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RESEARCH ARTICLE

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# A STUDY ON INFLUENCE OF FLY ASH AND NANO-SILICA ON MACHANICAL PROPERTIES OF M30 AND M60 GRADE CONCRETES

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**ABSTRACT**

Cement consumption in any country is directly related to the country's infrastructure sector and thus growth in determining the development of the country. World demand for cement is projected to rise 4.5% per year to 5.2 billion metric in 2019.India is the second largest producer of cement in the world. Cement has a negative impact over Environmental, because at the time of manufacturing it emits about a ton of greenhouse gas (CO2) into the atmosphere for every ton of cement manufactured. Production of Portland cement not only releases 7% of the World's carbon dioxide, the cement industry also uses a lot of natural resources such as limestone, clay, petroleum, coal and other substances to preserve the natural resources and to reduce the pollution due to the production of cement is by limiting the cement content in the concrete without compromising the strength. There were efforts before to partially replace cement in concrete with new compounds and industry by-products.

The Aim of the present experimental investigation is to find the influence of combined application of Nano-Silica (NS) and Fly Ash (FA) on the strength properties of concrete. Fly Ash and Nano-Silica are used as partial replacement of cement. In the present experimental investigation the cement is partially replaced by 0%, 10%, 20% and 30% of Fly Ash and Nano-Silica 0%, 1.5%, 3% and 4.5% by weight. The effect of combined application of Fly Ash and Nano-Silica on compressive strength, split tensile strength and flexural strength of M30 and M60 grades of concretes are investigated. The test results of concrete prepared using the combination of different proportions of Fly Ash and Nano-Silica are compared with that of controlled concrete. The variation of different test results of concrete prepared with various proportions of Fly Ash and Nano-Silica indicates the same trend. Based on the test results, it can be observed that concrete prepared with20% Fly Ash and 3% Nano-Silica combination possesses improved strength properties compared to the controlled concrete. The increase in the various strength characteristics of concrete prepared using Fly Ash and Nano-Silica can be attributed to the effective particle packing and the also the availability of additional binder in the presence of Fly-Ash and Nano-Silica .

**Key words:** Fly-Ash, Nano-silica, Partial Replacement, particle Packing and Strength of Concrete.

**INTRODUCTION**

Cement can be considered as the most generally utilized material as a part of the development business. In the present day development hone, alongside the quality equivalent significance is given to the solidness of cement. The Indian Standard Code of practice for plain and strengthened cement prescribes the base bond substance to fulfill the quality and solidness prerequisites. Consequently, the use of concrete is expanded. Be that as it may, the concrete generation expends expansive measure of vitality and transmits carbon dioxide results in natural contamination. Henceforth, one of the answers for these issues is to decrease the utilization of bond and use Pozzolana materials for the planning of cement. Past studies demonstrates that the utilization of Fly-Ash (FA), Micro Silica (MS), Metakaoline (MK) and Ground Granulated Blast Furnace Slag (GGBS) as halfway substitution of bond decreases the bond utilization furthermore expands the quality and sturdiness of cement. To enhance the execution of cement further, Nano materials are likewise now being presented as supplementary materials.

Late advancements in Nano-innovation and the accessibility of nano-silica made the utilization of such materials in cement. Nano-Silica (NS) is a Nano-sized, profoundly receptive nebulous silica. Because of the littler particles size and high surface regions contrasted with the other pozzolanic materials, the utilization of Nano-silica perhaps upgrades the execution of solid all the more viably. As the Nano-silica particles are exceptionally fame and they tend to agglomerate because of high surface collaboration, uniform scattering of Nano-silica is a vital issue to get its useful impacts. The impact of joined utilization of fly cinder and Nano-silica is to be researched.

It is the activity of people that decides the value of any material. Materials having potential for profitable usage stay in the classification of waste until its potential is comprehended and put to right utilize. Fly powder is one such sample, which has been dealt with as a waste material in India, till 10 years back, and has now risen as an asset material, as well as a domain guardian angel. The Indian business sector is to a great degree open to clean advancement system (CDM), with a considerable lot of thankfulness both by the legislature and the business. Created nations like US record for 30 % of worldwide outflows, while India contributes around 3% of the worldwide Green House Gasses (GHS) against the worldwide normal of 5.2%. Utilization of fly slag in different items and halfway substituting bond at current yearly levels in India lessens the era of C02 by 25 million tons, great quality lime by 35 million tons and coal by 15 million tons a year. The potential that is yet to be tapped is multi-fold of the present levels.

