Effect of Brick Kiln Dust & Flyash in Cement Concrete

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Abstract: ***Now day's construction work is going on a very large scale so requirement of cement concrete plays an important role. On the basis of topic, cement concrete will be mixed with some waste materials like fly ash and brick kiln dust. in this thesis the cement and fine aggregates were partially replaced by fly ash and brick dust. the main theme was to use the wastage by replacing wealthy materials. Bust fly ash and brick dust are available in metteric tones. The objective was to study the workability and compressive strength of cement concrete. In the ancient period, construction work was mostly carried out with help of mudstone from industry. Fly ash is a by-product of burned coal from power station and brick dust are the wastage from the brick kilns are commonly used nowadays in order to improve the mechanical properties of concrete. Especially Synthetic (Polypropylene, polyester etc.,) glass, nylon, asbestos, carbon and steel fibers used in concrete caused good results to improve numerous concrete properties. Considerable efforts are being taken worldwide to utilise natural waste and bye –product as supplementary cementing materials to improve the properties of cement concrete. Brick dust and Fly ash (FA) with are such type of materials. Brick dust is the powder from brick kiln which is available in tonnes. FA is finely divided produced by coal-fired power station. Fly ash possesses pozzolonic properties similar to naturally occurring pozzolonic material. The detailed experimental investigation is doing to study the effect of partial replacement of cement by FA, brick dust in concrete. In this paper started proportion form 5% FA and 10% brick dust mix together in concrete by replacement of cement and fine aggregate ,last proportion taken 15% FA and 10% brick dust, with gradual increase in fly ash by 5% and simultaneously taking constant brick dust by 10% and to improve the strength of concrete.the The purpose of this research is to study the effects of fly ash on the workability, compressive strength, flexural tensile strength, splitting tensile strengths, durability.***

Keywords: Admixture, Cement, Concrete, Fly Ash, brick dust

1. Introduction

Concrete is made up of cement, fine aggregates (sand), coarse aggregates and water. Being the basic engineering material it is used in most of the civil engineering structures, it is the only construction material used throughout the world in most of construction works. Cement concrete solidifies or hardness after mixing with water and placement due to a chemical process known as hydration. During the process of melination water reacts with cement which binds the other materials together eventually constructs a stone like material.

Concrete being the most popular material used in the world is needed to be designed for the properties like.

Concrete mix design is the science of the deciding relative proportions of ingredients of concrete, to achieve the desired properties of cement concrete.

Admixtures like fly ash , brick dust, silica fume etc. are used in concrete to achieve the desired strength and usage of steel fibre has put the concrete into the next level by increasing its strength and durability .

The concrete in which steels bars, plates are used to strength the material are known as reinforced cement concrete(RCC). Nowadays construction of new and demolition of old structures is one of the countries largest waste produces. The waste produced by the demolition of structures can be minimized and the demolished material can be utilised again. Concrete recycling process is increasing day by day through this method disposal of dismantle concrete structures which where earlier shipped to pits for disposal. Due to awareness, some govt laws , and economic benefits recycling of concrete is increasing.

In India about 15Mt of solid wastes are received from the construction industries annually. Which includes solid wastes, aggregates, solid blocks, bricks, etc. However little amount of solid waste is being recycled and reused in building construction. But still large amount of solid wastes are transported and dumped in land pits which results in shortage of landfill in the urban areas. So it has become necessary to recycle the solid waste to save the environment. Reusing of demolished material will help us to conserve natural resources and to solve a big problem of disposal crises. Now days landfill availability is getting reduced and solid wastes are increasing. Concrete being the heterogeneous mix of cement water and aggregates. The solid materials can be used as admixtures to concrete which will enhance some benefits over concrete.

In todays life there are numerous solid wastes which can be used as admixtures such as fly ash, brick dust, silica fume , and use of steel fibre through which desired properties can be achieved.

The character of concrete is determining by the quality of paste. The key to achieving strong durable concrete rest in the careful proportioning, mixing compacting of the ingredients. The detailed experimental investigation is done to study the effect of partial replacement of cement and sand by fly ash and brick dust in concrete. Nemours tests are performed on wet concrete such as workability tests, compaction factor test, and slump test. The concrete samples are to be cured for 28 days in normal method to arrive at the compressive strength and for necessary follow up action. It is not difficult to dismantle the suspected portion of concrete at such a stage but also expensive in terms of time and money. Predicting the strength at the manufacturing stage, however is yet to receive due to attention of engineers.

