# Investigation of Natural Fibers as Ceiling Material

**Salmia Beddu, Mahyun Mohd Zainoodin, Zakaria Che Muda, Nur Liyana Mohd Kamal, Daud Mohamad, Fadzli Mohamed Nazri, Sivakumar Naganathan, Nadiah Md Husain and Siti Nabihah Sadon**

**Abstract** This paper investigates the performance of scirpus grossus (SG) fiber and fiberglass (FG) as ceiling material. Scirpus grossus was extracted by peel method. Mixture containing scripus grossus, fiberglass and carboxymethyl cellulose (CMC) was cast with thickness of 7.5 and 15 mm of both fibers namely as 7.5SG, 15SG, 7.5FG and 15FG and undergo tensile strength test, flexural strength test and water absorption test. The result show, 7.5FG has the highest water absorption compared to SG7.5 with difference of 21% whilst for ceiling with thickness of 15 mm, 15SG show the lowest value of water absorption compared to 15FG with 17% of difference. Meanwhile, flexural strength of both thicknesses was comparable for both fibers. It is concluded that, natural fiber shows a good potential to be explore as ceiling material for energy efficiency building application in future for tropical climates zones area.

**Keywords** Fiber · Ceiling · Flexural · Thickness · Water absorption

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S. Beddu (✉) · M. M. Zainoodin · Z. C. Muda · N. L. M. Kamal · D. Mohamad · S. N. Sadon
Department of Civil Engineering, Universiti Tenaga Nasional, Jln IKRAM-UNITEN, 43000 Kajang, Selangor, Malaysia
e-mail: Salmia@uniten.edu.my

F. Mohamed Nazri
School of Engineering, Universiti Sains Malaysia, Engineering Campus, 14300 Nibong Tebal, Malaysia

S. Naganathan
Department of Civil Engineering, S.S.N College of Engineering, Old Mahabalipuram Road, Kalavakkam, Chennai 603110, India

N. M. Husain
Kuliyyah of Engineering, IIUM Gombak Campus, 50728 Kuala Lumpur, Malaysia



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# 1 Introduction

The most common ceiling is the suspended ceiling hanging from the structural elements above. Pipes can run through the ceiling above the gap, insulation and fire protection materials can be placed here [1]. The most popular types of ceilings that are used in Malaysia are asbestos ceilings and fiber ceilings. Ceilings can serve to reduce temperature, water and fire protection, and a system can be used to evaluate the fire performance of suspended ceilings. Although the traditional ceiling is flat and 8 feet high, which is a standard that meets standard construction practices and material dimensions, many ceilings deviate from these standards due to structural, spatial or decorative reasons [2].

Gypsum false ceiling is a hydrated sulfate of calcium. This type of false ceiling is a lightweight, sound insulated, fire resistance, soft and thermally insulated. Gypsum false ceiling comes in the shape of square boards that are hung with the help of iron framework. The finishing work on these boards like paints, laminates, wallpapers and texture finish gives good look [3]. Fiber may be further defined as an agglomeration of cells in which the diameter is negligible in comparison with the length. Apart from economic considerations, the usefulness of a fibers for commercial purposes is determined by such properties as length, strength, pliability, elasticity, abrasion resistance, absorbency, and various surface properties. Most fibers are slender, flexible, and relatively strong [4]. They are elastic in that they stretch when put under tension and then partially or completely return to their original length when the tension is removed [5]. Fiberglass is a strong lightweight material and is used for many products [6]. Although it is not as strong and stiff as composites based on carbon fiber, it is less brittle, and its raw materials are much cheaper. Its bulk strength and weight are also better than many metals, and it can be more readily molded into complex shapes.

