Design of Rigid Pavement by using Fly Ash as a Stabilizing Material

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***Abstract*- This paper is attempting to investigate the use of fly ash in the cement concrete industry. In developed countries, the use of mineral mixtures such as fly ash and silica fume and asphalt ash has already been adopted to make concrete. This includes large-scale commercial applications for addition or replacement of cement. In India, too many replacements have already been prepared and adopted with the introduction of mixed concrete, and the process has been accelerated in recent years to affect construction economics. A study was conducted to investigate the effect of fly ash on concrete. In this paper, mechanical properties with different levels were found. The level of cement replenishment by fly ash was suggested to be 0, 20, 30, 40, 50 and 60 percent for analysis in this project work. The compression strength of cubes of 3, 7, and 28 days as a quality criterion was determined according to general code practice. Results are displayed in related tables and graphs. The performance of the mixture designed using fly ash content is sufficient and the results are recommended as recommendations for various cement concrete industries.**

***Index Terms*- Ordinary Portland Cement, Fly Ash, Concrete.**

I.INTRODUCTION

Concrete is a composite building material mainly composed of aggregate, cement and water. There are many formulas with various properties. Aggregates are rough rocks, or rocks that are made of limestone or granite, with fine aggregates like sand in general. Other materials such as cement general Portland cement and fly ash cement, and as a binder for aggregate. Various properties are exhibited by adding various chemical mixtures. Water mixes with this dry complex and is hardened, hardened and hardened through a chemical process known as moisture. Water reacts with the cement that binds other components and eventually creates a solid stone-like material. Concrete has relatively high compressive strength but much lower tensile strength. For this reason, it is usually reinforced with strong materials in steel (often steel). Concrete can be molded by many processes, such as trap freezing. Concrete includes scaffolding for architectural structures, foundations, brick / block walls, paved roads, highways / runways, runways, parking structures, dams, pools / reservoirs, pipes, doors, fences and pillars and even boats. Famous concrete structures include BurjKhalifa (the tallest building in the world), Hoover Dam, Panama Canal and Roman Pantheon pedwater. Fly ash is powder produced from small dark spots that burn coal or other materials.

II. LITERATURE REVIEW ON FLY ASH

S.K. Kaushik discussed the parameters commonly associated with the production of three component concrete with high quality fly ash and high fly ash content. Experimental results on high slump concrete with 80-90 MPa strength with low calcium fly ash content nearly equal to that of cement were discussed. Addition of fluidity due to fly ash, refinement of porosity and strengthening effect. The development of polycarboxylic acid super hard plasticizers has helped to achieve fluidity using a low moisture-binder ratio of concrete containing a large amount of fly ash.

N.P. Rajamane, J. Annie Peter and S. Gopala Krishna (2) investigated the concrete at a compressive strength of about 85 MPa and 105 MPa for 28 days and considered a cement replenishment level (CRL) of about 25%. These concrete were mixed with GGBS and silica fume while maintaining a total CRL of 25%. A 90 day compressive strength of 94 to 116 Mpa was achieved. Pozzolanas such as grinding blast furnace slag (GGBS) and silica fume (SF) are separately used as mineral admixtures (MA) in cement concrete.

M.M. Prasad (3) investigated the effects of 17%, 22%, 27% and 32% cement replenishment by fly ash and silica fume on conventional M20 grade concrete. The M20 grade of concrete is considered a reference mix. The specimens were cast and hardened for 28 days, then flexural strength and tensile strength were tested according to IS standard and the results were compared. The test results show that the flexural and tensile strength of fly ash-silica fume concrete containing fly ash and silica fume up to 27% is comparable to conventional concrete.

In this report, the ACI committee reportedly outlines the physical, chemical and pozzolanic properties of silica fume. It discusses the use of silica fume in concrete and describes the characteristics of fresh and hardened concrete containing it. We discuss the durability of silica fume concrete and briefly explain the limitations of its use in concrete. The report concluded by testing the need for research.

