Effect of Fly Ash and Silica Fumes on Strength, Stress Strain Behavior of M25 Concrete Mix

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Abstract*-Concrete pavement has long been considered an environmentally and economically sustainable pavement choice for its longevity. This hallmark of concrete pavements ensures that the desirable performance characteristic of the pavement remains essentially intact for several decades. Concrete pavement mixtures incorporate industrial byproducts i.e., (fly ash and silica fumes) which lower the disposal needs, reduces the demand on virgin materials, and conserves natural resources. The design and properties of this type of concrete, which could be applied by using conventional equipment, are presented in this project. The technical characteristics of the concrete which includes local Fly Ash and Silica Fumes are well described including durability performance observation. The usage of these industrial by products to replace the cement is because the production of cement emits carbon dioxide gas in to atmosphere by increasing the effect of global warming. To enhance the strength properties of the ordinary Portland cement (OPC), industrial by products such as Fly Ash and Silica Fumes can be utilized. The effect of Silica Fumes and Fly Ash as a partial replacement of Ordinary Portland Cement on compressive strength, split tensile strength and stress strain behavior of concrete has been studied.*

Keywords-Active Vibration Control, PZT, Piezoelectric Effect, Piezoelectric Sensor, Piezoelectric Actuator, PID, SRF controllers

I. INTRODUCTION

In conventional method of concrete pavement construction natural resources like sand, stone metal are used which causes ecological imbalances. The use of Fly Ash and silica fumes in concrete pavement construction will save such resources. The costly ingredient in concrete is cement; some portion of the cement is replaced by silica fumes and fly ash which results in reducing the cost of the concrete without any change in strength. The usage of industrial wastages such as Fly Ash and Silica Fumes will solve the problem of disposal and automatically reduces the cost of the pavement construction. Properly designed and constructed concrete structures are favorable compared to the other material like steel and timber. So we can obtain low cost concrete mix with partial replacement of mineral admixtures such as Fly Ash and Silica Fumes.

Concrete is made up of three basic components: water, aggregate (rock, sand, or gravel) and Portland cement. Cement, usually in powder form, acts as a binding agent when mixed with water and aggregates. This combination, or concrete mix, will be poured and harden into the durable material. It is a composite material composed of coarse granular material (the aggregate or filler) enclosed in a hard matrix of material that fills the space among the aggregate particles and glues them together. The weight of concrete used worldwide is twice that of steel, wood, plastics, and aluminum combined. Concrete's use in the modern world is exceeded only by that of naturally occurring water.

Silica fume is a by-product of producing silicon metal or ferrosilicon alloys. Because of its chemical and physical properties, it is a very reactive pozzolan. Concrete containing silica fume can have very high strength and can be very durable. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production and consists of spherical particles with an average particle diameter of 150 nm. Silicon metal and alloys are produced in electric furnaces. The raw materials are quartz, coal, and woodchips. The smoke that results from furnace operation is collected and sold as silica fume, rather than being land filled. Addition of silica fume also reduces the permeability of concrete to chloride ions, which protects the reinforcing steel of concrete from corrosion, especially in chloride-rich environments such as coastal regions and those of humid continental roadways and runways (because of the use of de-icing salts) and saltwater bridges. With the addition of silica fume, the slump loss with time is directly proportional to increase in the silica fume content due to the introduction of large surface area in the concrete mix by its addition. Although the slump decreases, the mix remains highly cohesive. Silica fume reduces bleeding significantly because the free water is consumed in wetting of the large surface area of the silica fume and hence the free water left in the mix for bleeding also decreases. Silica fume also blocks the pores in the fresh concrete so water within the concrete is not allowed to come to the surface.

Methods Of Incorporating Mineral Admixtures In Concrete:

The mineral admixtures such as silica fumes and fly ash can be introduced in to concrete by two methods. They are

- A blended cement containing fly ash and silica fumes may be used in place of ordinary Portland cement.
- Fly ash and silica fumes may be introduced as an additional component at the concrete-mixing stage.

