An Experimental Investigation on No Fines Concrete with Partial Replacement of Cement with Supplementary Cementitious Materials

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Abstract- Concrete is a sophisticated material to which contains a mixture of Portland cement or any other hydraulic cement , fine aggregates, coarse aggregates and water ,with or without admixture. Concrete usually has low tensile strength. Present day's concrete value economically increased alot. low strength-to-weight ratio, and Concrete is susceptible to cracking. To overcome this problem concrete is required to reinforced to avoid any cracks in which it can lead to expensive. The concrete has also low ductility. To overcome all these defects No-fines concrete (NFC) is found which is also called as pervious concrete or light weight concrete or porous concrete. No fine concrete is made by using cement , coarse aggregates and water Aggregate particles are covered with a very thin layer of cement paste and they are in point-to-point contact with each other. No fines concrete therefore has the large interconnected voids and with a lower density than the conventional concrete. The main use of the no fines concrete is ideal for the use of a drainage level under the reservoir and for the basement floors. The mineral admixtures like silica fume & metakaolin are used in the No fines concrete by replacement of cement with 0%, 10%, & 20% to study the properties like compressive and split tensile strength of the no fines concrete. The present study gives the required compressive strength & tensile strength results for no fines concrete by replacement of cement with supplementary cementitious materials. The compressive strength has been determined for the mixes up to 7, 28, 56 & 90days, where as the tensile strength has been determined for 28days only. From experimental studies, it is observed that the normal no fines concrete without admixtures achieved compressive strength about 22.96N/mm^2. i.e. for 90days, where as for no fines concrete with 10% silica fume ,20% silica fume has 24.5 N/mm^2 & 16N/mm^2 for 90 days, With 10% & 20% of metakaolin replacement with cement ,it is observed about 22.518N/mm^2 & 17.777N/mm^2 of compressive strength for 90days. The tensile strength for normal no fines concrete is 2.133N/mm^2 .The compressive strength for all mixes at 90days & tensile strength for 28days observed that 10% of silica fume with replacement of cement has more compressive strength i.e. 24.500N/mm^2 when compared to all other mixes. With 10% replacement of cement by silica fume obtained more strength compared to control mix. By addition of 10% silica fume it is observed that an increase in percentage of strength about 6.28% and as well as for metakaolin it is about 1.96%. Again by addition of 20% silica fume it is observed that there is a percentage decrease of about 12.3 and for 20% metakaolin it is about 11.8% compare to control mix strength values. The tensile strength for 10% & 20% of silica fume by replacement of cement is 2.4N/mm^2 & 2 N/mm^{2,} and for 10%& 20 % of metakaolin by replacement of cement is 2.1N/mm^2 & 2N/mm^2. So, it is observed that 10% silica fume gave better results in tensile strength test compare to control mix.

Keywords – No fines concrete, Compressive strength, split tensile strength, silica fume, metakaoline

I. INTRODUCTION

Concrete is a vigorous, sustainability & multifarious mouldable engineering construction material, in which it contains cement, sand and aggregate (e.g:crushed gravel or crushed rock) and then commixed with dihydrogen monoxide. The dihydrogen monoxide & cement dihydrogen monoxide forms a paste which coats the sand and aggregates or the term concrete withal justifices as coalescence of coarse aggreagates,fine aggregates,cement, and some volume of dihydrogen monoxide or water (H_2o) are required to compose the concreate.When the cement chemically reacts with the dihydrogen monoxide,it hardens and binds the whole amalgamation together. The initial hardening reaction conventionally occurs within a few hours. It takes some weeks for concrete to reach full hardness and vigor. Concrete can perpetuate to harden and gain vigor over many years.

In archaic time, the romans commenced utilizing the concrete intensively,due to its workability and durability properties. Romans are the reason for the worldspread of this concrete. In that time,romans selectively commixes the lime ,rubble, with pozzolana sand & dihydrogen monoxide,so that it can forms a vigorous concrete ,which is called as opus caementicium.After that Victorians commixes the lime mortar and sand which engenders a same reaction is equipollent to the Roman pozzolana.After regular use & lot of experiments on concrete with different binding materials,finally the conventional concrete has discovered,in which we have grades in concrete like M5 ,M7.5,M10,M15,M20,M25,M30,M35,M40,M45,M50,M55,M60. Where M5 ,M7.5 are called as lean mix.M10,M15 & M20 are called as ordinary concrete. M25, M30, M35, M40, M45, M50, M55 are called as standard concrete. M60 is called as the high strength concrete.

Ordinary Portland cement is the ecumenically used cement around the world. The main product for the preparation of cement is limestone. The limestone powder is most finest powder which is engendered by heating materials in a kiln like immensely colossal container, where the clinker is composed. The obtained clinker is ground fine and then other chemical material are integrated in minuscule batches. Generally the mundane Portland cement was sub categorized into 3grades such as 33,43 & 53 grades depending upon the compressive vigor of the cement at 28days In the project, we have utilized OPC 53grade (zuvari cement).

The majority of the gravel or coarse aggregates are angular in shape which has a rough surface texture, the angular aggregates have the best surface area than the rounded gravel. so the angular aggregates have more bond vigor when compared to the rounded gravel or aggregates. The dihydrogen monoxide-cement ratio under 0.4 with crushed angular gravel results up to 38 than the rounded gravel.

II. LITERATURE REVIEW

As our aim is to develop no fines concrete, which does concern on the architectural, drainage, light weight structure's purpose, it also has many other aspects to be fulfilled like less durability, capillary absorption. Now a day’s one of the new application technique in various structured fields is no fines concrete.Our project main aim is to see whether the no fines concrete has the capability to achieve the desired compressive strength and split tensile strength which is useful in the engineering construction works.

Dr.M.Mageswari- In spite of having low Compressive and flexural vigor, No-fines concrete has properties capable of being utilized as rigid pavement for low traffic volume roads. Along with the commix proportions and dihydrogen monoxide content to have ample bond between the aggregate particles, it is critical to determine what transpires to the dihydrogen monoxide once it perforates the pavement surface. Different amalgamations of Cement, GGBS, dihydrogen monoxide and Course aggregate with different maximum size and gradation were adopted for tribulation commixes to arrive at M20 grade concrete.M20 grade concrete is achieved with a w/c ratio of 0.36, Coarse aggregate of nominal size 20 mm passed and 10 mm retained, cement is partly superseded with 30% of GGBS and with a cement to Course aggregate ratio of 1:4. Its compressive vigor were observed to be 20.4 kN/m3.A perforated pipe can be provided at centre of the pavement above sub-base such that it amasses the dihydrogen monoxide stored in concrete and drains it to the required treatment plant or a recharge pit.

K.Satham ushane- More than 40 million residential units are needed to house millions of waifs in India. Blocks are paramount components in residential buildings. Even though bricks composed of soil have been widely used so far, there is very good scope for utilizing blocks composed of cement, sand and coarse aggregates because bricks are not available at all places to the desired requisites. A concrete block is primarily utilized as a building material in the construction of walls. A concrete block is one of several precast concrete products utilized in construction. Major advantage of concrete blocks is that their vigor can be engineered as per requisite, thus making them relatively more vigorous than masonry with bricks walls by around 15-20%. The market for building block is growing at a rapid rate, especially in the areas where burnt bricks are not facilely available or of poor quality. Lamentably, rigorous scientific studies have not been made on the vigor, durability and economy of concrete building blocks. Lightweight concretes can either be lightweight aggregate concrete, foamed concrete or Autoclaved Aerated Concrete (AAC). Such lightweight concrete blocks are often utilized in mason’s house construction, because of their less density and self-weight, it avails for more expeditious construction.