Materials of Concrete Mixtures (SCMs). Typical concrete details, strength and durability characteristics of M40 grade mixtures studied by incorporating SCM at various cementation levels are presented in this white paper. Based on the results of the study, it has been demonstrated that SCM available in India can be used to produce concrete mixtures with desired strength development and durability characteristics.

Swamy et al. (1983) reported that a concrete mixture containing 30 wt.% Of fly ash (ASTM Class F) can be proportioned to have an initial day strength and modulus of elasticity for proper workability and structural applications. Dosages of admixtures or hot plasticizers can be adjusted to achieve cohesion and workability with slumps greater than 4 inches (100 mm) and can be easily placed into structural members with reinforcing steel reinforcements.

Tarun Naik et al. (1991) conducted a study to investigate the performance of structural concrete mixed with a large amount of low calcium fly ash. Two different ASTM Class F fly ash were used. In this experiment, Portland cement concrete with a compressive strength of 6000 psi (41 MPa) for 28 days was used as the reference concrete. The concrete mixture is also designed to perform fly ash substitution based on the total cement weight in the range 0 to 60% by weight. The ratio of water to cement was kept almost constant, and the desired workability was achieved by using a topping agent. Concrete was tested for compressive strength, tensile strength and elastic modulus according to ASTM test method. The compressive strength and split tensile strength of concrete were measured at 1, 7, and 28 days, and the elastic modulus was measured at 7 and 28 days. High replacement of cement by fly ash in concrete has been shown to reduce compressive strength, split tensile strength and elastic modulus within experimental range. The compressive strength of fly ash concrete was slightly lower than that of concrete with 60% addition of fly ash. However, fly ash concrete was able to achieve adequate strength for structural use even when replacing 60% of cement.

Kumar Mehta (2002) briefly describes the theory and construction examples of a concrete mixture containing more than 50% fly ash as mass of cementitious material. The addition of large amounts of fly ash to concrete will discuss mechanisms to reduce water demand, improve workability, minimize cracking due to heat shrinkage and shrinkage, and improve durability against reinforcement corrosion, sulfate attack and alkali-silica expansion. For countries like China and India, this technology can play an important role in meeting the huge demand for infrastructure in a sustainable way.

In modern construction practices, 15% -20% of the fly ash due to the mass of cementitious material is currently commonly used in North America. When there is concern about pyrolysis, alkali-silica swelling or sulphate attack, more than 25% -30% fly ash ratio is recommended. This high proportion of fly ash is not readily accepted by the construction industry because of the early development of strength. He concluded that a large amount of fly ash concrete technology is particularly important in countries such as China and India. Given the limited amount of financial resources and natural resources, the enormous demand for infrastructure and housing concrete is cost-effective and ecological.

Mathur et al (2005) conducted a survey using a large amount of fly ash (30-50%) for various grades of concrete (M-20, M-30 and M-40) in the construction sector. The main purpose of this survey is to develop confidence among Indian user agencies that use larger amounts of fly ash concrete for building construction. They performed tests to find compressive strength, fast chloride permeability testing and permeability measurements. Replacing

the appropriate proportion of cement with fly ash can meet the minimum cement content requirements. It can be seen that replacing cement with fly ash in all three grades of concrete can achieve a strength of 28 days compared to the control concrete. All grades of fly ash concrete showed improved resistance to chloride ion penetration and reduced permeability. They report that the use of fly ash affects the physico-chemical effects associated with pozzolanic and cementitious reactions, which result in pore size reduction and particle size reduction. This affects the rheological behavior of fresh concrete and the strength and durability of the cured concrete. Therefore, resistance to chloride ion penetration and reduced permeability can be derived from the use of fly ash as a supplemental bonding material. The cost of fly ash concrete is lower than the cost of each regular concrete. Therefore, adding fly ash to concrete helps to achieve cadal requirements, which improves durability and reduces product costs.

III. EXPERIMENTAL PROCEDURE

A. Materials Used:

Cement: Ordinary Portland cement of confirming to ISI standards IS:8112-1989 has been used. In order to avoid the possible variation in the properties of cement from various batches all the specimens are prepared from the same batch of cement.

Fly ash: Fly Ash used in the present experimental study was obtained from gandhinagar thermal power station, Gujarat..