In this project we use mineral admixture as blended cement containing fly ash and silica fumes used in place of ordinary Portland cement. Thus admixtures have generally been considered to be a replacement for cement, rather than a component that complements the functions of the cement, sand, or water. The trend now is to consider the components of fly-ash, silica fumes concrete as a whole and to treat it as a unique material without reference to an equivalent plain-concrete mixture.

Mechanicsm In The Cement-Mineral Admixture System:

Mineral admixtures enhances the properties of concrete by several physical mechanisms, including increasing the strength of the bond between the paste and aggregate by reducing the size of the CH crystals in the region by: (1) providing nucleation sites for the CH crystals so they are smaller and more randomly oriented, and (2) reducing the thickness of the weaker transition zone. Physical mechanisms also include increasing the density of the composite system due to the filler packing effect and by providing a more refined pore structure. For the above mechanisms to take place, it is essential that admixture particles be well dispersed in a concrete mixture.

Objectives Of The Project

The main objective of the project is to determine the improvement of strength of concrete by incorporating fly ash and silica fumes. To study the fracture behaviour of concrete by replacement of fly ash and silica fumes.

- To study the compressive strength, split tensile strength and flexural strength properties of concrete with fly ash and silica in certain proportions.
- To utilize volume of silica fumes and fly ash in concrete up to 5%and 30% respectively.
- To compare the strength of concrete between partially replaced fly ash concrete and the concrete with addition of silica.
- To compare fracture energy of concrete by replacing fly ash and silica fumes.
- The scope of this paper is to study the effect of mineral admixtures on strength characteristics of low cost concrete.
- The objective is to study the mechanical characteristics of concrete such as compressive strength split tensile strength and modulus of elasticity by varying the percentage of mineral admixtures i.e., fly ash and silica fumes with 0,10 ,20, 25, 30 percentage replacement at two water-cement ratios of 0.3 and 0.35.

II. REVIEW OF LITERATURE

Manmohan and Mehta studied that durability to chemical attack is improved with the use of most fly ash and slag mainly due to the pore refinement of concrete made with such materials. Experiments have shown that cement pastes containing10-30% low calcium fly ash causes significant pore refinement in the 28 to 90 day curing period.

Gebler and Klieger said that High dosages of silica fume can make concrete highly cohesive with very little aggregate segregation or bleeding. With little or no bleed water available at the concrete surface for evaporation, plastic cracking can readily develop, especially on hot, windy days if special precautions are not taken. Proper curing of all concrete, especially concrete containing supplementary cementing materials should commence immediately after finishing. At seven-day moist cure or membrane cure should be adequate for concretes with normal dosages of most supplementary cementations materials. As with Portland cement concrete, low curing temperatures can reduce early-strength gain. The impact resistance and abrasion resistance of concrete are related to compressive strength and aggregate type. Supplementary cementing materials generally do not affect these properties beyond their influence on strength. Concretes containing fly ash are just as abrasion resistant as Portland cement concretes without fly ash.

L. Lam, Y.L. Wong, and C.S. Poon in their studied entitled Effect of fly ash and silica fume on compressive and fracture behaviors of concrete had concluded enhancement in strength properties of concrete by adding different percentage of fly ash and silica fume.

Roy, found that the hydration rates are greatest in silica fumes paste, followed by OPC pastes and fly ash pastes it was found that the degree of reaction of silica fumes is much greater than fly ash pastes even at 90 days primarily due to silica fumes high specific area and that the overall reaction with class c ash is greater than the class F after a few days.

Campbell, strum, and Kosmatka,The, The amount of carbonation is significantly increased in concretes with a high water-cementing materials ratio, low cement content, short curing period, low strength, and a highly permeable or porous paste. The depth of carbonation of good quality concrete is generally of little practical significance. At normal dosages, fly ash is reported to slightly increase carbonation, but usually not to a significant amount in concrete with short (normal) moist-curing period

WatcharapongWongkeo, PailynThongsanitgarn and Arnon Chaipanich-2011 studied the physical properties, compressive strength and drying shrinkage of multi-blended cement under different curing methods. Fly ash, ground bottom ash and undensified silica fume were used to replace part of cement up to 50% by weight. From this research, the compressive strength of blended cement with FA and BA (ternary blended cement) under different curing conditions contributed to a lower compressive strength than that of PC control.