Geronimo- A study for concrete commixes includes the factor of having a lightweight specimen. This can be defined as a type of concrete which includes an agent that increments the volume of coalescence, giving supplemental quality, and efficaciously supersedes dead weight. This lightweight concrete is lighter than the conventional concrete, having a dry density of 300kg/m3 up to 1840 kg/m3; 20% to 80% lighter (N.B Manaf, year). Lightweight concrete is kenned for its low density and thermal conductivity which is great to consider especially in our country that requires to be economical to gain paramount advantages. It is withal an efficacious material to reduce dead load capacity of a certain structure. The designed dimension could withal be reduced predicated on the design, more expeditious building rates, and hauling of material which is proportion to its cost may additionally be reduced. Taking into consideration that lightweight concrete is efficient to utilize for construction and has economical advantage, most especially in cases when there is a desideratum to construct alternative bunk houses for victims of earthquake, typhoon and other calamities who cannot afford to build them. In this figure, it shows that lighter materials can be utilized in concrete construction that can last for a long span of time.

Techbrief- Pervious concrete sometimes referred to as no-fines, gap-graded, permeable, or enhanced porosity concrete, is an innovative approach to controlling, managing, and treating the stormwater runoff. When utilized in pavement applications, pervious concrete can efficaciously capture and store the inclemency dihydrogen monoxide runoff, thereby sanctioning the runoff to percolate into the ground and recharge groundwater supplies. Pervious concrete contains little or no fine aggregate (sand) and punctiliously controlled amounts of dihydrogen monoxide and cementitious materials. The paste coats and binds the aggregate particles together to engender a system of highly permeable, interconnected voids that promote the rapid drainage of dihydrogen monoxide (Tennis et al. 2004; ACI 2010). Typically, between 15 and 25 percent voids are achieved in the hardened concrete, and flow rates for dihydrogen monoxide through the pervious concrete are generally in the range of 2 to 18 gal/min/ft2 (81 to 730 L/min/m2), or 192 to 1,724 inch/hr (488 to 4,379 cm/hr) (ACI 2010).

Sanket Sharma (2012)- determined the effect of percentage of fine aggregates and cement to coarse aggregate ratio to study the mechanical properties of pervious concrete. Tests and results concluded that with integration of 5% fine aggregates in pervious concrete, it incremented the compressive vigor but withal vigor decremented with further increment of percentage of fine aggregates. And compared to no fine aggregates in concrete , flexural vigor of pervious concrete incremented by 50% with additament of 10% fine aggregates.

Jing yang (2012) - investigated the effect of more minute sized aggregates, silica fume and super plasticizer to increment the pervious concrete vigor greatly. Predicated on results, they concluded that with utilization of more minute sized aggregates it availed to amend the consequentiality vigor of pervious concrete. SF and SP withal enhanced the vigor of pervious concrete. Additionally compressive vigor of composition of these materials can be reach up to 50 MPa and it can be applied to footpath and withal the low traffic conveyance road.

Rui zhong (2015)- dealt with silica fume and ultra-fine silica powder to ameliorate the ultra high performance pervious concrete matrix. To achieve the goal of ultra-high performance cement predicated matrix with compressive vigor in excess of 150 MPa and high durability properties designed and applied to the amalgamation design concept of pervious concrete. They concluded from the results that Predicated on enhanced mechanical properties as well as amended durability, high performance pervious concrete potentially sanctions elongating the application of pervious concrete and thus carries a vital potential in efficaciously counteracting the magnification of impervious urban areas.

Baoshan huang (2009)- carried out the experiment on pervious concrete with utilization of latex polymer to amend the vigor properties. With utilization of latex, natural sand and fibre they evaluated the effect of polymer modification on mechanical and physical properties of PMPC. Predicated on results, it was possible to engender pervious concrete coalescence with acceptable permeability and vigor through the amalgamation of latex and sand.

Anthony Torres (2015) - presented the utilization of thick cementitious paste on performance of pervious concrete and carried out the paramountcy vicissitude in mechanical properties of pervious concrete. To thicken the cementitious paste, they used limestone with sizes of 9.54 mm and 6.35 mm. and for amending thickness of cement paste, they minimized the other variables such as cement types, w/c ratios, sample size, admixtures etc. predicated on tests and results they concluded that porosity of pervious concrete decremented with an incrementation of cementitious paste thickness. And withal permeability of concrete decremented with increase of cementitious past thickness in pervious concrete. And surely decrement in porosity and permeability, compressive vigor and split tensile vigor incremented but it can vanquish the purport of pervious concrete if paste thickness becomes too thick.

James Sommerville, Nigel Craig1 and Antoinette Charles - No-fines concrete (NFC) homes comprise about 1% of the housing stock, in Scotland, which equates to around 33,000 homes. Most of these homes are located within the convivial housing providers' domain and given the 2050 target to reduce Scotland's carbon emissions by 80%, and then it becomes ostensible there may be consequential challenges for these homes to achieve a u-value proximate to 0.3 W/m²K. In the 1970's, NFC was identified as a material which could preserve cement and energy. However, as practices transmuted, technology developed, and climate change became an authentic force, then the right of these housing units to subsist became controvertible. This research aims to evaluate the future value of subsisting NFC homes through detailed cost-benefit analysis. The cost-benefit analysis compares the cost of refurbishing subsisting NFC homes and the cost of building incipient homes. It is suggested that the cost analysis comparison will avail gregarious housing providers and construction managers to better understand the feasibility of refurbishing these homes. Data for this analysis was accumulated through fieldwork and case studies where a commixed methodology approach was adopted to derive answers to questions through both quantitative and qualitative methods. The sample for this research fixates on subsisting NFC homes in Irvine, Glasgow and West Dunbartonshire. The findings of this research will avail gregarious housing providers and construction managers make decisions about the future of their NFC stock. The cost of an incipient build is £205/m² higher than refurbishment and the minimum payback period for the refurbishment activity of a single bedroom property, generally, has a 16 year period. The findings from this paper show the desideratum for further research on evaluating the assessment criteria used when considering to either 'make or break' subsisting NFC properties. The current accentuation on cost versus quality of life of the tenants within these subsisting properties may be disputable.

Nea Riverside- This project will address the heat loss and damp issues prevalent in no-fines concrete housing, retrofitting 35 such houses in Runcorn. These are arduous to retrofit costeffectively, so 7 different coalescences of measures will be trialled, each applied to five houses. The technologies are categorised as: external wall insulation, internal airtightness and complementary measures. Each property will receive a cumulation to test the efficacy of the different measures. In phase one all five properties will benefit from the same technology (there is a different technology for each group). In phase two (after a three-month period), a second set of minor amendments will be made to test the impact of low caliber air-tightness interventions for the best coalescence of 'marginal gains'.

