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A REVIEW ON EFFECT OF WASTE CARPET FIBRES AND PALM OIL FUEL ASH ON SELF COMPACTING FIBRE REINFORCED CONCRETE

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Abstract - *Self-consolidating concrete is a highly flowable type of concrete that spreads into the form without the need for mechanical vibration. SCC is described as the most revolutionary development in concrete construction for several decades. SCC is produced using high-range water-reducing admixtures (HRWRA), viscosity-modifying admixtures (VMA), and well-graded aggregates. Palm Oil Fuel Ash (POFA) is a good pozzolanic material with high performance in the development of strength and durability properties of concrete. This journal highlights the scope of finding the properties of self compacting fiber reinforced concrete in cooperating waste carpet polypropylene fibers and palm oil fuel ash. The positive interaction between carpet fibres and POFA leads to high tensile strength, flexural strengths and the durability characteristics of the concrete significantly Improved. the utilization of waste carpet fiber and palm oil fuel ash in the production of sustainable green concrete is feasible both technically and environmentally.*

***Key Words*: Palm Oil Fuel Ash, Waste Carpet Fibers, Self Compacting Concrete, Sustainability, Green Concrete**

1. INTRODUCTION

In the construction industry, the idea of sustainability encourages the use of waste products to replace raw materials, such as fine and coarse aggregates, cement and fibrous materials. The advantages of recycling include reducing environment pollution, reducing land filling and disposal of wastes and preserving natural resources. Introducing fibres into the concrete matrix can improve its properties, and enable the utilization of high strength concrete, while maintaining a ductile behavior. Self-compaction encourages the application of macro-fiber reinforcement in concrete, mitigating concerns regarding reduced workability.

1.1 Palm Oil Fuel Ash

Palm Oil Fuel Ash (POFA) is an agricultural by-product obtained by the combustion of residues from a palm oil generation such as palm fiber and palm kernel shell, for electricity production in a palm oil factory. From each bunch of fresh palm fruit, approximately 22% of palm oil, 7% palm kernels, 15% of palm fibers, 7% of palm shells and 24% of empty fruit bunches are obtained. The combustion of these wastes leads to the formation of oil palm ash (or palm oil fuel ash) which again creates a lot of environmental pollution.

Fig 1: Palm Oil Fuel Ash

1.2 Waste Carpet Fiber

Carpet is the most commonly used flooring material. Carpets and area rugs accounted for 51.2 percent share in square feet of the U.S. floor covering market. The rate of carpet disposal is about 4–6 million tons per year worldwide. Carpet wastes are produced during the manufacturing process such as trimming the edges of carpet and producing sheared face yarn. Currently the majorities of post-consumer carpets are either land filled or burned in incineration plants or cement kilns. Finding a suitable landfill space will be difficult thereby resulting in serious environmental concerns that may have adverse effects on the carpet industry. Land filling has numerous negative environmental and economic impacts. Synthetic carpets biodegrade very slowly in landfills, contribute to methane emissions, take up space, and can leach dangerous chemicals.

2. LITERATURE SURVEY

In recent years, many studies were conducted by various researchers on environmental friendly concrete materials. Palm Oil Fuel Ash is such a materials that can be used in the construction industry. The goal which is expected from the paper is to study the effect of waste carpet fibres and palm oil fuel ash on self compacting fibre reinforced concrete.

2.1 Palm Oil Fuel Ash Self Compacting Concrete

Nagaratnam H R., et.al (2019) evaluated the feasibility of utilizing blends of palm oil fuel ash (POFA) and fly ash (FA) as an Ordinary Portland Cement (OPC) replacement in self-compacting concretes (SCC). SCC is evaluated in terms of its compressive strength, tensile strength and micro structural characteristics and the suitability of SCC as medium strength concrete for the local construction industry. The 7, 28 and 90 days Compressive strength of SCC is determined using both cubes and cylinders. The compressive strength was within a 25–63 MPa range, at 28 days, for all grades of concrete mixes; this being appropriate for structural use. Splitting tensile strengths of concrete mixes showed a similar trend to the compressive strengths, and were within 2.44– 5.51 MPa at 28 days. Utilization of FA in SCC had a better influence on its tensile strength than POFA.

