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A Literature Review on Use of Cellulose Fibres and Supplementary Material Silica Fume in Concrete

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ABSTRACT

Concrete is widely used for construction material in the world. During the last four decades, fibre reinforced concrete has been increasingly used in structural applications. It is generally accepted that addition of natural fibres significantly increases tensile, toughness and ductility, also slightly enhances the compressive strength and flexural strength. The different types of pozzolanic materials like GGBS, Silica Fume, Fly Ash, RHA etc. are used in concrete in replacement of cement to produce a high performance concrete. Among all cementitious material Silica Fume give best performance in strength and durability aspect of concrete. In this paper combination of different types of Cellulose fibres with Silica Fume are studied on strength aspect of concrete.

KEYWORDS: Cellulose Fibres, Cementitious material, Silica Fume, Mechanical properties of concrete

1. Introduction :

Concrete = Cement + Sand + Aggregate + Water + Admixtures + Air.

Concrete is the most frequently used construction material in the world. However, it has low tensile strength, low ductility, and low energy absorption. An intrinsic cause of the poor tensile behavior of concrete is its low toughness and the presence of defects. Therefore improving concrete toughness and reducing the size and amount of defects in concrete would lead to better concrete performance. An effective way to improve the toughness of concrete is by adding a small fraction (usually 0.5–1% by volume) of short fibers to the concrete mix during mixing. Fly ash, Ground Granulated Blast furnace Slag, Rice husk ash, High Reactive Metakaolin, silica fume are some of the pozzolanic materials which can be used in concrete as partial replacement of cement. The strength, durability and other characteristic of concrete depends on the properties of its ingredients, proportion of mix, method of compaction and other controls during placing and curing. Many fibres have been used for concrete reinforcement and some are widely available for commercial application. They include steel, glass, natural cellulose, carbon, nylon, and polypropylene, among others which are adding with pozzolonic material to develop concrete. The literature being reviewed is given under.

2. Experimental Research:

Eman K. Jallo(2011) This paper determine the effect of silica fume on the compressive strength of concrete under two types of loading, monotonic and repeated compressive loads. Mixes were carried out by replacing cement with different percentages of silica fume of (0, 5, 10, 15, 20) % by wt. of cement with a constant water-binder ratios 0.25. Tests on standard cylinders (300*150) mm for the different ratios of silica fume were carried out to study the behaviour of concrete under monotonic and repeated loads, the load was applied for many cycles up to failure with rate of loading (0.3) N/mm2/sec. The results indicated that the addition of silica fume improves the properties of concrete giving high compressive strength, high stress and strain, stresses carried by the concrete increased by (46.3,68.8,63.1,57.5)% also the strain increased by (58.5,97.8,52.8,22)% for silica fume percentages (5,10,15,20)%. for monotonic loading, and stresses increased by (44.4,68.5,63.7,56.5)% and strain increased by (45.8,68.4,51.5,26.3)% for the same percentages under repeated loads. Compressive strength, dissipated energy, and modulus of elasticity also increased with increasing silica fume percentage.

M. Bentchikou (1), A. Guidoum(1), K. L. Scrivener(1), K. Silhadi(2), S. Hanini(3) This paper presents an experimental study of the effect of adding cellulose-recycled fibres on mechanical and thermal properties of cement paste. Thermal conductivity, tensile strength and compressive strength were investigated in terms of fibre content, fibre size and soaking time. The results reveal that the thermal conductivity decreases with fibre content in the composite material and seems to stabilize around 10%. Up to a fibre content of 16%, the compressive strength exceeds the standard for hollow non-load bearing concrete masonry. Therefore it is possible to use for the construction of walls, ceilings and roofs of housing. Backscattered electron (BSE) images taking in the scanning electron microscope (SEM) shows that increasing Water-Cement ratio up a certain limit, which depends on fibre fraction, improves the fibre dispersion and enhances mechanical strength.

Preeti P. Patel, Elizabeath George, Deepa A. Sinha (2008) the work was carried out for two grades M20 and M30 of concrete. For the grades of concrete the cement content, sand, grit, coarse aggregate and w/c ratio is kept constant. Only the percentage of silica fume has been changed 0%, 7.5%, 10% and 12.5%.The results have shown the considerable improvement in compressive strength, modulus of elasticity and durability with respect to sulphate. Split tensile strength is observed to be nearly same with or without the use of silica fume for both the grades. They conclude that the increase in strength of concrete may be attributed to the fact that when silica fume is mixed with cement, micro silica reacts with $Ca(OH)_2$ liberated by the hydrating Portland cement. When properly dispersed, thousands of reactive micro spheres surround each cement grain, densifying the matrix, filling the voids with strong hydration Products, improving the bond with the aggregates. It is found that the workability varies with % of silica fume. As the % of silica fume increases the workability decreases.

