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International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

An experimental study on partial replacement of fly ash and silica fume on concrete

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ABTRACT :

Concrete is the most versatile building material available today since it can be made to withstand the most extreme conditions and still take on the most uplifting shapes. The majority of concrete mixtures in use today include extra cementitious material, which is a component of the cementitious element. The ability of supplemental cementitious materials to return a certain amount of cement while maintaining their cementitious properties is their main advantage, which lowers the cost of employing Portland cement. The leftovers from blast furnaces, fly ash, silica fume, steel slag, and other processes that can be utilised as additional cementitious material. . The results showed the same percentage at the different of 0% 5%, 7.5%, 12.5%, 15%, 20%, & 25%. The results indicate that replacing 15% of the cement with silica fume increased the strength of the concrete to the greatest extent possible. It was found that adding fly ash at the ideal percentage of 20% increased the material's compressive, flexural, and split tensile strengths to the greatest extent possible.

Key Words: Concrete, Silica -fume, Fly ash, Compressive strength, Flexural Split tensile strength, Aggregate.

INTRODUCTION :

Because it can be shaped to take on the most inspiring shapes and endure the most severe circumstances, concrete is the most adaptable building material available today. Extra cementitious material, a part of the cementitious element, is present in most concrete formulations used today. The primary benefit of using supplemental cementitious materials is their capacity to return a specific amount of cement while retaining their cementitious qualities, which reduces the expense of using Portland cement. Additional cementitious materials that can be used include steel slag, fly ash, silica fume, blast furnace residues, and other materials. The most effective cementitious elements among all of these waste products are silica fume and fly ash, which boost the strength strength and longevity of concrete to the extent that current design requirements mandate the use of silica fume when creating high-strength concrete. Micro silica, often known as silica fume, is a synthetic super plasticizer with pozzolanic properties. These days, concrete with excellent performance and strength is used in many civil engineering structures. To reduce the amount of cement in concrete, supplementary components are used. Fly ash and silica fume are the most often added materials to concrete in order to increase its strength and improve its flexural, split tensile, and compressive strengths. Because of this, 0%, 5%, 7.5%, 12.5%, 15%, 20%, and 25% of the fly ash and silica fume are substituted with the weight of cement. For concrete grade M-25, the water-to-binder ratio is 0.42. The study compared the effects of employing microsilica against cement on split tensile strength, compressive strength, and flexural strength after 7, 14, and 28 days of curing through a battery of tests. The same percentage was displayed in the results at different points of 0%, 5%, 7.5%, 12.5%, 15%, 20%, and 25%. The findings show that the concrete's strength was maximally enhanced by substituting 15% of the cement with silica fume. The highest potential increase in the material's compressive, flexural, and split tensile strengths was observed when fly ash was added at the optimal amount of 20%.

Fly Ash

Efforts to address environmental concerns have led to a focus on recycling waste materials instead of discarding them into the environment. This approach not only helps reduce waste deposits but also maximizes the use of natural resources. Waste materials, such as fly ash, a finely divided mineral residue produced from burning coal in thermal power plants, can be repurposed as additives in concrete production.

Silica Fume

Silica fume plays a vital role in bolstering concrete properties due to its ultra-fine particles and abundant silica content, serving as an effective pozzolanic material. Incorporating silica fume into Portland cement concrete blends enhances abrasion resistance, bond strength, and compressive strength. These improvements stem from pozzolanic reactions between silica fume and calcium hydroxide, along with mechanical advantages derived from the inclusion of minuscule particles in the mixture.

LITERATURE SURVEY :

Material testing has been done to determine the physical characteristics of silica fume and eco sand, according to Manikandan A et al. (2020). A sequence of different percentages has been achieved when these two combinations are combined. Concrete has been cast into cube, prism, and cylinder shapes to determine its split, flexural, and compression strengths after seven and twenty-eight days of curing, respectively, for various percentages that have been calculated. The ideal proportion for replacing some of the eco sand and silica fume has been established using the test findings.

K. et al., V. Gopi (2019): This research examines the ideal proportion of these by-products to use in lieu of some cement while taking into account the strength characteristics of the final concrete. 10%, 15%, 25%, and 35% replacement of fly ash and 0%, 4%, 6%, 8%, and 10% replacement of silica fume are attempted in order to find the best replacement in order to get the necessary attributes of strength and durability in the concrete.

Imam Ashhad et al. (2018): An overview of the use of silica fume (SF) as a mineral additive in concrete is given in this study. Here, distinct findings from many studies are presented, with a focus on the characteristics of concrete that are both fresh and hardened when mixed with silica fume (either micro- or nano-silica). The findings demonstrated that adding SF to concrete significantly improved its mechanical qualities.

