Strength of Corrugation in Roofing Sheet with Various Fibres

A.Sivakumar, G. Dhanasekar, L.madhumitha, V. Parthiban

Abstract: ***Due to tearing out at its corrugations because of high wind and impact loads most of the corrugated roofing sheets have damaged. By using fibre reinforcement the strength of these sheets can be improved. The fibres play the role of crack arrest and absorb energy. In this research paper the fibre namely polyester, glass fibre, coconut coir fibre and fly ash are used as reinforcement in cement matrices for producing corrugated roofing sheets and it has been investigated and reported. These roofing sheets were cast by hand and the strength of the corrugations of the sheets in terms of splitting due to water absorption test, impact load and flexure test were experimentally evaluated. It is identified that the strength of the fibre sheets due to buckle strength and impact loads increased as compared to the corrugated sheets without fibres. This study has shown that asbestos can be replaced by these fibres, in the fabrication of corrugated roofing sheets.***

Keywords**: *Corrugation, Fibre, Roofing, Impact load, Strength***

I. INTRODUCTION

Among all the developing and developed countries, there is a high range demand for roofing products. Most of the roofs are mainly made of locally available materials such as stone, lime, palm leaves etc. Roofing products made using these materials require huge maintenance and are affected severely when exposed to heavy rain. The cost of roofing materials plays a major expense for individual home builders [6]. More than one number of constituent materials having various physical and chemical properties combined to form composite materials. Composites are formed by matrix resins and reinforced fibres. The surface-modified in case of jute fibre improved the adhesion properties of the upper surface with the matrix [9]. The composite materials have that superior property to resist high tensile force to weight ratio are replacing the traditional materials nowadays. When compare coir composites with groundnut fibre, coir composite fibre better in mechanical properties [5].

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The compression moulding process was used to jute fibre polypropylene reinforced composite production. From the end of this investigation reveals that 40% weight of jute fibre reinforced polypropylene composite has high tensile strength. Natural fibres are preferred over man-made fibres [13]. Natural fibres like coir, jute, and bamboo used in concrete can have advantages the same as that of other fibres. Use of these composite fibres it improved over 25% of impact strength and improved the ductile property of 50% to 70% compared to normal concrete without any fibre [14]. Coir fibres are identified to withstand a greater percentage of the initial strength compared to other all fibres under the different medium of exposures [15]. The coir fibre cement boards are manufactured with the mix ratio 70:30 of cement and coir fibre. Before conditioning the extracted fibres were immersed in water, mixed and combined with pre weighted cement. Then it gets pressed and trimmed. Asbestos fibre as a reinforcement in cement materials caused lung cancer when exposed to the atmosphere. To overcome these effect fibres are used instead of asbestos. The water absorption of fibres was too high due to the presence of impurities and results in a high water-cement ratio. Natural fibres should be cleaned before use and Portland cement hydration products have high pH values which make natural fibres more brittle in mortar. The use of a 40% replacement of pozzolanic materials improved the ductility property and reduced the water demand [4].

II. MATERIALS USED

A. Cement

The cement which is used in construction are commonly inorganic with calcium silicate or lime-based and depending upon the ability of the cement to set in the presence of water can be characterized as being either hydraulic or non-hydraulic. Non-hydraulic cement such as Portland cement set and due to a chemical reaction between the water and dry ingredients it becomes adhesive. The chemical reaction in mineral hydrates that are quite durable in water which is safe from chemical attack and are not good water-soluble. This permits to set roofing sheets even in wet or underwater condition and also, it resists chemical in hardened concrete. By using volcanic ash (pozzolana) with added lime (calcium oxide) ancient Romans found the chemical process for hydraulic cement. Portland Pozzolana cement was used in this study and as per IS 4031:1991 different tests were conducted and as per IS 1489 (part-1):1991 specifications the properties of cement were confirmed.

