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THE POSSIBILITY OF REPLACEMENT OF CEMENT BY FLY ASH AND GLASS POWDER

VijetaVerma[1],Harshit Varshney[2]

[1]*Department of Civil Engineering*

IFTM University, Moradabad

[2]*Department of Civil Engineering*

RajshreeInstitute of Management &Technology, Bareilly(India)

ABSTRACT

The most common material for construction is concrete in India and its production causes some environmental effects during the production. Most of developing country facing shortage of post consumers disposal waste site and it's become very serious problems to every country. In order to address environmental effects associated with cement manufacturing, there is a need to develop alternative binders to make concrete. The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. In recent years, many researchers have established that the use of supplementary cementitious materials (SCMs) like glass powder, fly ash (FA), blast furnace slag, silica fume, and rice husk ash (RHA), etc. can, not only improve the various properties of concrete - both in its fresh and hardened state, but also can contribute to economy in construction costs. Efforts have been made in the concrete industry to use mixture of fly ash and waste glass as partial replacement of coarse or fine aggregates and cement.Glass is used in many forms in day-to-day life. As glass is non-biodegradable, landfills do not provide an environment friendly solution for disposal. The fly ash contains more silica compared to cement. Now adays many industries produce large amount of fly ash and it is sold at a cheaper rate in the market. The cement has been replaced with Class F fly ash(upto 40%) and glass powder(upto 40%)together in the range of 0%(0%FA+0%GP), 10% (5%FA+5%GP), 20% (10%FA+10%GP), 30%(15%FA+15%GP)& 40%/(20%FA+20%GP) by weight of cement for M20 grade of concrete. Glass powder finer than 600 µ is reported to have pozzolanic behavior. Concrete mixtures were produced, tested and compared in terms of compressive and flexural strength with the conventional concrete. These tests were acquitted out to evaluate the mechanical properties for the test results for compressive strength and flexural strength up to 7 days and 28 days. The objective of the present work was to replace cement by glass powder and fly ash as admixture to evaluate the pozzolanic activity in concrete and compare its performance with plain concrete.The workability of concrete is determined by using slump test and compaction factor test. This research work describes the feasibility of using such industrial waste in concrete production as partial replacement of cement.

Keywords:fly ash;glass powder;strength of concrete.

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I.INTRODUCTION

Concrete is a versatile construction material that is widely used in virtually all structural works. It is a composite material comprising cement, aggregates, water and admixtures. Concrete is a blend of cement, sand, coarse aggregate and water[1]. Due to global warming the need to cut down energy consumption has increased. The effect of global warming has impacted everyone on the planet and is a well-recognized concept. High levels of energy are needed to produce cement, which releases large amounts of carbon dioxide (CO2) and also contributes to the green-house gases. Atmospheric levels of carbon dioxide have risen by about 30 percent over the past 200 years[8]. Cement industry emits 7% of green-house gases to the atmosphere.One ton of Carbon-di-oxide (CO2) is released to the atmosphere for the production of one ton cement in industry. To reduce the emission the alternative materials to be used in concrete. There are many alternatives like rice husk ash, fly ash, egg shell, glass powder. When we are going for an alternative in construction it should be economical and easily available. The construction companies are interested in using recycled materials to give sustainable construction. In recent years there has been an increasing incentive to minimize the environmental effect of construction[7].

Fly ash is an industrial waste and a material of pozzolanic characteristic occurring due to burning the pulverized coal in the thermal power plants. In the construction sector, the fly ash is used in the production of cement as an additive-material, in production of concrete instead of some of the cement or instead of some of the fine aggregate, as a base and sub-base material in highway construction, as a filling material in dams, in retaining walls, and for production of light construction material[1]. The properties of fly ash contribute to strength gain and improved durability when used with Portland cement. India has vast resource of fly ash generation all across the country. This material if segregated, collected and used properly can resolved the major problems of fly ash disposal and reducing the use of cement, which consumes lot of energy and natural resources [3]. The interest of the construction community in using waste or recycled materials in concrete is increasing because of the emphasis placed on sustainable construction, the waste glass from in and around the small shops is packed as a waste and disposed as landfill[5]. Normally glass does not harm the environment in any way because it does not give off pollutants, but it can harm humans as well as animals, if not dealt carefully and it is less friendly to environment because it is non-biodegradable. Thus, the development of new technologies has been required. The term glass contains several chemical diversities including soda-lime silicate glass, alkali-silicate glass and boro-silicate glass. To date, these types of glasses glass powder have been widely used in cement and aggregate mixture as pozzolana for civil works by passing from 90micron sieve. The introduction of waste glass in cement will increase the alkali content in the cement [1]. Waste glass contain high silica (SiO2) i.e. 72%. Waste glass when ground to very fine powder reacts with alkalis in cement (pozzolanic reaction) and cementitious product that help contribute to the strength development [6].

