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NATURAL AND LOW COST ROOFING SOLUTIONS "SISAL FIBER REINFORCED CEMENT COMPOSITES " - A SUBSTITUTE OF ASBESTOS - A GREEN CHEMICAL APPROACH"

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ABSTRACT

The need for economical, sustainable and safe shelter is well pronounced globally.Numerous challenges are unaddressed to produce environment friendly construction materials which are structurally safe and durable.Roofing is one of the most important components in housing. It alone represents more than 25-30% of the total construction cost of a house.The use of asbestos fiber for making asbestos cement roofing sheet causes many health problems as it is a carcinogenic material.

There is great need to replace asbestos, the mineral fiber, by eco- friendly materials. Plant fibers are renewable, eco friendly and have good mechanical properties hence they can be an appropriate alternative to asbestos. Agave sisalana (Family: Agavaceae) yields stiff fiber, traditionally used in making twine and rope.Sisal fiber (the green material) obtained from this species is exceptionally durable with low maintenance and minimal wear and tear. The fiber is tough for textiles and fabrics. It is biodegradable too. It can establish and easily grow in every climate covering sub humid to arid and semiarid regions.

Sisal plant can survive in almost all soil types and the input costs are least for its survival, regeneration and maintenance on sustainable basis.Sisal tolerates prolonged droughts and high temperatures also. It yields parallel hard fibers.

Sisal fiber is traditionally extracted by retting, a biodegradation process involving microbial decomposition of sisal leaves, which separates the fiber from pith.The fibers are washed and processed further.This process takes 15-21 days for a single cycle of extraction and degrades the quality of fiber.The retting process is water intensive, unhygienic and not eco-friendly.

The other methods available for the extraction of fiber are chemical treatment and mechanical extraction.The mechanical extraction is the best method and done with the help of Raspador machine.This green material is easily available and eco-friendly.It will substitute the carcinogenic material, asbestos.

The green material was chopped and pulp was prepared with chemical and mechanical treatments, then reinforced with cement and the sheets prepared, a substitute of asbestos sheets.These sheets have many engineering applications.

The present proposed development may open new avenue to use sisal fiber cement sheet in buildings where presently asbestos cement sheets are used globally.

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I. INTRODUCTION

The past few years the interest in lignocellulosic fibres has increased dramatically and they are now in great demand because of their good properties. They have become the focus of attention of scientists worldwide the potential of natural fiber-based composites using cellulose, wood, jute, kenaf, hemp, coir, sisal, pineapple, etc., as reinforcing fibers has received considerable attention among scientists all over the world for their excellent specific properties as they exhibit a combination of high strength with low specific gravity [1]

Natural fibres are largely divided into three categories depending on their origin: Mineral based, Plant based, and Animal based. In general, a mineral based composite is asbestos and is only a naturally occurring mineral fibre (silicate based mineral). In 2006, 2.3 million tonnes of asbestos were mined worldwide. Russia was the largest producer with about 40.2% world share followed by China (19.9%), Kazakhstan (13.0%), Canada (10.3%), and Brazil (9.9%) [2]. The main properties of asbestos fibres are their thermal, electrical, and sound insulation; inflammability; matrix reinforcement (cement, plastic, and resins), adsorption capacity, wear and friction properties (friction materials), brake linings and chemical inertness (except in acids). Asbestos fibres are often mixed with cement or woven into fabric or mats/ sheets [3. 4]. Plant-based natural fibres are ligno-cellulosic in nature composed of cellulose, hemicellulose, and lignin, whereas animal based fibres are of proteins, e.g., silk and wool. Natural fibre-reinforced composites have attracted more and more research interests owing to their potential as an alternative for synthetic fibre composites such as glass or carbon fibre composites [5]Natural fibre composites posses the advantages such as easy availability, renewability of raw materials, low cost, light weight and high specific strength, and stiffness.

