

# **An Experimental Study on the Properties of Concrete by Replacing Cement Partially with Hypo Sludge**

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**ABSTRACT:** 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 cast 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 The mix has been replaced by Hypo Sludge accordingly in the range of 0% (without Hypo Sludge), 10%, 20%, 30% and 40% by weight of cement for M-40 mix.

**KEYWORDS:** Hypo sludge, concrete mix, M40 concrete mix, ISI method.

## **I. INTRODUCTION**

Paper mill sludge is a major economic and environmental problem for the paper and board industry. The material is a by-result of the de-inking and re-pulping of paper. The aggregate amount of paper plant muck created on the planet is numerous million tones. The primary reusing and transfer courses for paper muck are land-spreading as rural manure, delivering paper ooze powder, or transfer to landfill. In useful terms, paper slop comprises of cellulose filaments, fillers, for example, calcium carbonate and china earth and lingering chemicals bound up with water.

The dampness substance is normally up to 40%. The material is thick, sticky and difficult to dry and can fluctuate in thickness and knottiness. It has a vitality substance that makes it a valuable competitor as an option fuel for the make of Portland concrete. Paper generation is an exceptionally capital and work serious movement. Wood mash is the stringy material that outcomes when wood is isolated into its constituent strands by concoction or mechanical

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means. Squander paper is made out of beforehand disposed of paper or paperboard items. Along these lines, by utilizing this paper squander we can take care of the transfer issue. In urban communities, Solid waste administration is a standout amongst the most difficult issues, which are confronting a genuine contamination issue because of the era of colossal amounts of strong waste. In this paper presents making hypo ooze from paper squander, which is use as a development material. An utilization of hypo ooze in the development business is in the generation of auxiliary cement. Hypo slop contributes advantageous properties to the solid while looking after economy. The utilization of hypo slop, the paper mechanical waste in solid definitions as a supplementary cementations material was tried as a contrasting option to conventional cement. Hypo slop contains, low calcium and most extreme calcium chloride and least measure of silica. Hypo muck acts like concrete as a result of silica and magnesium properties. This silica and magnesium enhance the setting of the solid. Paper slop comprises of cellulose filaments, calcium carbonate and china earth and leftover chemicals bound up with water. Paper making for the most part delivers a lot of strong waste. Paper filaments can be reused just a predetermined number of times before they turn out to be too short or powerless to make great paper. This paper process slop expends a vast rate of neighborhood landfill space for every last year. To decrease transfer and contamination issues exuding from these mechanical squanders, it is most basic to create beneficial building materials from them. The amount of slop changes from factory to process.

## II. RELATED WORK

To get an overview of problem building for the present research, all the available earlier studies were browsed both in India as well as around the world. Special attention was given on how the earlier workers have used towards understanding the strengths of the concrete of their study area. A brief review of available studies related to the present strength properties of concrete materials is as follows.

Experimental examinations in growing minimal effort concrete from paper industry squander R. Srinivasan, \*K. Sathiya and M. Palanisamy, 2010 Over 300 million tones of mechanical squanders are being delivered per annum by synthetic and horticultural process in India. These materials posture issues of transfer and wellbeing dangers. The squanders like phosphogypsum, fluorogypsum and red mud contain repulsive debasements which antagonistically influence the quality and different properties of building materials in view of them.

Utilization of waste paper mash by fractional substitution of bond in cement Sumit A Balwaik; S P Raut, ISSN: 2248-9622 The utilization of paper-plant mash in solid definitions was examined as a contrasting option to landfill transfer. The concrete has been supplanted by waste paper slop as needs be in the scope of 5% to 20% by weight for M-20 and M-30 blend. By utilizing sufficient measure of the waste paper mash and water, solid blends were created and looked at regarding droop and quality with the traditional cement.

