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Investigation of flexural strength of Fly Ash and Super Plasticizers Filled Binary Concrete Composites

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ABSTRACT

In the present research presents the performance of binary concrete when filled with fly ash and plasticizers were discussed based on the soaking water in predetermined no of days such as 3, 7 and 28 days respectively. Flexural strength was evaluated for both fly ash filled concrete and super plasticizers. Hand layup technique was used to prepare the composites. Fly ash filled binary concrete was optimized at 30wt. %. Super plasticizers were proved that when the concrete filled with them with less weight ratio 1.5wt.% itself they showed good results when compared with flay ash filled binary concrete.

Keywords: Concrete, Flay Ash, Super Plasticizers, Flexural Strength

I. INTRODUCTION

It has been above 70 years to research and use fly ash. With its application, the action mechanism of fly ash had been recognized. During the initial stage, only its pozzolanic activity is paid attention. Many researchers devoted themselves to the research of the potential activity of fly ash and the hydration process of fly ash cement. With the deepening of the cognition for fly ash properties, some people found that the particles of fly ash have the morphology that is different to other pozzolanic materials. It is the unique particle morphology to make it have the ability reducing water, which other pozzolanic materials do not have. It influences not only the rheological property of fresh mortar but also the initial structure of hardened cement stone.

Jan de Zeeuw and Abersch in the end of 1970s put forward that the role of fly ash, which its particle size is less than 30 , may be similar to that of the micro-particle of un hydrated cement in cement stone. Danshen et al., in 1981 summarized the previous research results and put forward the hypothesis of "fly ash effects." They considered that fly ash has three effects in concrete, i.e., morphological, activated and micro aggregate effects. The three effects are relative each other. This shows that the morphological effect is the important aspect of fly ash effects. The morphological effect means that in concrete, mineral-powdered materials produce the effect due to the morphology, structure and surface property of the particle and the particle size distribution. From the influence of fly ash on the properties of cement-based materials, the morphology effect includes three aspects: filling, lubricating and well distributing. These roles depend on the shape, size distribution, etc., of fly ash and influence many properties of concrete. Dayal and Sinha (1999) have reported the specific gravity of Indian coal ashes to range between 1.94 and 2.34 with a mean value of 2.16 and standard deviation of 0.21. The specific gravity of fly ash decreases as the particle size increases. The specific gravity increases when the fly ash particles were crushed. Typical values of the specific surface of Indian fly ashes (3267 to 6842 cm2/g) were comparable with that of the foreign ashes (2007 to 6073 cm2/g).Diamond 1986 studied the fly ash contained spherical particles of wide size range about 1m to more m with smooth surface. Some of the particles were covered with surface irregularities or deposits. The interior structure of a particle revealed the presence of iron rich magnetic grain on a sphere and in the adjacent sphere needle shaped particles of mullite crystals were present. Garg (1995) studied the morphology of Indian fly ashes. The fly ashes contained angular as well as rounded black particles, spheroid glass, and minute silica grains. Sharma (1993) has classified Indian fly ashes based on the shape of particles as one of the parameters. According to him group-fly ashes contained mainly spherical particles with the size range between 2-25m. The surfaces of glassy spheres in this group are predominantly smooth without any deposit, only some adherence was observed. Poon, C.S.,et al.(2002) Low calcium fly ash (ASTM Class F) has been widely used as a replacement of cement in normal and high strength concrete. In normal strength concrete, the replacement level can be more than 50%, while in high strength concrete; the replacement level is usually limited to 15± 25%. According to ASTM C 618-89, fly ash, or pulverized fuel ash (PFA) in the U. K., is a "finely divided residue that results from the combustion of ground or powdered coal." It is primarily the inorganic portion of the source coal in a particulate form. The amount of literature concerning fly ash is considerable, including an ASTM standard (C 311-89) for sampling and testing fly ash for use as an admixture in Portland cement concrete. A number of standards exist which specify the desired properties of the fly ash. In the United States, ASTM C-618 is the standard. The hydraulic behavior of a fly ash is influenced by (1) its carbon content, which should be as low as possible; (2) its silica content, which should be finely divided and as high as possible; and (3) its fineness, which should be as high as possible Orchard 1973b. Fly ash is normally produced by burning coals which have been crushed and ground to a fineness of 70 to 80% passing a 75μm sieve. Different types of coal produce different quantities of ash. Depending on the concentration of mineral matter in that type of coal the ash content of the coal used in the western countries is generally less than 20% as the coal is processed prior to delivery at the power point, while in India the ash content of coal used is as high as 50% as the coal contains a higher percentage of rock and soil. Two kinds of fly ash are produced from the combustion of coal are Class C - High, more than 10%, calcium content produced from sub-bituminous coal and Class F - Low, less than 10%, calcium content produced from bituminous coal. The addition of fly ash to concrete has a considerable effect on the properties of fresh concrete. There is agreement that low calcium ashes