Mehmet Gesog˘lu, et al -2012 reported an experimental study on the mechanical properties of steel fiber incorporated plain and silica fume (SF) concretes produced with cold bonded artificial fly ash aggregates (AFAs). The production of concretes with artificial cold bonded fly ash aggregates having proper mechanical properties was proved to be possible through incorporation of silica fume and steel fibers. Use of SF as a replacement material provided improved mechanical properties of concretes when compared to plain ones for both w/c ratios. The inclusion of steel fibers also contributed to the compressive strength.

AlirezaBagheri et al -2013 Investigated the possibility of using fine fly ash in binary and ternary mixes with the aim of overcoming the rather slow rate of strength development in concretes containing conventional fly ashes or enhancing their durability was investigated. The results show that the rate of pozzolanic reaction of fine fly ash is only moderately higher than conventional fly ash and the water demand is slightly reduced. The results of tests on concrete mixes at equal water to binder ratio show that binary concrete mixes containing fine fly ash had somewhat lower water demand compared to the conventional fly ash mixes.

Zdenek P. Bazant and Emilie Becq-Giraudon-2002 showed how the fracture energy of concrete, as well as other fracture parameters such as the effective length of the fracture process zone, critical crack-tip opening displacement and the fracture toughness, can be approximately predicted from the standard compression strength, maximum aggregate size, water–cement ratio, and aggregate type. Among these parameters, the maximum aggregate size, the aggregate shape appears to be the most important for the fracture energy and the water cement ratio the least.

M. Šejnoha et al -2013 several cement and alkali activated fly ash based concrete samples are examined in this paper with emphasis on their fracture properties. These are first obtained from an extensive experimental program. The measured loading curves are then compared with those derived numerically in the framework of an inverse approach. The artificial neural network and the ATENA finite element code are combined to constitute the optimization driver that allows for a reliable determination of the modulus of elasticity, fracture energy, and tensile strength of individual concretes.

YU Rangang, Zhou Jinshun, Li Zhingmingstudied polypropylene fiber concrete's fracture properties, the polypropylene fiber concrete with different fiber content and size under three-point bending was researched, and the fracture energy, unstable fracture toughness and critical crack tip opening displacement of the polypropylene fiber concrete in modified double-K criterion parametric model were also analyzed. The result indicated that any influence coefficient of the different specimen sizes was approximately similar with different fiber volume ratio; polypropylene fiber had biggish enhancement effect to the concrete.

ZI-IAf\G Jun, LIU Qian 2003 explained the mechanical behavior within the processing zone of concrete material by the crack bridging performance. The material properties related to the crack bridging are cracking strength, tensile strength, and the stress-crack width relationship. In general, the cracking strength is lower than the tensile strength of concrete. Crack propagation is governed by the cracking strength. This paper presents a method to determine the above material parameters from a three-point bending test. In the experiment, a pre-notched beam is used. Corresponding values of load, crack mouth opening displacement, and load point displacement are simultaneously recorded. From experimentally determined load-crack mouth opening displacement curves, the above-mentioned crack bridging parameters are deduced by a numerical procedure. The method can be used to evaluate the influence of coarse aggregate and cementitious matrix strength on the stress-crack width relationship, tensile strength, and fracture energy of concrete.

III. EXPERIMENTAL INVESTIGATION GENERAL

The different materials used in this investigation are

- Ordinary Portland Cement (53 grade)
- Aggregate

- Fly ash (Class F)
- Silica Fumes
- Potable Water

ORDINARY PORTLAND CEMENT (OPC)

Portland cement is by far the most common type of cement in general use around the world. This cement is made by heating limestone (calcium carbonate) with small quantities of other materials such as clay to 1450 °C in a kiln, in a process known as calcinations, whereby a molecule of carbon dioxide is liberated from the calcium carbonate to form calcium oxide, or quicklime, which is then blended with the other materials that have been included in the mix. The resulting hard substance, called clinker, is then ground with a small amount of gypsum into a powder to make Ordinary Portland Cement, the most commonly used type of cement often referred to as (OPC). Portland cement is a basic ingredient of concrete, mortar and most non-specialty grout. The most common use for Portland cement is in the production of concrete. Concrete is a composite material consisting of aggregate gravel and sand, cement, and water. As a construction material, concrete can be cast in almost any shape desired, and once hardened, can become a structural load bearing element. Portland cement may be grey or white.