Some data has been distributed on utilizations for hypo ooze. There is an absence of data on the building properties of the material. In 2013, Jayraj et al done test examination on quality of concrete and ideal rate of the halfway substitution by setting up a blend M20 review was composed according to Indian Standard strategy and the same was utilized to set up the test tests. In the test played out, the ideal compressive anxiety got by using paper waste was 30% substitution. The looked at estimations of cost show continuous decrement in absolute cost of per cubic meter concrete. At the point when government execute the tasks for brief havens for who those influenced by common calamity, this material can be utilized for monetary feasibility. As a part of 2013, Jayesh kumar Pitroda et al concentrated on examination of quality of concrete and ideal rate of the halfway substitution by supplanting bond by means of 10%, 20%, 30%, and 40% of Hypo Sludge. Keeping this view, the point of examination is the conduct of cement while including of waste with various extents of Hypo slop in cement by utilizing tests like pressure quality and split strength. In 2013, Rushabh shah and J. Pitroda concentrate the consequences of the bond mortar of blend extent 1:3 in which concrete is in part supplanted with Hypo Sludge as 0%, 10%, 30% and half by weight of concrete. Test comes about demonstrate the reductions in the quality properties of mortar with Hypo Sludge for quality at 7 & 28 days as incomplete supplanting with the bond in the concrete mortar 1:3. So it can be utilized as a part of non-basic

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components in the low range compressive quality where quality is not required and minimal effort brief structure is prepared.

### III. MATERIALS AND METHODS

Hypo muck delivered in a vast sum as by result of paper industry and is generally utilized as a part of solid creation as halfway substitution of concrete. It contains low calcium and least measure of silica and its because of nearness of silica and magnesium properties, that it acts like concrete.

#### PAPER AND ITS PROPERTIES:

The synthetic piece of paper will relies on upon the sort or review of paper. Commonly most grades of paper comprise of natural and inorganic material. Natural bit comprising of cellulose, hemi-cellulose, lignin as well as different compound of lignin (Na-lignite and so forth.) might be 70 to 100%. Inorganic segment comprising of for the most part filling and stacking material, for example, calcium carbonate, mud, titanium oxide and so forth., might be 0 - 30% of paper.

Table-1

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%

The above figure shows the grade of paper along with organic and inorganic percentages. In this four types of grade paper is used.

The premise weight, substance or gram mage is clearly most major property of paper board. The Basis weight of paper is the weight per unit region. This can be communicated as the weight in grams per square meter (GSM or g/m<sup>2</sup>), pounds per 1000 sq. ft. then again weight in Kg s or pounds per ream (500 sheets) of a particular size. Paper is sold by weight however the purchaser is keen on zone of paper. The premise weight is the thing that decides, how much zone the purchaser gets for a given weight. e.g., if premise weight is 50 g/m<sup>2</sup>, for each 1 kg weight, the purchaser gets 20 m<sup>2</sup>. At the point when the premise weight is communicated as ream weight, it tells the purchasers what number of reams he/she getting for a given weight. For papermaker premise weight is imperative from perspective of generation rate. For a given machine deckle and machine speed, the generation rate every day in MT will be = Machine Deckle(m) \* Machine Speed (m/min) \* Basis Weight (g/m<sup>2</sup>) \* 1440/1000000. Mass is another essential parameter of paper especially for printers. Mass is a term used to demonstrate volume or thickness in connection to weight. It is the complementary of thickness (weight per unit volume). It is figured from caliper and premise weight. Mass (cubic centimeter/g) = Thickness (mm)\* 1000/Basis Weight (g/m<sup>2</sup>). Sheet mass identifies with numerous other sheet properties. Diminish in mass or at the end of the day increment in thickness makes the sheet smoother, glossier, less murky, darker, bring down in quality and so forth. High mass is attractive in permeable papers while bring down mass is favored for printing papers especially book of scriptures paper, word reference paper and so forth. Book Bulk: It is characterized as the general thickness in mm of a given number of paper sheets.

