

APPLICATION OF PERFORMANCE STUDIES OF HIGH STRENGTH FIBROUS CONCRETE PAVEMENT INCORPORATING WOLLASTONITE AND BASSAGE ASH

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DOI: <https://www.doi.org/10.58257/IJPREMS32765>

ABSTRACT

Looking into the present era of road scenario in the developing countries like India, construction of rigid pavement is encouraging confidence of engineers due to its excellent riding surface and pleasing appearance. The life of cement concrete road pavements is much more than bituminous roads but unfortunately, due to its high initial cost it is not possible to construct all the roads with cement concrete, because cement is the major constituent which is used as a building material as well. Also concrete is weak in tension. So there is a need to look for the materials that can be used as partial replacement of cement and other ingredients of conventional concrete with improved mechanical properties of the concrete. These materials should fall under the category of low cost materials so that economy is maintained. The fusion of limestone with silica in the presence of hot magmas leads to the formation of wollastonite micro fiber, chemically known as calcium meta-silicate. Due to the presence of high amount of silica, wollastonite has the potential to be used as an admixture in concrete. Bagasse, an inexhaustibly delivered rural waste, is the build-up of sugarcane that is acquired after extraction of juice. The addition of bagasse ash to concrete improves compressive strength of concrete but contributes less to improve other properties like tensile strength, ductility, resistance to cracking etc. The present investigation has been aimed to determine the influence of wollastonite-bagasse ash combination on the strength of concrete to make economical and improved concrete pavement. In this study, wollastonite was used to replace cement by 5, 7.5, 10, 12.5, 15 and 17.5 percent while bagasse ash was used to replace 10 percent of sand of the control concrete.

Keywords- wollastonite micro fibre, bagasse, compressive strength, concrete pavement, mechanical properties

1. INTRODUCTION

In a developing country like India, road network forms the arteries of the nation. Roads play a very important part in building up nation's infrastructure. The country's total road length is 4.24 million km at present. The present national highway system includes a total road length of 93,051 km, most of the national highways are constructed with flexible pavement due to its low cost initial investment. Construction and maintenance of roads, and the vehicles that move over them, consume large amounts of energy. This energy consumption results in atmospheric emissions, reduction of a non-renewable resource, and other environmental impacts. Any reduction of the lifetime energy use associated with roads, even if only by a small percentage, will have significantly positive implications for sustainable development.

Concrete pavements are used for sustainable development. Due to high initial cost of concrete pavement it is not generally adopted in India.

Although construction agencies, engineers are well aware of the fact that life cycle cost of concrete pavement is less than flexible pavement, but the initial cost of these pavements is high and are therefore not commonly adopted. On the other hand, studies have proved that trucks consumed less fuel on concrete pavements than on asphalt pavements, with a profound impact on highway life-cycle costs (Zaniewski, J.P., 1989).

Concrete is a widely used building material which can be used for the construction of bridge, piles, pavement and many more due to its high strength, durability, mouldability, and versatility. However, its low tensile strength is one of the major concern that really need to be addressed before using it in any structure especially in pavement. It has been found that with the advancement in the vehicular configuration and the introduction of heavy load vehicles pavements are likely to experience high flexural tensile stress under the influence of these heavy loads. Therefore, it becomes essential to increase the tensile strength of concrete and many attempts have already been made. One of the successful and the most commonly used method is providing steel reinforcement, but it is not economical. Fiber reinforcement can also be one of the solution to improve the tensile strength of concrete and it is also economical in comparison to

the steel reinforcement. The main reasons for adding fibers to concrete matrix is to avoid the post-cracking i.e. to improve energy absorption capacity and apparent ductility, and to provide crack control and also helps to maintain structural integrity. As a matter of fact, the use of fibrous concrete comes up contributing to many benefits in pavement construction by reducing their thickness and surface layers on bridge and viaducts, less materials consumption and consequent minor environment impact by using less natural resources, decreasing the construction and repairing schedules, and increasing durability and service life, with lesser maintenance works and costs. An attempt has been made to improve the strength of concrete and from economic point of view also it would be beneficial if cost of concrete pavement is reduced.

