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Advancement in an Engineered Cementious Concrete

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***Abstract*— A review of representative research on the behavior of PVA-ECC concrete under flexure and shear action. Concrete is most widely used material but its brittle behavior is one of the most serious problem. This problem can be overcome by using ECC concrete which contains PVA fibers in place of course aggregates and fly ash replacing cement partially. The various materials which are to be used are ordinary Portland cement, fly ash, PVA fiber, Sand, Superplasticizer and water. Superplasticizer is to be used to control rheological properties of fresh concrete. PVA fiber are selected because they have strong bond with the concrete matrix, strain hardening property and provide pseudo-ductility to the concrete thereby increasing flexural and shear strength. The seismic disturbance to a structure can be partially stabilized with the help of ECC concrete.**

***Index Terms*— PVA fibre (Poly-vinyl Alcohol fibre), ECC (Engineered Cementious Concrete), fly ash, psuedo ductility, strain hardening.**

I. INTRODUCTION

Normal concrete has been widely used as construction material with the advantages of durability, resistance to fire, energy efficiency and on site fabrication. In constant, it has the disadvantages of low tensile strength, low ductility and inconsistent reliability due to variable applications skills of the job site. In addition to this, the brittle failure due to fast growing of single crack loading to sudden failure is one of the most disadvantages of conventional concrete. Engineered cementitious composites (ECCs) are cement mortar based fiber-reinThese composites are composed of cement, sand, water and small amount of admixture and optimal amount of fiber. ECCs have a tensile strain capacity of up to 6% and exhibit strain-hardening behavior.(5,19) Engineered cementitious composites (ECC) also known as "Bendable concrete", developed in last decade may contribute to safer, more durable and sustainable concrete infra structure that is cost- effective and constructed with conventional construction equipment. With 2% by volume of short fiber, ECC has been prepared in ready-mix plants transported to construction plant using conventional ready-mix trucks. Furthermore, the most expensive component of the composite fiber, is minimized resulting in ECC that is more acceptable to the highly cost sensitive construction industry. (3) ECC is ductile in nature. Under flexure, normal concrete fracture in brittle manner.(17) In constant, very high curvature can be achieved for ECC at increasingly higher loads, much like a ductile metal plate yielding. Extensive in elastic deformation in ECC achieved via multiple micro-cracks, with widths limited below 60µm (about half the diameter of human hair).This is elastic deformation, although different from dislocation movement, is analogous to plastic strange in ductile metal. Necessity of ECC for structural applications:-In the preparation of ECC 2% or less by volume of discontinuous fiber is adequate. Because of relatively small amount of fibers & its chopped nature the mixing process of ECC is similar to that of mixing in conventional concrete.

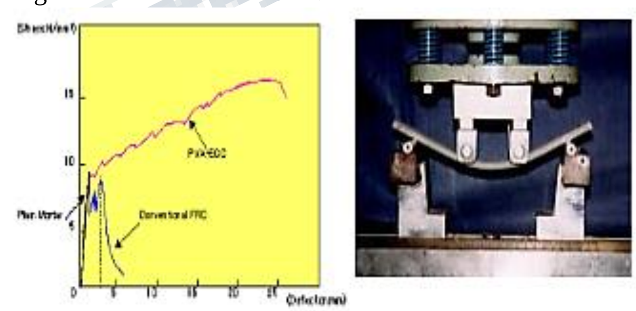

Figure 1 Behaviour of PVA-ECC concrete

The analysis of structure is to be done by using PVA-ECC concrete. The PVA ECC is used to enhance the resisting capacity of concrete against above forces. The various tests are approved to study the behavior of the structure against the above noted forces using a PVA-ECC Concrete. We shall study these tests in further analysis.

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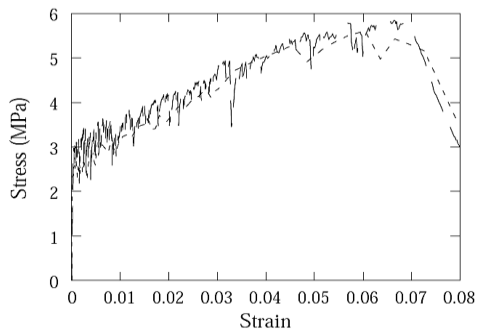

Figure 2 Stress strain relation of ECC concrete

The most fundamental mechanical property difference between ECC & FRC is that ECC strain – hardens rather than tension-softens after first cracking. Figure 2 shows tensile strain-hardening behavior of ECC.please contact us via e-mail.