AGGREGATE

Fine Aggregate

Locally available river sand conforming to Grading zone II of IS: 383 –1970. Clean and dry river sand available locally will be used.

Fig: Fine Aggregate

Coarse Aggregate

Crushed granite aggregate with specific gravity of 2.77 and passing through 4.75 mm sieve and will be used for casting all specimens. Several investigations concluded that maximum size of coarse aggregate should be restricted in strength of the composite. In addition to cement paste – aggregate ratio, aggregate type has a great influence on concrete dimensional stability. Locally available crushed blue granite stones conforming to graded aggregate of nominal size 20 mm as per IS: 383 – 1970.Crushed granite aggregate with specific gravity of 2.77 and passing through 4.75 mm sieve and will be used for casting all specimens. Several investigations concluded that maximum size of coarse aggregate should be restricted in strength of the composite. In addition to cement paste – aggregate ratio, aggregate type has a great influence on concrete dimensional stability.

Fig: Coarse Aggregate

FLYASH

Fly ash is a fused residue of clay minerals present in coal. The high temperature generated when coal burns in thermal power plants, transforms the clay minerals in coal powder into a variety of fused fine particles of mainly aluminum silicate composition. Fly ash can be used in Portland cement concrete to enhance the performance of the concrete. Fly ash can be used for construction of road and embankment. This utilization has many advantages over conventional methods. Fly ash is most commonly used as a pozzolan in PCC applications and is shown in Fig 3.1. Cement is the most costly and energy-intensive component of concrete. The unit cost of concrete can be reduced by partial replacement of cement with fly ash. . The pozzolanic effect is the main effect of Fly ash, which states that the unfixed SiO2 and Al2O3 in FA can be activated by Ca (OH) 2 product of cement hydration and produce more hydrated gel. Since the gel produced from pozzolanic action can fill in the capillary in concrete, it effectively contributes to concrete strength, especially in concrete with high volume fly ash. Chemical properties of fly ash are shown in Table:1

Fig:flyash

Table:1

S. No	Properties	Values in %
1	SiO_2	35.4
2	Al_2O_3	17.5
3	Fe_2O_3	5.3
4.	CaO	26.1
5.	MgO	4.6
6.	$S0_3$	2.8

SILICA FUMES

Silica fume, also known as micro silica, (CAS number 69012-64-2, and EINECS number 273-761-1) is an amorphous (non-crystalline) polymorph of silicon dioxide, silica. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production and consists of spherical particles with an average particle diameter of 150 nm. The main field of application is a pozzolanic material for high performance concrete.

It is sometimes confused with fumed silica (also known as pyrogenic silica, CAS number 112945-52-5, EINECS number 231-545-4). However, the production process, particle characteristics and fields of application of fumed silica are all different from those of silica fume.

Fig: Silica fumes

WATER

Portable tap water available in laboratory with pH value of 7.0 ± 1 and confirming to the requirement of IS: 456-2000 was used for mixing concrete and curing the specimens as well.

TESTS ON CEMENT

The Ordinary Portland (OPC) cement of 53 grade conforming to IS: 8112 1989 was used for the present experimental study. The important properties of this cement have been tested using Vicat apparatus, Le chatelier flask and the results are given in the table:2

Cement

Cement is one of the binding materials in this project. Cement is the important building material in today's construction world 53 grade Ordinary Portland Cement (OPC) conforming to IS: 8112-1989. Table 3.1 gives the properties of cement used.

Fig: cement

CONSISTENCY TEST

The basic aim of this test is to find out the water content required to produce a cement paste of standard consistency as specified by the IS: 4031 (Part 4) – 1988. The principle of standard consistency of cement is that consistency at which the Vicat plunger penetrates to a point 5-7mm from the bottom of Vicat mould and the vicat apparatus is shown in Fig 3.3.