II.LITERATURE REVIEW

R. D. Padhye et al (2016) their result shown that the fly ash can be replaced up to maximum of 40% and replacements above 40% may not be safe for different concrete mixes. The compressive strength of concrete mixesdecreases with increase in fly ash.

Rekha Shinde (2014) in her research work, cement has been replaced by glass powder and fly ash accordingly in the range of 0% (without fly ash), 10%, 20%, 30% & 40% by weight of cement for M-25 mix. Concrete mixtures were produced, tested and compared in terms of compressive and split strength with the conventional concrete. These tests were carried out to evaluate the mechanical properties for the test results for compressive strength up to 21 and 28 days. Compressive strength of concrete increases with increase in glass powder dosage up to 20% replacement to cement, then it starts decreasing. Compressive strength reduces when cement replaced fly ash. As fly ash percentage increases compressive strength and split strength decreases.

Veena V. Bhat et al (2014) in their research work they made concrete with replacement of cement by waste glass powder such as 5%, 10%, 15% and 20% and fresh and hardened properties of this concrete has been compared with conventional concrete. Increase of 27% strength can be achieved when 20% cement was replaced by glass powder in concrete when water/ cement ratio was maintained constant. Slump was found to be 70 to 72mm even with 20% replacement. Considering the strength criteria, the replacement of cement by glass powder is feasible upto 20%.

Dr. G.Vijayakumar et al (2013) in their research work experiments were conducted on concrete prepared by partial replacement of cement by waste glass powder by 10%, 20%, 30% and 40% of the binder. Replacement of glass powder in cement by 20%, 30% and 40% increases the compressive strength by 19.6%, 25.3% and 33.7% respectively. Replacement of glass powder in cement by 40% increases the split tensile strength by 4.4% respectively. Replacement of glass powder in cement by 20%, 30% and 40% increases the flexural strength by 83.07%, 99.07% and 100% respectively.

J.M. Khatib et al (2012) their research investigated the performance of concrete containing glass powder as partial substitution of cement. Portland cement (PC) was partially replaced with 0-40% glass powder. The slump of concrete seemed to increase with the increase in glass powder in the concrete mix.At 10% glass powder content the compressive strength of concrete is higher than that of the control. Above 20% glass powder the strength substantially decreases.

III.EXPERIMENTAL INVESTIGATION

Experiment are conducted on concrete prepared by partial replacement of cement by waste glass powder and fly ash of particle size 75µm.The waste glass powder and fly ash together is replaced by 10%, 20%, 30% and 40% by weight of the binder for M20 grade of concrete and the mix design is prepared. Concrete mixtures are produced,tested and compared in terms of compressive and flexural strength with conventional concrete for 7 & 28 days curing period.

IV.MATERIAL USED

1. Cement

Ordinary Portland cement of 43 grade is used to prepare the mix design.Cement is the most important ingredient in concrete. One of the important criteria for the selection of cement is its ability to produce improved microstructure inconcrete.

2. Fine and coarse aggregate

Clean river sand of maximum size 4.75 mm are used as a fine aggregate and angular aggregate of size between 4.75mm to 20 mm are used as a coarse aggregate.

3. Waste Glass Powder

Locally available glass is collected and converted into powder form. This material replace the cement in mix proportion. Before adding glass powder in the concrete, it has to be powdered to required size. In this experiment glass powder having particle size less than 90 µ is used.

4. Fly ash

Fly ash is finely divided residue resulting from the combustion of pulverized coal and transported by the flue gases of boilers by pulverized coal. It was obtained from thermal power station, dried and used. In this experiment fly ash having particle size less than 90 µ is used.

5. Water

Drinking water is used for the preparation of concrete. The water samples are potable and of uniform quality. Water – cement ratio is 0.40 for this mix design.

V.RESULTS AND DISCUSSION

Several tests, such as Slump Test and Compaction Factor Test were carried out to determine the properties of fresh concrete, while Compressive and Flexural Strength Tests were carried out to determine mechanical properties of hardened concrete.

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1. Tests on Fresh concrete

Some experiments such as SlumpTestand Compaction Factor Test were conducted for determining the workability of Concrete. The Table 1 displays the results of different tests of workability of the Concrete.

