A Study On Mechanical And Durability Properties Of Interlocking Fly Ash Based Concrete Paver Block Using Different Types Chopped Fibers.

Gitanjali Maharana[1], Biswajit Jena[2], Sagarika Panda[3*]
[1] Student of M.Tech Transportation Engineering, Centurion University of Engineering and Management studies, Odisha
[2] Asst. Prof. of Civil Engineering Department, Dhaneswar Rath institute of Technology and Management, Odisha

[3]Asst. Prof. of Civil Engineering Department, Centurion University of Technology and Management, Odisha

Abstract: ***In these days concrete paver block turned in to a component of towns and urban areas. It is to be locating in residential, commercial and industrial areas like as shopping malls, parking areas, footpaths, transport stops etc. The aim of this thesis is to construct paver block by using cement is replaced by different percentages of fly ash and various types of fibers. There are the motive behind using of fly ash in concrete to improve the durability and strength of harden concrete and fly ash also cost effective. In this thesis also discussed about the various types of chopped fibers which used in paver blocks like nylon fiber, steel fiber, coconuts fibers, glass fibers, polypropylene fibers etc for improving strength of paver blocks. The other materials have composed to design paver blocks like OPC 43 Grade cement, fine aggregate and coarse aggregate for concrete mixture. The curing process of paver block has done for 7days, 14 days and 28days. After curing days it is tested for compressive strength.***

Keywords: OPC 43 Grade cement, Chopped fibers, Compressive strength, Fly ash, Aggregates, Paver blocks, Curing process.

I. INTRODUCTION

Interlocking concrete paver block have been using in India a decade ago. For most necessity of paver -block in footpaths and parking zones, but now day's broadly apart uses where the construction of pavement using hot bituminous mix or cement concrete technology is not possible or advantageous. Concrete block is used now alternative pavement to asphalt and concrete pavements. Now these present times there has been investigating the characteristics of various fibers using in paver block to increases strength, durability and reduction in cracks. Advantages of paver block are low maintenance and cost effective. The recent experimental studies about fiber using in paver block found that the compressive strength and flexural strength increased .For this benefits it can be used in heavy traffic area and give surface resistance for long life. By using of fibre to design paver block that give the the best result to improve the quality of constructions and like pelting asphalt and concrete not cheaply crack and break use of fiber.

II. LITERATURE REVIEW

As concrete is second most consumed commodity in the world which generates a large amount of carbon dioxide and is responsible for global warming. Huge production of conventional concrete for infrastructural development also leads to probability of difficulties of getting raw materials in future. So, research is going on for sustainable material for green concrete. Study shows that replacing cement partially or fully can be a ecofriendly approach which also reduces carbon emission, caused due to cement production. Concrete can be produced by replacing concrete with fly ash [4,20], red mud [25], silica fume [15,17], rice husk, metakaolin, blast furnace slag. Geo-polymer masonry can be a sustainable building material which is produced by complete elimination of cement or partial replacement of cement with industrial wastes like fly ash, blast furnace slag as binders [1,13,14,16,22,23,26]. Mass reduction of GPC block with quarry dust at the end of 84 days is found to be 0.72% due to hydrochloric acid resistance [2]. Fly ash combines with alkalis from cement that might otherwise combine with silica from aggregates, prevents destructive expansion, hence durability increases [3]. Addition of fibers may be natural [1,2,5,18] or synthetic [4,6-9,21,24], in designed concrete generally not much have effect on compressive strength but flexural strength increases [1]. Addition of polypropylene fibers in paver block enhances the abrasion resistance and flexural strength of paver blocks compared to standard paver block and reduces the maintenance cost of paver block. Also, it's helpful to improve the life span of paver block [4].

III. METHODOLOGY

There were discussed about methodology of different fibers below mentioned with required methods:

3.1. MATERIAL:

To design the paver block with different types of fibers the usual materials used like fine – aggregate of 20mm size, coarse aggregate, cement (OPC of grade 53), fly ash and water. The additional materials like semi grit less than 9.5mm particle, dolomite powder, pigment and quarry dust having size less than 4.75mm was used in coconut fiber paver block. At the content of glass fiber the other materials have used like Sikament FF liquid as admixture used in concrete. In case of polypropylene fiber, Sodium hydroxide and Sodium silicate have used. In nylon fiber have no additional materials. [1] [4] [8] [11]