Procedure to find consistency of cement:

- 300gms of cement is weighed and mixed with a weighed quantity of water the time gauging should be between 3 to 5 minutes.
- The Vicat mould is filled with the paste and leveled with a trowel.
- The plunger is lowered gently till it touches the cement surface.
- •The plunger is released allowing it to sink in to the paste and the reading is noted on the gauge.

Table:2

Sl. No	Weight of water in (gms) W_1	Weight of cement in (gms) W_2	(W_2/W_1) x 10	Depth of Penetration (mm)
1	75	300	40	6
2	78	300	38.4	5
3	81	300	37.03	6
4	84	300	35.7	6
5	87	300	34.48	5
6	90	300	33.3	6

As per IS 4031 [1968] it is in a range of 5 to 7 mm hence Pn=30% is taken

Fig:Vicat apparatus

INITIAL SETTING TIME

- Cement paste is prepared by gauging the cement with 0.85 times the water required to give a paste of standard consistency
- Start the stop watch the moment water is added to the cement.
- The Vicatmould should be filled completely with the cement paste gauged as above, the mould resting on a non-porous plate and smooth off the surface of the paste making it level with the top of the mould. The cement block thus prepared in the mould is the test block.
- The test block is placed under the rod bearing needle. Lower the needle gently in order to make contact with the surface of the cement paste and release quickly, allowing it to penetrate the test block. Repeat the procedure till the needle fails to pierce the test block to a point 5.0 ± 0.5mm measured from the bottom of the mould. The time period elapsing between the time, water is added to the cement and the time, the needle fails to pierce the test block by 5.0 ± 0.5mm measured from the bottom of the mould, is the initial setting time.
- The initial setting time of cement was 35 minutes.

FINAL SETTING TIME

- The above needle is replaced by the one with an annular attachment. The cement should be considered as finally set when, upon applying the needle gently to the surface of the test block, the needle makes an impression therein, while the attachment fails to do so. The period elapsing between the time, water is added to the cement and the time, the needle makes an impression on the surface of the test block, while the attachment fails to do so, is the final setting time and was about 7hrs.

SPECIFIC GRAVITY OF CEMENT

Specific gravity of cement is found using le-chatelier flask.

- A clean and dry le-chatelier flask is weighed with its stopper (w1).
- A sample of cement is placed up to half of the flask (about 50 Gms) and weighed along with the stopper (w2).
- Kerosene is added to cement in flask till it is half full and thoroughly mixed glass rod to remove entrapped air and stirring is continued and kerosene is added till the graduated mark and weighed as (w3).
- The flask is filled with kerosene up to graduated mark and weighed as (w4) Specific gravity = [(W2-W1)/ (W2-W1)-(W3-W4) x 0.79] = 3.15

SPECIFIC GRAVITY OF FINE AGGREGATE

- Specific gravity of fine aggregate is found by using pycnometer.
- The clean and dry pycnometer is weighed along with the lid (Wp).
- Pycnometer is then filled with fine aggregate up to half of it and then weighed (Wps).
- The pycnometer is filled with water up to graduated mark and then weighed (Wa).
- Pycnometer is then filled with water and weighed (Wb).

Specific gravity = [(Wps - Wp) / (Wps-Wp) + (Wa-Wb)]= 2.74

Fig: pycnometer

SPECIFIC GRAVITY OF FLYASH

Specific gravity of fly ash is found using le-chatelier flask.

- A clean and dry le-chatelier flask is weighed with its stopper (w1).
- A sample of fly ash is placed up to half of the flask (about 30Gms) and weighed along with the stopper (w2).
- Kerosene is added to fly ash in flask till it is half full and thoroughly mixed glass rod to remove entrapped air and stirring is continued and kerosene is added till the graduated mark and weighed as (w3).
- The flask is filled with kerosene up to graduated mark and weighed as (w4).

Specific gravity = [(W2-W1)/ (W2-W1)-(W3-W4) x 0.81] = 2.20

WORKABILITY

Slump test is used to determine the workability of fresh concrete. Slump test as per IS: 1199 – 1959 is followed. The apparatus used for doing slump test is Slump cone.