Supplementary Cementing Materials (SCM) is generally utilized as a part of India to incompletely supplant bond in cement. The SCM's most regularly utilized incorporate fly fiery remains, ground granulated impact heater slag and silica seethe. Determination of fly fiery debris as SCM for the bond is because of its accessibility and to shield environment from contamination.

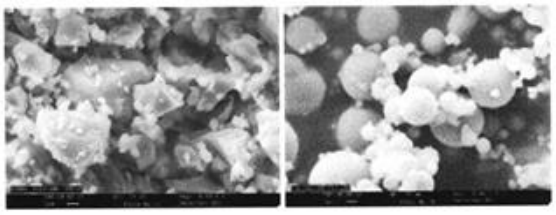
Fly fiery remains is a blazed and fine subordinate of inorganic mineral matter that creates amid the burning of pummeled coal in the warm power plant. The smoldered powder of the coal contains for the most part silica, alumina, calcium and iron as the real synthetic constituents. Contingent upon the smoldering temperature of coal, the mineral stages in crystalline to non-crystalline structures, for example, quartz (SiO2), Mullite ($3Al_2O_3.2H_2O$), Hematite ($Fe_2O_3$), magnetite (Fe3O4), Wustite (FeO), Metallic Iron, Orthoclase (K2O Al2O3 $6SiO_2$) and melded silicates for the most part happen in the blazed coal fiery debris. Silica and Alumina represent around 75 to 95% in the fiery remains. The order of warm plant fly ash is viewed as in light of receptive calcium oxide content as class-F (under 10%) and class-C (more than 10 %). Indian fly slag has a place with class-F. The calcium bearing silica and silicate minerals of slag happen either in crystalline or non-crystalline structures and are pressure driven in nature; they effectively responds with water or hydrated lime and create pozzolanic property. Be that as it may, the crystalline mineral periods of quartz and Mullite present in the fiery remains are steady

structures of silica and silicates, and are non-pressure driven in nature. Typically the fly fiery debris contains these two mineral stages as the real constituents. Along these lines, the use of fly fiery debris in making building materials like fiber concrete sheets generally relies on upon the mineral structure and pozzolanic property. Fly fiery debris is involved the non-ignitable mineral segment of coal. At the point when coal is devoured in the force plant, it is first ground to the fineness of powder. Blown into the influence plants kettle, the carbon is expended, leaving liquid particles rich in silica alumina and calcium. These particles cement as minute, polished circles that are gathered from the force plants deplete before they can take off subsequently the items name fly cinder.

There are two fundamental sorts of fly ash: Class F and Class C. According to ASTM C618, fly ash belongs to class F if ($SiO_2$+$Al_2O_3$+$Fe_2O_3$) > 70% and fits in with Class C if 70% < ($SiO_2$+$Al_2O_3$+$Fe_2O_3$) > half. Both these fly fiery remains experience pozzolanic response with lime (Calcium hydroxide) made by hydration of bond and water to shape calcium silicate hydrate like concrete.

Class F fly slag was utilized as a part of the task work. Most adequately conservatives heat pick up amid solid curing and are in this way considered a perfect cementations material in mass concrete and high quality blends. For the same reason, Class F is the answer for an extensive variety of summer cementing issues.

It has been above 70 years to examine and utilize fly fiery debris. With its application, the activity instrument of fly slag has been perceived. Amid the beginning stage, just its pozzolanic movement is focused. Numerous analysts gave themselves to the exploration of the potential action of fly fiery debris and the hydration procedure of fly powder bond. With the developing of the cognizance for fly fiery debris properties, it can be watched that the particles of fly slag have the morphology that is distinctive to other pozzolanic materials as appeared in Figure 1.1.



(a) Portland Cement (b) Fly Ash

Figure 1.1: **SEM micrographs (8,000 xs)**

It is the one of kind molecule morphology to make it have the capacity decreasing water, which other pozzolanic materials don't have. It impacts the rheological property of new Mortar as well as the introductory structure of solidified concrete stone.