show some retarding influence on the mix. This may be due to the fact that the cement is becoming more "diluted." The effects of fly ash on fresh concrete are well known. Workability and pump ability of concrete is improved with the addition of ash because of the increase in paste content, increase in the amount of fines, and the spherical shape of the fly ash particles. Note that this improvement in workability may not be true for coarse, high carbon fly ashes. The use of fly ash may retard the time of setting of concrete. This is especially true of Class F ashes. C lass C ash may or may not extend setting time and there are results that show reduction of setting time. Fly ash, in contrast to other pozzolans, reduces the water requirement of a concrete mix. It has been suggested that the major influencing factor in the plasticizing effect of fly ash is the addition of very fine, spherical particles. In fact, it has been shown that as the particle size increases, the plasticizing effect decreases. This indicates that some fly ashes do not improve workability. The rheology of fly ash cement pastes has been shown to behave as a Bingham model. Finally, the inclusion of some fly ashes in a mix reduce bleeding and segregation while improving finishibility. This again can be attributed --to the increased amount of fines in the mix and lower water requirement. It is reported that the use of some fly ashes causes an increase in the amount of air entraining admixture required in concrete. It is proposed that carbon in the fly ash absorbs the AEA therefore requiring more to be used as an active role in the mix. In general class C fly ashes require less AEA than class F ashes. Also, there may be an increased rate of air content loss with manipulation if this ash is used. Plasticizers or water reducers, and super plasticizer or high range water reducers, are chemical admixtures that can be added to concrete mixtures to improve workability. In order to produce stronger concrete, less water is added (without "starving" the mix), which makes the concrete mixture less workable and difficult to mix, necessitating the use of plasticizers, water reducers, super plasticizers or dispersants. Plasticizers are also often used when pozzolanic ash is added to concrete to improve strength. This method of mix proportioning is especially popular when producing high-strength concrete and fiber-reinforced concrete. Adding 1-2% plasticizer per unit weight of cement is usually sufficient. Adding an excessive amount of plasticizer will result in excessive segregation of concrete and is not advisable. Depending on the particular chemical used, use of too much plasticizer may result in a retarding effect. Super plasticizers have generally been manufactured from sulfonated naphthalene condensate or sulfonatedmelamine formaldehyde, although newer products based on polycarboxylic others [1-14]. The main objectives of using fly ash in high strength concrete are to reduce heat generation and to obtain better durability properties. However, in concrete mixes prepared at a low water-to-binder (w/b) ratio, 20% fly ash content may not be sufficient to suppress the excessive heat of hydration. Manz and others (1982) have suggested that high-calcium fly ashes (Class C ashes) are best distinguished from the low-calcium (Class F) ashes by the incrementing properties. Thus, a general term 'mineral admixtures' has been suggested to describe all classes of slags, ashes, pozzolans and other cement supplements, with a further distinct on being drawn the basis of their self-cementing capabilities. The above form of classification has been proposed as being preferable to the current division of fly ashes. Ramezanianpour, (1994) Haw ever the terminology, 'high-calcium' and 'low calcium have been used in this study, in general, and Class C and Class F, while referring reporting the type of fly ashes actual used by various researchers, in their investigations. Tcnoutasse and Marion (1986) investigated the selective dissolution of different Began low-calcium fly ashes with water, hydrochloric acid solutions by chemical and microscopically techniques. 'The behavior of fly ashes was also studied in lime-saturated solution. The hydration mechanism was investigated as a function of time, for OPC and OPC' containing 10% to 80% of fly ashes. Cannon (1968) research carried out on the methods of proportioning fly ash concrete mixtures to obtain equal strength to those of conventional control mixtures. Cannon employed Abrams' law and a factor that accounted for the relative costs of fly ash and concrete. Rosen (1976), Gosh (1976) and Popovers (1982) extended the above concept to develop mixture proportions for fly ash concrete. Ghoul (1976) approach, are the standard guidelines available for proportioning pozzolana cements. U.K., Munday and others (1983) proposed a procedure for obtaining any desire strength at 28 days, which requires the collection of data, for a fly ash source. Brown (1982) found that both slump and vee-bee time improved increased substitutions and the changes were found to depend on the level of ash substitution on the water content. He also observed an increase in workability up to 8%replacement of sand or aggregate by ash. Further increase in the percentage replacement caused a rapid decrease in workability. The main objective of thesis is to investigate the strengthen characteristics of the concrete using different proportions of fly ash and super plasticizers. Here fly ash is a product of pulverized coal, considered as a waste by product finding difficulty to be disposed off. Using different proportions of fly ash the maximum strength can be reached in certain proportion of fly ash value. Similarly, super plasticizers are also using different proportions the maximum strength can be reached certain proportion of super plasticizers**.** The scope of the study is to know the properties of the fly ash and super plasticizers in different proportions. It can be used for find the strength values and find out the maximum strength of the concrete.