Procedure to determine workability of fresh concrete by slump test is given below.

- The internal surface of the mould is thoroughly cleaned and applied with a light coat of oil.
- The mould is placed on a smooth, horizontal, rigid and nonabsorbent surface.
- The mould is then filled in four layers with freshly mixed concrete, each approximately to one-fourth of the height of the mould.
- Each layer is tamped 25 times by the rounded end of the tamping rod (strokes are distributed evenly over the cross section).
- After the top layer is rodded, the concrete is struck off the level with a trowel.
- The mould is removed from the concrete immediately by raising it slowly in the vertical direction.
- The difference in level between the height of the mould and that of the highest point of the subsided concrete is measured.
- This difference in height is 83 mm which is the slump of the concrete.
- The workability of concrete with 30% fly ash is 100 mm.
- The workability of concrete with 30% fly ash and 5% silica is 123 mm.

MIX DESIGN

The Mix Design is done according to
(BIS Method) and is discussed in table 3.3.

- Grade Designation : M25
- Type of Cement :OPC 53 grade confirming to IS 8112

- Maximum nominal size of aggregate : 20mm
- Minimum cement content : 300 kg/m3
- Maximum water cement ratio : 0.45
- Workability : 100 mm slump
- Exposure condition : mild
- Method of concrete placing : Manual placement
- Degree of supervision : good
- Type of aggregate : Crushed angular
- Maximum cement (Opc) content : 450 kg/m3
- Test data for materials:
- Cement used : Opc 53 grade confirming to IS 8112
- Specific gravity of cement : 3.15
- Fly ash : confirming to IS 3812 (part 1)
- Specific gravity of flyash : 2.20
- Specific gravity of Coarse aggregate : 2.74
  Fine aggregate : 2.74
- Water absorption Coarse aggregate: : 0.5%
  Fine aggregate : 1%.
- Free surface moisture Coarse aggregate : NIL
  Fine aggregate : NIL
- Sieve analysis : Coarse aggregate – Confirming to table2 of IS 383
  Fine aggregate – Confirming to zone 1 of table 4 of IS 383

Table: BIS Mix Design

Mix proportioning	Cement (kg)	Water (kg)	Fine aggregate (kg)	Coarse aggregate (kg)	Fly ash (kg)
Per m^3	276.024	197.72	698.49	1132.80	118.296
Per bag of cement	50	22.5	92.57	138.5	15
Ratio	1	0.45	1.85	2.77	0.30

Compressive Strength Test

When a specimen of material is loaded in such a way that it extends it is said to be in tension. On the other hand if the material compresses and shortens it is said to be in compression. On an atomic level, the molecules or atoms are forced apart when in tension whereas in compression they are forced together. Since atoms in solids always try to find an equilibrium position, and distance between other atoms, forces arise throughout the entire material which oppose both tension or compression. The phenomena prevailing on an atomic level are therefore similar.The "strain" is the relative change in length under applied stress; positive strain characterises an object under tension load which tends to lengthen it, and a compressive stress that shortens an object gives negative strain. Tension tends to pull small sideways deflections back into alignment, while compression tends to amplify such deflection into buckling.Compressive strength is measured on materials, components, and structures. By definition, the ultimate compressive strength of a material is that value of uniaxial compressive stress reached when the material fails completely. The compressive strength is usually obtained experimentally by means of a compressive test. The apparatus used for this experiment is the same as that used in a tensile test. However, rather than applying a uniaxial tensile load, a uniaxial compressive load is applied. As can be imagined, the specimen (usually cylindrical) is shortened as well as spread laterally. In the study of strength of materials, the compressive strength is the capacity of a material or structure to withstand loads tending to reduce size. It can be measured by plotting applied force against deformation in a testing machine. Some materials fracture at their compressive strength limit; others deform irreversibly, so a given amount of deformation may be considered as the limit for compressive load. Compressive strength is a key value for design of structuresAt the time of testing, each specimen must keep in compressive testing machine. The maximum load at the breakage of concrete block will be noted. From the noted values, the compressive strength may calculated by using below formula.(Fig.)

