

Effect of Characteristic Strength of Concrete by Replacing Cement Partially with Hypo Sludge

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ABSTRACT

The results of the analysis on the shear force, bending moment and torsion are compared. The results are presented in tabular and graphical form. The results on the drift and displacement are checked with serviceability conditions and are compared and presented in tabular form. The Zone wise results are also compared. Hypo Sludge is a waste produced in the paper manufacturing industry. Paper mills generate more than 4 million tons of sludge each year for disposal. Hypo Sludge is known to contain useful fibers and chemicals, as my project to get good results by adding of ferrous oxide to the hypo sludge to the fly ash improve the strength, durability, and life span of concrete structures exposed to weather. 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 "stickiest" (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. Keeping this in view, investigations were undertaken to produce low cost concrete by blending various ratios of cement with hypo sludge. This research work describes the feasibility of using the Hypo Sludge in concrete production as replacement of cement by weight. The use of Hypo Sludge in concrete formulations as a supplementary cementations material was tested as an alternative to conventional concrete. The mix has been replaced by Hypo Sludge accordingly in the range of 0% (without Hypo Sludge, fly ash, ferrous oxide), 10%, 20%, 30% and 40% by weight of cement for M-20 mix. Concrete mixtures were produced, tested and compared in terms of compressive strength, durability & life span to the conventional concrete. These tests were carried out to evaluate the mechanical properties. For the test results for compressive strength up to 56 days are taken. When government implement the projects for temporary shelters for who those affected by natural disaster, this material can be used for economic feasibility. To investigate the utilization of Hypo Sludge and fly ash as Supplementary Cementations Materials (SCM) and influence of these hypo sludge and fly ash on the Strength of concretes made with different Cement replacement levels and compare with ordinary concrete. Investigate low cost concrete by using hypo sludge and fly ash as Supplementary Cementations Materials (SCM) and compare the cost of each per meter cube.

Keywords: Hypo sludge, Supplementary Cementations Materials (SCM).

I. INTRODUCTION

Paper mill sludge is a major economic and environmental problem for the paper and board industry. The material is a by-product of the de-inking and repulping of paper. The total quantity of paper mill sludge produced in the world is many million tones. The main recycling and disposal routes for paper sludge are land-spreading as agricultural fertilizer, producing paper sludge ash, or disposal to landfill. In functional terms, paper sludge consists of cellulose fibers, fillers such as calcium carbonate and china clay and residual chemicals bound up with water. The moisture content is typically up to 40%. The material is viscous, sticky and hard to dry and can vary in viscosity and lumpiness. It has an energy content that makes it a useful candidate as an alternative fuel for the manufacture of Portland cement. Paper production is a highly capital and labour intensive activity. Wood pulp is the fibrous material that results when wood is separated into its constituent fibers by chemical or mechanical means. Waste paper is composed of previously discarded paper or paperboard products. So, by using this paper waste we can solve the disposal problem. In urban cities, Solid waste management is one of the most challenging issues, which are facing a serious pollution problem due to the generation of huge quantities of solid waste. In this paper presents making hypo sludge from paper waste, which is use as a construction material. A use of hypo sludge in the construction industry is in the production of structural concrete. Hypo sludge contributes beneficial properties to the concrete while helping to maintain economy. The use of hypo sludge, the paper industrial waste in concrete formulations as a supplementary cementations material was tested as an alternative to traditional concrete. 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. Paper sludge consists of cellulose fibers, calcium carbonate and china clay and residual chemicals bound up with water. 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. This paper mill sludge consumes a large percentage of local landfill space for each and every year. To reduce disposal and