II. METHODS AND MATERIAL

Materials used in Binary Concrete concrete are Cement, Fine aggregate, coarse aggregate, water, fly ash, and super plasticizer were used in this project. Zuari 43 grade ordinary Portland cement is used for casting the elements. The following test are conducted such as Fineness test, Standard consistency test, Initial setting time test, Final setting time test, Specific gravity test, Compressive strength test were conducted. In this study we can find out the various tests like compressive strength, split tensile strength and flexural strength are done. The strength properties are done M40 grade concrete mix design. The advantage of binary concrete can be enhanced by substituting some of the cement with other materials, such as fly ash. Fly ash is one of the by-products coal combustion in power generation plants. Large amount of fly ash are discarded each year, increasing costs for disposal. On the other hand, fly ash has been shown to improve the overall performance of concrete, when substituted for a portion of the cement. In same manner super plasticizers is also added different proportions the maximum strength can be reached certain proportion of super plasticizers**.** Then the maximum strength can be given at a certain proportion of adding fly ash and super plasticizers at various tests. These tests based on we can identified strength of concrete in addition of fly ash and super plasticizers. Results of the cement are tabulated in the **Table 1** as mentioned below.

Table 1 : Test results on cement

S.NO	TEST NAME	RESULT		
1	sieve test	8 %		
2	standard consistency	29 %		
3	Initial setting time	52 min		
4	Final setting time	480 min		
5	Specific gravity test	3.15		
6	Compressive strength	3 days	7 days	28 days
		N/mm^2	N/mm^2	N/mm^2
		22.12	30.12	44.23

In this investigation fine aggregate is naturally available sand and it is free from dirt, dust and any organic matter. The fine aggregate used for the project was obtained from Penna river .The following tests were conducted on the sand such as Sieve analysis, Bulking of sand by volume method, Specific gravity test. **Table 2** indicates the results of the fine aggregates as mentioned below.

Table 2 Test result on fine aggregates**.**

S.NO	TEST NAME	RESULT
1	Sieve analysis	Zone lll
2	Bulking of sand by volume method	12.5%
3	Specific gravity test	2.51
4	Relative density	45% (medium dense)

In this investigation hard broken granite aggregate is used. The size course aggregate is various from12 mm to 20 mm. The source the aggregates is Srikalahasti. The following tests like sp. gravity test, fineness modulus test, water absorption test, aggregate impact test, and aggregate crushing strength tests were conducted. The final results thereof as mentioned below in the **Table 3.**

Table 3 Evaluation of course aggregates concrete composites.