1.1 Fly Ash

Simply fly ash is generated from the combustion of coal. Fly ash is taken from the coal burn industries such as coal burn chimneys of power plant these coal fired chimneys not only generate fly ash but also bottom ash and coal ash. Fly ash generation totally depend upon the burning of coal the more you burn the more it generate with High fineness, low carbon content, good reactivity are the essence of good fly ash. Since fly ash is produce by rapid cooling & solidification of molten ash, a large portion of components comprising fly ash particles in amorphous state. Fly ash also contains some amount of silicon dioxide & calcium oxide. Fly ash consisting mainly spherical glassy particles ranging from 1-150 microns in diameter, of which the bulk passes through a 45 micron sieve. There are two ways that the fly ash can be used: one way is to integrand certain percentage of fly ash with cement clinker at the factory to produce Portland Pozzolana cement (PPC) & the second way is to use the fly ash as an admixture at the time of making concrete at the site of work. Fly ash is broadly in 2 classes viz class F fly ash & class C fly ash.

1.1.1 Benefits of Fly Ash

There are a lot of benefits of fly ash over the fresh concrete by reducing the water content mixing requirement and make the paste like material. The below are the results

Workability

The flyash improves the workability of the fresh concrete. The flyash provides lubricant effect to the concrete which later on increases the pumpability that means loss of friction during pumping process. Flyash also helps in finishability, gives a smooth finish to the concrete layer.

Water Demand

The flyash decreases the water demand of concrete. By replacing the cement content to flyash the overall water demand is reduced by 10%

Heat of Hydration

By replacing cement with flyash the heat of hydration is reduced up to a certin limit. This fly ash also controls the heat rise problems while placing the concrete.

Ultimate Strength

The main benefit of fly ash over concrete is that it increases the ultimate strength of the concrete. It does not only increase initially but later on it gives good results.

1.1.2 Types of Flyash

Class F

- Most effectively moderates heat gain during concrete curing and is therefore considered and ideal cementetious material in mass concrete and high strength mixes. For the same reason class f is the solution to a wide range of summer concreting problems.
- Provides sulfide and sulfate resistance equal for superior to type 5 cement. Class f is often recommended for use were concrete may be exposed to sulfate ions in soil in ground water.

Class C

- Most useful in performance mixes prestressed application and other situations were higher earlier strength is important.
- Especially useful in soil stabilization since class c may not require the addition of lime.

Advantages of Fly Ash Over Concrete

- Economical
- Eco friendly.
- Make concrete dense.
- Reduces shrinkage.
- Smooth finishing.
- Weather resistance
- Reduces bleeding
- Reduces CO2 emission
- Produces high strength concrete

Disadvantages of Fly Ash Over Concrete

- The quality of fly ash can effect the overall quality of cement concrete. The poor quality fly ash can increase the permeability of cement concrete which can affect the durability of the concrete
- Slower strength gain
- Some seasonal drawbacks
- Increase in air entraining admixture
- Salt scaling due to higher fly ash.

Brickkiln Dust

Brick dust is a waste material obtained from brick kiln industries. Now day's construction work is on large scale so demand of brick also increases so due to this brick kiln industries all over the world also increased. Tons of brick kiln dust comes out from such brick kiln industries. So such materials are used in filling low lying area and also in construction work it also used in mixture of cement concrete to fill the voids. As brick kiln dust contains mixture of ashes (coal + wood) and dust particles.

Brick dust not only occupy place but also results in some environment problems. These problems could have been lowered upto a large range by using brick kiln dust as waste material.

Advantages

- Eco friendly material.
- Increases density of concrete
- Reduces bleeding
- Reduces segregation of concrete
- Gives concrete early strength.
- Increase in compressive strength

Strength of concrete is one of the most important factor engineering properties of construction material. In any construction, structure which involves concrete as binding materials there comes a major problem that concrete does not gain its strength within given specific of time i.e. 28days. A decision should be taken at the time 28 days to remove formwork depend on the rate of strength gain by concrete which considers safety as well as quality also. Some of the researchers have given their opinions on concrete strength as given below-

Chatterjee, (2011) reported that about 50 % of fly ash generated is utilised with present efforts. He also reported that, one may achieve up to 70% replacement of cement with fly ash when high strength cement and very high reactive fly ash is used along with the sulphonated naphthalene formaldehyde superplasticizer. He reported improvement in fly ash property could be achieved by grinding and getting particles in submicrocrystalline range.

Bhanumathidas, & Kalidas, (2002) with their research on Indian fly ashes reported that the increase in ground fineness by 52% could increase the strength by 13%. Whereas, with the increase in native fineness by 64% the strength was reported to increase by 77%. Looking in to the results it was proposed that no considerable improvement of reactivity could be achieved on grinding a coarse fly ash. Authors also uphold that the study on lime reactivity strength had more relevance when fly ash is used in association with lime but preferred pozzolanic activity index in case of blending with cement**.**

Subramaniam, Gromotka, Shah, Obla& Hill, (2005) investigated the influence of ultrafine fly ash on the early age property development, shrinkage and shrinkage cracking potential of concrete. In addition, the performance of ultrafine fly ash as cement replacement was compared with that of silica fume. The mechanisms responsible for an increase of the early age stress due to restrained shrinkage were assessed; free shrinkage and elastic modulus were measured from an early age. In addition, the materials resistance to tensile fracture and increase in strength were also determined.