3.1.1. COCONUT FIBER: Coconut fiber is a natural fiber, when it added to the concrete it increases the many properties of concrete like compressive strength, flexural strength, split tensile strength of concrete and also reduce the cracking. Coconut fibers are easily available with large amount and also very cheap. [1] [2] [3]

Figure (1) – coconut fiber

Table 1 Properties of coconut fiber

Material Specification								
Physical properties of Cement		**Aggregates**		**Other Materials**			**properties of coconut fiber**	
		Fine aggregate						
Specific gravity	3.05	Specific gravity	2.5	**Semi grit**	Fineness modulus	3.148	length	6 mm
Consistency limit	27%	Fineness Modulus	2.93	**Quarry dust**	Fineness modulus	4.266	Diameter	0.01mm
Initial setting time	45min	Water absorption of aggregate	0.097%	**Dolomite powder**	Specific gravity	2.84 to 2.86		
Final setting time	4 hr45min							

3.1.2. GLASS FIBER: Glass fiber is a material consists of various fine fibers of glass. The use of glass fiber in concrete is to improve flexural strength. Glass fiber can use replacement of standard steel reinforcement in concrete. The advantages of Glass fibers to improve the matrix densification, reducing of voids, minimize cracking due to stresses and improve the durability to reinforcement corrosion [4] [5] [6].

Figure (2) – Glass fiber

Table 2 Properties of Glass fiber

Material Specification									
Physical properties of Cement		**Chemical properties of fly ash**		**Aggregates**				**Physical properties of glass fiber**	
				Fine aggregate		**Coarse aggregate**			
		Chemical	**Percentage**						
Specific gravity	3.14	SiO2	61.24	Specific gravity	2.62	Specific gravity	2.66	Diameter µm	12
Consistency limit	33%	Al2O3	25.00	Fineness Modulus	3.034	Water absorption value	0.45%	Specific Gravity	2.60
Initial setting time	140 min.	Fe2O3	8.71	Grading Zone IS II.		Impact Value	26%	Elasticity, (GPa)	80
Final setting time	310 min.	Na2O	0.09					Tensile Strength (GPa)	2.5

3.1.3. **NYLON FIBER**: The melt – processed of nylon is nylon fiber. It is a Thermoplastic silky material. There is various products manufactured used of nylon fiber like rope, carpet, clothes, tires etc. The used of fiber in concrete improved the durability of concrete. The addition of nylon fiber with various proportions in concrete, give the effects on compressive strength, tensile strength and workability etc. [8] [9] [10].

Figure (3) – Nylon fiber

Table 3 Properties of Nylon fiber

Material Specification									
Physical properties of Cement		physical properties of Fly ash		Aggregates				Physical properties of Nylon fiber	
				Fine aggregate		Coarse aggregate			
Specific gravity	3.15	Specific gravity	2.50	Specific gravity	2.56	Specific gravity	2.75	Diameter µm	0.30-0.40
Consistency limit	33%	Fineness Modulus	2.7	Fineness Modulus	3.29	Fineness Modulus	7.44	Cut length	6-12mm
Fineness Modulus	3.8			% moisture	4.7	Impact Value	15.65 %	Density	1.15 g/cm3
						Water absorption	1.4%	Melting Point	190-350^{0}C

3.1.4. POLYPROPYLENE FIBER: Polypropylene is a thermoplastic polymer used in variety applications. It also known as polypropylene. Polypropylene is the best fiber for its better performance in industrial and construction field. The use of different proportion of fiber in concrete mix improve the compressive strength, splitting tensile strength and mechanical properties of concrete. [11] [12] [13]

Figure (4) – Polypropylene fiber

Table 4 Properties of Polypropylene fiber

Material Specification									
Physical properties of Cement		physical properties of Fly ash		Aggregates				Physical properties of Polypropylene fiber	
				Fine aggregate		Coarse aggregate			
Specific gravity	3.17	Specific gravity	2.35	Specific gravity	2.7	Specific gravity	2.67	Diameter µm	0.03-0.04mm
Consistency limit	37%	class	F					Cut length	6-12mm
Initial/ Final setting time	60 min./450 min							Melting Point	150-160^{0}C

3.2. MIXING AND CASTING THE SPECIMENS:

3.2.1. COCONUT FIBER: In the bottom layer of paver block the concrete contains cement, fine aggregates, quarry dust and in the top layer of paver block the materials used like mix of cement, semi grit, dolomite powder and fly ash. The 20mm coconut layer is to be added in top layer with the concrete proportion of 0.1%, 0.2%, 0.3%, 0.4% and 0.5% depend on the weight of concrete. The wet purpose of water only added in the mix at casting time. After 24 hours the specimens placed to water curing process 7, 14, and 28 days. [1]

3.2.2. GLASS FIBER: The mix proportion of glass fiber paver block have designed M35 grade as per IS 15658:2006. At the start the percentage of glass fiber from 0.1% to 0.4% per the weight of cement added in mix and 10 to 40 percentage of fly ash added to the mix replacement of cement. The casting and testing procedure have done by two stages. In first stage the paver blocks are casted mix with glass fibre and placed to water for curing age of 7 and 28 days.