S.NO	TEST NAME	RESULT
1	Fineness modulus	7.5
2	Specific gravity	2.33
3	Water absorption	2.1%
4	Crushing strength	22.43%
5	Impact test	28.12%

The following tests of fly ask such as Moisture content, Loss on ignition, Silicon oxide content, Alumina oxide content, Calcium oxide content, Chloride content, Free calcium oxide content, Total alkali oxides content, Particle density determination (by Pycnometer bottle and Le-Chatlier Flask methods), Fineness determination (by dry sieving, wet sieving, Blaine air permeability and laser methods) were conducted. The following tests for fly ash cement pastes, mortars, or concretes are outlined and they are namely Soundness (expansion test), water requirement (expressed as water content of test specimen divided by water content of control specimen to achieve equal specified consistencies), Preparation and curing of specimens, determination of compressive strength (28 days).

III. RESULT AND DISCUSSION

This test was developed by BRAZILAN at Japan in 1943, this is the simplest test and it has been referred in ASTM C78.

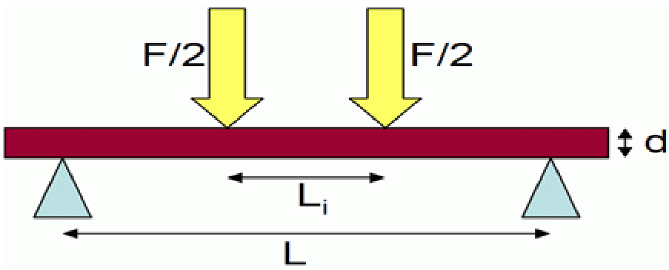

Figure1 Line diagram of flexural strength test using UTM.

This method is used to measure the tensile strength of concrete, and it is a laboratory test. The apparatus for conducting the flexure strength test essentially consists of 4000 kg U.T.M., weighing balance, scale, beam of size 10x10 cm, and length 50 cm, vibrator, measuring jar, pan for mixing cement & sand, trowel, and non porous plate. **Figure 1** shows the line diagram flexural strength testing by UTM. The test specimens are stored in water at a temperature of 24^0c to 30^0c for required curing period as per ASTM C 192. T hey tested immediately on removing from the water whist they are still in a wet condition. The dimension of each specimen should be note down before testing. The specimen is placed in the machine in such manner that the load is applied to the upper surface as in the casting mould. The axis of the specimen is carefully aligned with the axis of the loading device. **Figure 2** shows the photo picture of UTM.

Figure 2 Photo picture of Universal testing machine.

The load is applied without shock and increasing continuously at a rate such that the extreme fibers stress increased approximately 0.7 kg/cm^2 the load is increased until the specimen fails, and the maximum load is applied to the specimen during. The test recorded. The flexural strength is expressed as *modulus of rupture.* **Figure 3** shows the arrangement of loading below.

Figure 3 Arrangement of loading.

Flexural MR is about 10 to 20 percent of compressive strength depending n type. Size and volume of the coarse aggregate used. Figure 4 shows the Typical fracture failure of the specimen. **Figure 5** shows the variation of flexural strength as a function of fly ash after 3 days soaking in the water conforms that the flexural strength is gradually increases when the fly ash increases on other hand. It was also observed that the when the fly ash was 30wt.% maximum flexural strength was observed as 3.58N/mm^2 and after that strength was decreased.

Figure 4 Illustration of fracture of failure specimen.

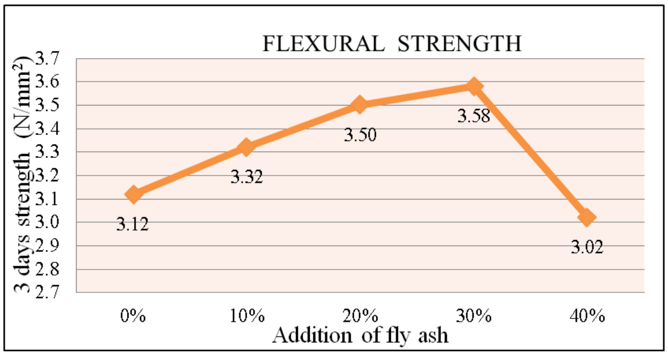

Figure 5 Variation of flexural strength as a function of fly ash after soaking 3 days in water.