B. Fine Aggregate

Manufactured Sand is also a type of sand manufactured from crushing of stones especially a granite stone in essential grading which nowadays acts as a replacement material for river sand. The manufactured sand has physical properties such as shape, consistency and smooth surface textures which make the sand apt for construction and M-Sand has required gradation offiness. The physical properties of manufactured sand add greater strength to the concrete by decreasing bleeding, segregation, voids, capillary and honeycombing. The voids between the coarse aggregates can be filled by using the necessary grade of sand and this makes concrete more dense and compact, in this way expanding the quality of cement. Since produced sand (M-Sand) is prepared from the chosen nature of the rock, it has the fair physical and compound properties for the development of solid structures. This property of M-Sand enables the solid structures to withstand extraordinary natural conditions and anticipates the consumption of fortification steel by diminishing porousness, dampness entrance, and stop defrost impact expanding the sturdiness of solid structures.

C. Water

Water is one of the ingredients of concrete. It is usually less expensive and testing it frequently to be ignored. Water is required for hydration and forgetting proper workability. All waters are not suitable for making of concrete. Water used for concrete should be clean, clear and free from injurious amounts of materials like salts, oils, acids, alkalis, sugar and organic materials. Portable water is generally considered fit for concrete. In the present work, faucet water was used for both mixing and curing purposes.

D. Fibre

The introduction of fibres was introduced as an alternative to developing concrete to improve its flexural and tensile strength. It is also known that the basic governing principles between conventional reinforcement and fibre system are identical, there are several characteristics difference; such as – fibres are generally short, closely spaced and scattered throughout a given cross-section. With the development of synthetic fibre, synthetic macro- fibre (fibre's, the diameter is larger than 0.1mm is defined as macro-fibre) has been widely using in civil engineering. In this study fibres like polyester, glass fibre, coconut coir and fly ash were used in this investigation.

E. Polyester

Polyester is otherwise called "long-chain polymers synthesis of synthetic concoctions about 85% load of an ester and a dihydric liquor and a terephthalic corrosive". Polyester is otherwise called "long-chain polymers and organization of synthetic substances about 85% load of an ester and a dihydric liquor and a terephthalic corrosive". It is also defined as the linking of fibres with several esters. The reaction process is done between the carboxylic acid with alcohol results in the form of an ester. Polyester is a fibre made by man. It additionally alludes to the different polymers where the spines are shaped by the "esterification buildup of polyfunctional liquor and acids". Polyester can be delegated immersed and unsaturated polyesters. Immersed polyesters allude to that group of polyester where the polyester spines are soaked .they are in this manner not as receptive as unsaturated polyester. They comprise of low sub-atomic weight fluids utilized as plasticizers and as reactants in framing urethane polymer, and straight, high sub-atomic weight thermoplastics, for example, polyethene terephthalate. Regular instigators for the soaked polyesters are glycol and a corrosive or anhydride. Unsaturated polyesters allude to that group of polyester where the spine comprises of alkyl thermosetting gums described by vinyl unsaturation. They are most generally utilized as an efficient group of pitches.

F. Glass Fibres

Glass fibre is also named as fibreglass. By using fine fibres of glass fibreglass this material is made and it is extremely strong lightweight and robust material. When glass fibres compared to carbon fibre the strength properties are less than that of carbon fibre. The raw materials are less expensive and less brittle. Its bulk weight and physical properties are also very grateful when compared to other materials like metals and it can be easily formed by moulding processes. Glass is one of the well-known, good performance and ancient fibre. From 1930 itself those fibres have been manufactured from glass.