**ORIGIN OF FLY ASH**

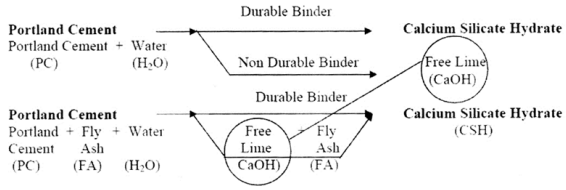
The main utilization of fly fiery debris concrete in the U.S. was the Hoover Dam venture. Because of the gigantic volume essential for its development, the exothermic warmth produced by hydrating Portland bond was foreseen to be an issue. An excessive amount of inward warmth in cement was anticipated to detrimentally affect solid qualities. It was found that by diminishing the measure of Portland bond in a solid blend and supplanting it with fly fiery debris, the same quality could be accomplished while the inner temperature of the solid could be enormously decreased. On the off chance that this material, alongside different procedures had not been utilized it is evaluated that it would have taken roughly 150 years for the Hoover Dam face to cool to encompassing temperature.

The utilization of fly slag in the readiness of cement was done by Cleveland Electric Illuminating Company and The Detroit Edison Company. Then again, the utilization of Fly Ash in cement was initially completed by Davis and his partners in University of California in 1937. In spite of the fact that broad exploration was completed all through the world to advance the utilization of Fly fiery remains in development, just a couple of turning points could be accomplished till 1960 and that too in created nations just. Similarly as India is concerned, the first ever think about on utilization of fly powder in cement was completed in 1955 by CBRI, Roorkee, as a survey of American and Australian research chip away at Fly cinder. Later, Fly slag was utilized as a part of little extents in

mass cementing for dams and other pressure driven structures.

Bond is the most - and vitality serious part of cement. The unit expense of cement can be lessened by halfway supplanting of bond with different Admixtures; Fly cinder is one of the admixtures and the transfer of fly fiery debris is one of the real issues for hippies as dumping of fly slag as waste material reasons extreme ecological issues. The usage of fly fiery remains as opposed to dumping it as a waste material can be prescribed on monetary grounds as a pozzuolana for fractional substitution of bond and mostly as a result of its gainful impacts of lower water interest for the same workability, lessened draining and bring down advancement of warmth. It has been utilized especially as a part of mass solid applications.

Portland bond cement is and will remain a noteworthy development material of decision in Civil Engineering development. Portland bond is the most imperative constituent of cement. Sadly, concrete assembling devours substantial sum vitality around 7.36x I 06 kJ per ton of bond furthermore roughly 1 ton of C02 is discharged into the air amid the creation of 1 ton of bond. Hence halfway substitution of Portland concrete by mineral by-items, for example, fly fiery debris, slag, silica smoke can fundamentally lessen CO2 discharge. Fly fiery debris is utilized as a part of cement to accomplish vitality preservation and financial, biological and specialized advantages. It is utilized as pozzolanic mineral admixture as a part of cement. By C125, Pozzolan is a siliceous or siliceous and aluminous material which itself has almost no cementitious esteem however will in finely partitioned structure and in the vicinity of dampness, artificially responds with calcium hydroxide at customary temperatures to frame mixes having cementitious properties. Fly fiery debris is normally found to enhance workability and add to quality advancement and henceforth thought to be a successful element of cement. It likewise has been generally utilized as substitution of bond as a part of typical and high quality cement. The primary goals of utilizing fly fiery debris are because of its high fineness, which diminishes the porosity and pore estimate and builds the compressive quality. The accompanying mathematical statement demonstrates the distinction in response when fly cinder is presented.




The pozzolanic impact i the primary impact of FA, which expresses that the unfixed SiO2 and AbO3 in FA can be enacted by Ca (OH) 2 result of concrete hydration and create more hydrated gel. Following the gel created from pozzolanic activity can fill in the fine in solid, it viably adds to solid quality, (frequently the era of long haul quality is principally from pozzolanic impact).