The building number is characterized as number. Cellulose strands (primary constituent of paper) swell in distance across from 15 to 20% from dry condition to immersion point. Since the vast majority of the fiber in paper sheet are adjusted in the machine run bearing, retention and de-assimilation of dampness by paper causes the adjustment in CD measurement. Such changes in measurement may genuinely influence enroll in printing forms and meddle with the utilization of such things as organizing cards. Dimensional changes in paper start in the swelling and

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withdrawal of the individual filaments Change that happens in the measurements of paper with variety in the dampness substance is a critical thought in the utilization of paper. Development is a pointer of how consistently the strands and fillers are appropriated in the sheet. Arrangement assumes a vital part as the majority of the paper properties rely on upon it. A paper is as solid as its weakest point. An inadequately framed sheet will have more feeble and thin or thick spots. These will influence properties like quality, covering capacities and printing attributes of the paper, and so on. There is no standard technique or unit to express development. All review of paper has some rate of dampness. Dampness in paper fluctuates from 2 - 12% relying upon relative moistness, kind of mash utilized, level of refining and substance utilized. Most physical properties of paper experience change as a consequence of varieties in dampness content. Water has the impact of plasticizing the cellulose fiber and of unwinding and debilitating the between fiber holding. The assimilation and reflectance of specific groups of infrared and microwave radiation by paper are influenced by its dampness content. The measure of water present in a sheet of paper is generally communicated as a percent.

The measure of water assumes an imperative part in calendaring, printing and changing over process. Dampness control is additionally huge to the monetary part of paper making. Water comes free. Poor dampness control can unfavorably influence many paper properties. The total dampness substance is communicated as a % of the paper/paperboard weight. The specimen is by and large not molded while doing this test. It is most essential parameter for printer. Smoothness is worried with the surface form of paper. It is the evenness of the surface under testing conditions which considers unpleasantness, levelness, and compressibility. In the vast majority of the employments of paper, the character of the surface is of extraordinary significance. It is basic to state that paper has a "smooth" or a "harsh" surface. The expressions "complete" and "example" are regularly utilized as a part of depicting the shape or appearance of paper surfaces

The cube and cylindrical specimen is kept vertically between the compressive plates of the testing machine. The load is applied uniformly until the specimens fails, and ultimate loads are recorded. The test results of cube and cylinder compressive strengths are furnished in table 2 and 3 respectively. This test setup is presented in plate 2 & 4 respectively. An attempt to find out the modulus of elasticity has been done by the 3000KN automatic compression testing machine with 0.5KN/sec rate of loading. The results of modulus of elasticity are furnished in table no 6. The cylindrical specimen was kept horizontally for finding the split tensile strength. The test setup is shown in plate 6. The compression test on the DCN cubes was conducted on 3000KN digital compression testing machine. The rate of loading applied is 0.5 KN/sec. For testing DCN specimens of size 150x150x150mm, notches were introduced at one third portion centrally as shown in fig. 1 during casting. The loading arrangement along with frame setup used for DCN specimen is shown in plate 8. Uniformly distributed load was applied over the central one third part between the notches and square cross section steel supports were provided at bottom along the outer edges of the notches, so that the central portion could get punched/sheared through along the notches on the application of loading.

## EXPERIMENTAL INVESTIGATIONS

### SIZE OF SPECIMEN

Plain Concrete 3D square, plain solid pillar and barrel

1. The extent of the block : 150 x 150 x 150 mm
2. the extent of the barrel: 150 x300 mm

### Materials utilized as a part of the trial work

- Cement
- Hypo ooze
- Ferrous oxide
- Fine Aggregate
- Coarse aggregate

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### AGGREGATE

Aggregates are the imperative constituents in cement. They offer body to the solid, decrease shrinkage and impact economy. A standout amongst the most critical components for delivering workable cement is great degree of totals. Great evaluating infers that a specimen parts of totals in required extent with the end goal that the example contains least voids. Tests of the very much evaluated total containing least voids require least glue to top off the voids in the totals. Least glue will mean less amount of concrete and less water, which will additionally mean expanded economy, higher quality, bring down shrinkage and more noteworthy strength. Aggregate contains around 55% of the volume of mortar and around 85% volume of mass cement. Mortar contains a size of 4.75 mm and cement contains total up to a most extreme size of 150 mm. Total possesses the greater part of the volume of the solid show they are the critical constituents of cement. Least glue is mean less amount of bond and less water, which is further mean expanded economy, higher quality, bring down shrinkage and more noteworthy strength.