pollution problems emanating from these industrial wastes, it is most essential to develop profitable building materials from them. The quantity of sludge varies from mill to mill. The amount of sludge generated by a recycled paper mill is greatly dependent on the type of furnish being used and end product being manufactured. This study includes different concrete mixtures to determine the influence of hypo sludge derived from Rayalaseema paper mill Pvt.Ltd, plant near the northern bank of river Tungabhadra near Kurnool town Gondiparlla village in the State of A.P. Different percentage of hypo sludge replacement. The testing is just carried out after 56 days of casting. The resting specimen was 150mm diameter and 300 mm height cylinder, 150mmX150mmX150mm cube and 600X150X150mm beam. There were total of five batches of concrete mixes, consists of every 10% increment of hypo sludge, fly ash, ferrous oxide replacement from 0%, 10%, 20%, 30% and 40% by its weight. The new technology will offer the pulp and paper industry a practical and economical solution for waste disposal. It will also provide the concrete industry with a low-cost source of fibers to produce a better product for its customers. Government purchases of concrete could potentially decrease by one-third, equal to 20 million cubic yards of concrete annually. By avoiding that amount of concrete production, the industry's annual energy use and carbon dioxide emissions will be significantly reduced, which, along with keeping the mill sludge out of landfills, will be of significant benefit to the environment. The utilization of paper industry waste hypo sludge can reduce the consumption of natural resources, reduce the quantity of expensive cement, reduce environmental pollution and make cement concrete structures denser and thus improve their durability. In recent years, many researchers have established that the use of supplementary cementations materials (SCMs) like fly ash, blast furnace slag, silica fume, met kaolin, rice husk ash and hypo sludge etc. can, not only improve the various properties of concrete both in its fresh and hardened states, but also can contribute to economy in construction costs. Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for the nation. Fly ash is one of the types of coal combustion by-products. The use of these by-products offers environmental advantages divert the material from the waste stream, reduce the energy used in processing

virgin materials, use of virgin materials, and decreases pollution. India is a resourceful country for fly ash generation with an annual output of over 110 million tones, but utilization is still below 20 % in spite of quantum jump in last three to four years. Availability of consistent quality fly ash across the country and awareness of positive effects of using fly ash in concrete are pre requisite for change of perception of fly ash from a 'A waste material' to 'A resource material. Although fly ash offers environmental advantages, it also improves the performance and quality of concrete. Fly ash affects the plastic properties of concrete by improving workability, reducing water demand, reducing segregation and bleeding, and lowering heat of hydration. Fly ash increases strength, reduces permeability, reduces corrosion of reinforcing steel, increases sulphate resistance, and reduces alkali-aggregate reaction. 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 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 and fly ash for compare it with cement. Fly ash is a waste by-product from thermal power plants, which use coal as fuel. It is estimated that about 125 million tons of fly ash is being produced from different thermal power plants in India. It consumes thousands of hectares of agriculture land for its disposal. It causes serious health and environmental problems. In spite of continuous efforts made and incentives offered by the government, hardly very few percentage of the produced ash is being used for gainful purposes like brick making, cement manufacture, soil stabilization and fill material. In order to utilize fly ash in bulk quantities, ways and means are being explored all over the world to use it for the construction of embankments and roads. Paper mill sludge is a major economic and environmental problem for the paper and board industry. The total quantity of paper mill sludge produced in the world is many million tones. The main recycling and disposal routes for paper sludge are land-spreading as agricultural fertilizer, producing paper sludge ash, or disposal to landfill. In

functional terms, paper sludge consists of cellulose fibers, fillers such as calcium carbonate and china clay and residual chemicals bound up with water. The moisture content is typically up to 40%. The material is viscous, sticky and hard to dry and can vary in viscosity and lumpiness. It has an energy content that makes it a useful candidate as an alternative fuel for the manufacture of Portland cement. As it is happening in most major areas, the waste management problem has already become severe in the world. The problem is compounded by the rapidly increasing amounts of industrial wastes of complex nature and composition. Energy plays a crucial role in growth of developing countries like India. 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. Many research organizations are doing extensive work on waste materials concerning the viability and environmental suitability.

II. METHODS AND MATERIAL

Study on Hypo Sludge, Fly Ash & Iron Oxide

Hypo Sludge : Fig show the hypo sludge chemical properties and comparison between cement and hypo sludge



Figure 1. Hypo Sludge

Chemical Composition of Paper:

The chemical composition of paper will depends on the type or grade of paper. Typically most grades of paper consist of organic and inorganic material. Organic portion consisting of cellulose, hemi-cellulose, lignin and or various compound of lignin (Na-lignite etc.) may be 70 to 100%. Inorganic portion consisting of mainly

filling and loading material such as calcium carbonate, clay, titanium oxide etc., may be 0 - 30% of paper.