(Siddique, 2003) carried out experimental investigation to evaluate mechanical properties of concrete mixes in which fine aggregate (sand) was partially replaced with class F fly ash. Fine aggregate was replaced with five percentages (10%, 20%, 30%, 40% and 50 %) of class F fly ash by weight. The test result showed that the compressive strength of fly ash concrete mixes with 10% to 50% fine aggregate replacement with fly ash were higher than control mix at all ages. Also the compressive strength of concrete mixes was increasing with increase in fly ash percentages. This increase in strength due to replacement of fine aggregate with fly ash was attributed to pozzolanic action of fly ash. The splitting tensile strength also increased with increase in percentage of fly ash as replacement of fine aggregate. The tests on flexural strength and modulus of elasticity also showed improvement in the results as compared to control concrete

THOMAS. *ET AL* 1999

Reported that result from labs studies on the durability of concrete that contains ternary blends of Portland cement, brick dust and wide range of fly ashes previously works have shown that high CaO fly ashes are generally less effective in controlling alkali silica reactivity and sulphate attack compared with class f or low lime fly ash. Indeed, in this study it was shown that replacement level up to 60% were required to control expansion due to ASR with some fly ash. However, combinations of relatively small brick dust and moderate levels of fly ash were very effective in reducing expansion due to ASR and also produced a high level of sulphate resistance. Concrete made with proportions generally excellent fresh and hardened properties since the combination of silica fume and fly ash is somewhat synergistic. For instance fly ash appears to compensate for some of the workability problems often associated with the use of higher levels of brick dust, whereas the brick dust appears for relative low early strength of fly ash concrete..

LANGLEY and OTHERS (1984)

Have reported using 56% of Class F fly ash (by wt.) of total cementious materials in concrete for structural applications. They have concluded that high-volumes of ASTM Class F fly ash and low cement constant provide an economical material for strength of the order of 60 MPa at 120 days. They have also reported that compressive strength, among other things, compare favourably with normal Portland cement concrete.

This chapter deals with the materials used & methods adopted to conduct study on compressive strength & workability characteristics of concrete containing fly ash & brick kiln dust with superplastizer.

2. Material used

Portland cement

Portland cement (referred to as OPC) is by far the most important type of cement & is fine powder produced by grinding Portland cement clinker (more than 90%), a limited amount of calcium sulphate, which control the setting time & up to 5% minor constituent. The OPC is classified into 3 grades, namely 33 grade, 43 grade & 53 grade depending upon the strength of cement at 28 days. It has been possible to upgrade qualities of cement by using high quality lime stone modern equipment, maintaining better particle size distribution, finer grinding & better packing. Generally use of high grade cement offer many advantages for making stronger concrete. Although they are little costlier than low grade cement, they offer 10-20% saving in consumption & they also offer many other hidden benefits. One of the most important benefits is faster rate of development of strength. The various constituents of OPC are Cao- 60 to 67 %, Sio_2-17to 25 %, Al_2O_3 – 3 to 8 %, Fe_2O_3 – 0.5 to 0.6 %, Mgo -0.1 to 0.4 %, Alkalis (k_2o, Na_2O)- 0.4 to 1.3 % &SO_3 -1.3 to 3 %. Ultratech 43 grade OPC was used in this study. Kit was fresh & without any lumps. The properties of cement were determined.

Aggregate

Aggregate impart greater volume stability & durability to concrete. They are used primarily for the purpose of providing bulk to the concrete. To increase the density of the resulting mix the aggregate are frequently used in two are more sizes. The most important function of the aggregate is to assist in producing workability & uniformly in mixture. The fine aggregate assist the cement paste to hold the coarse aggregate particles in suspension. This action promotes plasticity in the mixture & prevents the possible segregation of the paste & coarse aggregate, particular when it is necessary to transport the concrete some distances from the mixing plant to the point of placement.

The aggregate provides about 75 % of the body of the concrete & hence it influence is extremely important. They should therefore meet certain requirements if the concrete is to be workable, strong, durable & economical. The aggregate must be of proper shape, clean, hard, strong & well graded.