In order to partially replace cement, Sasikumar and Tamilvanan (2016) conducted an experimental investigation on the properties of silica fumes. This study's primary parameter is M30 grade concrete that has silica fume replaced in part at rates of 0%, 25%, 30%, 40%, and 50% in lieu of cement. When the amount of silica fume rises from 0% to 25%, the usual consistency increases by around 40%. The 25% silica fume replacement amount yielded the best 7 and 28-day compressive strength. When 25% of the cement is substituted with silica fume, the split tensile strength is also strong.

OBJECTIVE :

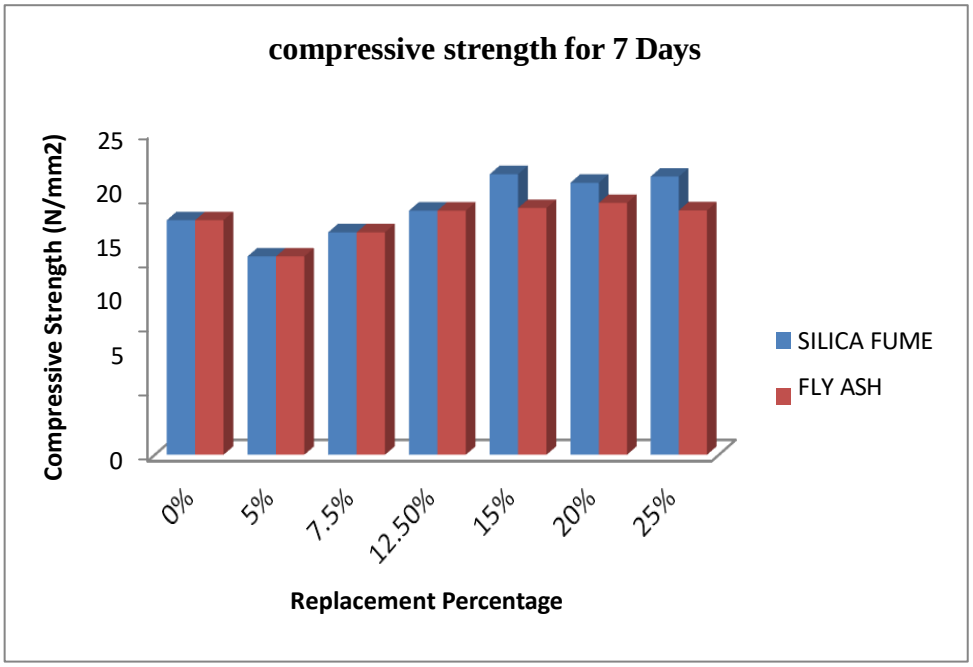
In the present Experimental Investigation the following are the main objectives.

1. Comparative study of the behavior of the concrete with & without silica fume as well as Concrete with & without fly ash.
2. To study the behavior of concrete using silica fume and Fly ash, in strength enhancement
3. To find the optimum percentage of silica fume and Fly ash for obtaining the maximum strength of concrete.

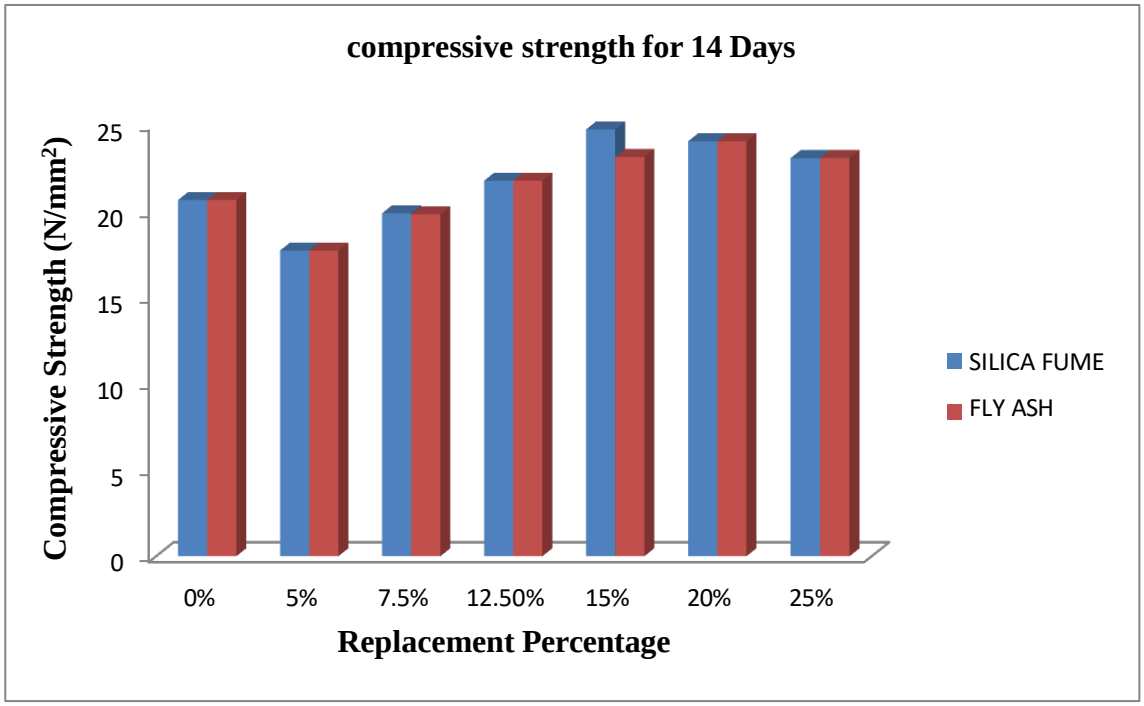
IV RESULTS AND DISCUSSIONS :

