STUDY OF STRENGTH CHARACTERISATION OF CONCRETE BY REPLACEMNT OF CEMENT & SAND WITH HIGH VOLUME OF FLYASH

A Report

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In
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Certificate

This is to certify that the thesis entitled "**Study Of Strength Characterisation Of Concrete By Replacemnt Of Cement & Sand With High Volume Of Flyash**" submitted by (Name- **Danardan Naik** , Regd no-**1801298110**) in partial fulfilment of the requirements for the award of **Batchlor of Technology Degree** in **Civil Engineering** at Gandhi Institute For Technology, Bhubaneswar is an authentic work carried out by him under my supervision and guidance.

To the best of my knowledge, the matter embodied in this Project Report has not been submitted to any other University/Institute for the award of any Degree or Diploma.

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ABSTRACT

As Fly Ash is a waste product of thermal industries which is obtained from the combustion of coal, transported by the flue gases and get collected by electrostatic precipitator. In order to reduce the problem of dumping this waste product, it is good to use it. Investigation is to be made about the replacement of cement and sand in concrete to get the nominal compressive strength and lower the cost of concrete. The thesis presents the result of concrete mix with a ratio of 1:1.5:3 and further replacement is made in the concrete. Replacement of sand is done with a percentage of 50and replacement of cement is done with a percentage of 40,50 and 60.The compressive strength is to be found and gives an decreasing result with the increase in percentage of fly ash.

Hence, it can be used in low load structural building. The economic studies of the above replacement mixes were calculated for fly ash concrete cubes and bricks.

CONTENTS

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF GRAPHS

CHAPTER - 1

INTRODUCTION

1.0 INTRODUCTION

Coal ash is the by-product which is obtained when coal is combusted in thermal plants. this coal ash is further classified into two types - fly ash and bottom ash. The utilisation of these by-products depends upon the locality and can be used for various purposes. For the use of these by-products many types of experiments are going on and as these are very low in cost . Mainly the use of fly ash is implemented in building industries. Fly ash is used as a partial replacement of cement and sand in order to increase the workability in concrete. This type of replaced concrete helps to improve impermeability in concrete and has a good advantage of resisting the sulphate attack.

Mortar is considered and worldwide accepted material which is widely used in civil engineering structures. In case of the walls of different residential and commercial buildings , most of them are made up of stone , bricks and concrete blocks. Mortar plays the crucial role in case of performance of the structures but it only make 7 % of the total volume of a masonry wall. In order to maintain the balance between the natural energy and waste materials, many effort and research are going on in order to use these waste materials. Another main factor is cost of cement, which is rapidly increasing day by day. In order to reduce the use of cement in concrete and in different construction industries fly ash used as the replacement of both cement and fine aggregate, which further reduces the cost of the concrete. By determining the compressive strength conclusion can be drawn.

During the production of Portland Cement large amount of carbon dioxide is emitted and a lots of money and energy is used. In order to reduce these costs and environmental problems Fly ash are used as the partial replacement for the total weight of cementitious material ranging from 0% to 40 %.Use of high volume Fly ash and lime is going to be the best solution to meet the demand of the cement consumption in construction industries.

Concrete is the main and most used item in the construction industries. So, it obvious to reduce the cost and increase the strength would the first preference for everyone and use of Fly Ash is more referred in construction industries.

1.1 OBJECTIVE

- Preparation of high volume fly ash concrete replacing cement and sand.
- Preparing concrete using cement replaced with 40 % Fly Ash.
- Preparing concrete using cement replaced with 50 % Fly Ash.
- Preparing concrete using cement replaced with 60 % Fly Ash.
- Preparing concrete using sand replaced with 50% Fly Ash and cement replaced with 40, 50, 60 % Fly Ash.

CHAPTER 2

LITERATURES REVIEW

2.0 INTRODUCTION

Fly Ash is a by-product, which is produced when the coal is burnt. The main source of Fly Ash is the thermal power plant. Now a days the main part of research in case of the construction industry is how to use the waste products in different fields. Utilisation of different waste materials like Coal Fly Ash, Coal Bottom Ash, Silica Fume, different domestic Solid wastes etc. for the formation of concrete and replacing these materials with fine aggregate and coarse aggregate.

2.1 CEMENT AND SAND REPLACED BY FLY ASH

2.1.1 MIX PROPORTIONS

A. Duran-Herrera et al. [1] studied three series of replacement of cement with Fly ash. In his study 0, 15, 30, 45, 60 & 75 % of Fly Ash is added by replacing cement. Again binder is used in three different ratio of [W/(C + FA) ,(w/b)] 0.5, 0.55 and 0.60. Blended (with limestone powder) hydraulic cement (designated as CPC 30R by the Mexican standard NMX-C-414-ONNCCE-2004) that meets ASTM C 595-08 specification for a Type IP (MS) cement. The physical properties and chemical composition are listed in Table---. Class F fly ash according to ASTM C 618-08 [18] with an average particle diameter of 80 lm. The fly ash was obtained from the José Lopez Portillo carboelectric plant located in the state of Coahuila in the Northeast of México, which has a monthly average production of 141,000 metric tons, from which only 4700 metric tons are currently used. Physical properties and chemical composition are listed in Table----. It should be noted that the particle sizes of this particular fly ash may improve particle packing by efficiently filling in the particle sizes between those of the cement and the fine aggregate. Locally available crushed limestone sand that meets the grading requirements of the ASTM C 33-07 specification. It has a specific gravity of 2.65, a fineness modulus of 3.1, and water absorption of 1.25%. Locally available crushed limestone coarse aggregate with a maximum size of 19 mm that meets the grading requirements of the ASTM C 33-07 # 67 specification. The specific gravity and the water absorption were 2.72% and 0.44%, respectively. For both aggregates, properties were determined according to standard procedures described in the corresponding ASTM test methods. Potable water that meets the requirements of ASTM C 1602-06 was used to mix the concrete and cure the specimens. Mixtures were prepared at three different w/b of: (A) 0.5, (B) 0.55, and (C) 0.60. A polycarboxylate based high-range water reducer or superplasticizer conforming to ASTM C 494-92 Class A and Class F in aqueous form was used to reduce the paste content and improve workability.