Coarse Aggregate

The aggregate most of which are retained on the 4.75 mm IS sieve are termed coarse aggregate. The coarse aggregate may be one of the following types:

1) Crushed gravel or stone obtained by crushing of gravel or hard stone.
2) Uncrushed gravel or stone resulting from the natural disintegration of rocks.
3) Partially crusher gravel or stone obtained as a product of the blending of the above 2 types

The graded coarse aggregate is described by its nominal sizes i.e 40 mm,20 mm, 16 mm, 12.5 mm & 10 mm etc. since the aggregate are formed due to natural disintegration of rocks or by the artificial crushing of rocks or gravel, they derive many of their properties from their parent rocks. Some other properties of the aggregates not possessed by parent rocks are particle shape & size surface texture etc. all these properties may have considerable effect on the quality of the concrete in fresh & hardened state. 20 mm & 10 mm coarse aggregates in the proportion of 50:50 were used in this study. The properties such as specific gravity fine modulus of coarse aggregate are determined.

Fine Aggregate

The aggregates most of which passes through a 4.75 mm IS sieve are termed as fine aggregate. The fine aggregate may be of following types:

1) Natural sand
2) Crushed gravel sand

According to size, the fine aggregate may be as coarse, medium & fine sand. Depending upon the particle size distribution IS 383-1970 has divided the fine aggregate into four zones (grade 1 to grade 4). The grading zones become progressively finer from grading zone to grading 4.

Fly Ash

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Water

Water used for making concrete was tap water available in the laboratory. This was free from any determinable contaminates & was of good portable quality:-

Properties of Material Used

The aim of studying various properties of material used is to check the conformance with the code requirements and to enable an engineer to design a concrete mix for a particular strength. The following material is used in present study.

Table 3.2: Properties of course used

Characteristic	Value
Shape	Angular
Colour	Grey
Specific Gravity	2.63
Max Size	20MM

Fine Aggeragates

Fine aggregates used where taken from local river. It was dark brown in color and sand was little course. Fine aggregates were washed and then dried to surface before performing sieve analysis.

Table 3.3: Properties of fine aggregate

Properties	Value
Fines Modulus	3.24
Specific Gravity	2.66
Size	4.75mm
Water Absorption Value	1%

Fly Ash

Fly used in present work fall under F category. The physical and chemical properties of fly ash under F category are given in below table.

- **Fineness**

The flyash must be fine without lumps. It's important for the flyash to be fine because it effects the workability of concrete and the pozzonic activity, that is why the sieve analysis is performed. The requirement to be fine that the 66% of the flyash should pass through the 0.045mm sieve.

- **Specific Gravity**

The specific gravity of the flyash should be checked at regular interval so that the quality of flyash will not fluctuate otherwise it does not effect directly on concrete quality

- **Colour**

The color of the fly ash should be light although it will change the overall color of the cement concrete.

Table 3.4: physical and chemical properties of fly ash

S.No	*Characteristics*	*Values*
1	Color	Light brown
2	Specific Gravity	2.089
3	Class	F
4	Chemical Composition	
	SiO_2	57.4
	Al_2O_3	26.93
	Fe_2O_3	5.22
	CaO	2.06
	MgO	0.72
	SO_3	0.084
	LoI	1.19
	IR	93.11
	Lime reactivity	59.49
5	Sieve Analysis and Sieve No	Percentage age Weight Retained
	100	0
	140	31.35
	200	26.51
	270	24.72
	Pan	17.42

Brick Dust Properties

Brick dust is wastage from the brick kilns. Nowadays this can be used as an admixture. By using brick dust it will increase the space in kilns up to a large extant. Brick dust has enormous uses. It can be a replacement of cement or fine aggregate up to a certain extent. Some experiments have been made that shows upto 20% cement or fine aggregate can be replaced by brick kiln dust have good compressive strength then an nominal concrete. Through brick dust we can replace cement or fine aggregates.

Chemical Composition of Brick Dust Used

Table 3.5: Showing chemical compossion of brick dust

Material	OPC	Brick Powder
SiO2	21.4	46.52%
Al2O3	5.3	10.62%
Fe2O3	3.2	4.29%
CaO	61.6	24.48%
Na2O	-	1.02%
K2O	-	1.84%
MgO	0.8	8.56%
TiO2	-	0.514%
MnO	-	0.079%
P2O5	-	0.199%
SO3	2.2	0.895%
LOI	-	0.66%
Cl	-	108 ppm

When its replaced by fine aggregate we can replace upto 50% which gives us higher compressive strength. Workability also decreases with increase in replacements.

Methods of Concrete Mix

Design:-

He various methods used for concrete mix design are:-

1) ISI mix design method.
2) Trail & error method
3) Road note no. 4 method
4) USBR mix design method
5) Minimum void method
6) Maximum density method
7) Fineness design method
8) British mix design method
9) ACI mix

In this research mix design was done by ISI mix design method.