Leaving the waste materials to the earth straightforwardly can bring about ecological issue. Subsequently the utilization of waste material has been underscored. Waste can be utilized to create new items or can be utilized as admixtures so that characteristic assets are utilized all the more proficiently and the earth is shielded from waste stores. Fly fiery debris is a helpful mineral admixture for cement. It impacts numerous properties of cement in both crisp and solidified state. Besides, usage of waste materials in bond and solid industry lessens the ecological issues of force plants and diminishes vitality utilization. Bond with fly fiery remains decreases the penetrability of concrete as thick calcium silicate hydrate(C-S-H) is framed. Research demonstrates that adding fly cinder to concrete, as a fractional substitution of bond (20 and 30% percent), will advantage the crisp states. While in the new express, the fly slag enhances workability. This is because of the smooth, round state of the fly fiery debris molecule. The minor circles go about as a type of metal roller that guides the stream of the solid. This enhanced workability takes into consideration lower water-to-concrete proportions, which later prompts higher Compressive Strengths. In the solidified state, fly cinder contributes in various ways, including quality and toughness. While fly powder tends to expand the setting time of the solid. The pozzolanic response uprooting the

abundance calcium hydroxide, created by the concrete response, and shaping a harder CSH.

**Fly Ash effects in concrete**

Taking after are the impacts which were discovered in roller compacted concrete with high substance of class F fly fiery debris:

1. Since the pozzolanic response in the middle of FA and bond falls behind concrete hydration, High Fly fiery debris Roller Compacted Concrete (HFRCC) quality at ahead of schedule curing age is poor and diminishes with expanding FA content.
2. Following the curing age, more prominent measures of FA are enacted and cause the quality of HFRCC to consistently create.
3. Incorporating fly fiery remains by high substance and super-substituting technique makes HFRCC less demanding to smaller, and together with the measure of precious stone stage Ca(OH)2 and destructive pore lessening, HFRCC at long haul curing age gets to be thick and homogeneous. These enhanced properties are more helpful to flexural quality, which is more touchy to internal structure trademark than compressive quality.

**NANO SILICA**: In the present days the miniaturized scale level does not give enough understanding into the building materials. Along these lines, all around the globe, the examination is being occupied into the nano level, which is asserted to have huge potential for what's to come. The essential procedures that oversee the properties of cement are influenced by the execution of the material on a nano scale. The fundamental hydration result of concrete based materials, the C-S-H gel, is a characteristic nano-organized material.

Nanotechnology is the utilization of little particles of material either without anyone else or by their control to make new vast scale materials. The extent of the particles, however, is imperative in light of the fact that at the length size of the nano-meter, 10-9m, the properties of the material really get to be influenced. The exact size at which these progressions are showed shifts between materials, yet is more often than not in the request of 100 nm or less.

Nanotechnology is not another science and it is not another innovation either. It is fairly an expansion of the sciences and advancements that have as of now been being developed for a long time and it is the intelligent movement of the work that has been done to analyze the way of our reality at ever littler and littler scale as clarified in Fig No. 1.2.

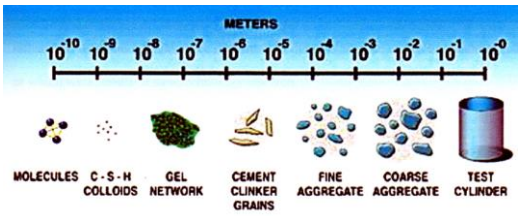



Fig. 1.2 Particle Size Scale

**HISTORICAL BACKGROUND OF NANO SILICA:** The thought was initially started by Richard Feynman in 1959. In the 1980s the fundamental thought of this definition was investigated in considerably more profundity by Dr.Eric Drexler, who advanced the innovative essentialness of N ano-scale marvels and gadgets through talks and the books Engines of Creation: The Coming Era of Nanotechnology and Nano frameworks: Molecular Machinery, Manufacturing, and Computation, thus the term obtained its present sense.

All the more comprehensively, nanotechnology incorporates the numerous methods used to make structures at a size scale beneath 100 nm, including those utilized for manufacture of nano wires, those utilized as a part of semiconductor creation, for example, profound bright lithography, electron bar lithography, centered particle pillar machining, nano engrave Lithography nuclear layer statement, and sub-atomic vapor testimony, and further including sub-atomic self-get together systems, for example, those utilizing di-piece copolymers. It ought to be noticed that these strategies went before the nanotech time, and are augmentations in the improvement of logical progressions instead of systems which were conceived with the sole reason for making nanotechnology or which were consequences of nanotechnology exploration.

