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Strength of Corrugated Roofing Elements Reinforced With Coir

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Abstract - *Roofing is the most important and costliest of all elements of the dwelling. In low cost construction, use of heavy roofing often lead to increase of cost. Engineers always look for efficient and light roofing, in order to optimize the cost of construction, which requires minimum labour to install. Asbestos sheets are widely used as these sheets are cheap and easily available. But due to its health hazards to life these sheets are constantly replaced by natural fibers and even most of corrugated sheets damaged due to heavy wind load and tearing out. In the present study, Natural Fiber namely coconut fibers are used as reinforcement in cement matrices. Roofing sheets were casted with flyash- based coir fibers and are experimentally evaluated for the strength of the corrugated sheets in terms of flexural and impact load. Flyash based coir fibre has witnessed improved result in the strength of the corrugated roofing sheets due to flexural and impact loads as compared to the corrugated sheets without coir fibers. The Result of study revealed that the flyash with coir fiber can be used to replace asbestos in production of corrugated roofing sheets*

Key Words: **Coconut Fibers, Corrugated Roofing Sheets, Flyash, Residual Impact Strength, Water Absorption.**

1. INTRODUCTION

Roof, is one of the main building element, consumes about 25% of the total expenditure of construction. Corrugated roofing system is the most preferred and widely used in ruler and industrial area. Because it allows mechanical and dry consumption methods to cover larger areas without the need for ceiling compounds to prevent leakage. ACCS & CGIS are the most accepted and extensively used roofing materials in the country. Unfortunately, many developed countries has banned from use in due to recent studies indicate that ACCS is a hazardous material from health point of view. However, there are other alternate fibers, which can be suitable for use in roofing materials. For example, sisal fibers from plants, which are available in abundant, less expensive and are harmless, and hence, can be used to develop various building products like roofing element etc. The fibers enhances the impact resistance of the concrete through bridging action leading to prevent surface cracking. Of the various pozollona, flyash is in abundance which is available in several countries and also in India. In spite of the above fact, it has use, particularly, in cement based system for the production of building resources and for other beneficial uses.

Coconut fibers / Coir are rigid coarse fiber and are being found between the husk and the outer shell of a coconut. The individual fiber cells are narrow and hollow, made with thick cellulose wall. There are two varieties of coir, namely, brown coir and white coir. Brown coir is less flexible but stronger made with lignin and cellulose which are available in varieties of ripe coconut. White coir extracted from coconut before they are ripe, which are white or light brown in colour and are smoother, finer, and also weaker.

2. MATERIAL &METHODOLOGY

2.1Materials

Ordinary Portland cement (OPC - 53 grade); Manufacture sand meeting the requirements of Indian Standard: 383. Potable water and Coconut fiber (0.1%, 0.2%, 0.3%, 0.4%) by volume of mortar; and fiber length is 15mm were the various material used. Flyash was obtained from the nearest Ultratech industry in Bengaluru, Karnataka, India. Flyash is a fine paniculate materials obtained by burning solid fuels of industrial furnaces. Depending on nature of the fuel and the size of furnaces used the properties and characteristics of flyash. Depending on the origin, chemical and mineralogical composition flyash is categorized in two categories. Low calcium fly ashes which is obtained by combustion of anthracite or bituminous coal and high calcium fly ashes from sub bituminous coal or lignite. Ordinary Portland cement is procured from the single source and stored in a air tight container till the usage. Manufactured sand confirming to zone-II was adopted, coconut fibers of required aspect ratio was supplied by coir board.

Methodology

A Steel mould of size 500 x 320 x 6 mm was fabricated to case the specimen. Commercially available corrugated AC Sheets were used to corrugate the specimen. Composites were manufactured by manual mix of coir fiber, ordinary Portland cement, sand and potable water in a mortar mixer using predestined cement, sand and water ratios. For the control sample, the fiber and mineral admixture content were both 0%. The water to cement was 0.5 while the mortar ratio was 1:2. For other test specimens, coir fibers were incorporated at the rate of 0.1%, 0.2%, 0.3% and 0.4%. Flyash was varied at the rate of 10%, 20%, and 30% as partial substitution for cement. The dosages of the fiber and pozollona added were based on the mass of cement.

The following procedure was adopted while preparing the test specimen. Initially homogenous slurry was prepared by thoroughly mixing cement with water, and then the sand was added to the slurry to make a mortar. Three sets of samples each comprising all the combination of mix proportions of dimension 500x320x6 mm were prepared to conduct strength test, water absorption test and impact test on the specimen. The sample with the desirable properties was chosen and used in the production composite roofing sheets incorporating coir and flyash to improve the ductile properties of specimen. Each mixture was stretched uniformly to a thickness of 6mm. It was then tamped for 60 seconds to reduce and eliminate voids in the composite produced. The specimen was carefully shifted on a corrugated mould as shown in figure; the mixture was surface finished with the aid of a hand trowel as seen in figure and covered with polythene. It was allowed to dry for 24 hours, and then it was cured for 28 days.