ISI Mix Design Method

The basic steps involving in the concrete mix design can be Summarized as follows:-

1) Based on the level of quality control the mean target strength is estimated from the specified characteristic strength.
2) The water cement ratio is selected from the mean target strength 7 checked for the requirement of durability.
3) The water content for the required workability is determined.
4) The cement content can be determined from the water cement ratio & water content obtained in step 2 & 3 respectively & is checked for water requirement.
5) The relative proportion of fine & coarse aggregate is selected from the characteristics of coarse & fine aggregates.
6) The trail makes proportional are determined.

The trail mixes are tested for verifying the compressive strength & suitable adjustment are made to arrive at the final mix composition

Preparation of test specimens of cement

Mix proportion & mixing

Clean appliances were used for mixing & the temperature of the water & that of the room test room at the time when the above operation are being performed was 27 (±) 2 degree, portal water was used in preparing the cubes.

The material for each cube was mixed separately. Mix the concrete by hand or by lab batch mixer mix the material thoroughly until the uniform color is achieved. Add some water and mix till the concrete appears to be homogeneous

Moulding Specimens

In assembling the moulds ready for use, cover the joints between the joints between the halves of the mould with a thin film of the mould with a thin film of petroleum jelly& apply a similar coating of petroleum jelly between the contact surfaces of the bottom of the mould & its base plate In order to ensure that no water escape during vibration treat the interior face of the mould with a thin coating of mould oil.

Place the assemble mould on the table of the vibration machine 7 hold it firmly in position by means of a suitable claim. Attach a hopper of suitable size & shape securely at the top of mould to facilities filling at this hopper was not be removed until the completion of the vibration period.

Immediately after the mortar in accordance with mix proportion & mixing place the mortar in the cube mould & prod with mix the rod. The mortar was prodded 20 times in about 8 sec to ensure elimination of entrained air & honey-combining place the remaining quantity of mortar in the hopper of cube mould & prod again as specified for the ist layer & then compact the mortar by vibration.

The period of vibration was 2 mints at the specified speed 12000 ± 400 vibrations/mint.

At the end of vibrations remove the mould together with the base plate from the machine & the finish the top surface of the cube is the mould by smoothing the surface with the blade of a trowel.

Curing Specimen

Keep the filled moulds in moist closet are moist room for 24 ± 1 hr after completion of vibration.

At the end of that period, remove them from the moulds & immediately submerge in clean fresh water & keep there until taken out just prior to breaking.

The water in which the cubes are submerged shall be renewed every 7 days and shall be maintained at a temperature of 27 ± 2c.

After they have been taken out & until they are broken, the cubes shall not be allowed to be become dry.

Calculation

The compressive strength of the cubes were calculated by dividing the maximum load applied to the cubes during the test cross-sectional area, calculated from the mean dimension of the section in determining the compressive strength differing by more than 10% from the average value of all the test specimens. After discarding specimens or strength values, is less than two strength values are left f or determining the compressive strength at any given period a retest was made.

Procedure

There are two types of specimen that can be used for cube test one is 15*15*15cm and 2nd one is 10*10*10 . the most commonly used specimen15*15*15cm. these moulds are cubical in nature.

- Moulds can be chosen accordingly with aggregate sixe. But 15*15*15cm cube is most preferable.
- Mould is filled with motar and then tamping is done my means to remove the excessive voids. Tamping is done layer by layer .
- Vibrator are also used to compact the concrete.
- After 24hr moulds are removed out from specimen. And then specimen is submerged in water for curing process
- The top surface of mould is kept smooth by spreading cement paste on top layer of specimen
- Theses specimens are tested on basis of different period after7 days,14adys, and 28days.
- The load is applied laterally on the mould by compression testing machine @ 140kg/cm^2 per min until specimen fails under load
- Load at the failure gives the compressive strength of concert

Procedure for using Testing Machine

Take out the specimen from the water after curing is done. Wipeout the water from the mould specimen. Clean all the surfaces of testing machine especially the bearing surface

Put specimen on bearing surface the specimen should be placed in such a manner that the load applied shall be in opposite side of the specimen.

Check the eccentricity of the cube the cube should be placed centrally on the bearing surface of the test machine.

Rotate the top portion of the test machine which is movable by hand so that it pokes the top surface of the mould

Apply the load slowly, smoothly, and continuously @140ka/cm2/min till the cube fails under load.

Report

Have some identification mark on cube
Date of performed test
Age
Date of manufacturing

Workability of Concrete

It is defined as that property of freshly mixed concrete or mortar which determines the ease & homogeneity with which it can be mixed, Placed, compacted & finished. A number of different methods are available for measuring the workability of fresh concrete, but none of them is wholly satisfactory. The widely used tests are:

The slump test.
The compacting factor test
For this project, both compaction factor test and slump test was chosen.

Slump Test

Slump test is the internationally accepted text to determine the workability of the concrete mix. This test can be performed in lab as well as in site during the construction process. Slump test is carried out continuously from batch to batch to check the uniform quality of concrete mix. Slump test is one of the most simple method to check the workability of the fresh concrete. This test is also economical to perform involves low cost.