**Nano Technology in Concrete**

Nano Technology connected to concrete incorporates the utilization of nano materials like nano silica, nano filaments and so on. By including

the nano materials, solid composites with prevalent properties can be created. Expansion ofNano-Silica (NS) in cements and mortars results in more proficient hydration of bond. Because of the pozzolanic movement, extra calcium silicate hydrates are framed prompting expanded quality and to lessen free calcium hydroxide.

This likewise helps in decreasing the bond prerequisite,nano-silica enhances the microstructure and lessens the water penetrability of solid along these lines making it more tough. Utilization of nano-silica in cement enhances the cohesiveness between the particles of cement and diminishes isolation and dying. Cements with qualities as high as 100MPa with high workability, hostile to draining properties and short de-forming time can be created. Nano-silica can be utilized as an additi e to eco solid blends.

On account of eco solid blends, mechanical squanders, for example, fly fiery debris, impact heater slag are utilized as admixtures at specific rates as substitution to bond. Certain issues like longer setting time, lower compressive quality at higher rates can be overcome by including nano-silica which enhances these properties.

**Production of Nano Silica (NS)**

At present an extensive variety of silica items is made modernly for a differing cluster of utilizations. Silicas are chiefly utilized for strengthening, thickening and straightening purposes. In1999 the world encouraged silica creation limit was 1100 kilo tons. There are two principle courses for the creations of manufactured nebulous silica. Nano materials have atleast one measurement of the request of a nano which is 10-9m. For instance one strand of DNA is 2nm wide and human hair has a measurement of about 10-4m. A nano molecule turns into a quantum speck with measurement of the request of 10nm and this size is small to the point that hops in vitality levels happen.

There are diverse strategies to deliver NS items. One generation strategy depends on Sol-gel process (natural or water course) at room temperature. In this procedure, the beginning materials like Na2SiO4 and Organometallics like Tetramethoxysilane (TMOS)/Tetraethoxysilane (TEOS) are included a dissolvable and afterward the pH of the arrangement is changed coming to the precipitation of silica gel. The delivered gel is blended and separated to wind up a Xero gel. This is further dried and blazed or scattered again with balanced out operators (Na, K, NH3) to create a concentrated scattering (with 20 to 40% strong substance) suitable for use in cement. There are different routines like vaporization of silica between 1500 to 2000 °C diminishing quartz in an electric circular segment heater, organic technique, and precipitation strategy and so on

**Benefits of Nano Silica :** Expansion of nano silica in cements results in more proficient hydration of concrete. More quality is created which helps in lessening the concrete necessity. Nano silica enhances the small scale structure and makes solid more impermeable and more strong. As it creates thick cement compressive quality is expanded. What's more, it lessens isolation and dying. Expansion of NS likewise contributes in avoiding breaking of cement at right on time age in the asphalt development. Figure 1.3 demonstrates the nano-silica in powdered structure.

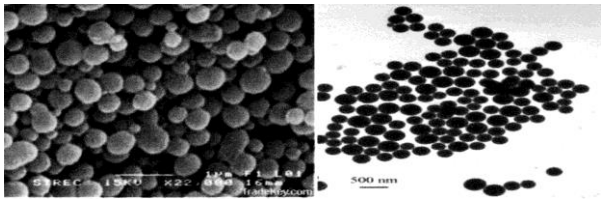



Figure 1.3.Spherical Nano - Silica Powder.

**Objectives**

The goals of the present examination work are to concentrate on the

- Effect of Fly fiery remains content on compressive strength, split tensile strength, flexural strength of cement.
- Effect of joined use of Nano-Silica and Fly fiery debris on compressive strength improvement splittensile strength and flexural strength.
- Comparison of the consequences of Conventional Concrete, with consolidated utilization of Fly slag and Nano-Silica as substitution of Cement.

**CONCRETE MIX DESIGN**

**TABLE 1: Mix Proportion for M30**

| Cement (Kg/m$^3$) | Fine aggregate(Kg/m$^3$) | Coarse aggregate(Kg/m$^3$) | Water(lit/m$^3$) |
|---|---|---|---|
| 1 | 2.04 | 2.30 | 0.43 |
| 411 | 841 | 946 | 178 |

**TABLE 2: Mix Proportion for M60**

| Cement(Kg/m$^3$) | Fine aggregate(Kg/m$^3$) | Coarse aggregate(Kg/m$^3$) | Water(lit/m$^3$) |
|---|---|---|---|
| 1 | 1.35 | 2.19 | 0.29 |
| 504.21 | 683.24 | 1108.13 | 141.61 |