Karthik.H.Obla-Pervious concrete is a special type of concrete with a high porosity utilized for concrete flatwork applications that sanctions dihydrogen monoxide from precipitation and other sources to pass through it, thereby reducing the runoff from a site and recharging ground dihydrogen monoxide levels. The void content can range from 18 to 35% with compressive strengths of 400 to 4000 psi. The infiltration rate of pervious concrete will fall into the range of 2 to 18 gallons per minute per square foot (80 to 720 liters per minute per square meter). Typically pervious concrete has little to no fine aggregate and has just enough cementitious paste to coat the coarse aggregate particles while preserving the interconnectivity of the voids. Pervious concrete is traditionally utilized in parking areas, areas with light traffic, pedestrian walkways, and greenhouses. Pervious Concrete is a consequential application for sustainable construction.

Govind Ravish and , Er.V.K. Ahuja- No-Fine concrete pavements are use mostly in rural area. This concept of pervious concrete is relatively incipient for rural road pavement. Pervious concrete has competency to flow dihydrogen monoxide through it and this property avail to recharge the ground dihydrogen monoxide. Pervious concrete pavement is unique and efficacious technique to meet the future demand. Vigor of the pervious concrete is low as compared to conventional concrete it is all due to high porosity. No-fines concrete is mostly utilized in non-pavements applications, inhibited use in pavements applications. This assignment purport is to assess the felicitousness for no-fines concrete to be utilized for the construction of road pavement

Hussam A. A. Rehman- This work fixate on studying the mechanical characteristics of polypropylene and carbon fiber reinforced no fine aggregate concrete, containing different percentages of fiber. This work was carried out utilizing several tests. These tests were workability fresh and hardened density, compressive vigor, splitting tensile vigor and modulus of rupture. Tests were performed for specimens at ages of (7, 28) days. The test results designated that the inclusion of fiber to the pervious concrete commixes did not affect the compressive vigor significantly, while the splitting tensile vigor and the modulus of rupture were amended significantly. Test results betokened that, the modulus of rupture of (5%) carbon fiber pervious concrete specimens are three times that of the control specimens, while the modulus of rupture of (5%) polypropylene fiber pervious concrete specimens are two times that of the control specimens. The percentage increase in tensile vigor for polypropylene commixes containing fiber by volume fraction of (1%, 3%, 5%) were (93%, 101% and 129%) respectively and the percentage increase in tensile vigor for carbon commixes containing fiber by volume fraction of (1%, 3%, 5%) were (170%, 177% and 220%) respectively.

A, R, Khaloo, Y. Khalighil &M, Irajian- No-tines concrete has considerable drainage property and a relatively low vigor. A wide aggregate grading range, with higher percentage of aggregate in lower bound, ameliorates vigor properties, however such grading results in lower drainage capability, The objective of this paper is to make highperformance single-sized No-fines Concrete commixes utilizing polymer modification. An experimental program was carried out to study the parameters of watercement ratio, aggregate-cement ratio, type of polymer, polymer content, setting time and remedying period. The test specimens were 6X12 in. cylinders and were cast utilizing hand rodding compaction in accordance with ASTM C 31-69, Initially an opportune capping method was established to minimize its influence on the concrete vigor. Then dihydrogen monoxide-cement ratio of the concrete was optimized predicated on elimination of aggregate segregation in the fresh concrete and reaching the highest possible vigor, Later, two commixes with different ratios for aggregatecement were culled, one with low cement content, and another with high cement content. These commixes were polymer modified by Styrene-butadiene and Acrylic latex. Test results betoken that Styrene-butadiene polymer amends the' vigor performance of low-cement No-fines concrete, however Acrylic latex is salutary in both commixes, The Acrylic modified commixes were more time sensitive than the Styrene-butadiene commixes. As a result, the Styrene-butadiene commixes are more applicable in practice.

SCOPE AND OBJECTIVE:

The objective of the present work is to develop concrete with good strength, more porous, more capillarity .For this purpose it requires the use of different pozzolanic materials like metakaolin and silica fume along with fiber. So the experimental program to be undertaken;

- To reduce the impact of waste materials on environment.
- To find out the percentage use of admixtures feasible for construction.
- To determine the mix proportion with metakaolin and silica fume for concrete to achieve the desirable needs.
- To determine the water/ binder ratio, so that design mix having proper workability and strength.
- To investigate different basic properties of concrete such as compressive strength, split tensile strength, and comparing the results of different proportioning.
- For safe construction, to find the how much percentage of silica fume and metakaolin is partially replaced by cement as an admixture to attains strength at maximum level.

III. MATERIALS AND PROPERTIES

The physical and chemical properties of cement, coarse aggregates and dihydrogen monoxide utilized in this investigation are analyzed predicated on standard experimental procedure laid down in standard codes like Indian standard code, ASTMC, and Bureau of Indian standard codes.

MATERIALS:

The materials used in present investigation include;

1. Cement-Ordinary Portland Cement (OPC)
2. Mineral Admixtures-
   a. Silica Fume &
   b. Metakaolin
3. Coarse aggregates
4. Water.

CEMENT :

Ordinary Portland cement of 53 grades was used for the experimental investigation.

Table .1 Physical Properties of OPC

S.No	Characteristic of cement	Value	Code specifications (IS 4031-1988)
1	Fineness of cement	94.76%	-
2	Normal consistency	33%	**Not specified**
3	Initial setting Time	40 minutes	>30
4	Final setting time	350 minutes	<600
5	Specific gravity	3.14	-

Table. 2 Chemical Composition of Cement

S.NO	Oxide	Present Content
1	CaO	65.49
2	SiO_2	21.67
3	Al_2O_3	5.97
4	Fe_2O_3	3.85
5	SO_3	1.66
6	MgO	0.78
7	K_2O	0.46
8	Na_2O	0.12

COARSE AGGREGATE:

Crushed granite broken stone of 20 mm nominal size is used as coarse aggregate in this work.

Table .3 Coarse Aggregate Properties

S.No	Properties	Unit	Results
1.	Specific gravity	-	2.68
2.	Particle size variation	mm	6.35 to 6.4 to 20mm
3	Fineness Modulus	-	6.26
4	Water Absorption	%	0.5
5	Bulk Density	kg/m^3	1469.8
6	Elongation index	%	20.49
7	Flakiness index	%	13.19

Water

Locally available potable drinking water used in the experimental work for all mixes.

Table .4 Mix-Proportions for No Fines Concrete

SAMPLE	CEMENT %	SILICA FUME %	METAKAOLIN %	COARSE AGGREAGTE (kg/m^3)	W/C ratio	WATER (ltrs)
CONTROLLED MIX	100	0	0	1356	0.24	1.5
CEMENT+10%OF SILICAFUME	90	10	0	1356	0.24	1.6
CEMENT+20%OF SILICAFUME	80	20	0	1356	0.24	1.7
CEMENT+10% OF METAKAOLIN	90	0	10	1356	0.24	1.6
CEMENT+20% OF METAKAOLIN	80	0	20	1356	0.24	1.7

IV. RESULTS AND DISCUSSIONS

The results of present investigation are presented both in tabulated and graphical forms. In order to facilitate the analysis, interpretation of results is carried out at each phase of experimental study. This interpretation of the results obtained based on the current knowledge available in the literature as well as on the basis of results obtained. The significance of results is assessed with reference to the standards specified by the relevant IS codes. Also durability of concrete during its service life may be significantly affected by the environmental condition to which it is exposed, and in order to produce a concrete of high quality, appropriate mix, curing system in a suitable to the environmental condition during the early stages of hardening. The cubes, cylinder and beams were taken tested 7, 28, 56 and 90 days and results were obtained and the graphical views were shown in the below tabulations. By the results the calculations shows the increasing the compressive strength, split tensile strength, flexural strength. This result shows the maximum addition of silica fume & metakaolin at the peak point this makes the maximum utilization of silica fume & metakaolin should be added to the concrete at certain intervals to attain the maximum strength.