F.U.A. Shaikh et al. [2] The experiment is completed in two phases. In the first phase, effects of different nano-CaCO3 contents on the compressive strength of mortar and concrete are evaluated. The optimum nano-CaCO3 content that exhibited the highest compressive strength is selected to include in high volume fly ash concretes and mortars to evaluate its effects on both early age and later age compressive strengths. The mixture proportions of mortars and concretes used in this phase .The second phase was designed to study the effect of optimum nano-CaCO3 (i.e. 1%) on water sorptivity, volume of permeable voids, chloride permeability, porosity and chloride diffusion of HVFA concretes containing 39% and 59% fly ash and cured at both 28 and 90 days. studied four types of replacement.

K. Celik et al.[3] Concrete mixture proportions are given in Table 2. The water to cementitious material ratio (W/CM), being the water to total binder ratio, was held constant at 0.35 for all mixes and the amount of superplasticizer (SP) was added to provide a slump flow diameter between 635 and 690 mm, and a diameter of 50 mm flow time, T50, between 3 and 5 s. The actual W/CM ratio was 0.36 as the water contribution for the SP increased the overall water content. In order to reduce cement content compared to typical SCCs, the total aggregate to fines ratio was fixed at 4:1, and the cement replacement (CR) ratio ranging from 30 mass% to 65 mass%. For the ternary blends, the LF content was set as 15 mass%, and the ratio of NP/ FAF was varied between 30 mass% and 50 mass%. The mix designs are entitled 55 OPC-30 NP/FAF-15 LF, for instance, for the 55 mass% OPC, 30 mass% NP or FAF, and 15 mass% LF mix. The ratio between coarse aggregates (CA) and fine aggregates (FA) was kept at 1:1. The CA consists of 30 mass% pea gravel and 70 mass% basalt. For the each mixture, a total volume of 22L of concrete was prepared in a pan planetary-type mixer. The mixing procedure was as follows; CA and a small amount of water were mixed for 30 s. OPC, NP/FAF and more water were added and mixed for one minute. LF and the rest of the water were added and mixed for a further minute before the superplasticizer was added and again mixed for one minute. Fine aggregate was then added and mixed for three minutes. During that time, the mixer was stopped and the bottom scraped to remove fine particles. Then, the slump flow test was performed. If the concrete was satisfactory, it was then returned to the mixer and mixed for an additional minute before casting. If the slump flow was too low or flow time too high, the concrete was returned to the mixer, mixed for an additional minute and the water reducer added until the desired workability was reached. The slump flow test was again performed. If the concrete was then satisfactory, it was remixed for an additional minute before casting. Otherwise, it was discarded and the mix attempted again with more or less water reducer. The material was cast into eighteen 75 150 mm cylinders and three 100 200 mm cylinders in two lifts without mechanical vibration. Light shaking was allowed as the only method of consolidation for the SCC specimens. Cylinders were immediately covered with plastic wrap and remained undisturbed for 24 h in lab conditions. After 24 h, cylinders were demolded and placed in an environmental chamber (100% relative humidity at room temperature) to cure until testing in accordance with ASTM C192 [3].

R. Siddique et al.[4] In this work, one control mixture M-1 was designed per Indian Standard Specifications IS: 10262-1982 to have 28-day compressive strength of 37.2 MPa. The other three concrete mixtures were made by replacing cement with 40%, 45%, and 50% of Class F fly ash by mass. In doing so, water-to-cementitious materials ratio was kept almost same to investigate the effects of replacing cement with high volumes of Class F fly ash when other parameters were almost kept same. Mixture Preparation and casting of test specimens Concrete cubes, 150 mm in size were cast for compressive strength, 150300-mm cylinders for splitting tensile strength, 1014508-mm beams for flexural strength, 150300-mm cylinders for modulus of elasticity, and specimens of size 656560 mm for abrasion resistance. All the specimens were prepared in accordance with Indian Standard Specifications IS: 516-1959. After casting, test specimens were covered with plastic sheets and left in the casting room for 24 h at a temperature of about 24F1 jC. They were demolded after 24 h and were put into a water-curing room until the time of the test. Fresh concrete properties, such as slump, unit weight, temperature, and air content, were determined per Indian Standard Specifications IS: 1199-1959.Concrete cubes, 150 mm in size were tested for compressive strength, 150300-mm cylinders for splitting tensile strength, 101.4101.4508-mm beams for flexural strength, and 150300-mm cylinders for modulus of elasticity per Indian Standard Specifications IS: 516-1959. Abrasion test on specimens of size 656560 mm was performed in accordance with Indian Standard Specifications IS: 1237-1980.

C. Cao et al.[5] Raw materials used in the experiment consist of 425 Portland cement with specific gravity of 3,100 kg/m3. Grade II dry-moved fly ash with residual percent on 45- mm sieve was 10.3%. See Table 2.1 and 2.2 for its chemical composition. Ordinary river sand was used as fine aggregate, with nominal density of 2,650 kg/m3, piled density of 1,540 kg/m3, and fineness modulus of 2.5. Crushed dolomite was used as coarse aggregate, with 5- to 25-mm continuous grading, while its nominal density was 2,800 kg/m3 and piled density was 1,500 kg/m3. Water-reducing admixture and tap water were also used. Mix design took flexural strength as the design index. FA was incorporated by the method of super-substituting, and the super-substituting coefficient was 1.5. Water amount and sand ratio were determined by Marshall-compacting method, with the compacting density not less than 96%. Table 3 gives the mixing ratios of HFRCC. Specimens were vibrated for 120 s, with a top compressive force of 50 g/cm2. After 24 h, moulds were removed and specimens were moved into a curing room with a temperature of 20 6 3 8C and relative humidity not less than 90% for the required days. Flexural strength was tested by the four-point flexural method and then the broken specimens were used to test the compressive strength.