Fig -1 Preparation of Mould for casting

Fig -2 Placing materials to mould

Fig-3 Dragging of polythene

Fig-4 Allowing sheets to dry for 24 hours

3. TEST CONDUCTED

There are various test conducted on roofing sheets so that these sheets are expected to fulfill the desired properties. Some of these properties of sheets are-Flexural strength to test the strength and load carrying capacity of sheets; water absorption quality of sheets to resist penetration of water through building. Ductility property of roofing sheets is also an important aspect which determines sustainability to impact loading. As far as weight is concerned, it should be light so that it does not provide heavy load on building. Heat Resistance & good thermal properties are to provide better indoor climate of building.

The test specimens were subjected to (1) Compressive strength of mortar cubes (2) Flexural strength of corrugated sheets (3) Impact strength of corrugated sheets and (4) Water absorption of corrugated sheets, to study properties and characteristics of the corrugated coir fiber reinforced sheets in this study.

4. RESULTS & DISCUSSIONS

4.1 Compressive strength:

For 7 days, the specimen with 30% replacement is showing a higher strength in different Mix Ratio. As the mix proportion of Mortar ratio increases from 1:1 to 1:4, there is reduction in the strength of the cement mortar. The compressive strength of specimen with 20% flyash is highest among the other replacement levels of 10% and 30%.

For 28 days, the specimen with 30% replacement is showing a higher strength in different Mix Ratio. As the Cement Sand ratio changes from 1:1to 1:4, there is reduction in the strength of the cement mortar. The compressive strength of specimen with 30% flyash is highest among the other replacement levels of 10% and 20%.

The highest compressive strength is for mix ratio 1:1and lowest is for 1:4.

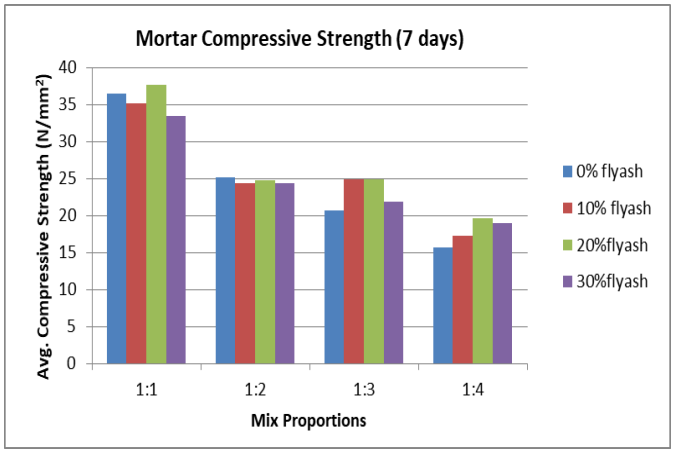

Chart -1: Compressive strength of cement mortar cubes with 0%, 10%, 20% and 30% replacement of flyash

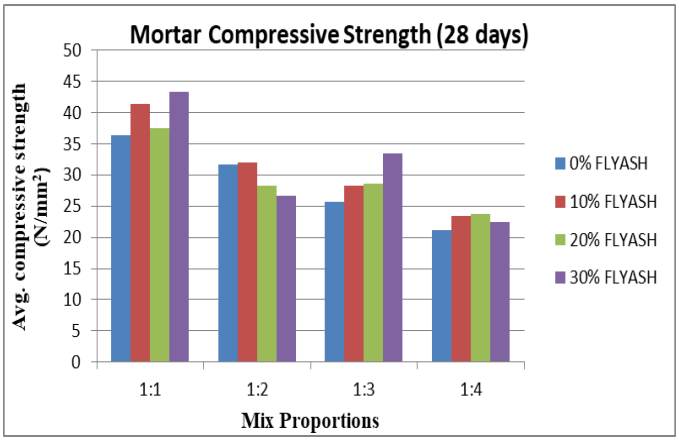

Chart -2: Compressive strength of cement mortar cubes with 0%, 10%, 20% and 30% replacement of flyash for 28 days

4.2 Bending strength:

The results of the Bending strength test on corrugations of coir fibre corrugated sheets in CM 1:2 are shown in the graph for 28 days. The specimens with 20% flyash