The compressive strength of concrete for different replacements of cement with 10% and 20% of silica fume and 10%,20% metakaolin by volume of concrete were tested for 7,28,56 and 90 days using compressive test machine. The water to cement ratio was taken as 0.24. Three cubes were casted for each proportion and the average of three test samples was taken for the accuracy for results. At the room temperature, the concrete cubes were cured.

Normal Consistency:

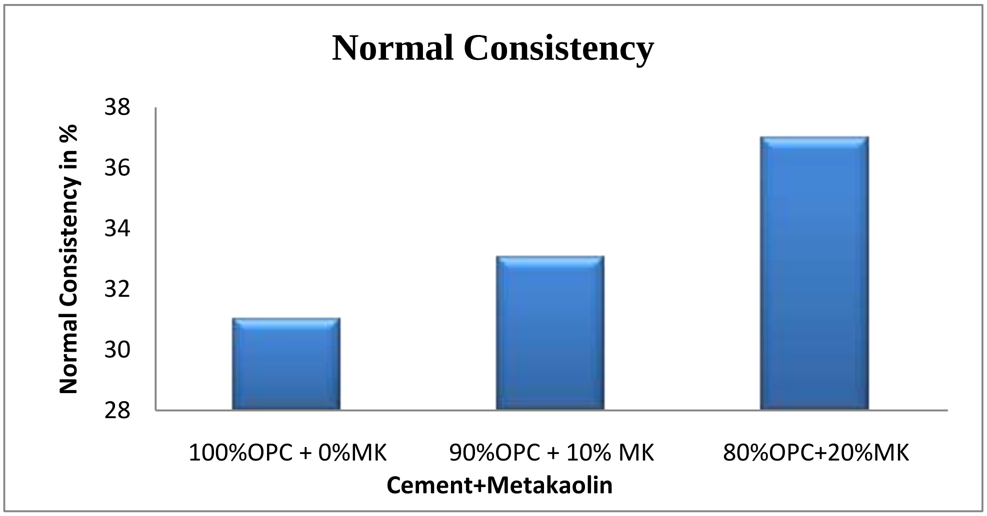

Fig 1. Normal Consistency percentages for replacement of Cement by 0%,10%,20%metakaolin

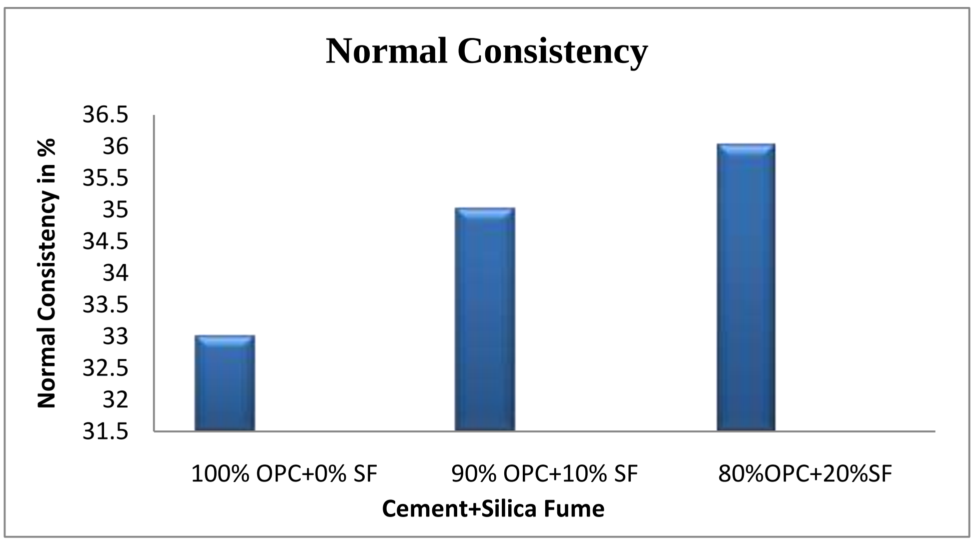

Fig 2. Normal Consistency percentages for replacement of Cement by 0%,10%,20%silicafume

Initial and Final Setting Time:

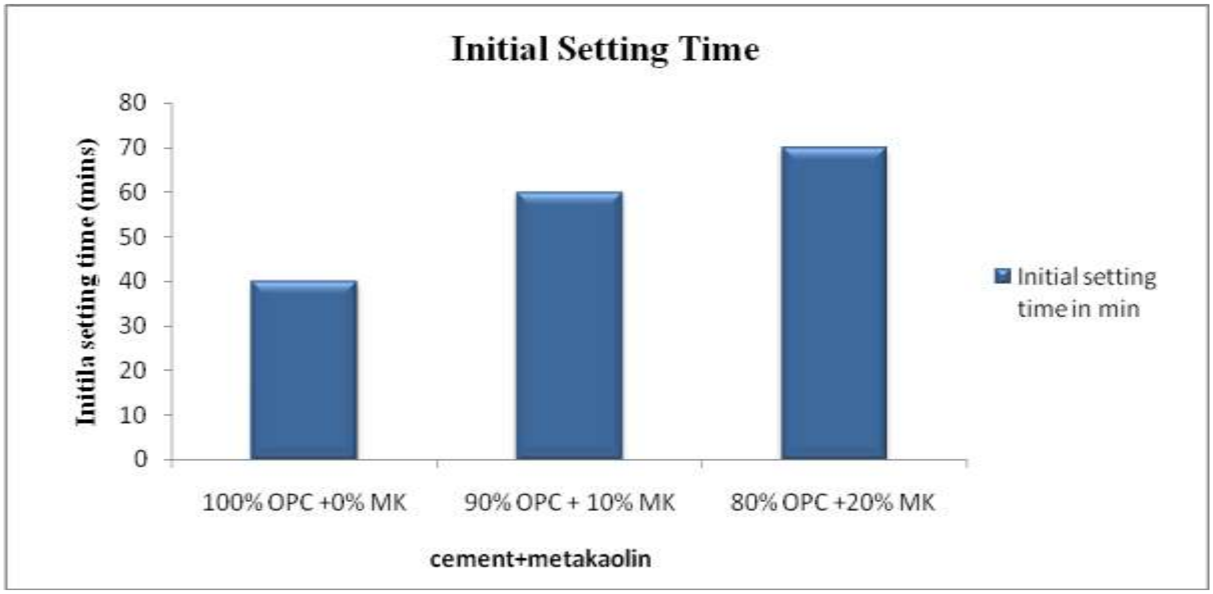

Fig .3 initial setting time for different replacement percentages of 0%,10%&20% Cement with Metakaolin