II. HISTORICAL DEVELOPMENT OF ECC

Development of fiber reinforced concrete material has undergone no. of phases.(3) In the 1960s, research by Romualdi and Coworkers (Romualdi and Batson, 1963; Romualdi and Mandel,1964)(3) demonstrated the effectiveness of short steel fiber in reducing the brittleness of concrete. This development has continue with expansion to a variety of other fibers, such as glass, carbon, synthetics, natural fiber and in recent years hybrids that combine either different fiber type or fiber length. The continuously enhanced knowledge of fiber reinforcement effectiveness has resulted in structural design recommendations by RILEM TC 162 – TDF (Vandewalle et al., 2003).(3) In the beginning of 1980s, interest in creating fiber reinforced concrete material with tensile ductility has been gaining ground. Within FRC, the toughness of the material is increased but no change in ductility is attend. Ductility is measure of tensile deformation (strain) capacity typically associated with Ductile steel but not with concrete material. Attempts to achieve tensile ductility in concrete material are simplified by the early efforts of Avestonetal(1971)(1) and later Krenchel and Stange(1989)(1), who demonstrated that, with continuous aligned fibers, high tensile ductility hundreds of time that of normal can be attained. The modern- days version of continuous fiber reinforcement is represented by textile reinforced concrete material that may be prestressed (Curbach and Jesse, 1999; Reinhardt et al., 2003). Research on pultruded continuous fiber reinforced concrete was pioneered by Mobasher et al.(2006). In parallel, research into the Use of discontinuous fibers at high dosage (4% to20%), such as in cement laminates (Allen, 1971) and in slurry in filtrated fiber concrete (SIFCON)(Lankard, 1986; Naaman, 1992), has resulted in concrete composite material that attain higher tensile strength than normal concrete and are not as brittle, but which have much less ductility than their continuous- fiber and textile-reinforced counterparts. These materials may be considered a class of materials separate from FRC in that different degree of tensile ductility is achieved, often accompanied by a strain-hardening(5) response distinct from the tension softening response of FRC. Naaman and Reinhardt (2003) classified such material as high-performance fiber reinforced cementitious composites (HPFRCC)(4). It should be noted that most members of this class of material have a matrix that does not contain coarse aggregates. In recent years, two new classes of HPFRCC have emerged. Ductile has a high tensile strength of 12MPa and a ductility of 0.02 to 0.06%(chanvillard and Rigaud,2003)(4). Engineered cementitious composites (ECC), originally developed by victor Li of the university of Michigan, has a typical moderate tensile strength of 4 to 6 MPa and a higher ductility of 3% to 5% (Fischeretel., 2003; Li, 1993). The development approach for these two classes of material is quite different. For Ductile, which can be traced back to the work of Bach (1981), the approach is to employ a tightly packed dense matrix to increase both tensile and compressive strength of material(24). Fiber is added to counteract the resulting high brittleness of the densities matrix. The dense matrix allows a strong bond with the fiber that results in high post-cracking strength as long as a fiber with high strength is utilized. For ECC, the approach is to create synergistic interactions between the fiber, matrix and interface to maximize the tensile ductility through development of closely spaced multiple micro-cracks while minimizing the fiber content generally 2% or less by volume). Ductile is designed for use in the elastic stage, so the fiber action becomes effective only when the structural ultimate limit state (ULS) is approached. ECC is generally designed for use in the elastic and strain-hardening (inelastic) stages,(5) so fiber action becomes effective even under normal service loads. The development of ECC is still evolving, even though a number of full-scale structural applications have already appeared in Japan, Europe, and the United States. 2.1 Use in expansion joint: Normally in bridges expansion joints are provided, these are the joints where no material is filled. Naturally, the rain water penetrates through and reaches to the steel member below the bridge deck. All this results in corrosion of members, replacing it, is a very costly affair and if member are not replaced it causes collapse of bridge. Another alternative to prevent this is filling expansion joints with bendable concrete, which is not only bear lateral load but also allow expansion of road during summer. It also bears compressive load that may come due to vehicular load. Most of the thing is that it prevents the entry of water to reach at bridge member. 2.2 In earthquake resistant structures: Extensive researches are to be carried out on steel reinforced ECC (RIECC) structural elements including beams, columns connections and frames under simulated seismic loading. These experiments are shown significant improvement in damage tolerance, suppressing many of the commonly observed failure modes in R/C such as cover spilling and bond splitting. Additionally, the amount of steel shear reinforcement can be drastically reduced. 3. PVA-ECC CONCRETE Engineered cementitious composite is made up of cement, sand, fly ash, water, small amount of admixture and an optimal amount of fibers. In the mix the coarse aggregates are deliberately not used because property of ECC is formation of micro cracks with large deflection. Coarse aggregates increases crack width which is contradictory to the property of ductile concrete. PVA fiber has suitable characteristics as reinforcing materials for cementitious composites. In this paper, typical characterizations of PVA fiber are reviewed on the basis of comparison with other fibers used for cement reinforcing material. Figure 3 Structural Formula of PVA fiber One of the remarkable characteristics of PVA fiber is strong bonding with cement matrix. Figure 5 shows the microscopic images of cross section for PVA and polypropylene (PP) fiber reinforced composites after breaking specimen. These images show PVA fiber was ruptured and PP fiber was pull-outed, namely PVA fiber has strong bonding compare with PP fiber. Combination of bond strength, high tenacity and modulus gives PVA-reinforced concrete substantial tensile and flexural strength.

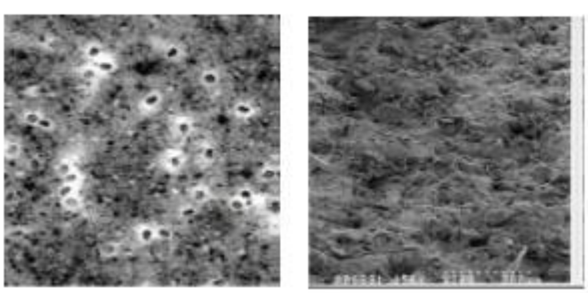

Figure 4 Microscopic image of interface between PVA and cement matrix

The overcoat of Ca(OH)2 pretended ITZ(Interfacial jaunt zone) about PVA fiber is formed as vapid friendship as shown in be clear 6, and in scrap of Poly Propylene, this layer is not observed. It is similar to go off at a tangent PVA is lead-pipe cinch to justify engross clump with metal hydroxide.

III. CONCLUSIONS

This function esteem suggests the castigate for progress a progressive classification of FRC which has the grow hardening property but which can be processed round conventional equipment. It is alleged wander such a blind, termed insincere cementitious composites or ECC, can be designed based on micromechanical principles. The prudence is a rather wicked fiber total ringlets (<2%) mixture which shows wide-ranging strain-hardening, with strain capacity of about 3 to 5% compared to 0.01% of customary valid. The grant of ECC-bendable concrete are durability, compressive strength, self consolidation.

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