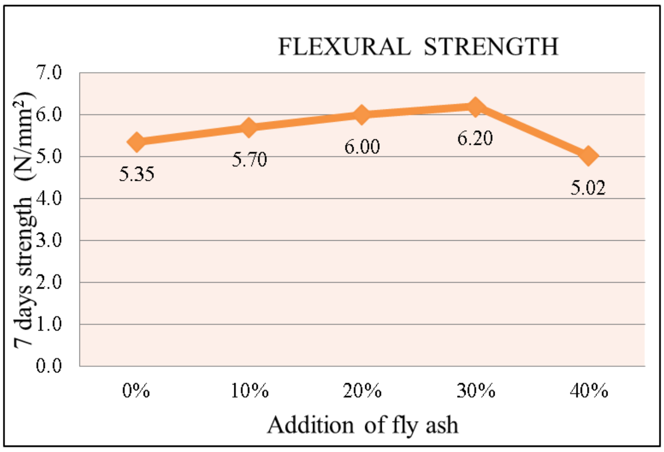

Figure 6 Variation of flexural strength as a function of fly ash after soaking 7 days in water.

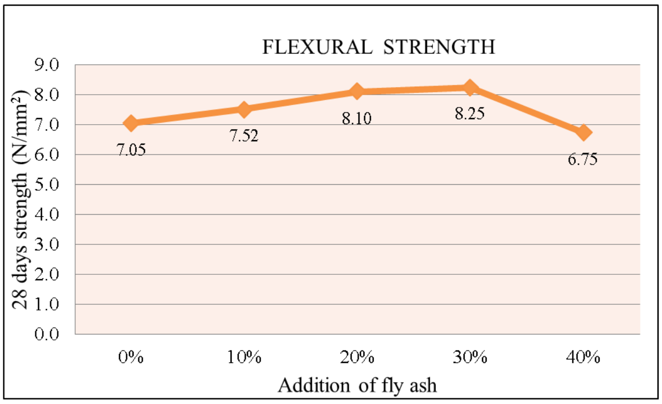

Figure 7 Variation of flexural strength as a function of fly ash after soaking 28 days in water.

Figure 6 shows the variation of flexural strength as a function of fly ash after 7days soaked in the water was indicates that the flexural strength is gradually increases when the fly ash increases on other hand. It was also observed that the when the fly ash was 30wt.% maximum flexural strength was observe as 6.20 N/mm^2 and after that flexural strength is decreased [2].

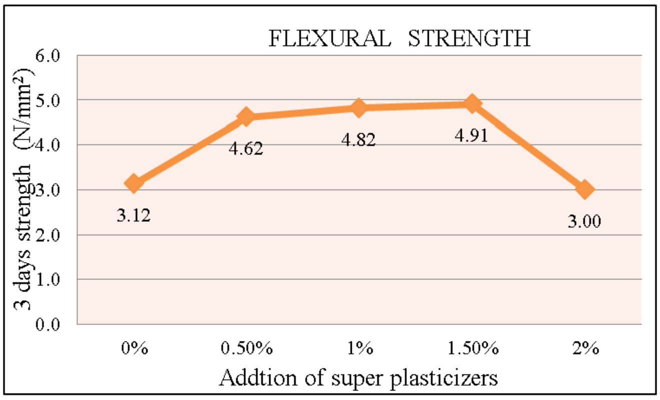

Figure 8 Variation of flexural strength as a function of super plasticizers after soaking 3days in water.

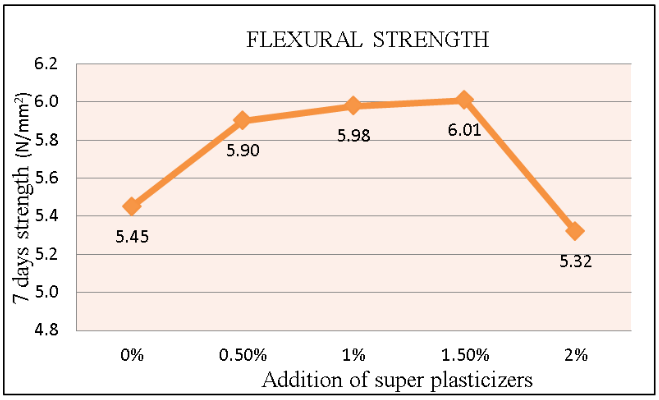

Figure 9 Variation of flexural strength as a function of super plasticizers after soaking 7days in water.