### COARSE AGGREGATE

The portions from 80 mm to 4.75 mm are named as coarse total. The divisions from 80 mm to 4.75 mm are named as coarse total. The Coarse Aggregates from pulverized Basalt shake, fitting in with IS: 383 is beuse. The flakiness and elongation index were maintained well below 15%



. Figure-3 Coarse Aggregate

The above figure shows the coarse aggregate and its behaviour. if coase aggregate will absorb more water then no strength will obtained.

### FINE AGGREGATE

The river sand and crushed sand is to be used in combination as fine aggregate conforming to the requirements of IS: 383. The river and sand is wash and screen, to eliminate deleterious materials and over size particles.



Figure-4 Fine Aggregat

The above figure shows the fine aggregate and its behaviour. if fine aggregate will absorb more water then no strength will obtained.



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## **WATER**

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement.

## **CHEMICAL COMPOSITION OF PAPER**

The chemical composition of paper will depend on the type or grade of paper. Typically most grades of paper consist of organic and inorganic materials. Organic portion consisting of cellulose, hemicellulose, lignin and various compounds of lignin 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. The studies on different procedures to get the new concrete which are formed by replacing of hypo sludge, fly ash materials and to give the economical study when producing of concrete with industrial waste. The present study is producing the concrete by mixing of hypo sludge and fly ash, these two are the industrial waste materials. By using of this material we can make concrete and is low cost concrete. By this experimental study on strength of concrete by adding of 10%, 20%, 30%, 40% of ferrous oxide material and get a good concrete.

## **MIX DESIGN**

The way toward selecting reasonable elements of cement and deciding their relative sums with the target of creating a solid of the required, quality, toughness, and workability as monetarily as would be prudent, is named the solid blend outline. The proportioning of element of cement is administered by the required execution of cement in 2 states, in particular the plastic and the solidified states. In the event that the plastic cement is not workable, it can't be appropriately set and compacted. The property of workability, hence, is the fate of key significance. The compressive quality of solidified solid which is for the most part thought to be a file of its different properties, relies on many components, e.g. quality and amount of concrete, water and totals; clumping and blending; setting, compaction and curing. The cost of cement is comprised of the cost of materials, plant and work. The varieties in the cost of materials emerge from the way that the concrete is a few circumstances expensive than the total, along these lines the point is to deliver as incline a blend as could be allowed. From specialized perspective the rich blends may prompt to high shrinkage and splitting in the auxiliary cement, and to development of high warmth of hydration in mass solid which may bring about breaking. The genuine cost of cement is identified with the cost of materials required for creating a base mean quality called trademark quality that is determined by the planner of the structure. This relies on upon the quality control measures, however there is probably the quality control adds to the cost of cement.

## **COMPRESSIVE STRENGTH**

It is a standout amongst the most vital properties of cement and impacts numerous other describable properties of the solidified cement. The mean compressive quality required at a particular age, more often than not 28 days, decides the ostensible water-bond proportion of the blend. The other element influencing the quality of cement at a given age and cured at a recommended temperature is the level of compaction. As indicated by Abraham's law the quality of completely compacted cement is contrarily corresponding to the water-concrete proportion.

## **WORKABILITY**

The level of workability required relies on upon three components. These are the measure of the area to be cemented, the measure of fortification, and the technique for compaction to be utilized. For the thin and convoluted segment with various corners or out of reach parts, the solid must have a high workability so that full compaction can be accomplished with a sensible measure of exertion. This likewise applies to the implanted steel segments. The coveted workability relies on upon the compacting gear accessible at the site.