Compressive Strength = Load / Area
Size of the test specimen=150mm x 150mm x 150mm

Fig: Compressive Strength Test

CASTING OF CYLINDER SPECIMEN

Casting of the specimen is done as per IS: 10086-1982, material preparation, requirement of materials and casting of cylinders. The mixing, compacting and curing are done according to IS 516: 1959. After casting the cylinder mould is left for 24 hours for air drying. Then the cylinder is demoulded and the cylinder is placed in the curing tank for 28 days

III. STRESS STRAIN RELATION SHIP

1. After 28 days of curing period the specimens are removed from the curing tank and wipe out the excess water from the surface.
2. Let the specimen dry in atmospheric temperature for 24 hrs. before testing.
3. The air dried specimen is placed in the compressive strength testing machine in such way that the load of the machine is applied on the opposite faces of the cylinder.
4. The cylinder is positioned properly on the base plate of the machine.
5. The piston of the machine is adjusted so that it touches the top surface of the specimen.
6. The frame consisting of a dial gauge is fixed to the cylinder to calculate the deformation values with respect to the load.
7. Load is applied gradually without any impacts at a rate of 140kg/cm2 /minute until the specimen fails.
8. At regular intervals of deformation calculate the respective loads.
9. At the point of failure note down the maximum load value.

CALCULATIONS AND RESULTS:

Size of the specimen = 150mm in diameter and 300mm long

Fig: specimen set up to find stress strain behavior

Area of the specimen = 17671.45 mm^2

Compressive stress $= \frac{load\ in\ N}{area\ in\ mm^2}$ ……… N/mm^2

Strain $= \frac{deformation\ in\ mm}{original\ length\ in\ mm}$ ……….NO UNITS

S NO	DESIGNATION	W/C ratio	AVERAGE COMPRESSIVE STRENGTH(N/mm2)
1	CONVENTIONAL CONCRETE	0.3	39.6115
		0.35	36.21
2	80% CEMENT +10% FLY ASH +10%SILICA FUMES	0.3	25.745
		0.35	34.2
3	60% CEMENT +20% FLY ASH +20%SILICA FUMES	0.3	18
		0.35	31.672
4	50% CEMENT +25% FLY ASH +25%SILICA FUMES	0.3	12.449
		0.35	23.201
5	40% CEMENT +30% FLY ASH +30%SILICA FUMES	0.3	11.883
		0.35	23.766

Table: compressive strength of M 25 concrete at 28 days

Casting

The concrete cubes were casted in moulds of size 15cmx15cm x 15cm (30 cubes for compressive strength) and also 10cm x 10cm x 10cm (45 cubes for durability). The standard moulds as mentioned above were poked with tamping rods and the well-mixed concrete was poured into the moulds in layers.

After completion of poking the concrete, a thin layer of cement slurry is formed at the top surface, thus making the top surface level well finished.

Curing

The specimens cast were removed from moulds after 24hrs and were immersed in a clean water tank and left for curing. After the curing was complete, the specimens were removed and allowed to dry under shade, after which testing was done.

Fig: curing cubes

Compressive strength of concrete

A total of 3 sets of cubes are cast and tested to study the compressive strength at 28 days respectively.

Specimen preparation

M25 grade concrete design mix is made and cubes of 150mm x 150mm x 150mm are cast as per IS : 516-1999 with replacement ranges from 0% to 20% with 5% increment by weight. After casting, the specimens are demoulded after 24 hours and immediately submerged in clean fresh water of the curing tank. After the completion of curing period the specimens are taken and kept under shade.

Testing procedure

After the required period of curing the cube specimens are removed from the curing tank and cleaned. A set of cubes are tested for compressive strength at 28 days.