3.2.3. NYLON FIBER: There are two methods used for precast concrete.

a. Wet mix
b. Dry mix

In wet mix, concrete was compacted in the mould but in dry mix first the semi dry cohesive concrete mix then placed to mould but not immediately compacted. After compacted the concrete mix putout from the mould. In this theory M20 concrete mix used. Cement was replaced by fly ash with percentage of 10%, 20%, 30% and 40%.

3.2.4. POLYPROPYLENE FIBER: In this study the paver block was also designed as per standard of IS 15658:2006. The crushed stone of granite used as coarse aggregate and quarry sand used as fine aggregate. Tap water was used for mixing and curing process. Fly ash was used replacement of cement and activator alkaline solutions were used replaced of water. Activator alkaline solution is specially used polymerization process. Polypropylene fibers were mixed in the concrete with different percentages from 0.1% to 0.5%.

3.3. TESTING OF THE SPECIMENS:

3.3.1. COCONUT FIBER: There were three types of tests compressive strength test, flexural strength test and water absorption test done in this study. For compressive strength compressive machine and for flexural strength universal testing machine was used. All tests determined according to the standard of IS 15658:2006. For every test three cubes ware tested and from the result the average value was taken.

3.3.2. GLASS FIBER: The load was applied in compressive strength without flick and the load enhanced consecutively at a rate of 15 +/- 3N/mm2/min until the found of greater loads.in flexural strength test the load was applied without flick and load increased consecutively at a rate of 6 KN/min. In the first stage the result was determined with different percentage of glass fiber but in second stages the result was determined with different percentage of fly ash added wit glass fiber. All the tests were conducted as per IS 15658:2006.

3.3.3. NYLON FIBER: There was only compressive strength test was conducted in this study. After cured days the test was conducted. For test three cubes was taken and the average strength value was reported from the test result.

3.3.4. POLYPROPYLENE FIBER: Concrete specimens were tested three times at 3,7 and 28 days. Another three tests were abrasion resistance test was conducted at 28 days, flexural strength test at 28 days and water absorption test at 24 hours.

3.4. RESULT:

3.4.1. COCONUT FIBER: The compressive strength increased from 1.22% to 6.81% with the enhanced of fibers from 0.1% to 0.3% at the curing age of 28 days. The increased of flexural strength from 2.55% to 14.65% with added of fibers from 0.1% to 0.5% respectively. By the changing of top layer, thickness from 10 mm to 40mm the strength was increased successively.

3.4.2. GLASS FIBER: The addition of 0.2% optimal fiber by weight of cement and inclusion of glass fiber, the compressive strength of paver block increased. As the curing age of 28 days added 0.2% fiber, increased of compressive strength 10.52%. There was 90.31% cost decreased compare to the each unit of paver block. On the replacement of cement with 20% fly ash and addition of 0.2% glass fiber.

3.4.3. NYLON FIBER: After the completed compressive strength test, noticed that the strength was increased by the addition of 0.3% nylon fiber and 20% fly ash. The strength was increased during the curing age of 7, 14 and 28 days.

3.3.4. POLYPROPYLENE FIBER: It significant that the use of polypropylene fibers in geo-polymer concrete increased the flexural, abrasion resistance and compressive strength. The inclusion of 0.2% Polypropylene fiber in paver block the abrasion result at age of 28 days increased up to 45%. By the weight of 0.4% Polypropylene fiber was added to the geo-polymer concrete the flexural strength and compressive strength highly increased.

IV. CONCLUSION

Study about inclusion of various types of fibers in concrete, shows that strength as well as durability increases. In addition to that fly ash, which was harmful to the environment if dumped openly, can be used as replacement of cement partially or fully. Fly ash in concrete enhances its strength, durability, mechanical properties. Hence the use of cement in concrete decreases which

ultimately reduces cost, as well as carbon footprints of structure. So production of concrete for pavers with flyash and fibres is a economical sustainable approach.

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