**EXPERMENTAL WORK**

**COMPRESSION STRENGTH TEST:** Compressive strength is one of the most important engineering property of Concrete which designers are concerned of. It is a standard industrial practice that the concrete is classified based on grades. This grade is nothing but the Compressive Strength of the concrete cube or cylinder. Cube or Cylinder samples are usually tested under a compression testing machine to obtain the compressive strength of concrete. The test requisites differ country to country based on the design code. As per Indian codes, compressive strength of concrete is defined as the compressive strength of concrete is given in terms of the characteristic compressive strength of 150mm x 150mm x 150mm size cubes tested at 28 days (fck). Compressive Strength of cement is controlled by applying load at the rate of 140kg/sq.cm/minute till the examples fizzled.

Fig: Compressive strength with CTM

**SPLIT TENSILE STRENGTH:** The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack. To determine the splitting tensile of concrete. Tensile Strength test was led on the examples at 28days according to IS 5816-1999. Three round and hollow examples of size 150 mm x 300 mm were thrown. The heap was connected continuously till the disappointment of the example happens. The most extreme burden connected was then noted. The part elasticity (Ft) was ascertained as takes after:

Where Ft = 2P/□DL

P = Compressive load

L = Length of the cylinder

D = Diameter of the cylinder

Fig: Split Tensile Strength Test

**FLEXURAL STRENGTH TEST**

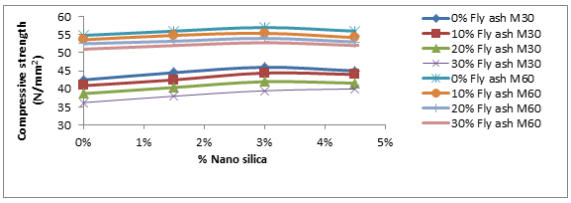
Flexural quality is one measure of the rigidity of cement. It is a measure of an unreinforced solid shaft to oppose disappointment in bowing. The flexural quality can be dictated by Standard test system. In this study, three light emissions 100 mm x 100 mm x 500 mm were utilized to discover flexural quality. In the event of three point stacking, the basic split might show up at any segment. Flexural strength is calculated using the following formula.

(a) When fracture initiates in the tension surface (i.e., the bottom surface) within the middle third of the beam, Where P is the failure load, l is the span length, d is the depth of the beam, and b is the width of the beam. All dimensions are in mm.

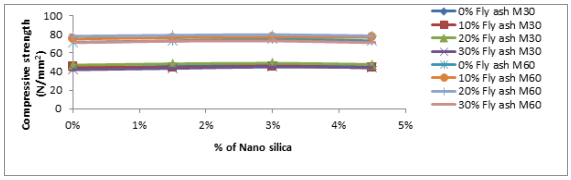
(b) If fracture initiates in the tension surface (i.e., the bottom surface) outside the middle third of the beam by not more than 5% of the span length.

**FINAL TEST RESULTS**

COMPRESSIVE STRENGTH FOR 7 DAYS WITH DIFFERENT PROPORTIONS OFFLY ASH AND NANO-SILICA



COMPRESSIVE STRENGTH FOR 28 DAYS WITHDIFFERENT PROPORTIONS OF FLY ASH AND NANO-SILICA:

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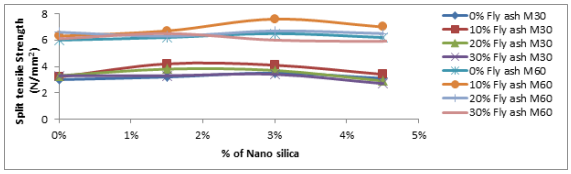


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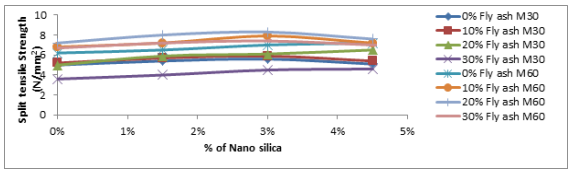