This test provides an immediate result due to that widely used to determine workability since 1922.Slump test not only determine workability but also properties of aggregates, mixing methods, w:c ratio etc. also effect slump value.

Factors Effect Slump Value

Materialistic EQUIPMENTS USED FOR SLUMP-TEST

Metal Mould

The metal mould is used to carry the slump test, The mould is in the form of frustum cone having height 30cm, Bottom diameter 20cm, top diameter 10cm

- NON POROUS BASE PLATE
- MEASURING SCALE
- FOR TAMPING (TAMPING ROD)

Procedure for Slump Test

- Clean the mould surface and apply some oil
- Place the mould on the top of the non porous base plate
- Fill the steel mould with mixed concrete in 4 layers
- Tamp each concrete layer approximately with 25 strokes from the rounded end
- Remove the surplus concrete with trowel level the surface
- Remove the mould in vertical direction slowly and immediately.
- Measure the height of mould and that of height of specimen that we called as slump.

Remember slump should be measured in terms of mm. The following are the different shapes of slump

True Slump

It's the only slump that is measured in the test. Its taken between the top of cone and the top of concrete shown in above fig

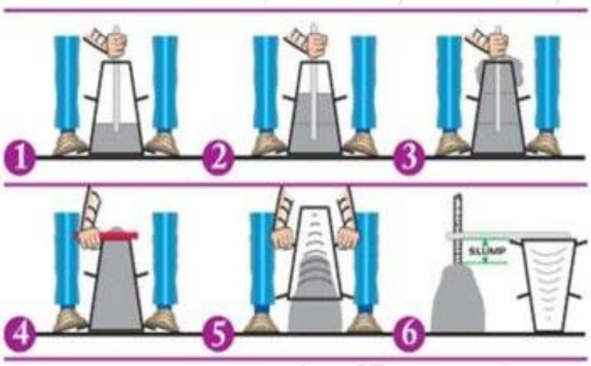

Figure 3.2: Concrete cube in UTM

Zero Slump

Zero slumps indicate that the very low water cement ratio. This type of slump occurs in dry mixes. These type of mixes are commonly used for the road construction.

Collapsed Slump

Is the indication of very high water cement ratio. This type of slump occurs in wet mixes. This type of slump mix is known as high workability mix

Shear Slump

This slump is indication that the result is incomplete

Compaction Factor Test

The compacting factor is defined as the ratio of the weight of partially compacted concrete to the weight of fully compacted concrete. It shall normally be started to the nearest second decimal place. This test is used for determining the workability of concrete, where the nominal maximum size of aggregates does not exceed 38mm.the test is designed primarily for use in the laboratory, but if circumstances permit, it may also be used in the field. It is more precise and sensitive than the slump test and particularly is useful for concrete micas of very low workability.

Procedure

The sample of concrete to be tested was placed gently in the upper hopper, using the hand scoop. The hopper was filled level with its brim and the trap door was opened so that the concrete falls into the hopper.

Immediately after the concrete has come to rest, the cylinder was uncovered into the cylinder.

The excess of concrete remaining above the level of the top of the cylinder was cut off by holding a trowel on each hand, with the plan of the blades horizontal and moving them simultaneously one from each side across the top of the cylinder. At the same time keeping them pressed on the top edge of the cylinder.

The above operations were carried out at a place free from vibration and shocks. The weight of the concrete in the cylinder was then determined to the nearest 10kg. The weight shall be known as the weight of the partially compacted concrete.

The cylinder was filled with concrete from the sample in BHlayers approximately 5 cm deep, the layers being heavily rammed or perfectly vibrated so as to obtain full compaction. The top surface of fully compacted concrete was carefully struck off the level with the top level with the top of the cylinder. The outside of the cylinder was then being wiped clean.

The weight shall be known as the weight of fully compacted concrete.

Tensile strength is most important property of cement concrete because structures are extremely catastrophic to tensile cracking due to different effects and application of loading itself. The split cylinder test and flexural test gives values higher then the direct test or uniaxial tensile strength.

Compressive Strength of Concrete

The compressive strength of concrete of all the mixes was determined at the ages of 3, 7 and 28 days for the various replacement levels of fly ash and silica fume. The result are reported in table 4.24 fig 4 shows the variation of compressive strength of concrete with different percentage of fly ash and brick dust. The compressive strength of reference mix is 11N/mm^2 14N/mm^2 and 25N/mm^{2}for 3,7 and 28days respectively. With the addition of percentages of brick dust 10% to the (5,10,15)% level of fly ash, the maximum value of compressive strength of 3,7& 28 days are 11N/mm^2,14N/mm^2& 25N/mm^2 respectively where as the min values of compressive strength of 3,7 & 28 days are 10N/mm^2 , 13N/mm^2 24N/mm^2 respectively. It is observed addition of brick dust to concrete, result in increase in compressive strength of concrete as compared to the strength shown by control mix at all ages.