Figure 7 shows the variation of flexural strength as a function of fly ash after 28 days soaked in the water was indicates that the flexural strength is gradually increases when the fly ash increases on other hand. It was also observed that the when the fly ash was 30wt.% maximum flexural strength was observe as 8.25N/mm^2 and after that flexural strength is decreased [13]. **Figure 8** shows the variation of flexural strength as a function of super plasticizers after 3days indicates that the flexural strength is gradually increases when the plasticizers increase on other hand. It was also observed that the when the fly ash was 1.5wt.% maximum flexural strength was observe as 4.91/mm^2 and after that flexural strength is decreased. When soaking days are increased as a result of that strength is gradually increases.

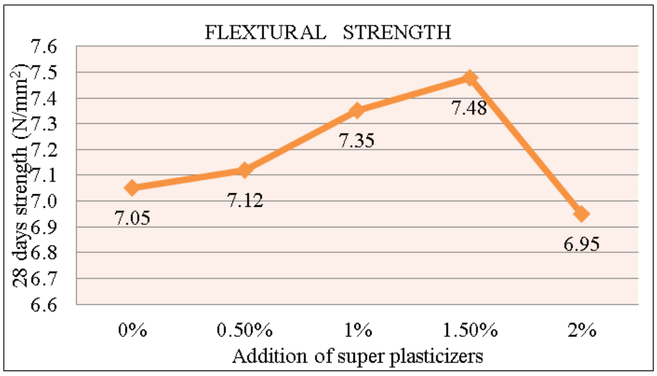

Figure 10 Variation of flexural strength as a function of super plasticizers after soaking 28 days in water.

Figure 9 shows the variation of flexural strength as a function of fly ash after 7days indicates that the flexural strength is gradually increases when the plasticizers increase on other hand. It was also observed that the when the fly ash was 1.5wt.% maximum flexural strength was observe as 6.01N/mm^2 and after that flexural strength is decreased. When soaking days are increased as a result of that strength is gradually increases. **Figure 10** shows the variation of flexural strength as a function of fly ash after 28days indicates that the flexural strength is gradually increases when the plasticizers increase on other hand. It was also observed that the when the fly ash was 1.5wt.% maximum flexural strength was observe as 7.48N/mm^2 and after that flexural strength is decreased. When soaking days are increased as a result of that strength is gradually increases.

IV. CONCLUSION

- Fly ash is added at different proportions namely 0%, 10%, 20%, 30% and 40%.
- For 43 grade cement with M40 mix, by adding up to 30% of fly ash to the cement, the strength is increased and by adding 40% of fly ash the strength is decreasing.
- The test results show that on addition of 30% of fly ash to cement it has gained maximum strength at 28 days period but the rate of strength gain compared to ordinary Portland cement concrete OPCC is at slower rate at initial days.
- The flexural strength increased by 16.18% when compare to normal concrete.

- By use of fly ash as admixture, the cost of construction is also considerably reduced.
- Non-biodegradable fly ash is effectively utilized in Binary concret, so it reduces the disposal problem of fly ash.
- For 43 grade cement with M40 mix, by adding 0%, 0.5%, 1.0%, 1.5% of super plasticizer to the mix prepared the strength is slightly increased and at adding 2.0% of plasticizer to the mix prepared the strength will slightly decreased.
- The test results show that on addition of 1.5% of super plasticizers to concrete it has gained maximum strength at 28 days period.
- The flexural strength increased by 13.46% when compare to normal concrete.
- Super plasticizer may not increase the strength of concrete directly. But it helps in reducing the w/c ratio. Which in turn result in the increase of strength of concrete due to reduction of w/c ratio.
- It is concluded that when compare to super plasticizer, fly ash gives more desirable properties to concrete and ecofriendly.

V. ACKNOWLEDGEMENTS

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