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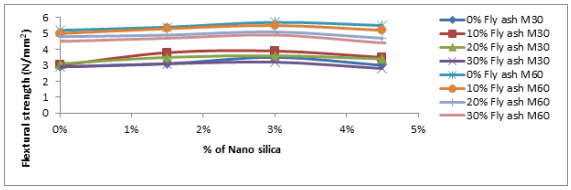


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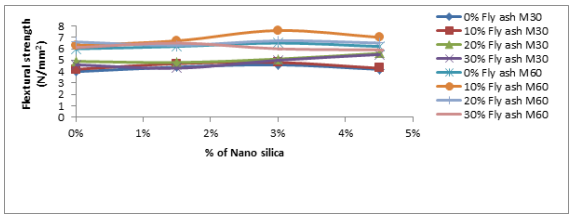


**CONCLUSIONS**

The effects of the test examination demonstrate that the blend of fly fiery debris and Nano-silica can be utilized as Ordinary Portland bond substitution for solid readiness.

- Using the test outcomes, it can be inferred that with the expansion in the rate of Nano-silica for distinctive rates of fly slag, the different quality properties of cement are expanded up to 3% of Nano silica and with further increment in the Nano-silica, the properties of cement are diminished.
- It is extremely intriguing to note that the variety of compressive quality, split tensile strength, flexural strength of M30 and M60 grade review fly fiery remains concrete with different rates of Nano-silica shows the comparable pattern.
- The reduction in the quality attributes of cement with expansion in the Nano-silica content past 3% is because of the low quality of cover shaped in the vicinity of high substance of Nano-silica and fly cinder.
- By conducting the different tests it has been noted that M30 and M60 grade fly ash concrete with various percentages of Nanosilica indicates the similar trend.
- Due to the high presence of Nano silica and fly ash the characteristics strength of concrete is decreased by using more than 3% of content
- By this project we can able to convert the waste materials in to use full building materials in construction fields..
- It has been observed optimum quantity of Nano silica to be used is still contradictory and it is for the re searcher to decide the optimum quantity for her own material.
- New development have taken place in the Nano engineering and Nano modification of concrete ; however, current challenges need to be solved before the full potential of Nano technology can be realized in concrete applications , including proper dispersion , compatibility of the nanomaterial's in cement.
- As a civil engineer we have construct the constructions with most economically and with high strength

**REFERENCES**

[1]. Belkowitz,J. and Armentrout, D. L. (2009). The Investigation of Nano Silica ill the Cement Hydration Process. ACI Special Publication 267(8): 87 -100.

[2]. C Freeda Christy and D Tensing. (20 I 0). "Effect of Class F Fly Ash as Partial Replacement with cement" IJEMS, Vol 17 pp 140 - 144

[3]. D.P. Bentz et al.,(2010),"studied the evaluation of sustainable high volume fly ash concretes, Cement and Concrete Composites, Vol 33, pp 39-45.

[4]. G.Carette et.al. (2010)," studied on the early age strength development of concrete incorporating fly ash".Materials, VoL. 90(6), pp.535-544.

[5]. G.Quercia and H.I.H. Browwers, (2010). 'Applications of Nano Silica 111 Concrete Mixtures', 8th Ph.D. Symposium in Kg Lyngby, Denmark, June 20-23,

[6]. Gengying Li, 2003, "Properties of high volume fly ash concrete incorporating nano-sio2" Cement and Concrete Research, 34, pp 1043-1049.

[7]. Gengying Li, 2003, "Properties of high volume fly ash concrete incorporating nano-sio2" Cement and Concrete Research, 34, pp 1043-1049.

[8]. Gengying Li., (2004). "Properties of High-Volume Fly Ash Concrete incorporating ano-SiO2, Cement and Concrete Research, pp. 1043-1049.

[9]. Hui Li, et al., 2004, "Microstructure of cement mortar with Nano-particles" Composites Part B – Engineering, 35, pp 185-189.

[10]. Hui Li, et al., 2004, "Microstructure of cement mortar with Nano-particles" Composites Part B – Engineering, 35, pp 185-189.

[11]. .Hui-gang Xiao, et al., 2004, "Mechanical and pressure-sensitive properties of cement mortar with Nano phase materials" Cement and Concrete research, 34(3), pp 435-438.

[12]. Hui-gang Xiao, et al., 2004, "Mechanical and pressure-sensitive properties of cement mortar with nan phase materials" Cement and Concrete research, 34(3), pp 435-438.