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Study of Materials Used in Engineered Cementitious Composites (ECC)

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Abstract:

Engineered Cementitious Composites (ECC) is a new composite which have wider application. More researches are carried out day by day to expand its use in all fields and hence new materials arise. This paper explores the currently used materials used in ECC. Each new material introduced in ECC imparts new property to ECC . The material chosen for ECC are those which enhance its ductility, tensile strength and other major properties.

Keywords **— Poly-vinyl alcohol fiber, Alcoffine, Silica fume, Super plasticizer, Polycarboxylate ether.**

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I. INTRODUCTION

Engineered Cementitious Composites (ECC) is a highly ductile composite and also has high tensile strength. It is a mixture of cement, fine aggregate and fiber and is devoid of coarse aggregate. It shows ductility range of 3–7% and low fiber content of 2% or less by volume. ECC exhibits tensile strain hardening property which is similar to metal. The fiber used in ECC is micro-fibers and poly-vinyl alcohol fiber is the most common one.ECC shows superior property than conventional concrete and thus more research works are carried out to expand the use of ECC. The typical fiber used in ECC is the polyvinyl alcohol fiber.

II. MATERIALS

There are various types of material used in ECC, some supplement the use of cement, fine aggregate and water. Some of the materials are discussed in this paper.

A. Cement

Ordinary Portland cement is used in production of ECC. Cement is a major constituent of ECC and hence results in high cost of production. To overcome this demerit, cement is replaced by many materials.

B. Silica sand

Silica sand which is finer is used as fine aggregate in ECC. In some cases it is also replaced by locally available fine aggregate.

C. Fly Ash

Fly ash is used both as replacement of cement and sand particle. Studies have shown that fly ash can replace cement by 30-75% of cementitious volume. Based on this limit, most of the ECC mixes are proportioned. Fly ash of class C and Class F are to be used in the production of ECC.

D. Poly Vinyl Alcohol fiber (PVA)

PVA fiber is used as reinforcing material in ECC. It has high elastic modulus and tensile strength.

Elastic modulus of PVA fiber is about (25 ~ 40 GPa) and also has fiber elongation of 6-10%. It has a characteristic Tensile strength of 880-1600MPa. The main reason to adopt PVA fiber is its strong bond formation with ECC.

E. Alccofine 1203

Alccofine is composed of low calcium silicates and is ultrafine. It is used as replacement of cement and fine aggregate.

F. Rice Husk Ash

Rice Husk Ash (RHA) is a commonly used pozzolonic material by many researchers. Rice husk is burnt in an enclosed space to produce ash which is used as a replacement to cement in small amount. This is not commonly used in ECC but researches are carried out to find the possibility.

G. Palm Oil Fuel Ash

Palm oil fuel ash (POFA) is a by-product from the palm oil industry. It is used as a replacement to cement. Using palm oil fuel ash can reduce the environmental hazards it causes due to dumping them in landfill.

H. Silica Fume:

Silica fume is a slag of high glass content. It is finer than OPC but requires less water than OPC. It is sometimes used in ECC as a replacement for cement.

I. Jute (Natural fiber)

Jute is a natural fiber obtained from plant called white corchorus capsularis. Jute fiber is also used in ECC in place of fibers but does not exhibits good properties like PVA fiber.

J. Nylon (Artificial fiber)

Nylon is an artificial fiber and known to be effective in imparting impact resistance. Even nylon fibers are also used in place of PVA fiber

K. Construction and demolishing waste (C&D)

Construction and demolishing waste end up in landfills cause a serious threat to nearby water resources and maximum usage of such waste in construction may reduce the hazard caused by them. Finer particles of C&D waste is used in ECC as a replacement of both cement and fine aggregate.

L .Crumb rubber (CR)

Crumb rubber is the scrap from tyre production and it is now incorporated in the production of ECC to decrease the fracture toughness of the matrix.

M. Limestone Powder

It is used as a blended material with cement. This replacement can increase the greenness of ECC and lower the cost.

N. Blast Furnace Slag

It is also blended with cement and found to increase the fresh and hardened properties of ECC.

O. Super plasticizers / High range water reducing admixtures (HRWA)

Super plasticizers are used to reduce water content in ECC to prevent it from drying shrinkage. Super plasticizer belonging to Polycarboxylate Ether family is commonly used.

P.Water

Water to be used in ECC should be devoid of acids, bases, salt, sugar and other matters.

III. CONCLUSION

ECC is found to increase the durability of structure which is subjected to harsh environments.The use of ECC can prolong the service life of structures and reduce the maintenance and repair costs. Therefore, the use of ECC lowers the life cycle cost of Structures. ECC finds its application as structural members, coupling members, seismic resistant structures, links slabs to bridges, etc. The significant properties of ECC concrete are ductility, durability, compressive strength and self-consolidation.

To improve the application of ECC, supplementary materials have been used. Some of them showed notable merits. Using nylon and jute fiber has reduced cost and also improved the flexural behavior of ECC specimens. ECC mixes having 20% replacement of cement with palm oil fuel showed best result. The maximum Compressive strength in ECC was obtained when cement was replaced with rice husk ash (20%). Replacement of fly ash or Alccofine improved Workability as well as Strength of ECC. Fly ash and Alccofine may be safely replaced up to 20% to gain optimum strength.

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