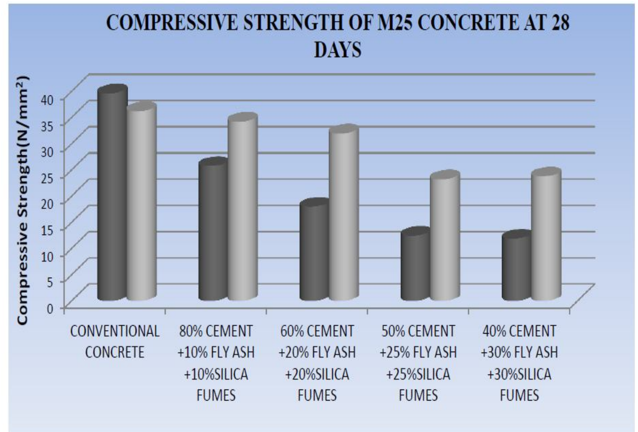
Test for Compressive strength of concrete cubes

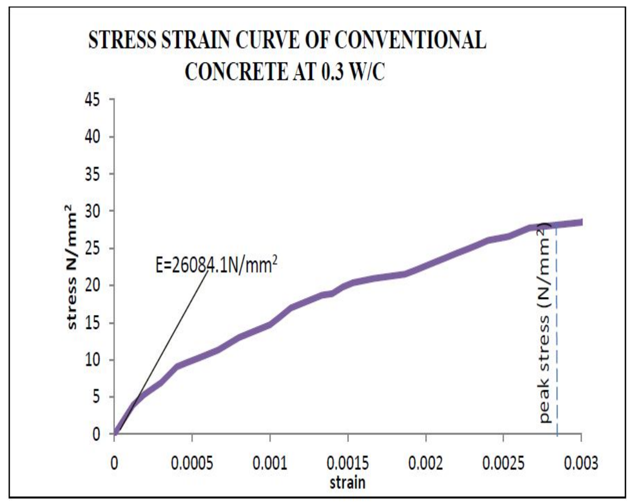
To calculate the compressive strength of concrete cubes the universal testing machine (UTM) having capacity of 300tonne was used. In this test the strength obtained in tonne. The measured compressive strength of the specimen shall be calculated by dividing the maximum load applied to the specimen during the test by the cross sectional area calculated from mean dimensions of the section and shall be expressed to the nearest N/mm2

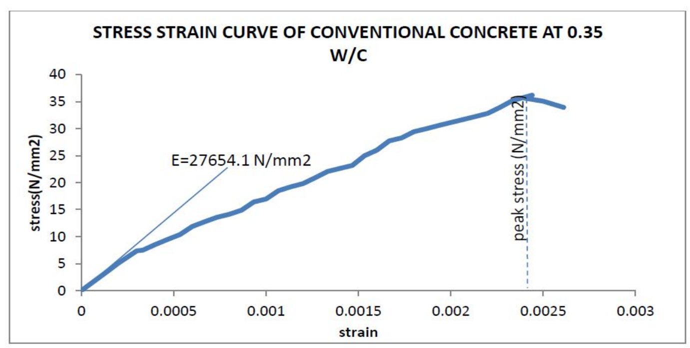
Out of many test applied to the concrete, this is the utmost important which gives an idea about all the characteristics of concrete. By this single test one judge that whether Concreting has been done properly or not. For cube test two types of specimens either cubes of 15 cm X 15 cm X 15 cm or 10cm X 10 cm x 10 cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15 cm x 15cm x 15 cm are commonly used. These specimens are tested by compression testing machine after 7 days curing, 14 days curing, 28 days curing and 56 days curing. Load should be applied gradually at the rate of 140 kg/cm2 per minute till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

Calculations:

Compressive strength = Maximum load/ Area = P/A







IV. CONCLUSIONS

1. Based on the experimental investigations, mechanical properties of concrete like compressive strength, tensile strength durability aspects and stress strain behavior of low cost concrete (with fly ash and silica fumes). The following conclusions are drawn
2. At 28 days the compressive strength of conventional concrete and low cost concrete of mix (60% cement+20% Fly Ash+20% Silica Fumes) is similar to that of the target compressive strength of M25 mix.
3. The stress-strain behavior for conventional concrete and low cost concrete with various proportions of fly ash and

silica fumes is observed to be similar. This shows addition of mineral admixture to optimum values does not affect the stress strain behavior.

4. The peak stress values for low cost concrete are similar to that of conventional concrete only varies by 0.2%. vibration control.

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