	Mix	Slump Test (mm)	Compaction Factor Test
	Limiting Value	0 - 150	0.78 – 1.0
M-a	Cement	123	0.89
M-b	Cement+5% flyash+5%glasspowder	115	0.89
M-c	Cement + 10% flyash+10%glass powder	127	0.86
M-d	Cement+15% fly ash+15%glass powder	135	0.87
M-e	Cement+20% fly ash+20%glass powder	140	0.89

Table 1: Fresh concrete properties of different mix

2. Tests on hardened concrete

2.1 Compressive strength test

Fig 1 & Fig 2 highlights the compressive strength of concrete after 7 days and 28 days of curing. These results revealed that initially with the addition of fly ash & glass powder in cement, the increase in the strength of concrete is observed as compared to ordinary concrete. There is an increase in the compressive strength by increasing the mixture of FA & GP. The values are presented in graph and it can be seen that the higher value is found at 10%. Upto30% addition of FA & GP in cement, it gives suitable results in comparision to ordinary concrete for both 7 days and 28 days curing period.

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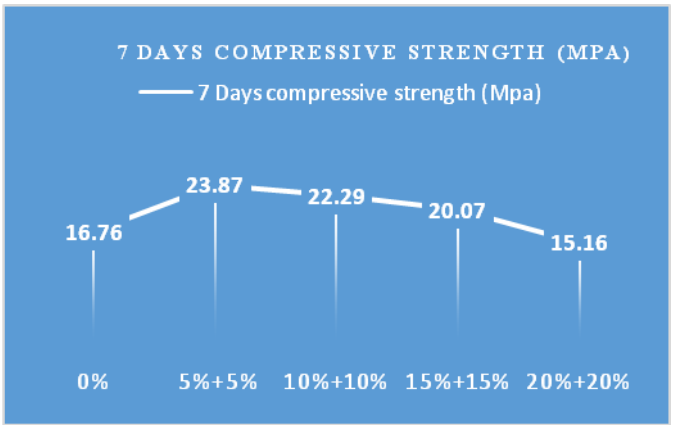

Fig 1: Results for 7 days compressive strength

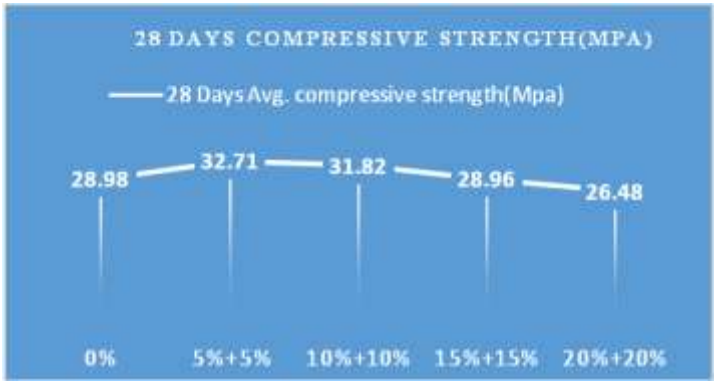

Fig 2: Results for 28 days compressive strength

2.2 Flexural strength test

Fig 3 & Fig 4 highlights the flexural strength of concrete after 7 days and 28 days of curing. These results revealed that initially with the addition of fly ash & glass powder in cement, the decrease in the strength at 7 days of concrete is observed as compared to ordinary concrete. There is an initial increase in the flexural strength by addition of FA & GP after 28 days of curing after that strength decrease with increment of FA & GP. The values are presented in graph and it can be seen that the higher value is found at 10%replacement (5% FA + 5% GP) after 28 days of curing but upto 30% replacement (15% FA + 15% GP) of cement gives the reasonable flexural strength as compared to ordinary concrete.