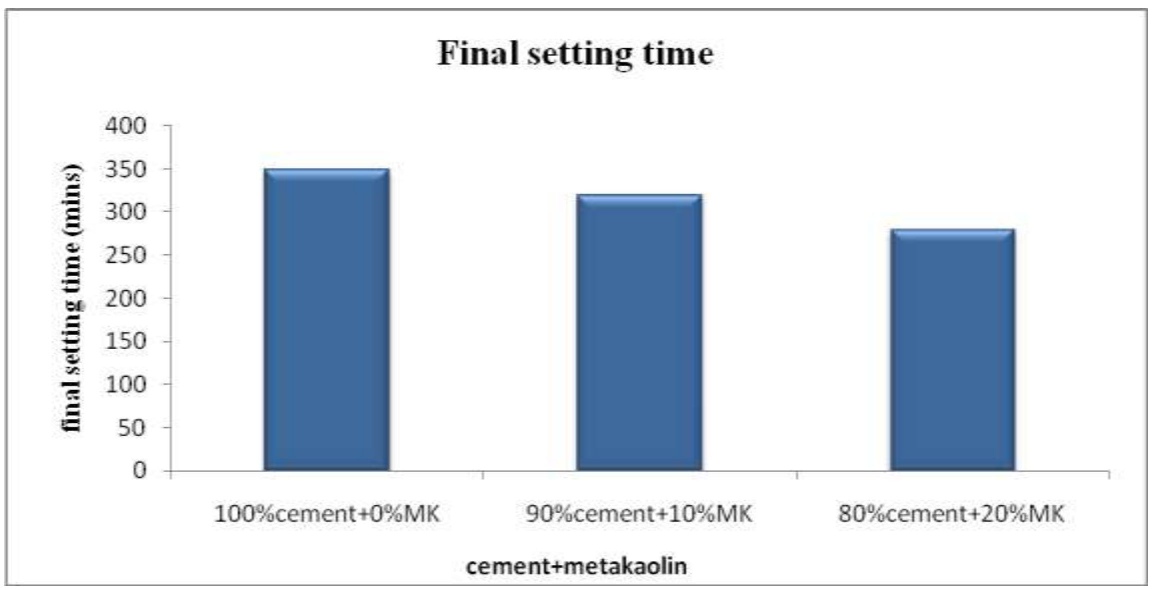

Fig .4 final setting time for different replacement percentages of 0%,10%&20% Cement with Metakaolin

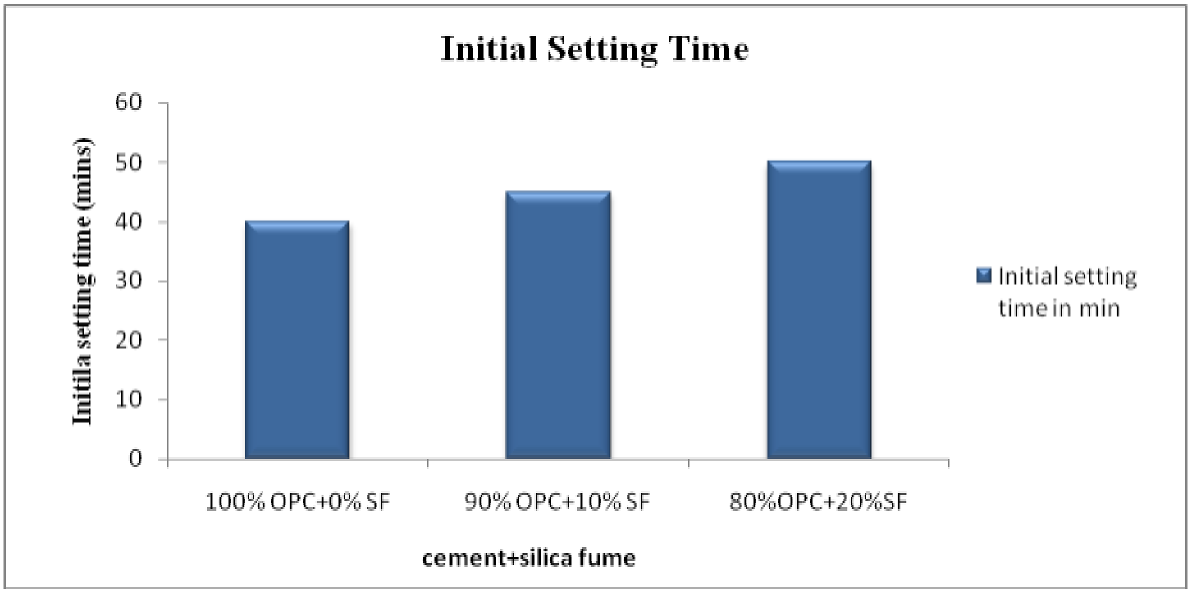

Fig .5 initial setting time for different replacement percentages of 0%,10%&20% Cement with silica fume

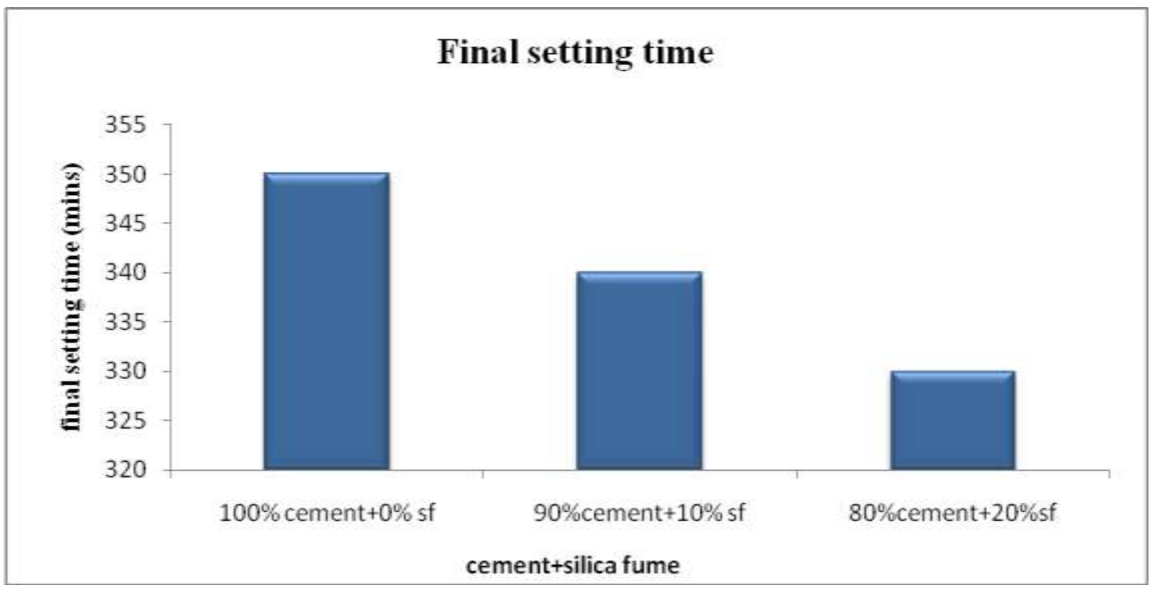

Fig .6 initial setting time for different replacement percentages of 0%,10%&20% Cement with silicafume