TYPE OF PAVEMENTS

A highway pavement is a structure which consists of superimposed layers of processed materials above the natural soil sub-grade, whose main function is to distribute the applied vehicle loads to the sub-grade. The pavement structure should be able to provide a surface of acceptable riding quality, adequate skid resistance, favorable light reflecting characteristics, and low noise pollution. The ultimate aim is to ensure that the transmitted stresses due to wheel load are sufficiently reduced, so that they will not exceed bearing capacity of subgrade. Two type of pavements are generally recognized to this purpose, namely flexible pavements and rigid pavements. In flexible pavements, wheel loads are transferred by grain-to-grain contact of the aggregate through the granular structure. The flexible pavement, having negligible flexural strength, acts like a flexible sheet. On the contrary, in rigid pavements, wheel loads are transferred to sub-grade soil by flexural strength of the pavement and the pavement acts like a rigid sheet.

2. LITERATURE REVIEW

The long-term performance of concrete infrastructures are associated with its mechanical strength and durability. The selection of proper ingredients and mix proportions are important to produce durable and economical concrete. In this chapter an introduction about the Wollastonite micro fiber (WMF) along with its application potential in cement concrete for the production of economical durable concrete has been described. In this chapter literature related to wollastonite and bagasse ash and their effect on properties of concrete was studied and important facts of related investigation are summarized.

HISTORICAL REVIEW OF WOLLASTONITE BLENDED CONCRETE

Preliminary investigation on use of wollastonite in cement concrete were reported in nineties (1992-1999), most of these studies were on cement composites. A review of literature pertaining to influence of wollastonite on strength, permeability and durability properties of concrete mixes have been reported in this sections. Low and Beaudoin, (1993)¹⁸ studied the flexural strength characteristics of cement- wollastonite and cement-silica fume-wollastonite system reinforced with WMF between 2% to 15% by volume of cement. Results of flexural strength test as shown in Figure 2.1, shows a small increase in flexural strength as the hydration period increase from seven days to twenty eight days. A liner increase in flexural strength was observed when amount of wollastonite was increased from 2% to 11.5%. A maximum flexural strength in the composite system was observed when the mixture contained about 11.5% by volume of the WMF. However increase in the WMF in the cement matrix up to 15% by volume resulted in a slight reduction in the flexural strength of the composite system. Low and Beaudoin, (1994) , further investigated the stability of Portland cement based binders reinforced with wollastonite, for hydration period up to one year. The composite systems were examined on a similar line to that of his earlier studies. Based on the experimental results obtained it was concluded that these fibres were relatively stable in cement composite systems and apparently unaffected by exposure to prolonged hydration in calcium hydroxide solution. Deutschmann and sickler et al, (1997) ^ 26 investigated the ductility properties of highperformance concrete by the change in the microstructure of cement matrix and the interfacialzone by mineral admixture such as wollastonite, polypropylene fibre, fly ash etc. Theimproved shape of stress- strain curve of concrete with above mentioned mineral admixturesin the region of maximum stress indicates modification in concrete microstructure.CRRI. (2004)²¹ reported the application of wollastonite in concrete mixes as a partial replacement of cement, sand or both. Different wollastonite grades designated as A-60, H-3and H-3k with different aspect ratios were used.

From the results of study it was evident that incorporation of wollastonite in concrete increases flexural strength. Mixes in which wollastonite was used as a partial substitute of sand (10% by weight) keeping the cementcontent same, the gain in flexural strength was between 9 to 10.5%. When 20% cement was replaced by fly ash and the total cementitious material was replaced by 10% wollastonite the gain in flexural strength was up to 12.7%. Strength properties of grade H-3k wollastonite were observed better as compared to other grades.

3. CONCLUSION

An extensive experimental study has been conducted to investigate the performance of high strength fibrous concrete pavement incorporating wollastonite and bagasse ash. In this study, fresh and hardened properties of concrete were analyzed after using wollastonite and bagasse ash as supplementary cementitious material by casting cubes, beams and cylinders. Also the thickness of concrete pavement was designed for varying strength of concrete and cost estimation was done in terms of material saving. This section comprises of the analysis of results and depiction of the conclusions.

The conclusions which can be obtained from the extensive study carried out to assess fresh and hardened properties of concrete incorporating wollastonite and bagasse ash based on the experimental analysis are as follow:

- The addition of wollastonite micro fibre with bagasse ash in concrete reduces the slump of concrete. The reduction in slump increases with increases in replacement level of cement by wollastonite.
- The strength properties of concrete such as compressive strength, flexural strength and splitting tensile strength has shown an upward trend up to 15% addition of wollastonite in combination with 10% bagasse ash. More than 15% addition of wollastonite micro fiber results in lowering the strength values. Thus the cement content in the construction of rigid pavement may be reduced to fifteen percent by weight of cement, by attaining minimum compressive strength criteria.

4. REFERENCES

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