The increasing trends are due to the use of brick dust, which helps in filling concrete porous resulting in improved impermeability of concrete, less moisture diffusion and increase strength may be attributed to increased concrete density. Also secondary reactions takes place between brick dust and by product of cement hydration that is calcium hydroxide to produce a cementitious agents, calcium silicate hydrates. The rate of growth of these pozzolanic products is small and their influence on strength of the system is seen only after long periods of curing.

3. Results

The present chapter deals with the result of tests conducted on concrete cube using fly ash, brick dust to determine the effect of fly ash, and brick dust on compressive strength & workability of concrete. The experimental program consist of casting, curing and testing of fly ash and brick dust concrete specimens at different ages. The compressive strength was investigated at the ages of 3,7,28 days. Workability of various mixes was also determined. The details of materials, equipment and experimental procedure adopted for various tests have already been described in chapter 3.

In the experimental program, a reference mix was prepared without fly ash, brick dust.4 mixes were prepared other than reference mix. Cement was replaced with fly ash & brick dust in reference mix to bring cement contents within the minimum range 360kg/m^3 as recommended by Indian standards.

In present study, 20 specimens were prepared by varying percentage of fly ash & brick dust as a part of replacement of cement besides 4 specimens of reference mix. In all 20 specimens were casted. The specimens were tested after 3, 7 & 28 days of casting. The ratio of different materials used in each mix & mix designation are shown in table 4.1.

Table 4.1: Designation of concrete mix

Mix designation	Fly ash (%)	Brick dust (%)	Cement %	Fine aggregates (%)
Reference mix M_0	0	0	100	100
M_1	5	10	95	90
M_2	10	10	90	90
M_3	15	10	85	90

Compressive Strength of Concrete

The compressive strength of concrete of all the mixes was determined at the ages of 3, 7 and 28 days for the various replacement levels of fly ash and silica fume. The result are reported in table 4.24 fig 4 shows the variation of compressive strength of concrete with different percentage of fly ash and brick dust. The compressive strength of reference mix is 11N/mm^2 14N/mm^2 and 25N/mm^{2}for 3,7 and 28days respectively. With the addition of percentages of brick dust 10% to the (5,10,15)% level of fly ash, the maximum value of compressive strength of 3,7& 28 days are 11N/mm^2,14N/mm^2& 25N/mm^2 respectively where as the min values of compressive strength of 3,7 & 28 days are 10N/mm^2 , 13N/mm^2 24N/mm^2 respectively. It is observed addition of brick dust to concrete, result in increase in compressive strength of concrete as compared to the strength shown by control mix at all ages.

The increasing trends are due to the use of brick dust, which helps in filling concrete porous resulting in improved impermeability of concrete, less moisture diffusion and increase strength may be attributed to increased concrete density. Also secondary reactions takes place between brick dust and by product of cement hydration that is calcium hydroxide to produce a cementitious agents, calcium silicate hydrates. The rate of growth of these pozzolanic products is small and their influence on strength of the system is seen only after long periods of curing.

Table 4.2: Test result for compressive strength after 7 days

Mixes	percentage of fly ash	percentage of brick dust	3 days N/mm^2	7 days N/mm^2
M0	0	0	11	14
M1	5	10	12	14.2
M2	10	10	12.3	15.01
M3	15	10	13.00	15.5

Compressive Strength Table and Graph After 28 Days

Table 4.3: Compressive strength after 28 days

Mixes	percentage of fly ash	percentage of brick dust	14 days N/mm^2	28 days N/mm^2
M0	0	0	16	25
M1	5	10	16.3	25.33
M2	10	10	17.01	26.00
M3	15	10	17.5	27.00