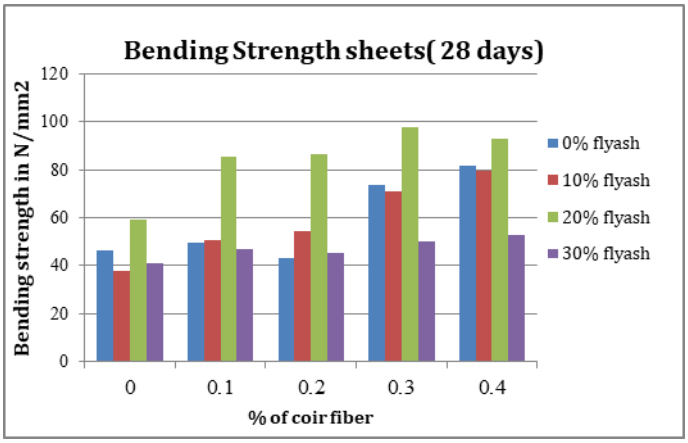

Chart -3: Bending Strength of Corrugated Sheets

Replacement is showing better strength than other replacement levels. The reference mix is showing a consistent improvement in bending strength from 58.98MPa to 97.95 MPa as fibre volume increases to 0.3%. This strength has been observed for specimens with different flyash replacement up to 30%.

4.3 Impact strength of corrugations:

The results of the Impact strength test on corrugation of coir reinforced corrugated sheets with CM 1:2 shown in the graph. At 0.2% fibre volume specimen with 20% flyash has shown to have highest residual impact strength ratio than specimens with other replacement levels.

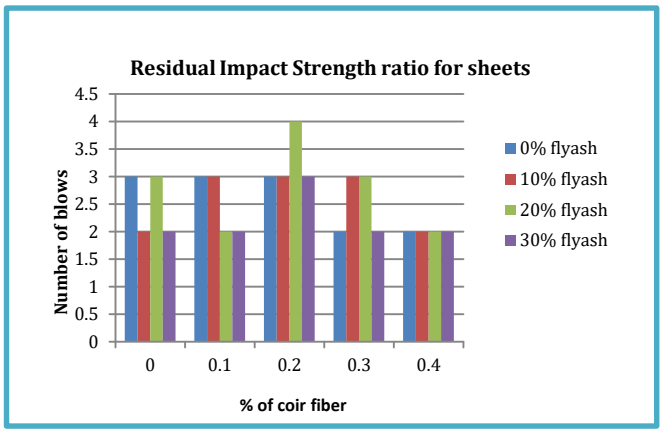

Chart -4: Residual impact Strength

4.4 Water Absorption:

It is observed that 2.9% water absorption is highest among other replacement levels. It is less than or equal to the standard specifications which states that sheets should not absorb more than 6% of water. As the graph shows that of 30% flyash with 0% fiber having least water absorption among all.

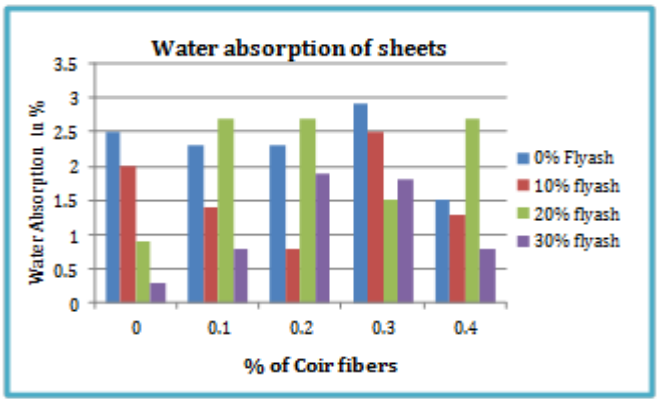

Chart -5: Water Absorption test

5. CONCLUSIONS

1. *Compressive Strength:*

- In obtaining compressive loading, all the specimens irrespective of the percentage RHA as replacement are observed to be similar.
- The specimens with mix 1:1 by volume are found to be reasonably sound in taking the compressive loading.
- For 7 days of curing, the compressive strength of all mix is found to be maximum in 20% replacement of flyash.
- For 28 days of curing, the compressive strength is found to be maximum in 30% replacement of flyash with 1:1 mix ratio and 1:3 ratios.

2. *Bending Strength:*

- In general the coir replacement of 0.4 is showing highest strength among all the other replacement of coir fibers.
- But specimens with 20% flyash replacement are better than other replacement levels.
- Fibre reinforced corrugated sheets with 20% flyash replacement is showing higher bending strength other replacement levels 0.4% fibers by volume.
- Other than 20% flyash, 0.3% fibers by volume seem to be optimum for all replacement levels giving more than 90 MPa as strength.

3. *Water absorption:*

- The water absorption of sheets is within the standard value of 6%.
- For a given mix, the water requirement decreases as the flyash content increases.
- 30% flyash with 0% fiber having least water absorption among all.

4. *Residual Impact Strength:*

- In having residual impact strength, 20% flyash 0.2% fibre mix is having higher value when compared to all specimens with flyash replacement.
- 0.4% fibers by volume is observed to give same residual impact strength ratio as that of other replacement levels as well as reference mix.

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