# 2 Material and Methodology

Scirpus grossus was collected from paddy field and was process in order to extract the fiber. Scirpus grossus was dry under the sun in order to eliminate moisture. Both fiber and CMC were mixed at arbitrarily selected ratios. A known weight of the fibers and CMC were mixed. Selected ratios of fibers and CMC was mixed with water in a bucket. It was stirred to a homogenous mix. A mould of size 603 × 603 mm with a thickness of 7.5 and 15 mm as illustrated in Fig. 1 was use. The mix was the cast into the mould. A trowel was used to smoothing the exposed top surface. There are four sample of ceiling as show in Table 1 was undergo flexural strength test, tensile test and water absorption test in order to study the performance of the ceiling.

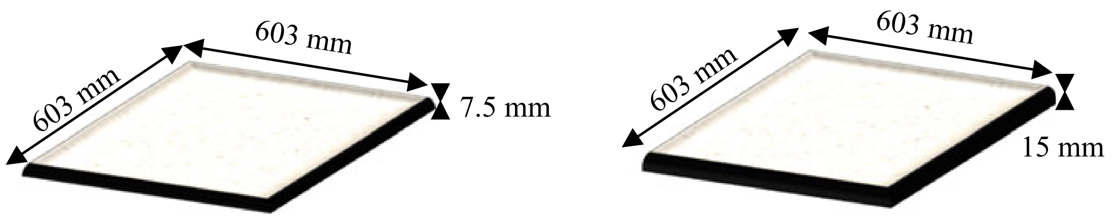



**Fig. 1** Ceiling dimension for 7.5 and 15 mm thickness

**Table 1** Ceiling samples for both fibers

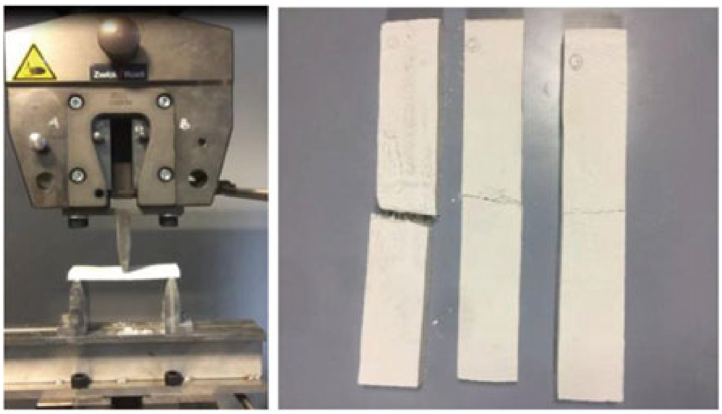
| Fiber | Sample mixture |
|---|---|
| Scirpus grossus | 7.5SG |
| | 15SG |
| Fiberglass | 7.5FG |
| | 15FG |

## 2.1 *Mechanical Properties*

Tensile strength testing was carried out to measure the interfacial strength in a natural and synthetic fiber composite and also investigation potential of scirpus grossus and fiberglass as a new sustainable material that used in ceiling. Tensile test was conducted by using Zwick/Roell machine accordance to ASTM standard, D3822 [7]. Fiber were cut with length of 10 mm and the diameter was measured by a digital vernier scale. The volume of each sample was evaluated as average value of density. The rate of extension or speed extension is 60 mm/min. The estimation elongation percentage at break of specimen, was chosen between 8 and 100%.

Flexural strength testing was conducted to measure resistance to bending of ceiling by determining the loaded at the center of span with the load was applied to the finished face. This bend test was carried out by using Zwick/Roell machine with center-point loading method accordance to ASTM C473 [8], test was conducted as shown in Fig. 2.

**Fig. 2** Specimen for flexural strength test



Water absorption was conducted to measure the rate of moisture absorption accordance to ASTM standard, D 1037 [9]. The dry boards were weighed and immersed in water for 24 h. They were allowed to surface-dry then weighed.

# 3 Results

## 3.1 Mechanical Properties

Tensile strength testing was carried out to measure the interfacial strength in a natural and synthetic fiber and also investigation potential of scirpus grossus and fiberglass for the development of a new sustainable materials that used in ceiling. Table 2 show the tensile strength test of both synthetic fiber and natural fiber in terms of elongation. Both of the fibers show comparable elongation as the elongation may influenced the fiber distribution of the ceiling.