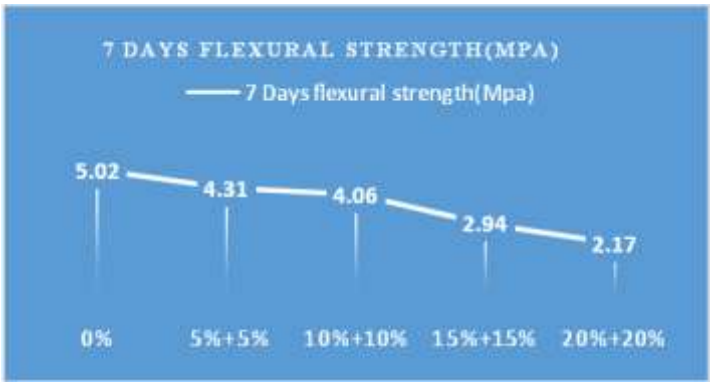

Fig 3: Results for 7 days flexural strength

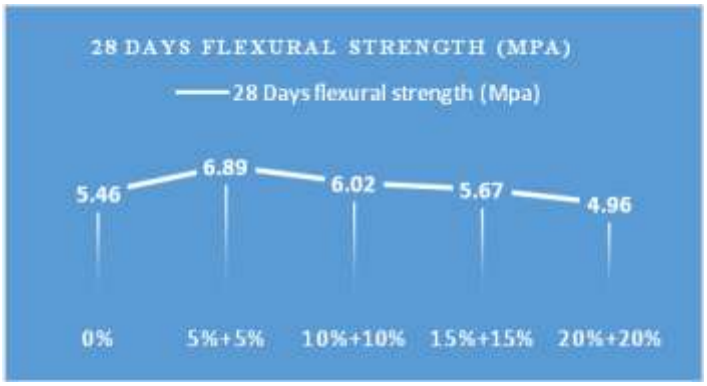

Fig 4: Results for 28 days flexural strength

VI.CONCLUSIONS

The following conclusions are drawn based on the results obtained -

1. Concrete prepared by replacing 10, 20,30 and 40% of cement by Glass Powder and Fly Ash(GP+FA) gave satisfied results and resulted in desired grade of concrete.
2. Concrete becomes more workable as the fly ash and glass powder content increases.
3. Optimum value of Compressive Strength and Flexural Strength is obtained at 10% replacement of cement by Glass Powder and Fly Ash(5%GP+ 5%FA) .
4. Utilization of Glass Powder and Fly Ash which are waste materials, is also economic and environmental friendly.
5. The fly ash with waste glass powder reduces the carbon monoxide gas emissions from increasing cement production. The fine particles in the fly ash helps to reduce the segregation and bleeding of cement mortars.
6. Mixture of fly ash and glass powder has been used for different activities in the construction industry such as for road construction and manufacture of building materials such as light weight aggregates, bricks, tiles and auto clave blocks. However its use as rigid payment is very much limited

REFERENCES

[1.] Rekha Shinde, "Utilization of Glass Powder and Fly Ash in Concrete Production", IJSRD - International Journal for Scientific Research & Development| Vol. 2, Issue 03, 2014 | ISSN (online): 2321-0613

[2.] J.Kanagamalai , V.Venugopal, V.Sathiyapriya, "Performance analysis on waste glass powder and fly ash as partial replacement for cement in Concrete", International Research Journal of Engineering and Technology (IRJET), Volume: 04 Issue: 09 | Sep -2017, p-ISSN: 2395-0072

[3.] AmarjeetRathi, Naveen Hooda, "A Study on Effect of Fly Ash and Glass Powder on the Compressive Strength and Permeability of Concrete", International Journal of All Research Education and Scientific Methods (IJARESM) ,ISSN: 2455-6211, Volume 4, Issue 7, July- 2016, Impact Factor: 2.287

[4.] Veena V. Bhat , N. Bhavanishankar Rao, "Influence of Glass Powder on the Properties Of Concrete" International Journal of Engineering Trends and Technology (IJETT) – Volume 16 Number 5 – Oct 2014

[5.] Dr. G.Vijayakumar, Ms H. Vishaliny, Dr. D. Govindarajulu, "Studies on Glass Powder as Partial Replacement of Cement in Concrete Production" International Journal of Emerging Technology and Advanced Engineering ,ISSN 2250-2459, ISO 9001:2008 ,Volume 3, Issue 2, February 2013

[6.] M.N. Bajad, C.D. Modhera and A.K. Desai, "Higher Strength Concrete using Glass Powder," Journal of Structural Engineering, Vol. 39, No. 3, August-September 2012, pp. 380-383.

[7.] Shanmuguanathan.N, Gokila., Parameshwari., HemathNaveen.K.S, " Study and experimental investigation of partial replacement of waste glass powder as cement in concrete" , International Journal of Engineering Trends and Technology (IJETT) – Volume-45 Number4 -March 2017 ,ISSN: 2231-5381

[8.] J.M. Khatib, E.M. Negim, H.S. Sohl and N. Chileshe, "Glass Powder Utilization in Concrete Production", European Journal of Applied Sciences 4 (4): 173-176, 2012, ISSN 2079-2077

[9.] R. D. Padhye, N. S. Deo, "Cement Replacement by Fly Ash in Concrete", International Journal of Engineering Research, Volume No.5, Issue Special 1 pp : 60-62, ISSN:2319-6890(online),2347-5013,8 & 9 Jan 2016