KEMENTERIAN PENDIDIKAN TINGGI

JOJAPS

eISSN 2504-8457

POLITEKNIK MALAYSIA PORT DICKSON

Journal Online Jaringan Pengajian Seni Bina (JOJAPS)

NNR ECO CEILING

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Abstract

Nowadays, there are many types of ceilings created, however leakage problems can't be resolved especially during the rainy season. Asbestos ceiling has a very delicate carcinogenic dust that causes a negative impact on health over the long term. The mixture of glass waste fiber in NNR ECO CEILING creation with the objective of studying the ability of mixture between glass waste with plastic waste and to study the capabilities of NNR ECO Ceiling compared to ceiling in the market in terms of waterproof, durable and economical. Glass waste used in this study comprise of three different ratios with plastic waste: NN1(100:1), NN2 (80:20) and NN3 (70:30). Each sample undergoes four types of testing which is Water Absorption Test, Flexural Strength Test, Tensile Strength Test and Density. Finding shows that Sample NNR ECO CEILING prove to have the double strength in Tensile Strength Test compared to others. It also has significant advantage in term of durability with waterproof and density properties. The cost for NNR ECO CEILING is in the range of RM1.19 – RM1.40 which is 72 -77% cheaper than the asbestos. The NNR ECO CEILLING product is not only strong, light and cheap but it is also one of the most innovative ways to preserve nature and help the nation towards sustainability while increasing the 'income from waste to valuable products'.

Key-word: - ceiling, glass and plastic waste, strength

1. Introduction

A ceiling is an overhead interior surface that covers the upper limits of a room. It is not generally considered a structural element, but a finished surface concealing the underside of the roof structure or the floor of a store above. There are many fine examples of frescoes and artwork on ceilings especially in religious buildings. The most common type of ceiling is the dropped ceiling which is suspended from structural elements above. Pipework or ducts can be run in the gap above the ceiling, and insulation and fireproofing material can be placed here. Other types of ceiling include the cathedral ceiling, the concave or barrel-shaped ceiling, the stretched ceiling and the coffered ceiling. Coving often links the ceiling to the surrounding walls. Ceilings can play a part in reducing fire hazard, and a system is available for rating the fire resistance of dropped ceilings.

Ceilings are classified according to their appearance or construction. A dropped ceiling is one in which the finished surface is constructed anywhere from a few inches or centimeters to several feet or a few meters below the structure above it. This may be done for aesthetic purposes, such as achieving a desirable ceiling height; or practical purposes such as acoustic damping or providing a space for HVAC or piping. An inverse of this would be a raised floor. A concave or barrel-shaped ceiling is curved or rounded upward, usually for visual or acoustical value, while a coffered ceiling is divided into a grid of recessed square or octagonal panels, also called a "lacunar ceiling".

A cove ceiling uses a curved plaster transition between wall and ceiling; it is named for cove molding, a molding with a concave curve. A stretched ceiling (or stretch ceiling) uses a number of individual panels using material such as PVC fixed to a perimeter rail. (Corky Binggeli, 2011).

Nowadays, there are many type of ceiling that are being invented, however the leakage problem still persists especially during the rainy season which will cause ceiling to become dirty and mossy. Water flow line that engraved upon ceiling due to leaking cause radiant and looks highly frail. This also affect the strength of the ceiling and the ceiling serves as the foundation of the roof. It is where the framing of the roof is mounted, and without a ceiling, the roof will not able to stand sturdily on top of your home. The most difficult part of the building to be repaired is the ceiling as it deals with limited access space such as walls or floor. When the ceiling is leaking it would suffer damage such as sag, peel off, wrap or become stained with a very undesirable color.

The leaks start from the roof and passes all the way to the crevices in the ceiling that allows drops of water to pass through. Besides that, the moisture on the ceiling surface will lead to the growth of the moss. There are two factor that cause moisture which is geological conditions with local weather and climate on the defects in the construction of a home fault.

1.1 Objective of Study

This study was conducted to achieve these objectives:

i) To study the ability of glass waste material into NNR ECO CEILING.
ii) To investigate the capabilities of NNR ECO CEILING compared to existing ceiling in the market in terms of tensile strength, flexural strength and waterproof.
iii) To produce an economical green waterproof ceiling.

1.2 Scope of Study

The scope or limit of product execution should be made as a reference to ensure that any implementation of the project does not exclude from the objectives to be achieved. The scope of project implementation is set based on product objectives or goals. Therefore, this "ECO Ceiling" product must not go beyond its goals and functions. The scope of study is for indoor uses (ceilings). The ceilings produced are light ceilings, to facilitate installation work. In addition, these ceilings are also non-fragile ceilings and waterproof. It also has attractive patterns to make it look more beautiful and can give users satisfaction. Sampling method involve several stages include collecting material for green ceiling fabrication, undergo fiber processes in accordance to the procedures prescribe by FRIM, mold making and testing parameter involving Tensile Strength Test (ASTM D790), Flexural Strength Test (ASTM D638) and Water Absorption Test (ASTM 570).