## **DURABILITY**

The sturdiness of cement is its imperviousness to the forceful natural conditions. High quality cement is for the most part more strong than low quality cement. In the circumstances when the high quality is a bit much but rather the states of presentation are with the end goal that high sturdiness is key, the solidness prerequisite will decide the water-concrete proportion to be utilized.

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## SIZE OF AGGREGATE:

As a rule, bigger the most extreme size of total, littler is the bond necessity for a specific water-bond proportion, on the grounds that the workability of solid increments with increment in greatest size of the total. In any case, the compressive quality tends to increment with the reduction in size of total. IS 456:2000 and IS 1343:1980 suggest that the ostensible size of the total ought to be as huge as would be prudent.

## GRADING AND TYPE OF AGGREGATE:

The evaluating of total impacts the blend extents for a predetermined workability and water bond proportion. Coarser the reviewing leaner will be blend which can be utilized. Extremely incline blend is not alluring since it doesn't contain enough better material to make the solid strong. The kind of total impacts firmly the total concrete proportion for the craved workability and stipulated water bond proportion. A vital component of a tasteful total is the consistency of the evaluating which can be accomplished by blending distinctive size portions.

## QUALITY CONTROL:

The level of control can be assessed factually by the varieties in test outcomes. The variety in quality outcomes from the varieties in the properties of the blend fixings and absence of control of exactness in bunching, blending, putting, curing and testing. The lower the distinction between the mean and least qualities of the blend lower will be the concrete substance required. The element controlling this distinction is named as quality control.

## MIX PROPORTION DESIGNATIONS:

The regular technique for communicating the extents of elements of a solid blend is in the terms of parts or proportions of bond, fine and coarse totals. For e.g., a solid blend of extents 1:2:4 implies that bond, fine and coarse total are in the proportion 1:2:4 or the blend contains one a player in concrete, two sections of fine total and four sections of coarse total. The extents are either by volume or by mass. The water-concrete proportion is typically communicated in mass.

## COMPONENTS TO BE CONSIDERED FOR MIX DESIGN

- The review assignment giving the trademark quality prerequisite of cement.
- The kind of bond impacts the rate of improvement of compressive quality of cement.
- Maximum ostensible size of totals to be utilized as a part of cement might be as vast as could reasonably be expected inside the cutoff points endorsed by IS 456:2000.

The workability of cement for agreeable setting and compaction is identified with the size and state of area, amount and dividing of fortification and method utilized for transportation, putting and compaction.

## CONSIDERATIONS:

Fly fiery debris is one of three general sorts of coal burning repercussions (CCBP's). The utilization of these side effects offers natural focal points by redirecting the material from the waste stream, lessening the vitality interest in handling virgin materials, rationing virgin materials, and relieving contamination. Thirteen million tons of coal slag is created in Texas every year. Eleven percent of this fiery remains is utilized which is underneath the national normal of 30%. Around 60 – 70% of focal Texas providers offer fly powder in prepared blend items. They will substitute fly cinder for 20 – 35% of the Portland concrete used to make their items. Albeit fly slag offers ecological points of interest, it likewise enhances the execution and nature of cement. Fly slag influences the plastic properties of cement by enhancing workability, diminishing water request, decreasing isolation and dying, and bringing down warmth of hydration. Fly slag achieves its greatest quality more gradually than cement made with just portland bond. Some divider shape materials are produced using EPS (extended polystyrene) which is a lightweight non-CFC froth material. There are likewise fiber-bond divider shape items that can contain wood squander. The EPS/solid frameworks offer high protecting qualities and simple establishment. The fiber-concrete pieces offer protecting qualities too. Some EPS items additionally have reused content.