Cengiz Duran Ati et al.[6] The proportions of the control NPC concrete mixtures are 1:1.5:3 by mass NPC, sand and gravel, respectively. The approximate quantity of NPC was 400 kg/m3. High-volume fly ash (HVFA) concrete systems were made using two NPC replacement levels, 50 and 70 mass%. Two fly ashes were used in the study. The mixtures were made with and without a super plasticizer. The first step in the determination of water content for the control cement and HVFA concretes was to find the optimum water content for maximum compact ability using the vibrating slump test described elsewhere .The optimum water content was determined because it was shown that it provided the maximum strength from the mixture. The optimum water contents obtained from the vibrating slump test were then used to produce the control cement and HVFA concrete mixtures with zero slump. These mixtures were made workable by the use of the super plasticizer. M0W (workable) and M0Z (zero slump) correspond to control Portland cement concretes. M1, M2, M3 and M4 are HVFA concretes made with Drax fly ash. M5, M6, M7 and M8 are HVFA concretes made with Aberthaw fly ash. M1, M2, M5 and M6 mixtures are made with 70% fly ash replacement. M3, M4, M7 and M8 mixtures are made with 50% fly ash replacement. The mixtures M0Z, M2, M4, M6 and M8, with zero slump, are called RCC. The mixtures M0W, M1, M3, M5 and M7 contain also super plasticizer. The use of the super plasticizer was very effective. The mixtures containing the super plasticizer were practically flow able. The mixtures were very stable, they did not bleed; their entrapped air content varied from 1% to 2.9%, and final setting times were in the order of 2–5 h. The concrete specimens were made with vibration until complete compaction was obtained. All the test specimens were demoulded at 1 day and then cured under constant temperature 20 8C and relative humidity conditions of 65% and 100% RH.

R. Siddique et al.[7] First, a control mixture without fly ash, was designed in accordance with the provisions of Indian Standard Specifications IS: 10262-1982 to have a 28-day cube compressive strength of 36 MPa. Then, cement was replaced with three fly ash percentages 35%, 45% and 55% by mass. After this, three percentages 0.25%, 0.50% and 0.75% of san fibers were added in each of the fly ash concrete mixtures containing 35%, 45% and 55% fly ash. The W/Cm ratio was maintained at 0.47 ± 0.02 and air content was kept at 4.8 ± 0.2%. Superplasticizer/cementitious materials ratio was kept around 0.015. Concrete mixtures were made in power-driven revolving-type drum mixers of 0.76 m3 capacity.

S. Aydın et al.[8] The physical, chemical and strength characteristics of Portland Cement (CEM I 42.5 N) used for this study. Natural river sand and crushed limestone were used as fine and coarse aggregates. A superplasticizer (SP) of sulfonated naphthalene formaldehyde type in conformity with ASTM C 494 Type F and TS EN 934-2 has been used. The pozzolanic activity index of FA is 88%, which is relatively low, however, this value is in acceptable limits of ASTM C 618. The concrete mixtures were prepared in a horizontal-axis mixer for about 2 min. Numbers in the mix codes represent FA content of concrete by cement weight. The total cementitious materials content and the water/binder ratio were kept constant at 360 kg/m3 and 0.40, respectively. Cylindrical (100/200 mm) and cubic (71 mm) specimens were compacted by a vibration table. These specimens were used to determine mechanical properties and acid resistance, respectively. A group of specimens has been kept in the moulds for 24 h at room temperature of 20 1C. After demoulding, the specimens were placed into a water curing (WC) tank full of saturated limewater at 2072 1C till testing times for standard curing. The remaining part of specimens was exposed to steam curing (SC). After SC, one group of specimens has been tested immediately to determine the initial compressive strength values. The remaining specimens were stored in WC. End of the curing processes splitting tensile strength and modulus of elasticity at 28 days, and compressive strength at various ages were determined as the average of three specimens.

Rushabh A. Shah et al.[9] Fly ash (Class F) investigated for its use as a partial replacement for cement in cement mortar (1:3). The utilization of Fly Ash as cement replacement material in mortar or as additive in cement introduces many benefits from economical, technical and environmental points of view. This paper presents the results of the cement mortar of mix proportion 1:3 in which cement is partially replaced with Fly Ash(Class F)as 0%, 10%, 30%and 50% by weight of cement. Two set of mixture proportions were made. First were control mix (without Fly Ash(Class F)with regional fine aggregate (sand)) and the other mixing contained Fly Ash(Class F)obtained from Thermal industry the compressive strength has been obtained with partial replacement of Fly Ash(Class F)with cement. A cement mortar mix 1:3 was designed as per IS: 269 methods and the same were used to prepare the test samples.

S. Bhanu Pravallika et al.[10] In the present study two grades of reference fly ash concrete M20, M25 were prepared using potable water for mixing and curing. The same grades of fly ash concrete were once again prepared using potable water for mixing and cured in sea water. Once again the same grades of fly ash concrete were prepared using sea water for mixing. In these concrete was designed as per IS: 10262-2009. In this experimental work, physical properties of materials used in the experimental work were determined. M20 and M25 grade of reference concrete was mixed and cured in potable water.

B. Balakrishnan et al.[11] In the present study two concrete mixes were made: one with OPC alone and the others with OPC replaced by weight of 40, 50 and 60% fly ash. These replacement levels were considered in view of the strength development obtained in the mix, studied the workability of the concrete by finding the slump value. The slump value was recorded as 65, 85, 90 and 110 mm for OPC, 40, 50 and 60% fly ash concrete respectively. From the result we concluded that higher replacement of cement with fly ash increases the workability of the fly ash concrete compared to that of OPC alone. In case of strength, a higher compressive strength value was obtained in Ordinary Portland Cement concrete, but in samples having 40, 50 and 60 % replacement made up 85, 72 and 63 % of the control sample strength at 28 days. The result is also given in table 2.1. The mix design has been adopted as per IRC: 44-2008.

D.K. Soni et al.[12] The Aim of Paper is Fly ash is used as a mineral addition in concrete to improve its strength and durability characteristics At high temperatures, chemical transformation of the gel weakened the matrix bonding, which brought about a loss of strength of fly ash concrete. Fly ash can be used either as an admixture or as a partial replacement of cement or as a partial replacement of fine aggregates or total replacement of fine aggregate and as supplementary addition to achieve different properties of concrete. Pozzolanic concretes are used extensively throughout the world where oil, gas, nuclear and power industries are among the major users. Apart from the usual risk of fire, these concretes are exposed to high temperatures for considerable periods of time. Although concrete is generally believed to be an excellent fireproofing material, but there is extensive damage or even catastrophic failure at high temperatures. the compressive strength, split tensile strength and modulus elasticity of fly ash concrete at elevated temperature up to 120˚C with mix proportions of 1:1.45:2.2:1.103 with a water cement ratio of 0.5 by weight was determined. Cement was replaced with three percentages of fly ash. The percentages of replacements were 30, 40 and 50 % by weight of cement.