Table-1 Chemical Composition of Paper

Type/Grade of Paper	Organic	Inorganic
1. Newsprint	>95%	<5%
2. Corrugated (Media & Liner)	>95%	<5%
3. Writing, printing, copying & book paper	70-100%	0-30%
4. Hygiene Tissue	>98%	<2%

PROPERTIES OF PAPER:

BASIS WEIGHT OR GRAMMAGE:

The basis weight, substance or gram mage is obviously most fundamental property of paper board. The Basis weight of paper is the weight per unit area. This can be expressed as the weight in grams per square meter (GSM or g/m²), pounds per 1000 sq. ft. or weight in Kg s or pounds per ream (500 sheets) of a specific size. Paper is sold by weight but the buyer is interested in area of paper. The basis weight is what determines, how much area the buyer gets for a given weight. e.g., if basis weight is 50 g/m², for every 1 kg weight, the buyer gets 20 m². When the basis weight is expressed as ream weight, it tells the buyers how many reams he/she getting for a given weight. For papermaker basis weight is important from point of view of production rate. For a given machine deckle and machine speed, the production rate per day in MT will be = Machine Deckle(m) * Machine Speed (m/min) * Basis Weight (g/m²) * 1440/1000000.

BULK:

Bulk is another very important parameter of paper particularly for printers. Bulk is a term used to indicate volume or thickness in relation to weight. It is the reciprocal of density (weight per unit volume). It is calculated from caliper and basis weight. Bulk (cubic centimeter/g) = Thickness (mm)* 1000/ Basis Weight (g/m²). Sheet bulk relates to many other sheet properties. Decrease in bulk or in other words increase in density makes the sheet smoother, glossier, less opaque, darker, lower in strength etc. High bulk is desirable in absorbent

papers while lower bulk is preferred for printing papers particularly bible paper, dictionary paper etc. Book Bulk: It is defined as the overall thickness in mm of a given number of paper sheets. The bulking number is defined as number. Cellulose fibers (main constituent of paper) swell in diameter from 15 to 20% from dry condition to saturation point. Since most of the fiber in paper sheet are aligned in the machine run direction, absorption and de-absorption of moisture by paper causes the change in CD dimension. Such changes in dimension may seriously affect register in printing processes and interfere with the use of such items as tabulating cards. Dimensional changes in paper originate in the swelling and contraction of the individual fibers Change that occurs in the dimensions of paper with variation in the moisture content is an important consideration in the use of paper.

FORMATION:

Formation is an indicator of how uniformly the fibers and fillers are distributed in the sheet. Formation plays an important role as most of the paper properties depend on it. A paper is as strong as its weakest point. A poorly formed sheet will have more weak and thin or thick spots. These will affect properties like strength, coating capabilities and printing characteristics of the paper, etc. There is no standard method or unit to express formation.

MOISTURE:

Almost all grade of paper has some percentage of moisture. Moisture in paper varies from 2 - 12% depending on relative humidity, type of pulp used, degree of refining and chemical used. Most physical properties of paper undergo change as a result of variations in moisture content. Water has the effect of plasticizing the cellulose fiber and of relaxing and weakening the inter-fiber bonding. The absorption and reflectance of certain bands of infrared and microwave radiation by paper are affected by its moisture content. The amount of water present in a sheet of paper is usually expressed as a percent. The amount of water plays an important role in calendaring, printing and converting process. Moisture control is also significant to the economic aspect of paper making. Water comes free. Poor moisture control can adversely affect many paper properties. The absolute moisture content is

expressed as a % of the paper/paperboard weight. The sample is generally not conditioned while doing this test.

SMOOTHNESS:

It is most important parameter for printer. Smoothness is concerned with the surface contour of paper. It is the flatness of the surface under testing conditions which considers roughness, levelness, and compressibility. In most of the uses of paper, the character of the surface is of great importance. It is common to say that paper has a "smooth" or a "rough" texture. The terms "finish" and "pattern" are frequently used in describing the contour or appearance of paper surfaces. Smoothness is important for writing, where it affects the ease of travel of the pen over the paper surface. Finish is important in bag paper as it is related to the tendency of the bag to slide when stacked. Smoothness of the paper will often determine whether or not it can be successfully printed. Smoothness also gives eye appeal as a rough paper is unattractive.