Compressive Strength:

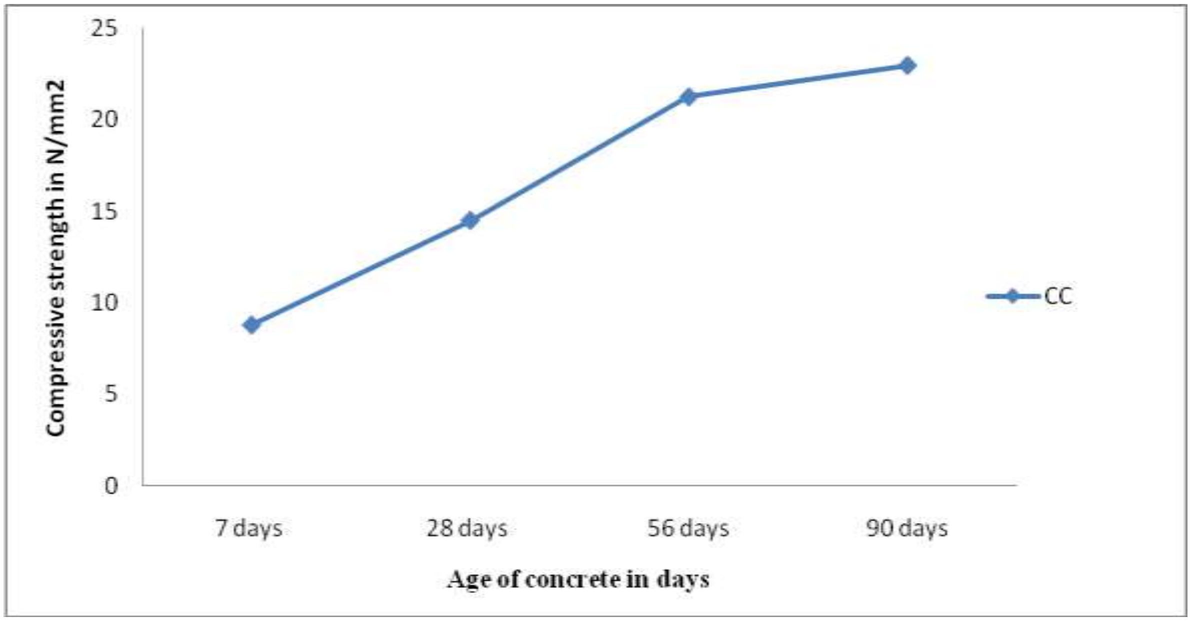

Fig.7 Compressive Strength of Ordinary No Fines Concrete

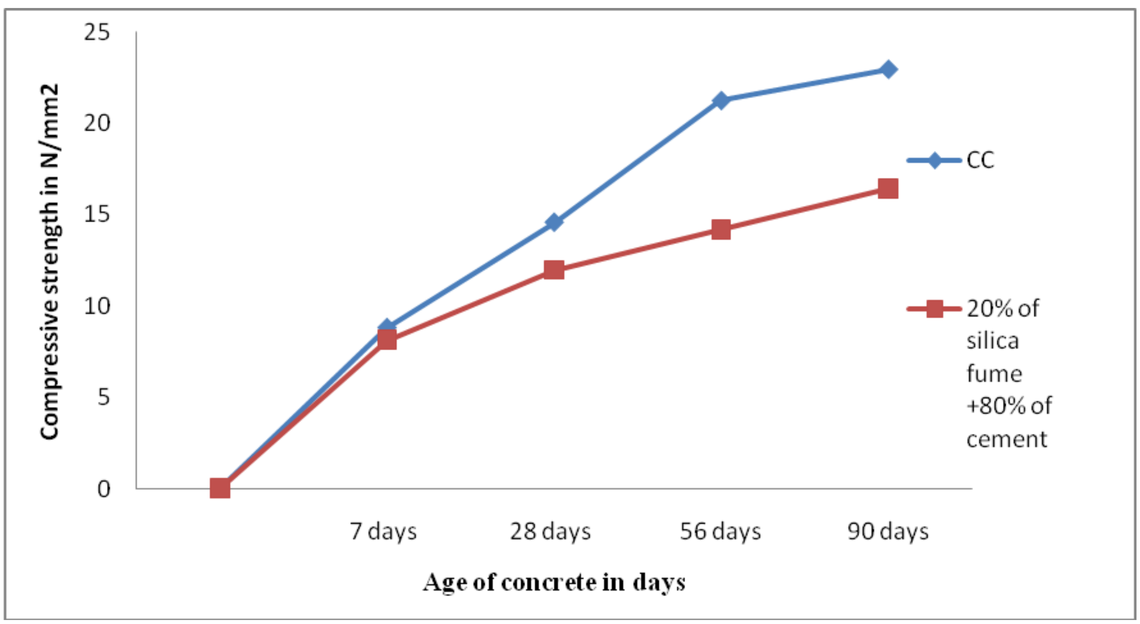

Fig .8 Compressive strength comparison between controlled concrete & concrete with 20% of silica fume

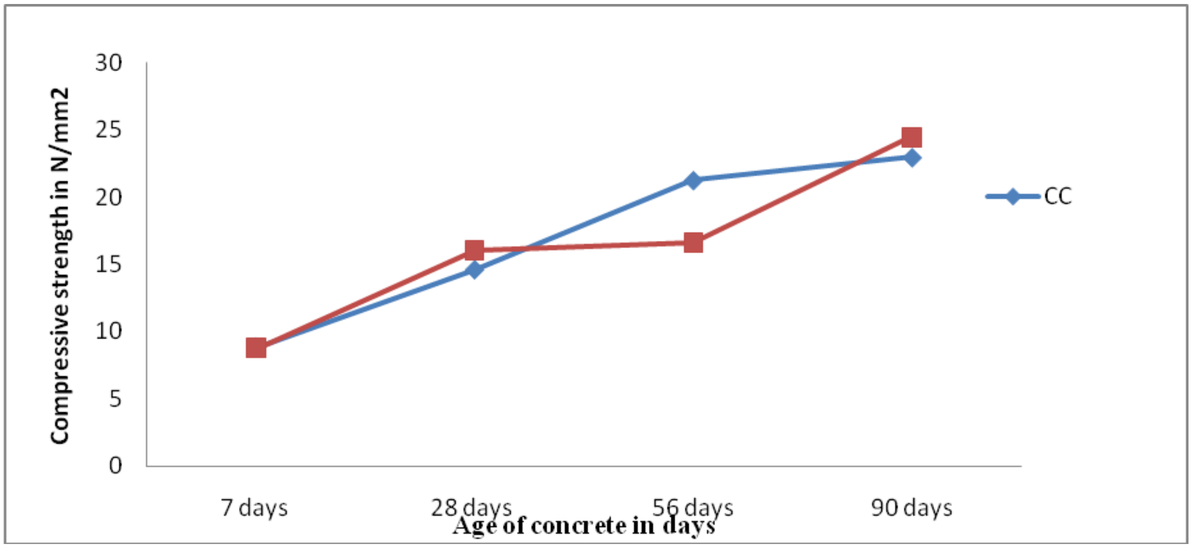

Fig .9 Compressive strength comparison between controlled concrete & no fines concrete with 10% of silica fume