P. Vipul Naidu et al.[13] The process of selecting suitable ingredients of concrete and determining their relative amounts with the objective of producing a concrete of the required strength, durability and workability as economically as possible is termed as the concrete mix design. The compressive strength of hardened concrete which is generally considered to be an index of its properties, depends upon many factors, e.g. quality and quantity of cement, water and aggregates; batching and mixing; placing, compaction and curing. The cost of concrete is made up of the cost of materials, plant and labour. In M40 grade, the control mix (without fly ash) was designed and further 30, 40, 50, 60 and 65% of cement was replaced respectively with the fly ash. And also the new control mix was designed in which 65 and 75% of cement was replaced with the fly ash + lime.

Dinesh.W.Gawatre et al.[14] The evaluation of fly ash for use as a supplementary cementations material (SCM),ie as a pozzalona ,begins with the concrete or mortar testing .The ordinary Portland cement (OPC) confirming IS 269 is replaced with the fly ash. The data from the fly ash concrete is compared with data from a "Control" concrete without fly ash. The water to cement ratio of each mixture therefore varies considerably as 0.35 to 0.50 in concrete. The cube samples were cast on the mould of size (150 x 150 x 150)mm for each M20,M25 and M30 grade concrete with partial replacement of cement with fly ash as 00.00%. 12.5% ,25.00% and 37.50% with water cement ratio were also casted. After about 24 h the specimens were de-moulded and moist curing was continued till the Respective specimens were tested after 28 days for compressive strength. The mixture proportions are summarized in table 4A, 4B,4C in which the mixtures were designated according to the type and the amount of cementations materials included.

Jo Jacob Raju et al.[15] High Volume Fly Ash concrete system addresses all the major sustainability issues. It is recommended over the ordinary concrete as it considerably saves cement and also prevents environmental pollution. The use of fibres improves specific material properties of the concrete, impact resistance, flexural strength, toughness, fatigue resistance, and ductility. In this paper an attempt is made to study the mechanical properties of High Volume Fly-Ash Concrete with addition of fibres at 0.1, 0.2, and 0.3% of cement and with 60% fly ash replacement with cement. It is found that fibre additions have increased its strength characteristics considerably over the ordinary cement concrete. A mathematical model was developed using SPSS 20 for the strength parameters of HVFAC with fibres. The major parameter that affected strength was total binders and water-binder ratio. The mix design has been adopted as per IRC: 44-2008.The concrete used in this study was proportioned to attain strength of 40 MPa. air content were measured.

Jino John et al.[16] The mix composition is chosen to satisfy all performance criteria for the concrete in both the fresh and hardened states. Proportioning of concrete mixes can be regarded as a procedure set to proportion the most economical concrete mix for specified durability and grade for required site conditions. The basic principle of the concrete mix design is to select the proportion of all the-ingredients the basis of the irresolute volume and taking total absolute volume of concrete 1m3.Inthe present Guidelines, the absolute volume of air has been considered as nil as against 2 per cent for 20 mm and 1percent for 40mm maximum size of aggregate each provided in IRC: 44-2008. The method given in these Guide lines is to be regarded as guidelines only, to arrive at an acceptable product which satisfies the requirements of replacement quire with development of strength with age and ensures the requirements of durability. A rational mix design process should be used, to reduce the number of trial tests in laboratory.

Pardeep Kumar Gupta et al.[17] The concrete mix used for the construction of the pavement was designed on the basis of following parameters and considerations: Concrete must obtain a minimum compressive strength of 400 kg/cm2 and flexural strength of 45 kg/cm2 at 28 days. The mix should be cohesive with reasonable workability. A slump value in the range of 10 to 15 mm was targeted which was found to be sufficient for road work. It was envisaged to replace as much as 50% of the total cement content with good quality dry fly ash. The fly ash for the purpose was sourced from first and second fields of ESP of nearby thermal plant. Use of low water cement ratio to ensure a dense concrete with low permeability. Dosage of water reducing admixture was to be optimised to get the necessary workability at the lowest cost.

Alvin Harison et al.[18] In order to study the effect of fly ash as partial cement replacement on the strength of concrete, 63 cubes for a mix have been cast in the laboratory. Cubes (100 mm × 100 mm × 100 mm) were cast using a design mix of 1:2.08:3.86 and water cement ratio of 0.46 was maintained to get the strength of cubes made up with different percentage of fly ash to the respective strength of conventional concrete at the end of 7, 28 and 56 d of moist curing. Optimum percentage of fly ash which does not affect the strength of non-conventional concrete was noted. PPC of Prism brand was obtained from single batches throughout the investigation. The fine aggregate was locally available river sand which is passed through 4.75 mm sieve. The specific gravity of fine aggregate is 2.2 and fineness modulus of fine aggregate is 2.84. The coarse aggregate was locally available quarry having two different sizes; one fraction is passed through 20 mm sieve and another fraction is passed through 10 mm sieve. The specific gravity of coarse aggregate is 2.66 for both fractions. In the present study, the fly ash is obtained from the NTPC, Unchahar, Raibareli, U.P. Potable water is used for mixing and curing. The water cement ratio (w/c) of 0.46 has been used. The concrete mix design is done in accordance with IS 10262 (1982). The cement content used in the mix design is taken as 380 kg/m3 which satisfies minimum requirement of 300 kg/m3 in order to avoid the balling affect.