G. Coconut Coir Fibres

Coconut fibre is produced using the external shell of a coconut. It is the normal fibre of the coconut husk where it is a thick and coarse yet sturdy fibre. Coir, coco'snucifera and palm are the common name, scientific name and plant family of coconut fibre. There are two sorts of coconut fibre, a dark coloured fibre removed from developed coconuts and white filaments extricated from youthful coconuts. Dark coloured strands are solid, thick and have high wearing opposition while white filaments are smoother and better, yet also more fragile. Both white and dark coloured comprise of strands extending long from 4-12 in (10-30cm). Those filaments which have at any rate 8 in (20cm) long are known as fibre. Shorter strands those that are better in a surface, are known as sleeping pad fibre. Ventures dependent on coir have created in numerous coconut delivering nations particularly India, Tanzania, Kenya, Bangladesh, Burma, Thailand, Srilanka, Nigeria and Ghana and so on. Green coconuts that are collected following six to a year on the palm, contain white filaments and darker strands are accomplished by reaping completely develop coconuts when the nutritious layer encompassing the seed is prepared to be handled into the parched coconut. By manually the fibrous layer of the fruits were separated from the hard shell through the dehusking process. Within a day driving husker can have the capacity to separate 2,000 coconuts manually. But within an hour machine can separate up to 2000 coconuts which are present nowadays. They crush the entire fruit to give the loose fibres.

H. Fly Ash

Fly fiery remains is a decent material for a wide scope of utilization through assembling of bond, substitute of concrete in solid, production of blocks, material sheets, tiles, and so forth it is profoundly helpful as a geotechnical material for development of dyke and recovery of low lying zones, filling of underground, open mines, use in farming and recovery of corrupted/Badlands, and so on the pozzolanic property joined with lime reactivity makes it extremely fitting for restricting applications. Its geotechnical property makes it a decent substitute of soil and the nearness of required level of silica, alumina and iron oxide and so forth makes it appropriate for sintered applications.

Due to very low levels of heavy metals, radionuclides and toxic elements in fly ash is suitable for various application and its physical and chemical properties being very close to the range of common soils as well as it is very safe.

III. METHODOLOGY

I. Casting Procedure

A plywood mould was prepared to cast the specimen. The size of the mould was 610 x 610 x 12 mm. Conventional corrugated AC sheets available in markets were used to corrugate the specimen. Materials such as Portland pozzolana cement, M-sand, fibre and water ratios were mixed manually to manufacture the composites. Fibre and mineral admixture were both 0% to get a control sample. The mortar prepares with a 1:2 ratio while water to cement was 0.5. For the specimens which subject to test, coconut coir fibre, fly ash, glass fibre and polyester fibre were incorporated at the rate of 0.5%, 1% and 1.5%. The accompanying system was embraced while setting up the test example. An embellishment edge is kept over a Lamination sheet and those two are kept on the level surface. A plastic sheet is put in the middle of the edge and, to give a smooth surface to throwing and for simple remoulding. The crisply blended mortar was deliberately put inside the shape edge and spread to cover the whole territory, and appropriately levelled. The mortar blend was spread into a uniform thickness. The trim edge was evacuated cautiously and the level formed mortar example was delicately set over a folded ACC sheet. Supervision ought to be taken to affirm that the level formed mortar example comes over the valley of the 'ridged ACC sheet' with the goal that the wet or green mortar won't slide down. A PVC pipe having its diameter equal to the dimension of the valley was rolled over the wet mortar specimen in the valleys and the ridges after shifting of the moulded mortar to form corrugations. Finally, by using a trowel the surface of the sheets was finished as smooth. Then it was subjected to dry for 1 day and 28 days it was cured.

Fig1. Stages of casting corrugated sheets

IV. TEST AND TEST PROCEDURES

J. Splitting Test on the Corrugated Sheet

Roofing sheets are subjected to various tests so that these sheets are expected to fulfil the desired properties. As well as the weight of the sheets also concerned, it should be light in weight so that the building does not subject to heavy dead load from the sheets. For good indoor climate of the building heat resistance and good thermal properties be afford. To find the strength and load-carrying capacity of sheets flexural strength A portion of these properties of sheets are flexural solidarity to test the quality and burden conveying limit of sheets; water ingestion nature of sheets to oppose the infiltration of water through the structure. The test specimens were subjected to water absorption, flexural strength and impact strength to split the corrugations.

K. Flexural strength test on the corrugated sheet

As per the specifications mentioned in IS: 654-1992 (tests on Mangalore pattern tiles) the flexural strength tests was arranged [6]. Over a simply supported span of 400 mm by a mid-line load the corrugated sheets are subjected. In natural dry condition, these sheets were tested. A 50KN proving ring was used to measure the load. The load was gradually applied to it until the specimen subjected to failure.