Alnahhal F M, et.al (2018), investigated POFA as a cement replacement at 0%, 30%, 50%, and 70% to produce sustainable self compacting concrete. The Mechanical and the durability properties were analyzed Test results showed that the fresh properties of all concretes containing POFA were ranged within SCC requirements. The mechanical properties exhibited a reduction in the early ages of POFA concretes; however, with increased curing time, these properties were significantly improved. SCC incorporating POFA exhibited significant resistance against rapid chloride permeability test and elevated temperature, and performed better than the control SCC. In general, POFA exhibited significant potential use as a cement replacement in self-compacting concrete. Finally they conclude that Self-compacting concrete can be produced by incorporating POFA up to 70% without an adverse effect on the fresh properties which were well within the range specified by the EFNARC code for SCC.

2.2 Fiber Reinforced Self Compacting Concrete

Abdullahi O, et.al (2016), an investigation of the mechanical properties and durability aspects of steel, synthetic, and hybrid fiber-reinforced self-compacting concrete exposed to early wet/dry cycles are presented and discussed. The experimental program consisted of two phases. Phase I involved tests on specimens for workability, mechanical properties, Rapid Chloride Penetration (RCP), and Scanning Electron Microscopy (SEM). The evaluation of mechanical properties included compressive, flexural and splitting tensile strengths, and modulus of elasticity. In Phase II, specimens were exposed to wet/dry cycles, and the effect of moisture on mechanical properties was investigated. All mixes containing fibers achieved adequate flowability, filling ability, and segregation resistance. Nonetheless, synthetic fibers reduced the passing ability of SCC more than steel fiber. This is attributed to the higher surface area and aspect ratio of synthetic fibers compared to steel fibers at a similar volumetric ratio Subjecting FRSCC to wet and dry cycles for 21 days provided an improved hydration process.. Fibers had a negligible effect on the compressive strength and modulus of elasticity of SCC. The flexural and splitting tensile strengths of all FRSCC were higher than that of the control mixture.

Dalvand A, et.al (2017), analyzed the results of extensive experimental tests on the fresh and hardened properties of self-compacting concrete reinforced with hybrid polypropylene (PP) fiber and recycled steel fiber (RSF) in different fiber volume fractions. Mix compositions were reinforced with different combinations of hybrid recycled steel fiber (0.35, 0.7 and 1.05%) and PP fiber (0.35 and 0.7%). In order to assess fresh state properties of mix compositions, flow slump diameter, T500, are used. Considering different combinations of hybrid fibers, the hardened properties of different mix compositions were characterized using 36 cubes. Compared to addition of PP fiber, adding RSF had a higher impact in increasing compressive strength.

Anand S, et.al (2016), analyzed the collected data and conclusion of the various studies done on the strength properties of steel fibered self-compacting concrete. Addition of Steel fibber at certain limit improves compressive strength and not only suppress the formation of cracks, but provides more strength. Steel Fibers have been added to hardened state. Fiber reinforced concrete becomes necessary whenever durability that is limited crack widths or safety considerations are design criteria. Compressive strength increases with increment of steel fiber in SFR-SCC. Workability slightly decrease with increase of steel fiber in SFR-SCC Flexural strength increases with increment of steel fiber in SFR-SCC Tensile strength increase with increment of steel fiber in SFR-SCC. Self-compacting concrete is simple and user friendly.

Hari R., et.al (2019) explained the idea of strengthening concrete with fibers. Bridging and arresting of crack propagation by addition of fiber significantly reduced dry shrinkage characteristics. The stress-strain relationship of hardened concrete shows better results when fibers are incorporated. The ductility is considerably increased with fibers. Fresh stage concrete tests like Slump flow test, T50 test, V funnel time test and L Box test have been conducted on the fresh concrete to assess the workability parameters of SCC after addition of different fibre combinations. Test results show that the increase in fibre volume reduces the workability as a result of moisture absorption by hydrophilic natural fibres Flowing ability is also considerably reduced at higher fiber volume fractions The maximum permitted fibre volume for the control mix in terms of workability is 0.375%. The results have revealed that an increased fibre volume results in reduced compressive strength. The decreased compressive strength has been inferred due to the heterogeneity of mix at higher fibre volume .A small volume fraction of 0.1% can enhance the compressive strength. Splitting tensile strength is found to set out a better performance compared with plain concrete. Split tensile strength increases with an increase in fibre volume.