P. P. Bhangale et al.[19] The ponded ash has been used as a part replacement of fine aggregate at different replacement labels water to cement ratio and pest volume in a given mix were the other parameters selected as a variables. The mix proportion ting is to produce the required properties in both plastic & hardened concrete by economical & practical combination of available material the design mixes prepared in accordance with the IS 10262. The mixes were designated as a mix with varying percentage ponded ash such as 0 %, 20%, 30 % and 40 % to evaluate the proportion. Cubes of dimension 150 mm were cast adopting weight batching and hand mixing technique. Steel moulds were used for casting and table vibrator was utilized for compaction. The cubes were demoulded after 24 hours and placed in water tanks for curing for 28 days after which they were air dried.

T. Phani Madhavi et al.[20] In the present work, various materials like Flyash, Cement, Glass aggregate, Coarse aggregate, Fine aggregate, Water were used. It was found that the Specific gravity and Fineness modulus of fine aggregate (G) was 2.66 and 2.892 respectively. It was found that the specific gravity, Fineness modulus and average water absorption of course aggregate was 2.936, 8.10 and 2.7 respectively. From the experimental results it was found that the specific gravity, Initial setting time, Final setting time of cement was 2.88, 75 minutes, and 250minutes respectively. The Fineness modulus of glass aggregate was 3.51.Characteristic compressive strength required in field at 28 days is 30 N/mm2; Maximum size of aggregate is 20mm (angular);Degree of workability is 0.90C.F; Degree of quality control is Good; Type of exposure is Mild Specific gravity for cement is 3.01; Specific gravity of Coarse aggregate is 2.85and Fine aggregate is 2.66; Water absorption for Coarse aggregate is 2.7 % and for Fine aggregate is 1.0 % Target Mean Strength of Concrete---Assumed standard deviation as per IS 456-2000. For Target mean strength = 39.9 N/mm2; W/C ratio = 0.375 For aggregate size 20mm, water content including surface water, per cubic meter of concrete is 186kg. Sand content as percentage of total aggregate of absolute volume is 35%.

S. Lokesh et al.[21] Grade of concrete selected is M25 and water cement ratio adopted was 0.3. The selection of this low water content of 0.3 was done because of spherical nature of FAs. The mix proportion taken was 1:1:2 and mixing satisfies the requirement of IS 456-2000. The various compositions of the binder and coarse aggregate are shown in the Table.2.1 each composition is given a designation comprising one or two letters and each letter followed by a numeric indicating the percentage of the material indicated in the letter in the binder and coarse aggregate. Letters C, F, S, NA and FA represent Cement, Fly ash, Silica fume, Natural Granite and Fly ash Aggregate respectively. For example binder composition C60F30S10 indicates 60% Cement, 30% Fly ash and 10% Silica fume.

Jay Patel et al.[22] Six mixture proportions were made. So in this project we will replace the alccofine and fine fly ash partially with cement and pond fly ash as a replacement of fine aggregate. In mix G1, G2, G3 we will replace cement with alccofine

4% and fine fly ash 26% and pond fly ash varies 10%, 20%, 30% as replacement of fine aggregate. Similarly in mix G4,G5,G6 alccofine 6% and fine fly ash 24% and pond fly ash same as 10%,20%,30%. In mix GA we will replace cement with alccofine 4% and fine fly ash 26%. Similarly in mix GB alccofine 6% and fine fly ash 24%.

R. Siddique et al.[23] Control mixture (M-1) was proportioned to have 28 days cube compressive strength of 30 MPa. Three additional concrete mixtures (M-2, M-3 and M-4) were proportioned where fine aggregate (sand) was replaced with Class F fly ash. The replacement levels of fine aggregate were 35, 45 and 55% by weight. 150 mm cubes were cast for compressive strength, 150×300 mm cylinders for splitting tensile strength, 100×100×500 mm beams for flexural strength, 150×300 mm cylinders for modulus of elasticity, and specimens of size 65×65×60 mm for abrasion resistance. All the specimens were prepared in accordance with IS: 1199 [19]. After casting, specimens were covered with plastic sheets, and left in the casting room for 24 hours at a temperature of about 23oC. They were demolded after 24 hours, and were put into a water-curing room until the time of the test. Three specimens were cast for each of the properties for all test ages.

Sravana Sarika et al.[24] Pozzolanic admixtures are generally being used along with the cement in concrete mixes so as to derive certain benefits like economy, durability, Chemical resistance in permeability etc. The use of high volumes of fly ash has become on of the current topics of research possibility promoted by the availability of a wide

CHAPTER 3

MATERIALS USED

MATERIALS USED

For the preparation of the high volume flyash concrete, following materials are used:

3.1 OPC of grade-43-

Used Ramco Cement of Grade-43

Table 3.1 Physical Properties of cement

Test Particulars	Results Obtained	Requirements of IS:8112-2013
Fineness (m^2/KG)	308	Minimum 225
Normal Consistency (%)	27.86	
Initial Setting Time (Minutes)	153	Minimum 30
Final Setting Time (Minutes)	256	Maximum 600
Le-Chatlier Expansion (mm) Soundness	1	Maximum 10
Autoclave Expansion (%) Soundness	0.02	Maximum 0.80
Compressive Strength (MPa)- 72 +/- 1 Hrs (3 Days)	34.1	Minimum 23
Compressive Strength (MPa)- 168 +/- 2 Hrs (7 Days)	43.5	Minimum 33

Table 3.2 Chemical Properties of cement

Test Particulars	Results Obtained	Requirements of IS:8112-2013
CaO % - 0.7 SO3% /2.8 SiO2 % + 1.2 Al2O3 %+ 0.65 Fe2O3 %	0.91	0.66 to 1.02
% Al2O3 / % Fe2O3	1.41	Minimum 0.66
Insoluble Residue (% by Mass)	0.77	Maximum 4.0
Magnesia (% by Mass)	1.17	Maximum 6.0
Sulphuric Anhydride (% by Mass)	2.04	Maximum 3.5
Total Loss on Ignition (% by Mass)	2.87	Maximum 5.0
Chloride Content (% by Mass)	0.012	Maximum 0.10
Tricalcium Aluminate (C3A)	8.11	

3.2 Fly Ash

As we know that this by-product is generated from thermal power plants. So, we contacted the nearest thermal power plant of N.T.P.C. It belongs to Government of India and which is situated in Angul, which is about 120 km from the institution. The physical and chemical properties are further studied at a private examination center called Graffin inspectorated , Mancheswar,bhubaneswar and the following result is found. In case of chemical analysis 2 sample of same Fly Ash is taken for more accuracy. The physical and chemical properties is given in table no.3.3 and 3.4.