L. Water absorption test

By using the oven the tiles are dried out at constant 600C and then put in water for 24 hours. The difference in weight is calculated and given as a percentage of tiles dry weight. The water absorption of cement concrete should be less than 6% of its dry weight.

Water absorption = [(A – B)/B] x 100%

Where, A = weight of specimen after 24 hours immersion

B = weight of the dry specimen

V. RESULT AND OBSERVATION

Table 1. Compressive strength of Cubes prepared with Cement Mortar 1:2

S.No	Sample type	Sample %	Compressive strength		
			7 Days	14 Days	28 Days
1	Cement sheet	0.5	14.1	15.8	19.7
		1	14.5	15.8	20
		1.5	14.4	15.7	19.9
2	Polyester fibre	0.5	19	22.2	24.3
		1	19.2	20.8	23.1
		1.5	18.9	20.5	22.9
3	Glass fibre	0.5	20	27	34.7
		1	19.8	23.7	31
		1.5	19.5	23.5	31
4	Coconut coir fibre	0.5	18.5	19.7	22
		1	18.9	20	21.6
		1.5	18.4	19.6	21.5
5	Fly ash	0.5	13.4	16.9	18.9
		1	13.8	17.5	21
		1.5	13	17.1	19.7

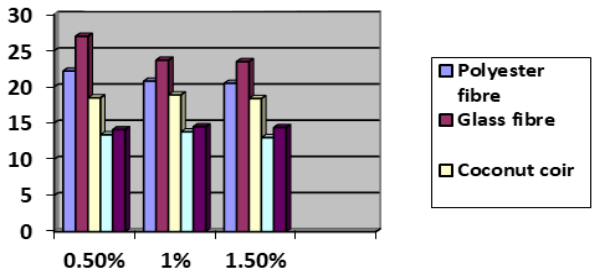

Fig.2.Compressive strength of cubes prepared by Cement Mortar

Table 2. Water absorption results of corrugated roofing sheets

S.No	Type	Water Absorption
1	Cement sheets	3.08
2	Coconut coir fibre	6.84
3	Polyester fibre	5.41
4	Fly ash	3.00
5	Glass fibre	1.03

Table 3. Impact test of corrugation of roofing sheets

S.No	Type	Impact Values		
		0.5 %	1 %	1.5 %
1	Cement sheets	1.04	1.2	1.28
2	Coconut coir fibre	1.35	1.47	1.55
3	Polyester fibre	2.00	2.04	2.23
4	Fly ash	1.22	1.15	1.41
5	Glass fibre	1.10	1.329	1.46

Table 4. Flexural load of corrugation of roofing sheet

S. No	Sample Type	Flexural Load (Kg)			
		Sample			Average
		1	2	3	
1	Cement sheet	154	190.2	210	184.73
2	Polyester	306	215.45	275.18	265.54
3	Coconut coir	315	245.46	299.89	286.78
4	Glass fibre	229.5	187	161.5	192.66
5	Fly ash	136	142	158.24	145.41

VI. CONCLUSION

From this project, based on the investigational results we have drawn the following conclusions. Polyester, Coconut coir fibre, Glass fibre and Fly ash of 0.5%, 1 and 1.5% are added to 1:2 cement mortars and compressive strength of the mortar is found out experimentally. Polyester fibre shows higher compressive strength at 0.5%, Coconut coir fibre shows higher compressive strength at 0.5%, Glass fibre shows higher compressive strength at 1% addition of fibre. The Flexural strength of the specimen is increased by using a Coconut coir fibre. Polyester fibre shows less Flexural strength compared to that of Coconut coir fibre. Fly ash shows a lower strength than the other fibres. The water absorption value of tiles is 6% and it is within the standard value. The water requirement decreases due to the addition of fibres for a given mix. Glass fibres show higher Impact strength, Flexural strength than the other fibres at 1%.

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