Compressive Strength

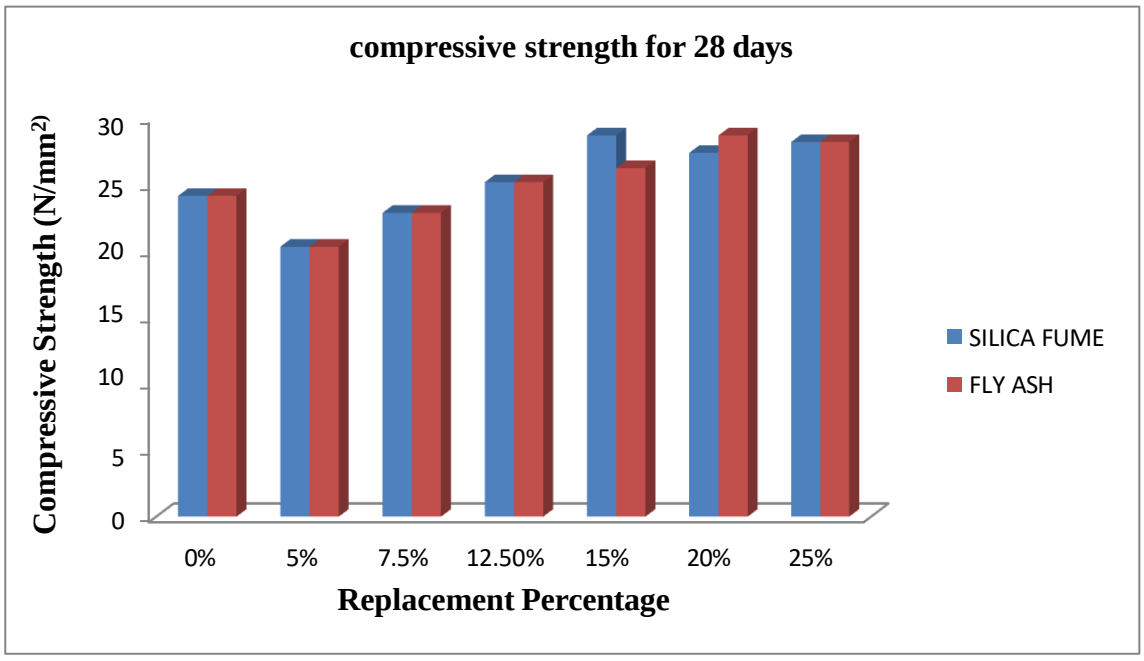
In the Compressive strength test is performed on 3 cubes of each batch mix for 7 days, 14 days & 28 days. There are 7 batch mixes and each one having 9 cubes of these 9 cubes, 3 cubes are tested for 7 days, 14 days & 28 days each. An average of 3 values as tabulated in subhead results, are considered for discussions.



Graph 1Compressive strength of silica fume and fly as for 7 day



Graph 2: Compressive strength of silica fume and fly as for 14 days



Graph 3: Compressive strength of silica fume and fly as for 28 days

According to the data presented in graph 1, when 15% of cement is replaced by silica fume (SF), there's a notable increase of 27.68% in compressive strength at 7 days compared to conventional concrete. However, further increases in the percentage of SF replacement result in diminishing strength, reaching a minimum point.

Similarly, examining graph 2 for 14 days strength, a 15% replacement of silica fume leads to a significant 24.5% increase in strength compared to conventional concrete. This trend is consistent with the findings from graph 5.3, which indicates a 26.85% increase in strength at 28 days with the same 15% replacement of silica fume.

Overall, it's observed that the compressive strength of the concrete mix (Mix-01) experiences a 27% increase when 15% of cement is replaced by silica fume compared to the conventional mix.

CONCLUSION :

CS (Compressive Strength) of a concrete mix with & without SF has been determined at 7, 14 and 28 Curing Days. The strength gained has been determined of silica fume added concrete with addition of 5%, 7.5%, 12.5% 15%, 20% & 25% for M25 grade replacement of cement for a conventional concrete. From the results it is conclude that the silica fume is a superior replacement of cement. The rate of strength increase in silica fume concrete is high. After performing all the tests and analysing their result, the following conclusions have been derived:

- The results achieved from the existing study shows that silica fume is great potential for the utilization in concrete as replacement of cement.
- Maximum compressive strength was observed when silica fume replacement is about 15%.

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