Table 3.3 Physical properties of Fly Ash

LOI	Density(g/cc)	Blain Area(m^2/kg)
	2.1	350

Table 3.4 Chemical properties of Fly Ash

Type of Fly Ash	Test Parameters(%)				
	Fe_2O_3	SiO_2	Al_2O_3	CaO	MgO
1	5.17	60.13	30.85	0.76	0.45
2	3.98	55.08	27.96	0.65	0.41

3.3 Fine Aggregate

Natural sand which is collected from the local river is of maximum size 4.5mm was used as fine aggregate for the study. The physical and sieve analysis of above fine aggregate are presented in table no. 3.5. and 3.6.

Table No. 3.5 Physical Properties of Fine Aggregate

Sl. No.	Properties	Studied Values
1	Bulk Density(Kg/m^3)	1652
2	Specific Gravity	2.7
3	Water Absorption %	0.73
4	Fineness Modulus	2.39

Weight of sample taken = 500 grams

Table No. 3.6 Sieve Analysis of Fine Aggregate

I.S.Sieve size in mm	Weight retained in gms	% Weight retained in gms	Cumulative % of weight retained	% Passing	Requirement for Zone-III as per IS:383-1970
10	0	0	0	100	100
4.75	8.8	1.77	1.8	98.23	90-100
2.36	44.7	8.93	10.7	89.3	85-100
1.18	38.5	7.7	18.4	81.6	75-100
0.6	76	15.2	33.6	66.4	60-79
0.3	189	37.8	71.4	28.6	12-40
0.15	112	22.4	93.8	6.2	0-10

The above Fine aggregate sample conforms to grading Zone-III of IS: 383-1970

3.4 Coarse Aggregate

Black hard coarse crusher broken granite natural stone aggregates with maximum 20mm size are used in this study. The aggregate are tested as per IS:383-1970. Different test results are mentioned in table no-3.7 and 3.8.

Table No. 3.7 Sieve Analysis of Coarse Aggregate

SL.NO.	PROPERTIES	OBSERVED VALUE
1	Bulk Density(Kg/m3)	1698
2	Specific Gravity	2.83
3	Water Absorption%	0.2
4	Fineness Modules	6.47
5	Abrasion Value%	18.6
6	Impact Value%	15.3

Weight of sample taken = 5000 grams

Table No. 3.8 Nominal size of Coarse Aggregates

I.S. Sieve size in mm	Weight retained in grams	%weight retained in grams	Cumulative% of weight retained	%Passing	Requirement as per IS: 383-1970
40	0	0	0	100	100
20	135	2.7	2.7	97.3	95-100
10	2440	48.8	51.5	48.5	25-55
4.75	2110	42.2	93.7	6.3	0-10

The coarse aggregate sample conforms to 20 mm graded aggregates of nominal size as per table 2 of IS: 383:1970.

3.5 Water

Normal portable drinking water from KIIT university was used for all the work in this paper. Water used was tested as per the requirements of IS:456-2000. The test results are presented in table no. 3.9

Table 3.9 Properties of Water

Sl No	Properties	Obseved Value
1	pH value	7.1
2	Dissolved Solid(mg/l)	290
3	Suspended Solids	Nil
4	Chlorides(mg/l)	20
5	Sulphates(mg/l)	74
6	MPN Value/100	Nil

CHAPTER 4

EXPERIMENTAL PROCEDURE

4.1 Mix Proportion

In order to prepare the specimen we have used grade-43 of Ramco Cement , Fly Ash , Sand , Coarse Aggregate and Water. As the specimen is of different proportions so, it was calculated according to the proportion. The portion was about the replacement of Fly Ash in a high volume in concrete. So, the proportion was replacing the cement with Fly Ash by 40% ,50% and 60%. Then for further high volume fly ash again the proportion was extended with the replacement of sand and cement both. The proportions are taken in order -

Name of proportion	Replacement of cement with Fly Ash and Sand	
	Fly Ash(%)	Sand(%)
CF 40	40	0
CF 50	50	0
CF 60	60	0
CF 40/50	40	50
CF 50/50	50	50
CF 60/50	60	50

Table 4.1- Name of Specimen according to the Proportion

4.2 Specimen Preparation

In order to make the mix uniform and to get the mix well mixed up we have followed the following procedure-

Sieve Analysis-

For Fly Ash we used 75μ of sieve and sieved the total amount of Fly Ash which is required in kg. Then, coarse aggregate is sieved. Coarse aggregate is taken in 2 different size by sieve analysis. Both are taken 50%. First one is taken with 20mm passed and 4.5 mm retain , then the second one is taken as 12mm pass and 4.5 mm retained.

Similarly,

According to the above table the materials are taken in kilogram/meter cube and then place in three different trays.

Figure-4.1- Dry mix specimens in different proportions

Preparation of Concrete:-

The above preparation are done in a series of 6 different days and in the above picture contains the three different trays which are taken to prepare the three different types of proportion and the dry concrete mixture are poured in the horizontal mixer machine.