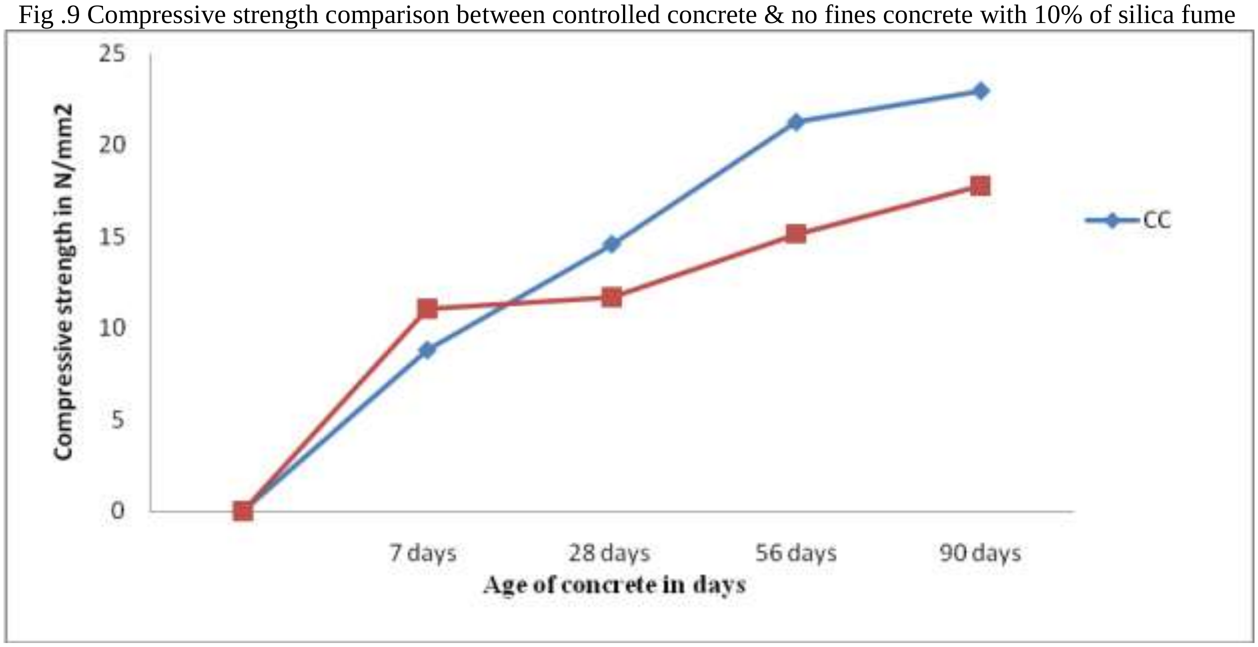

Fig .10 Compressive strength comparison between controlled no fines concrete & concrete 20% of metakaolin

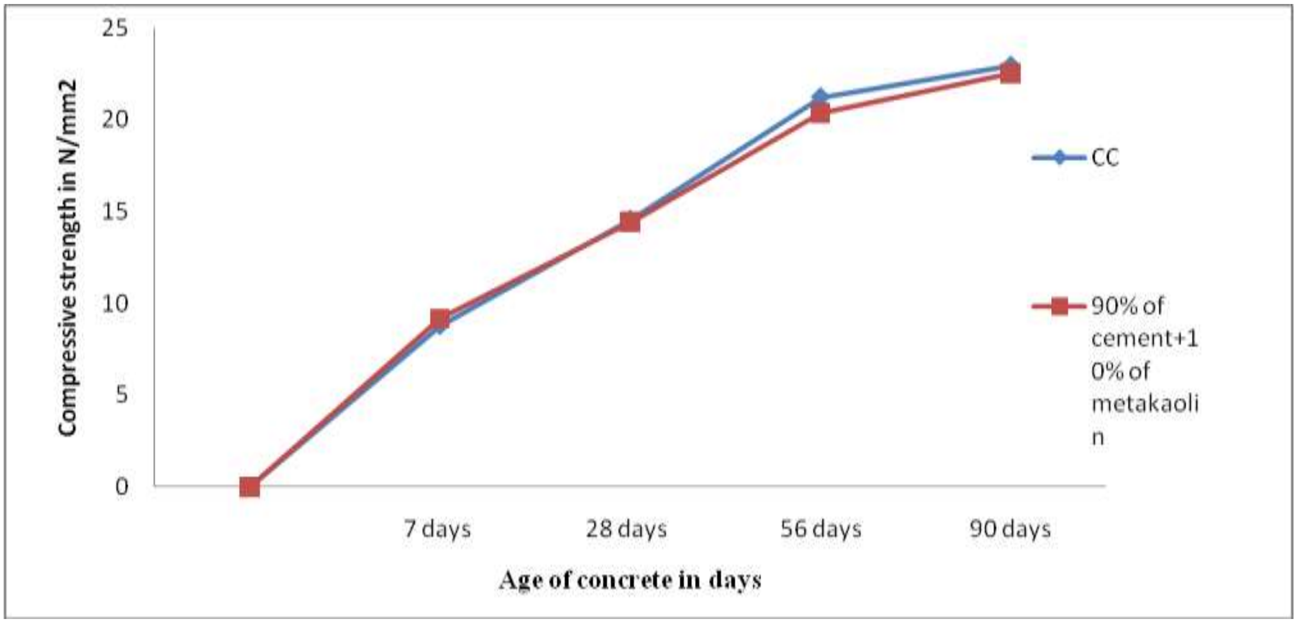

Fig .11 The above graph chart shows the compressive strength comparison between controlled no fines concrete & concrete 10 % of metakaolin