Fine Aggregate: Locally available sand has been used as fine aggregate. The sand is free from clayey matter, silt and organic impurities and that sand confirms to zone-I. (or The fine aggregate was standard river sand procured locally and was conforming to zone Il .The fine Aggregate was selected as per code IS 2386 part Il .100% of particles taken has passed from 4.75 mm and retained on 100 microns is used.

Coarse Aggregate: Coarse aggregate of 20 mm nominal size machine crushed angular granite metal from local source has been used in the experimental work.

B. Mix proportion For M40 Grade Concrete (as per ISI 10262-2009):

The mix proportion considered as follows Water content = 0.4, Sand = 1.53 kg, Cement = 1 kg, Coarse aggregate (10 mm) = 2 kgs, Coarse aggregate (20 mm) = 1.33 kgs

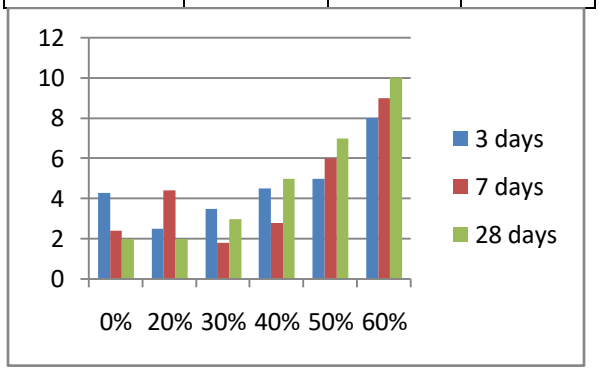
IV. TESTS CONDUCTED

Compressive strength: Compressive strength of concrete is the most important parameter and representative of overall quality of concrete. It mainly depends upon the water/cement ratio of the mix and curing and age after it is cast. Compressive strength of concrete is determined by testing the cylindrical or cubical specimens of concrete using a compression testing machine, at various age such as: 3,7 and 28 days

V. RESULTS AND DISCUSSIONS

Table 1 represents the variation of compressive strength with age for M40 grade Fly Ash concrete, in this table, variation of compressive strength with age is depicted for each replacement level of Fly Ash considered namely 20%, 30%, 40%, 50% and 60%. Along with the variations shown for each replacement, variations is also shown for control concrete i.e., for 0% replacement. In each of these variations, it can be clearly seen that, as the age advances, the compressive strength also increases. Graphical representation is also shown below graph 1.

Age in Days	30% F.A	40% F.A	50% F.A
3			
7			
28			



Graph 1: Compressive strength of M40 grade concrete with different % replacement at different ages

VI. CONCLUSIONS

- The Fly Ash can be suitable substituent's for cement.
- The required compressive strength of any mix can be obtained with Fly Ash resolving the conventional cement to that extent
- Very high strength above the normal required strength of concrete with Fly Ash replacement is noticed
- The strengths of the concrete mix cubes are increasing up to 30% fly Ash and then the strengths are decreasing when compared with normal concrete.By this studies/ analysis, M40 grade concrete with the maximum replacement of 30% Fly Ash may be recommended.

REFERENCES

[1] ACI Committee 226 (1988) Use of Fly Ash in Concrete
[2] S.K. Kaushik " Quality of Concrete using Fly ash contents " International Conference on Engineering Materials, 1998
[3] N.P. Rajamane, J. Annie Peter and S. Gopala Krishna " Performance of admixtures produced using a new technology as a Mineral Admixture in Concrete," Cement and Concrete Research (2000).
[4] M.M. Prasad "Strength Development of Concrete with Fly ash and silica fumes ," Cement & Concrete Composites (2002)
[5] S. Gopala Krishna "The role of Supplementary Cementitious Materials (SCMs) in concrete mixtures" Cement and Concrete Research 2004.
[6] Concrete Technology by M.S.SETTI
[7] Concrete Technology by A.R SANTHA KUMAR
[8] Mix design by N. KRISHNA RAJU. CODE BOOKS
[9] IS 456-2000
[10] IS 10262 - 200