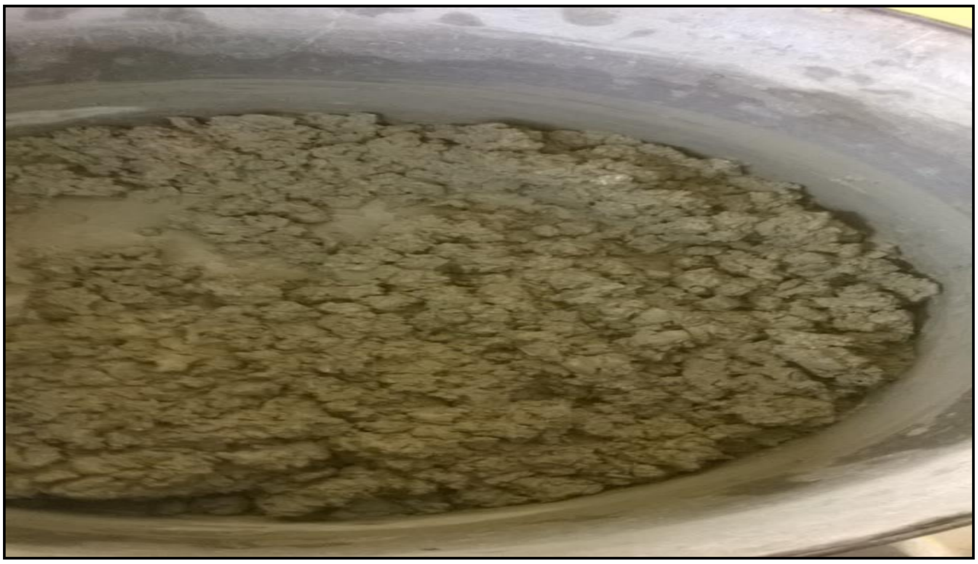


Figure- 4.2- Preparation of Concrete in Mixer Machine

Figure 4.3- Concrete cube

Figure 4.4- Mould for preparation of Cube

First the dry concrete mix is mixed for some time then according to the requirement of proportion water was added till the mix reaches the point of workability. Then it is thoroughly mixed and then the cube are casted. The size of cube taken is 150 X 150 X150 MM.

Figure 4.5- Preparation of cubes

Before filling the cube with concrete, the cubes are cleaned and oil is applied to reduce the sticking of concrete to surface of the cube mould. Then, the cubes are filled with concrete in three layers of 5 cm approx and each layers are tampered with the tampering rod for 25 times. Then the cubes are placed on table vibrator for further more compaction. After the vibration the surface of the cube is smoothened by using a trowel.

CURING-

After casting of cubes, the cubes are left for 24hrs for setting. Then, the cube mould were opened to take out the concrete cubes.

Figure 4.6 - Specimens

Then, the cubes are immersed the curing tank for 7 and 28 days.

QUANTITY OF MATERIALS USED FOR THE PREPARATION OF THE MIX.

Replacement(%)	Cement (Kg/m^3)	Flyash (Kg/m^3)	Sand(Kg/m^3)	Coarse aggregate (Kg/m^3)	Water %
40 cement	252.12	168.08	630.3	1260.6	0.45
50 cement	210.1	210.1	630.3	1260.6	0.45
60 cement	168.08	252.12	630.3	1260.6	0.45
40 cement - 50 sand	252.12	483.23	315.15	1260.6	0.45
50 cement - 50 sand	210.1	625.25	315.15	1260.6	0.45
60 cement - 50 sand	168.08	567.27	315.15	1260.6	0.45

Table 4.2- Materials Used in Kg/m^3

4.3 Compressive strength Testing

For the above studies we have decided to find the compressive strength of the hardened cubes. That's why to find the compressive strength of the cube we used the Compressive Test Machine which available in our laboratory.

Figure 4.8- Compressive Strength Test Of Cube in CTM

CHAPTER 5

RESULT AND DISSCUSION

5.1 Compressive Strength of Normal Concrete:

The compressive strength of the normal concrete cubes were mentioned in the table no. 5.1 for both 7day and 28 days.

The Compressive Strength of Normal Concrete without any replacement :

Table 5.1- Compressive Strength of Normal Concrete

Sl. No.	Sample Name	Days	Compressive Strength in MPa	Average Strength
1	C1	7	46.22	47.44
2	C2		47.76	
3	C3		47.35	
4	C4	28	63.44	63.8
5	C5		63.77	
6	C6		64.21	

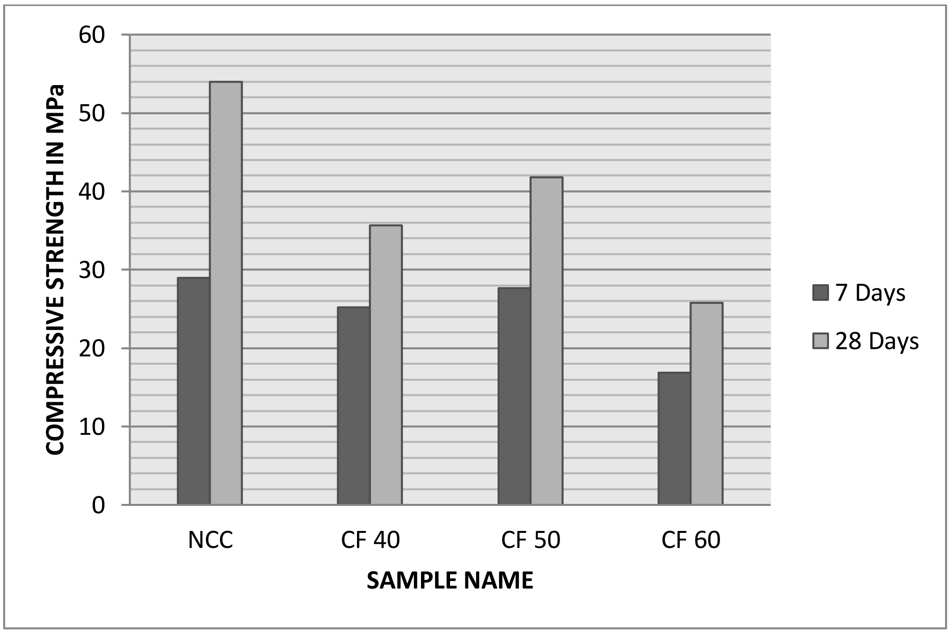
5.2 Compressive Strength of Concrete by weight replacement of Cement with Fly Ash:-

The compressive strength test results of concrete with 40, 50, and 60 % by weight of cement as partial replacement of fly ash were mentioned below in the Table 5.2.

Table 5.2 - Compressive strength of concrete with 40, 50, and 60 % replacement with Fly Ash

SL NO	SAMPLE NAME	DAYS OF TESTING	CEMENT REPLACED IN %	COMPRESSIVE STRENGTH IN MPa
1	CF 40	7	40	25.21
2	CF 50		50	27.64
3	CF 60		60	16.88
4	CF 40	28	40	35.69
5	CF 50		50	41.83
6	CF 60		60	25.8

From the below graph we came to conclude that the normal concrete has the highest compressive strength and in case of replacement of cement with fly ash, we got the 50% replaced concrete had the highest compressive strength.



