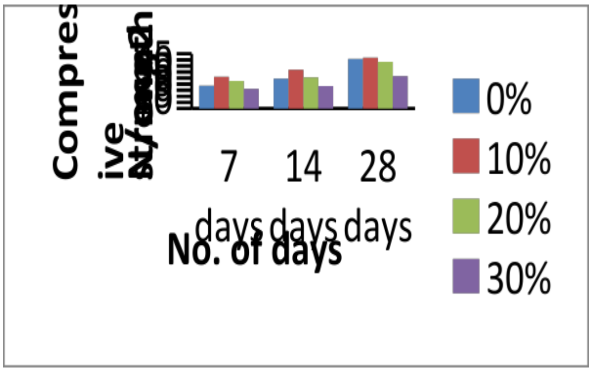
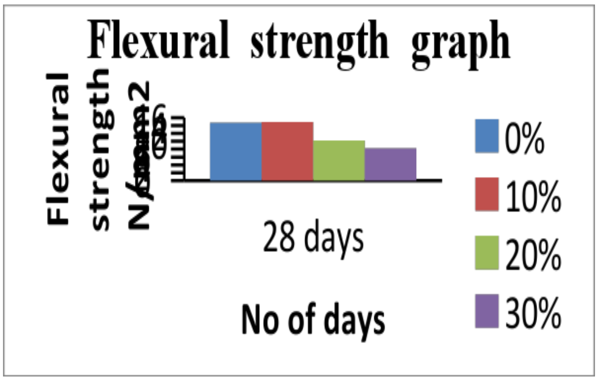


FLEXURAL STRENGTH:

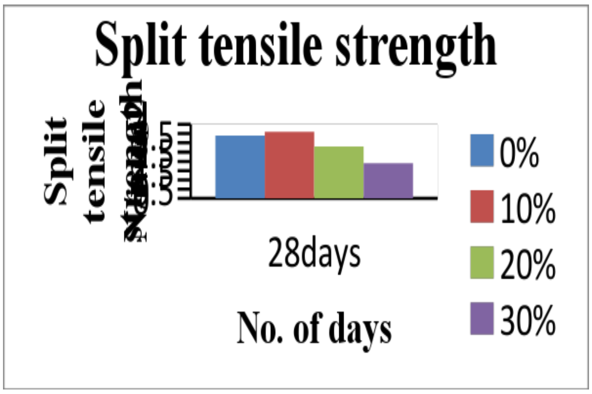
- For 10% replacement of cement, the flexural strength has increased to about 14.92 N/mm^2 from 14.71 N/mm^2 when compared to conventional concrete.
- For 20% replacement of cement, the flexural strength has decreased to about 10.24 N/mm^2 from 14.71 N/mm^2 when compared to conventional concrete.
- For 30% replacement of cement, the flexural strength has decrease to about 8.25 N/mm^2 from 14.71 N/mm^2 when compared to conventional concrete.



SPLIT TENSILE STRENGTH:

- For 10% replacement of cement, the split tensile strength has increased to about 3.6 N/mm^2 from 3.4 N/mm^2 when compared to conventional concrete.
- For 20% replacement of cement, the split tensile strength has decrease to about 2.8 N/mm^2 from 3.4 N/mm^2 when compared to conventional concrete.

For 30% replacement of cement, the split tensile strength has decrease to about 1.9 N/mm^2 from 3.4 N/mm^2 when compared to conventional concrete.



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V. CONCLUSION

The following conclusions are presented based on experimental results from the present investigation.

Strength diversity:

Concrete has various functions in constructions. The various percentages of replacements in cement has produced diversity in compressive strengths as well as flexural strengths · Various grades of concrete containing replacement of cement with hypo sludge may as well produce better compressive strength or equal compressive strength to that of the conventional concrete.

- Flexural strength and Split tensile strength was found to be increased by a considerable percentage with respect to the concrete unit containing natural sand.
- Workability were noted. Hence it is not necessarily advisable to use admixtures while mixing the concrete.
- It was found that 10 % replacement of cement with hypo sludge was productive when compared to the different percentages.
- The major aspect of the project is that the properties of hypo sludge and cement are almost the same and is more economical.
- Only a considerable amount of percentage replacement was effective than high percentage replacement of cement.

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