Fashandi H., et.al (2019) suggests a new application of synthetic fiber-based floor covering materials in concrete to reduce the rate of disposal and protect environment through its contribution in cleaner environment and production. By the use of mechanical methods, the face yarns of post-consumer carpets can be recycled into short fibers for applications such as reinforcing materials. The physical and mechanical properties of lightweight concrete which is made from modified needle-felt carpet waste cuttings are studied. The compressive strength is reduced by increasing the content of carpet waste. Incorporation of carpet waste with weight fraction of 1.0%, 2.0% and 3.0% results in reduction in compressive strength of concrete by 5.39%, 8.48% and 14.13% respectively. Irrespective of carpet waste content, the compressive strength of all prepared samples is still higher than the minimum compressive strength requirement for a structural concrete, i.e. 17.24 MPa for 28 days cured sample. The control concrete without carpet waste cuttings exhibits brittle behavior with a deflection capacity below 0.5 mm. After the addition of carpet waste the brittle concrete has been transformed into a ductile concrete due to the bridging ability of carpet waste in resisting against opening of emerged cracks. Because of its fibrous structure, they can effectively bridge the cracks emerged around them and avoid sudden decline of flexural load.

2.3 Waste Carpet Concrete

Awal A.S.M.A., et.al (2016) evaluated the mechanical properties of concrete containing Palm Oil Fuel Ash and waste carpet fibers.Fiber reinforced concrete (FRC) is a conventional concrete mix that contains cement, coarse and fine aggregates and a dispersion of discontinuous short fibers that are randomly distributed in the fresh concrete mix. The fibers improve the ductility, energy absorption and tensile and flexural strengths of concrete mixture. Various types of fibers, either polymeric or metallic, are generally utilized in the concrete mixture for their benefits. The most common fibers used in FRC are glass fibers, steel fibers, synthetic fibers such as nylon and polypropylene (PP), natural fibers and fibers from pre and Post consumer wastes. the addition of fibers at 0.25%, 0.5%, 0.75%, 1% and 1.25% volume fractions decreased the compressive strength by 6%, 7.5%, 11.15%, 18.06% and 21.23%, respectively at the age of 28 days. Further reductions in compressive strength of 13.45%, 10.23% and 3.22% compared to the OPC concrete were observed in concrete containing 20% POFA for the curing times of 7, 28 and 91 days, respectively. In fibrous mixtures containing POFA and 0.5% fiber, such as B9, the compressive strength values decreased by 18.2%, 16.3% and 5.4% compared to that of OPC concrete having the same amount of fiber for the curing times of 7, 28 and 91 days, respectively. the tensile strength of mixtures with OPC alone at the age of 28 days increased by 17.4%, 25.5%, 26%, 20.2% and 16.1% compared to that of plain concrete without fiber for the WCF contents of 0.25%, 0.5%, 0.75%, 1% and 1.25%, respectively. The combined effect of POFA and WCF was revealed, and a 13.4% increase in flexural strength was observed for 0.5% fiber compared to non-fibrous concrete containing 20% POFA.

3. CONCLUSION

The Flexural strength and split tensile strength are increased due to the increasing amount of Waste Carpet Fibres. Palm Oil Fuel Ash develops its later age's strength faster than that of ordinary concrete. Incorporation of waste carpet fiber generally reduced the compressive strength of concrete mixtures irrespective of POFA content. With the increase in the curing period, say at 91 days, the reduction in strength development dropped down. It is the pozzolonic behaviour of POFA that contributed to the strength development of concrete with the increase in curing period. The water absorption tests showed that the combination of carpet fiber and POFA had a great significance in the reduction of water absorption in the concrete composite, particularly at longer curing period. The 10% POFA replacement showed a 10 % decrease in compressive strength of concrete compared with control concrete. Addition of Carpet waste at 1% mass of cementitious material showed a decrease in density of 4%. Carpet waste can be incorporated at smaller volume fractions in concrete. Hybrid Fiber Reinforcement enhances the split tensile strength and flexural strength of concrete

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