Graph 5.1 - Compressive Strength of cement replaced concrete with Fly Ash

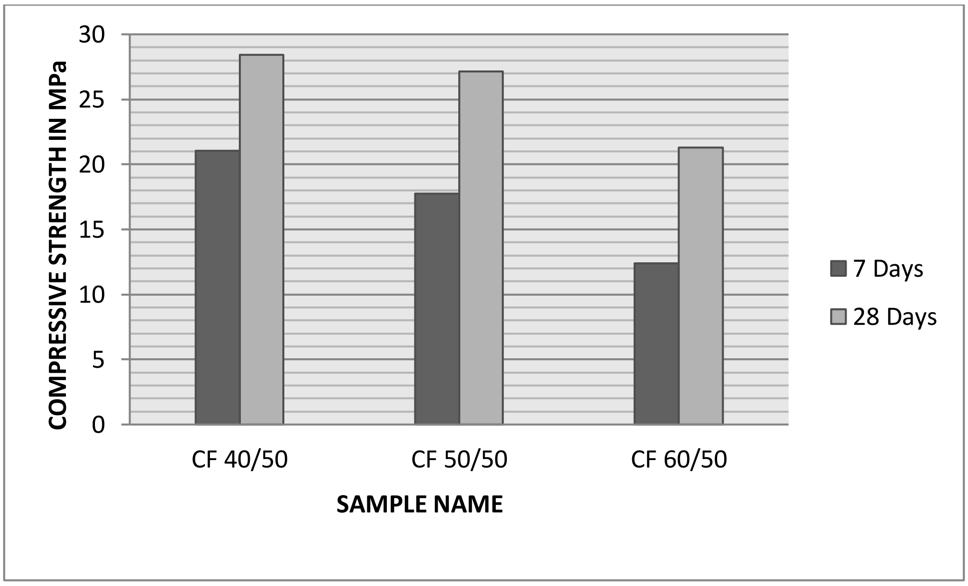
5.3 Compressive Strength of Concrete by weight replacement of Cement and 50 % sand with Fly Ash:-

The Compressive Test Result of Replacement of 40, 50, and 60 % of Cement with Fly Ash and 50 % replacement of Cement with Sand :-

Table 5.3 - Compressive Strength of Concrete by replacement of Cement and 50% sand with Fly Ash

SL no.	SAMPLE NAME	DAYS OF TESTING	CEMENT REPLACED IN%	SAND REPLACED IN%	COMPRESSIVE STRENGTH IN MPa
1	CF 40/50	7	40	50	21.06
2	CF 50/50		50	50	17.75
3	CF 60/50		60	50	12.4
4	CF 40/50	28	40	50	28.44
5	CF 50/50		50	50	27.14
6	CF 60/50		60	50	21.3

The below graph show the Compressive Strength result of 40, 50 and 60 % Cement and 50% sand replaced with Fly Ash in the concrete. The 40% cement and 50 % sand replacement with Fly Ash result has the highest Compressive strength.



Graph 5.2- Compressive Strength of Concrete by replacement of Cement and 50% sand with Fly Ash

5.11 Economic Analysis-

The main factor for the above study are Compressive Strength and Economic analysis. We get the compressive strength of all type of mix. Now, it's time to analyse the cost of the cubes which are prepared. If it is economical then it can be used in day to day life which is the main aim of all research. The economical analysis is given in the below table:-

Table 5.11 - Economic Study of the cube (150 mm)

Cube No	cube name	Materials Used	Quantity of materials per 1 cube in cum	Cost of materials in INR	Cube cost (15cm cube) in INR
1	Normal Concrete Cube	CEMENT(OPC)	1.55 kg	10.85	12.84
		SAND	0.001011	0.3033	
		COARSE. AGG.	0.002023	1.6858	
		FLY ASH	0	0	
2	CF 40	CEMENT(OPC)	0.93 KG	6.51	8.46
		SAND	0.001011	0.25	
		COARSE. AGG.	0.002023	1.68	
		FLY ASH	0.000269	0.02	
3	CF 50	CEMENT(OPC)	0.775KG	5.42	7.38
		SAND	0.001011	0.25	
		COARSE. AGG.	0.002023	1.68	
		FLY ASH	0.000337	0.03	
4	CF 60	CEMENT(OPC)	0.62 KG	4.34	6.31
		SAND	0.001011	0.25	
		COARSE. AGG.	0.002023	1.68	
		FLY ASH	0.000404	0.04	
5	CF 40/50	CEMENT(OPC)	0.93 KG	6.51	8.38
		SAND	0.000505	0.12	
		COARSE. AGG.	0.002023	1.68	
		FLY ASH	0.000775	0.07	
6	CF 50/50	CEMENT(OPC)	0.775 KG	5.42	7.30
		SAND	0.000505	0.12	
		COARSE. AGG.	0.002023	1.68	
		FLY ASH	0.000842	0.08	
7	CF 60/50	CEMENT(OPC)	0.62 KG	4.34	6.23
		SAND	0.000505	0.12	
		COARSE. AGG.	0.002023	1.68	
		FLY ASH	0.000909	0.09	

CHAPTER 6

CONCLUSION

6.0 CONCLUSION:-

- From the above experimental procedure we came to an conclusion that Fly Ash can be a better partially replacement of Cement and Sand. We found the compressive strength of different proportion along with the economical study of each specimen.
- By replacement of Cement with Fly Ash in percentage of 40, 50 and 60 cubes are casted and the compressive result are 35.69, 41.83 and 25.8 MPa respectively. Among these three results 50 % replacement has the highest value. But all the three results is above 20 MPa.
- Among the cement replacement the 50% replaced sample have the highest compressive strength of 41.83 and the cost for the preparation of 150mm cube is Rs. 7.38.
- Now by keeping the % of sand at 50, the % of cement is changed from 40 to 60, among these samples the proportion with 50 % sand replacement has the highest compressive strength of 28.44 and the cost for the preparation of 150 mm cube is Rs. 8.38.

CHAPTER 7

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