Fibre–reinforced cement composites have found several applications for housing construction such as sliding, roofing, panels etc. Roofing is generally said to be the most important construction element in housing. In many situations, roofing alone represents more than 25-30% of the total construction cost of the building [6]. In India, mostly asbestos cement roofing sheets (AC sheet) are being used as one of the major roofing elements, which cause many health problems because it is a carcinogenic material [7]. The asbestos group of naturally occurring hydrated minerals silicates has been shown to induce fibrosis, lung cancer and probably other kinds of intestinal cancer. So there is great need to replace asbestos fiber by some eco friendly materials. Natural fibers are renewable, eco friendly and have very good mechanical properties and can be an alternative to replace asbestos fiber. This paper describes the potential of Sisal Fibre-Reinforced-Cement Sheetsas a substitute of non-renewable and carcinogenic asbestos mineral fibre cement composites. Sisal fibre cement composites offer numerous advantages when compared to others fibre-reinforced cement based material because of sisal fibre has good tensile strength, locally available, and easy cultivation in all climate condition. For development of sisal fibre sheet using sisal fiber, cement, fly ash by optimising various parameters like fibre length, curing time Impact strength was evaluated. Sisal cement sheet reparability, less water absorption, impervious nature, and safety factor for human life found to be better and cost effective.

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II. EXPERIMENTAL

2.1 Material

Sisal plant (Fig. 1 a) was collected form Bhopal,and extraction of fibre from sisal leaf was done using Raspador machine (fig 1 b), it is a mechanical extraction of a fiber from sisal plant. The mechanical extraction method does not deteriorate the fibre quality. In figure 1 c show extracted fiber. Cement was use in this study purchased from local market, Fly ash (Industrial waste) from Electro Static Precipitator of Thermal Power Station, , Central India, were collected.

(a) (b) (c)

Fig 1: (a) Sisal plant (b) Raspador machine & (c) Extrcted fiber

For Development of sisal fiber fly ash cement composites hand layup technique were used, first Sisal fiber was chopped (Desirable length) and then the required amount of cement was add in mixing pan, sisal fibres was added little by little in cement as the mixer was running at low speed over until a uniform dry mixture is achieved and water gradually added into mixture as the mixer was running of low speed for about 2 minutes. And now increase the speed of mixer pan for 2 minutes. The mixing of material was up to fiber uniformly distributed in cement paste then all cement paste adds in composites making die and press the die in hand press for 24 hrs after remove the composites, curing in water for different interval days. In figure 3 sisal fiber cement fly ash composites. If fly ash is used for making sisal fiber cement composites, it reduces the requirement of cement in the composites and makes the composite economical use of fly ash as cement substitute also encourages utilization of waste from thermal power plant.

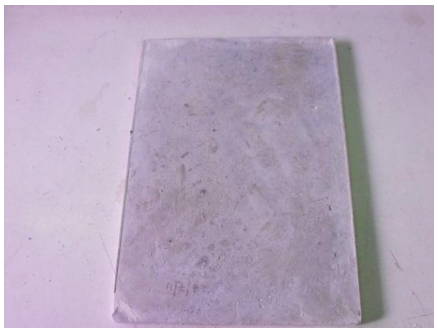

Fig 2. Sisal fiber cement fly ash composites

2.2 Physical properties

C, H, N & S studies- % concentration of Carbon (C), Hydrogen (H), Sulphur (S) and Nitrogen (N) in sisal fibre has been determined by Elementar, Vario EL, Germany

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2.3 Moisture content

Moisture absorption capacity of sisal composites was determined on LCGC moisture absorption analyzer**.** It is calculated with the help of sample weight and its oven dry weight by following the equation below

Moisture (%) = A/B * 100

A= Weight loss on heating (gm)

B= Sample used (gm)

2.4 Density

Density of composites was determined according to ASTM D792.

III. RESULT AND DISCUSSIONS

Basic element of sisal fiber is shown in table 1.The use of sisal fibre and its composites are becoming a great area of interest amongst scientists and engineers. Physical and mechanical properties of sisal fiber for commercial application similar to the other natural fiber in table 2.

Table 1: Chemical analysis of sisal fiber (C, H, N & S)

Element	% Carbon	Nitrogen	Sulphur	Hydrogen
%	40.0	0.112	0.007	6.523

IV. CONCLUSION

Utilization of a locally renewable resource (sisal) as a substitute of carcinogenic asbestos fibre. These sheets have many engineering applications. The present proposed development may open new avenue to use sisal fiber cement sheet in buildings where presently asbestos cement sheets are used globally. The safety factor of human life is higher from the production as well as utility point. Salient features of sisal fibre sheets are environment friendly, non carcinogenic, employment generation in rural sectors cost effective also contributes to sustainable development

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