Tensile strength shows the range of elongation of 0–3% for both of the fiber. Elongation is an estimation of the elasticity of the fibers before breaking. Level of elongation for both show a moderate elongation which result in lower fiber breakage when the fibers are subjected to mechanical stress.

Figure 3 show the results of the flexural strength for the seven days curing age. The results show that the bending strength of natural fiber and fiberglass used on the ceiling is comparable. The result show that the flexural strength of 7.5FG is 2.74 MPa and 7.5SG is 1.76 MPa. By comparing the result, it shown that the highest deformation (%) value at 3.1% is 7.5FG. Due to fiberglass has higher strength compared to scirpus grosses fiber. The result shows that the flexural

**Table 2** Tensile strength test of fiber

| Sample | Level | |
|---|---|---|
| | Minimum (%) | Maximum (%) |
| Scirpus grossus, SG | 0 | 3 |
| Fiberglass, FG | 0 | 3 |

**Fig. 3** Flexural strength of ceiling

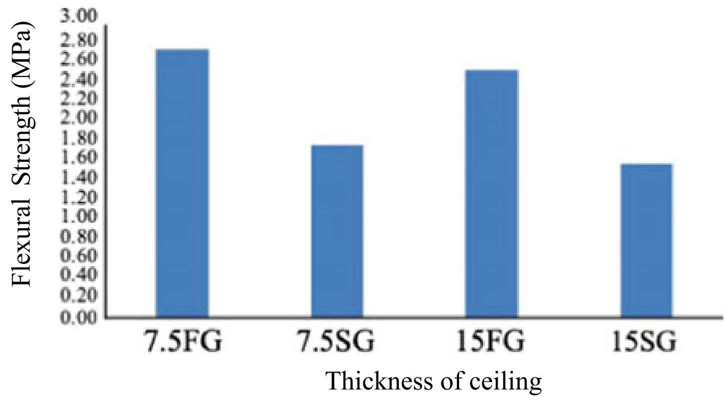


**Table 3** Water absorption at seven days of curing age

| Type of sample | Average percentage (%) |
|---|---|
| 7.5SG | 56.4 |
| 7.5FG | 72.4 |
| 15SG | 49.5 |
| 15FG | 58.8 |

strength of 15FG is 2.52 MPa and 15SG is 1.57 MPa at 7 days of curing due to fiberglass has higher tensile that can improve the strength of the ceiling and the result show the flexural strength of scirpus grosses is comparable with fiberglass ceiling.

Table 3 show the result for water absorption on seven days of curing age. The result show that the water absorption of 7.5 and 15 mm thickness by using scirpus grossus fiber and fiberglass in ceiling. The average result also shows that the water absorption for 7.5SG is 56.4% and 7.5FG is 72.4%. The result show, the water absorption for SG is 49.5% and FG is 58.8% for 15 mm thickness for specimen ceiling.

Based on the result, it can be clearly seen that the water absorption is the highest for 7.5FG compared to 15SG. Ceiling with higher thickness show a lower water absorption with the highest of 58.8% for 15FG and 49.5% for 15SG. Thus, the ceiling fiber that containing scirpus grossus fiber has potential to be develop as new material in ceiling in order to be sustain to long term used.

## 4 Conclusions

This study was focus on the effect of used scirpus grossus fiber as changed in ceiling fiber. The main objective is to investigate the effectiveness of ceiling containing scirpus grossus fiber in moisture and also to investigate the performance ceiling containing scirpus grossus fiber. The following conclusion was drawn from the study:

1. Flexural strength of ceiling fiber containing used SG fiber has comparable strength compared to ceiling material containing FG.
2. Water absorption of ceiling material containing SG fiber has lowest absorption compared to ceiling material containing FG. Thus, a further study needs to be conducted in order to investigate the thermal properties of the fiber-based ceiling.

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