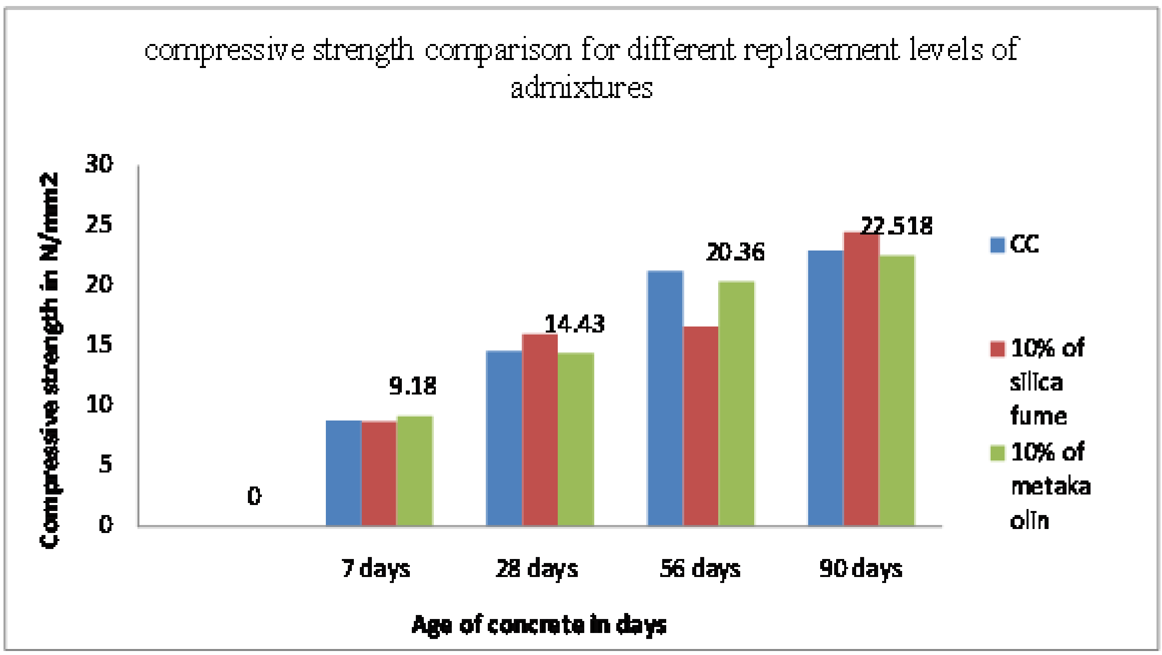

Fig. 12 compressive strength comparison between controlled no fines concrete +no fines concrete with 10% of silica fume +no fines concrete with 10% of metakaolin

Split Tensile Strength:

Table 5 Split Tensile Strength Results of Concrete made with different Replacement Levels of Silica Fume and Metakaolin

Days	Cases	Average split tensile strength (N/mm^2)
28 days	Controlled mix	2.133
	80% of cement+20% of silica fume	2
	90% of cement+ 10% of silica fume	2.4
	80% of cement + 20% metakaolin	2
	90% of cement+ 10% of metakaolin	2.1

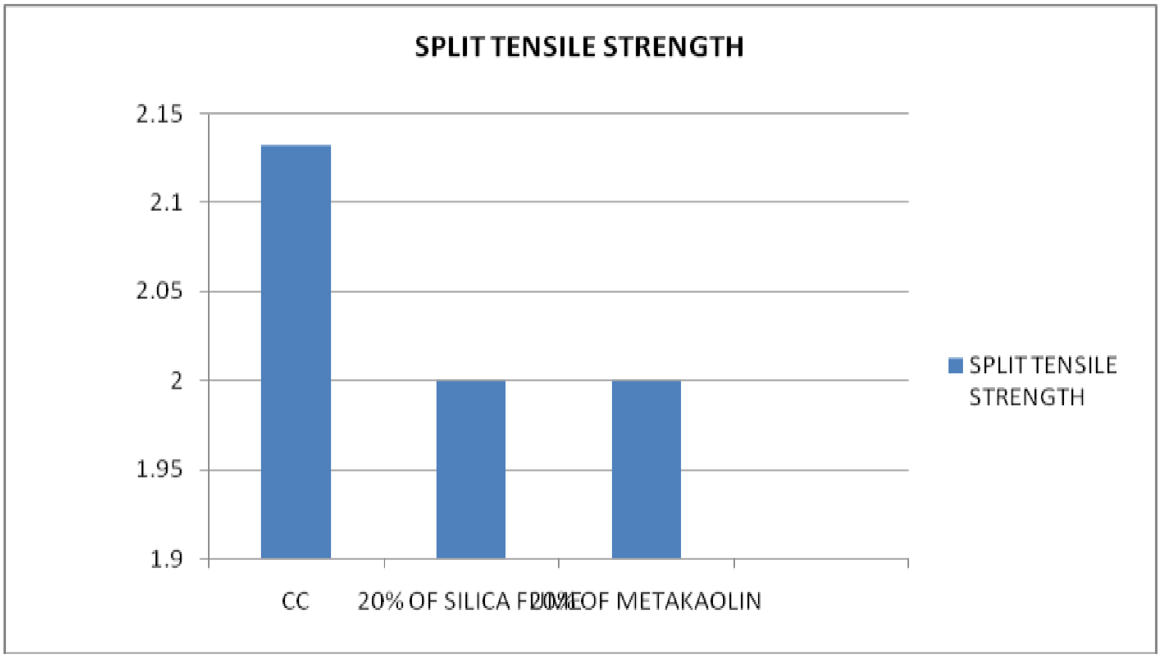

Fig.13 Comparison of split tensile strength results of concrete for various replacements of silica fume and metakaolin with 20% as admixture.

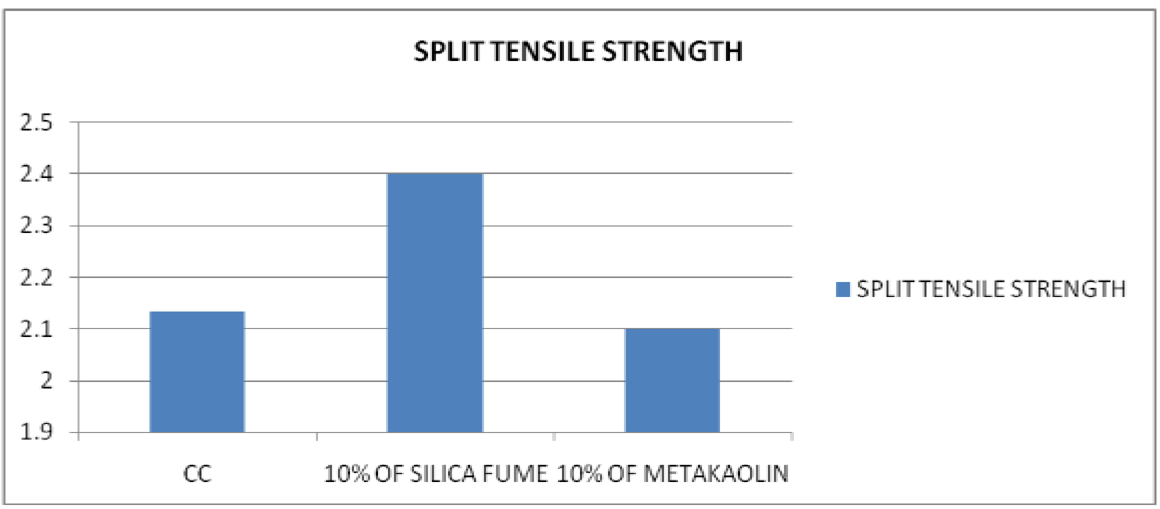

Fig .14 comparison of split tensile strength results of concrete for various replacements of silica fume and fly ash with 10% as admixture.

V.CONCLUSION

Based on the results obtained from the present investigation the following conclusions were made;

1. The addition of silica fume and metakaolin as replacement to cement, its normal consistency and initial setting time increases with increase in percentage and final setting time decreases with increase in percentage.
2. By the addition of 10% of silica fume to no fines concrete mix, the compressive strength has increased.
3. In split tensile tests, it is observed that crack width reduced due to the presence of admixtures when compared with conventional specimen.
4. When the cement is replaced with 10% silica fume gives the optimum compressive strength, split tensile strength.
5. At 10% silica fume replacement to cement compressive strength was increased up to 1.54 % when compared with conventional concrete for 28 days.
6. At 10% silica fume replacement to cement, split tensile strength were increased up to 0.3% when compared with conventional concrete for 28 days.

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