TEMPERATURE AND HUMIDITY:

CONDITIONING OF PAPER

As explained above it is important to control the moisture content of paper and keep it stable during converting operation. To keep moisture content constant, it is important that paper is conditioned. Conditioning of paper is also of important in many printing and converting operations. The tendency for paper to develop static becomes greater with increasing dryness. Cellulose fibers are hygroscopic i.e. they are capable of absorbing water from the surrounding atmosphere. The amount of absorbed water depends on the humidity and the temperature of the air in contact with the paper. Hence, changes in temperature and humidity, even slight changes, can often affect the test results. So, it is necessary to maintain standard conditions of humidity and temperature for conditioning.

Table-2 Chemical Requirements for Fly Ash Classification

Properties	Fly Ash Class	
	Class F	Class C
Silicon dioxide (SiO ₂) plus aluminum oxide (Al ₂ O ₃) plus iron oxide (Fe ₂ O ₃), min, %	70.0	50.0
Sulfur trioxide (SO ₃), max, %	5.0	5.0
Moisture Content, max, %	3.0	3.0
Loss on ignition, max, %	6.0	6.0
The use of class F fly ash containing up to 12% loss of ignition may be approved by the user if acceptable performance results are available		

III. RESULT AND DISCUSSION

COMPRESSIVE STRENGTH @ 0, 10, 20, 30 & 40% of Hypo Sludge

Days	Comp. strength				
	0	10	20	30	40
3	21.05	24.80	21.12	17.43	13.07
7	29.12	30.17	27.82	27.82	19.44
28	46.83	48.28	45.93	39.22	35.20
56	96.77	71.96	57.28	58.23	54.18

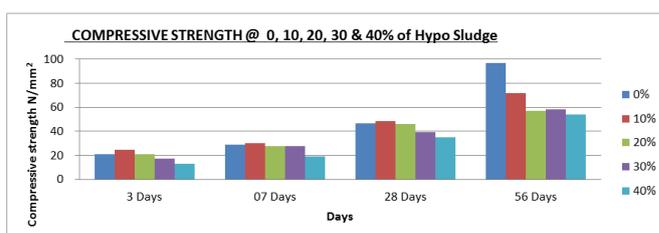


Figure 2. Bar chart of Compressive strength of different percentages by adding Hypo sludge

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V. CONCLUSION

Based on limited experimental investigations concerning the compressive strength of concrete, the following conclusions are drawn:

- [1] The 0% replacement of cement in M₂₀ grade of concrete gives compressive strength of 46.83 N/mm² and 96.77 N/mm² for 28 days and 56 days.
- [2] The 10% replacement of cement by hypo sludge in M₂₀ grade of concrete gives compressive strength of 48.28 N/mm² and 71.96 N/mm² for 28 days and 56 days.
- [3] The 20% replacement of cement by hypo sludge in M₂₀ grade of concrete gives compressive strength of 45.93 N/mm² and 57.28 N/mm² 28 days and 56 days.
- [4] The 30% replacement of cement by hypo sludge in M₂₀ grade of concrete gives compressive strength of 39.22 N/mm² and 58.23 N/mm² 28 days and 56 days.
- [5] By above results we know that the use of Hypo Sludge should in between of 10-15 % will increase the strength of concrete.
- [6] Use of Hypo Sludge reduces the amount of cement content. Thus, the construction work with Hypo sludge in cement becomes environmentally safe and also economical.
- [7] When compare in between flyash and Hypo sludge concrete compressive strength is more upto 20% replacement of cement by Hypo sludge.
- [8] In flyash cement concrete strength is increases up to 30% replacement of cement then when add extra 10% or more then strength of concrete is decreases.
- [9] In Hypo sludge cement concrete strength is increases up to 20% replacement of cement then when add extra 10% or more then strength of concrete is decreases.

- [10] Use of hypo sludge in concrete can save the paper industry disposal costs and produces a sustainable concrete for construction.
- [11] Disposal problem of the hypo sludge can be minimized by this project now days it is a big problem of getting the landfill.
- [12] Workability of the concrete can be increased with the increase in hypo sludge.

VI. FUTURE SCOPE

Large scale exploitation of lime stone for producing cement and emission of carbon from cement, it has become necessary to find any other alternative cementations material. Replacement of cement will not only save the natural sources for future generation but will also prevent the environment by using waste material as cement.

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