Elic Awwad, Mounir Mabsout, Bilal Hamad, Helmi Khatib(2010) Based on the preliminary test results, the use of industrial or local hemp fibres in concrete mixes would result in promising compression and flexural strength values and behaviour and reduction in the consumption of coarse aggregates, as compared to the control samples in addition to the palm and banana samples. However, due to the variation in the test results of the small specimens, it is recommended to conduct more research. Further research shall include standard 15x30 cm cylinder tests and standard 15x15x50 cm flexural beams. Tests shall include Slump Test, Density, Brasilian Test, Flexural Test, Compression Test, and Modulus of Elasticity Test. Besides, the Thermal Conductivity properties can be investigated using 5x5x30 cm block Test. The preliminary test results for palm and banana fibres were acceptable but not as with the industrial hemp fibres; moreover, the preparation process of the fibres is not simple and needs to be updated to include mechanical processing for large quantities production.

K. C. Biswal1 and Suresh Chandra Sadangi2 (2011) Nowadays high strength and high performance concrete are widely used in many civil engineering constructions. To produce them it is required to reduce the water/powder ratio and increase the binder content. Super plasticizers are commonly used to achieve the workability. Silica fume is one of the popular pozzolana used in concrete to get improved properties. The use of silica fume in conjunction with super plasticizers has become the backbone of high strength and high performance

concrete. An experimental program has been carried out to study the effect of super plasticizer alone and in conjunction with silica fume on some of the properties of fresh and harden of concrete. They conclude that use of both silica fume along with super plasticizers increases workability and strength. The water cement ratio reduces by 23% in concrete by using super plasticizer (1% by weight of cement) for a constant range of slump 80mm to 85mm.The compressive of concrete is increased by use of silica fume up to 20% replacement of cement. The flexural strength of concrete is increased by use of silica fume up to 15% replacement of cement.

Nilza et al. Use three Jamaican natural cellulosic fibers for the design and manufacture of composite material. They took bagasse from sugar cane, banana trunk from banana plant and coconut coir from the coconut husk. Samples were subjected to standardized tests such as ash and carbon content, water absorption, moisture content, tensile strength, elemental analysis and chemical analysis

Bilba et al. Examined four fibres from banana-trees (leaf, trunk) and coconut-tree (husk, fabric) before their incorporation in cementitious matrices, in order to prepare insulating material for construction. Thermal degradation of these fibers was studied between 200 and 700 °C under nitrogen gas flow. Temperature of pyrolysis was the experimental parameter investigated. The solid residues obtained were analyzed by classical elemental analysis, Fourier Transform Infra Red (FTIR) spectroscopy and were observed by Scanning Electron Microscopy (SEM).

Vikas Srivastava, Rakesh Kumar, Agarwal V.C, Mehta P. K (2012) By addition of some pozzolanic materials, the various properties of concrete viz, workability, durability, strength, resistance to cracks and permeability can be improved. Silica fume is known to improve both the mechanical characteristics and durability of concrete. The principle physical effect of silica fume in concrete is that of filler, which because of its fineness can fit into space between cement grains in the same way that sand fills the space between particles of coarse aggregates and cement grains fill the space between sand grains. As for chemical reaction of silica fume, because of high surface area and high content of amorphous silica in silica fume, this highly active pozzolan reacts more quickly than ordinary pozzolans. Metakaolin is also one of such waste/ non - conventional material which can be utilized beneficially in the construction industry. This paper presents the results of an experimental investigations carried out to find the suitability of Silica Fume and Metakaolin combination in production of concrete. The optimum doses of silica fume and Metakaolin in combination were found to be 6% and 15% (by weight) respectively, when used as part replacement of ordinary Portland cement**.**

3. Conclusion:

- Addition of Silica Fume decreases the workability of the concrete. To improve the workability of concrete containing Silica Fume use of super plasticizer is necessary.
- It is reported that decrease in water demand in Silica Fume mixture and stated that water reducing admixture have a greater effect on Silica Fume concrete.
- From the various researches it is concluded that both Silica Fume and Cellulose Fiber have significant effect on mechanical properties of concrete.
- Addition of Silica Fume in concrete improves the mechanical properties of the concrete.
- Addition of Silica Fume there is improvement in Compressive strength, modulus of elasticity and durability with respect to sulphate. Split tensile strength is observed to be nearly same with or without the use of Silica Fume.
- Due to less permeability of concrete containing Silica Fume it makes the durable concrete.
- Main purpose of using fibers in concrete is to eliminate or lower down the shrinkage cracks developed and improve the flexural and split tensile strength of concrete. It cannot be used as reinforcement but it can lower down the requirement of reinforcement.
- Wood-cellulose fibre has relatively good mechanical properties compared with many man-made fibres such as polypropylene, polyethylene, polyester and acrylic.
- Addition of Cellulose fibers in concrete containing Silica Fume also improves the properties of concrete. Due to addition of Silica Fume in concrete there is well dispersion of fibers in concrete which directly affects the mechanical properties of the concrete
- Fibre in larger percentage cannot use due to the problem of balling in concrete.

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