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## GUIDELINES

Fly fiery remains for use in Portland bond concrete should fit in with the prerequisites of ASTM C 618, Standard Specification for Fly slag and Raw for use as a Mineral Admixture in Portland bond. The solid provider might outfit a legally approved authentication from the fly fiery debris advertiser at the season of submittal of solid blend plans for endorsement showing conformance with these prerequisites. Likewise, a duplicate of the latest substance examination should be given. At no time over the span of the venture will a change of fly fiery remains source (plant) be allowed without the earlier composed assent of the Engineer or Architect. For sulfate situations, just Class F fly slag will be allowed and by no means will Class C fly fiery remains be utilized.

## CHEMICAL COMPOSITION AND CLASSIFICATION

Fly cinder material hardens while suspended in the fumes gasses and is gathered by electrostatic precipitators or channel packs. Since the particles harden quickly while suspended in the fumes gasses, fly slag particles are for the most part circular fit as a fiddle and range in size from 0.5  $\mu\text{m}$  to 300  $\mu\text{m}$ . The real outcome of the quick cooling is that lone couple of minerals will have room schedule-wise to take shape and that principally nebulous, extinguished glass remains. In any case, some hard-headed stages in the pummeled coal won't dissolve (totally) and stay crystalline. In outcome, fly fiery remains is a heterogeneous material.  $\text{SiO}_2$ ,  $\text{Al}_2\text{O}_3$ ,  $\text{Fe}_2\text{O}_3$  and once in a while  $\text{CaO}$  are the principle concoction parts display in fly fiery remains. The mineralogy of fly powder is extremely various. The primary stages experienced are a glass stage, together with quartz, mullite and the iron oxides hematite, magnetite. The groupings of other follow components differ also as indicated by the sort of coal combusted to frame it. Truth be told, on account of bituminous coal, with the remarkable special case of boron, follow component fixations are for the most part like follow component focuses in unpolluted soils. Two classes of fly powder are characterized by ASTM C618: Class F fly fiery debris and Class C fly slag. The central contrast between these classes is the measure of calcium, silica, alumina, and iron substance in the fiery remains. The concoction properties of the fly fiery remains are to a great extent impacted by the compound substance of the coal smoldered (i.e., anthracite, bituminous, and lignite). Not every fly fiery remains meet ASTM C618 prerequisites, in spite of the fact that relying upon the application, this may not be essential. Fiery remains utilized as a bond substitution must meet strict development principles, yet no standard ecological controls have been set up in the United States. 75% of the slag must have a fineness of 45  $\mu\text{m}$  or less, and have a carbon content, measured by the misfortune on start (LOI), of under 4%. In the U.S., LOI should be under 6%. The molecule measure circulation of crude fly fiery remains is all the time fluctuating continually, because of changing execution of the coal factories and the kettle execution. This makes it vital that, if fly fiery remains is utilized as a part of an ideal approach to supplant bond in solid creation, it should be prepared utilizing beneficiation techniques like mechanical air arrangement. Be that as it may, if fly fiery debris is utilized likewise as a filler to supplant sand in solid creation, unbeneficiated fly powder with higher LOI can be additionally utilized. Particularly imperative study.

## V. CONCLUSION

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

- 1 The 0% replacement of cement in M40 grade of concrete gives compressive strength of 46.83.83 N/mm<sup>2</sup> and tensile strength of 4.68 N/mm<sup>2</sup> for 28 days.
2. The 10% replacement of cement by hypo sludge in M40 grade of concrete gives compressive strength of 48.28 N/mm<sup>2</sup> and tensile strength of 4.82 N/mm<sup>2</sup> for 28 days.
3. The 20% replacement of cement by hypo sludge in M20 grade of concrete gives compressive strength of 45.93 N/mm<sup>2</sup> and tensile strength of 4.59 N/mm<sup>2</sup> 28 days.
4. The 30% replacement of cement by hypo sludge in M20 grade of concrete gives compressive strength of 39.22 N/mm<sup>2</sup> and tensile strength of 3.92 N/mm<sup>2</sup> 28 days.
5. By above results we know that the use of FERROUS HYPO SLUDGE should be in between of 10-15 % will increase the strength of concrete.



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