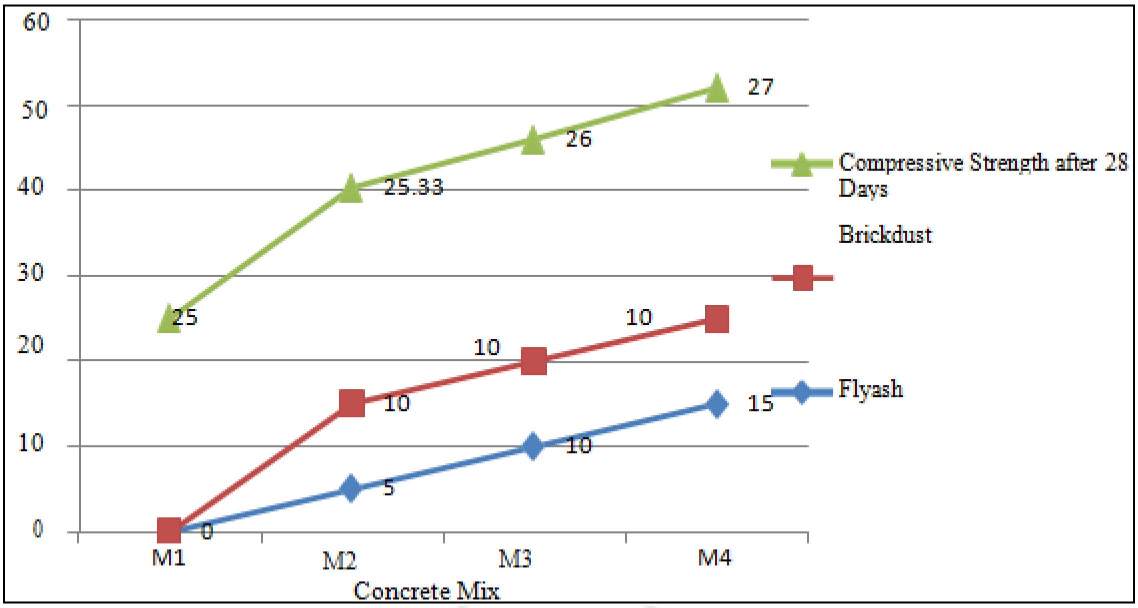

Figure 4.1: Compressive strength graph after 28days

Chart shows the increase in compressive strength with increase in fly-ash and brickdust.

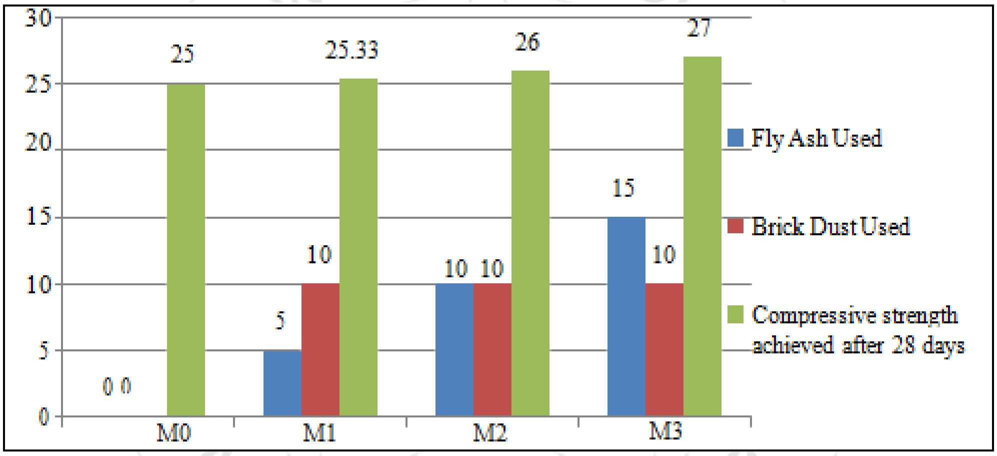

Figure 4.2: Graph showing increase in fly ash results in increases in compressive strength

Comparison of compressive strength after 7 and 28 days

Table 4.4: Comparison of compressive strength

Mixes	percentage of fly ash	percentage of brick dust	3 days N/mm^2	7 days N/mm^2	14 days N/mm^2	28 days N/mm^2
M_0	0	0	11	14	16	25
M1	5	10	12	14.2	16.3	25.33
M2	10	10	12.3	15.01	17.01	26.00
M3	15	10	13.00	15.5	17.5	27.00

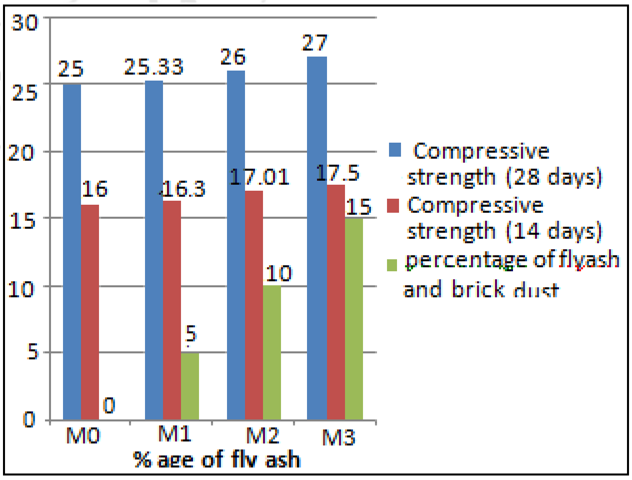

Figure 4.4: Comparison of compressive strength after 14 and 28 days

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