2. Literature Review

Waste mineral fiber is generally “off-spec” mineral fiber products generated by the manufacturers of mineral or glass wool. Providing the waste material is a clean, consistent mineral fiber, it is generally suitable for use in the manufacture of ceiling tiles or in other applications. The total quantity of waste mineral wool produced in the UK is believed to be about 10,000 Tons per annum. (Mass Balance, 2007).

2.1 Types of Ceiling

There are four broad types of ceiling tiles - acoustical, plastic, and tin and cork. Within those categories there is a further break down of tiles by design, installation and use such as acoustical ceiling tiles, plastic ceiling tiles, tin ceiling tiles and cork ceiling tiles.

There are several types of materials used in production such as Polypropylene (PP) and asbestos. Polypropylene is a thermoplastic polymer used in a wide variety of applications in industry, white color, mechanically rugged material, and is resistant to many chemical solvents, bases and acids. Asbestos is a set of six naturally occurring silicate minerals, which all have in common their eponymous asbestos form habit such as long (roughly 1:20 aspect ratio), thin fibrous crystals, with each visible fiber composed of millions of microscopic “fibrils” that can be released by abrasion and other processes. They are commonly known by their colors, as blue asbestos, brown asbestos, white asbestos and green asbestos.

Six mineral types are defined by the United States Environment Protection Agency (EPA) as “asbestos” including those belonging to the serpentine class and those belonging to the amphibole class. All six asbestos mineral types are known to be human carcinogens. Therefore, researchers have made a study to use plastic and glass waste to produce safer and cheaper ceilings for consumers and contribute variety of ceiling in construction material finishing.

Figure 1: Asbestos Fiber

Figure 2: Polypropylene (PP)

2.2 Plastic Waste

Environmental problems related to plastic waste have become a major problem in Malaysia where it has been ranked as 8th among the top ten countries with mismanaged plastic waste in the world. A study estimated that Malaysia had produced 0.94 million tons of mismanaged plastic wastes, of which 0.14 to 0.37 million tons may have been washed into the oceans as reported by (Jenna R. Jambeck et al. 2015). Some studies have also highlighted the potential health effects of single-use plastics on human and animals.Besides that, the Asia Pacific Economic Cooperation (APEC) had estimated USD13 billion impact of marine plastic pollution to the Asia Pacific region (APEC, 2009).

Figure 3: Plastic waste

Since the 1950s, the production of plastic has outpaced that of almost every other material due to its versatility and functionality. Most of these plastics are designed to be thrown away after being used only once (single-use) which results in single-use disposable plastics waste accumulation. Only nine per cent of the nine billion tons of plastic the world has ever produced has been recycled. Most ends up in landfills, dumps or in the open environment. Single-use plastics are plastics that are commonly used for plastic packaging, carry bags and include items intended to be used only once before they are thrown away (UNEP 2018).

2.3 Glass Waste

Glass Industries produce a lot of waste ranging from the byproducts of the used raw materials to the damaged glass products. The fuel used during glass production is also in large quantity. Proper utilization of such wastes from glass cullets (container, flat, electronics and other glass containing products) can minimize the energy requirements and reduce production cost. Clear glass, (flint) green and brown bottle, soft drink mineral, water, wine, beer, all glass jars, spread and sauce battles can be recycled. Other possible wastes from glass industries are refractory scraps, from which glass facilities can also be recycled.

Figure 4: Glass waste

3. Methodology

This research is a quantitative study. Primary data collection is through the laboratory testing. The production of ceilings was divided into 3 sample which are sample 1 contained 100% of glass waste, sample 2 and 3 contained a mixture of glass and plastic waste. All testing was done at Forest Research Institute of Malaysia (FRIM). Each sample undergoes four types of testing which is Water Absorption Test, Flexural Strength Test, Tensile Strength Test and Density.

3.1 Sampling Method

For sample 1 (NNR1: 100% glass waste), the material was weighted according to the weight set by 90g glass waste. Then the ingredients was putting into the mold. The sample is placed under the hot press machine and will takes about 3 minutes. After completion of the heating process, the sample will compact with cold press machine about 5 minutes.

For sample 2 and 3 (NNR 2 and NNR3 had portion between glass and plastic waste), the material was weighted according to the weight set by 90g mixture of glass waste and plastic waste. Then the ingredients was putting into the mold. The sample is placed under the hot press machine and will takes about 3 minutes. After completion of the heating process, the sample will compact with cold press machine about 5 minutes.

3.2 Testing

According to Standard Method of Testing Ceiling and Tile, the following tests are required on ceiling which are Tensile strength (ASTM D790), Flexural strength Test (ASTM 638), Density (ASTM D792) and Water Absorption (ASTM 570). Physical efficiency tests were conducted to ensure that the price of materials and installation of ceiling is more competitive than the existing ceiling in market.

4. Findings

This chapter discusses the data analysis and findings of the study. The testing used in this product was carefully analyzed to ensure that the data gathered was presented clearly with the aid of tables and graphs, where possible. A retrospective chart analysis was conducted to capture the data essential to accomplish the research objectives. The purpose is to identify the capabilities of our ceiling and compared with normal ceiling (asbestos ceiling) in term of water proofing and durability. Element durability for this product is being tested according to their bending strength, tensile strength and water absorption.

4.1 Tensile test

Table 4.1 Tensile Test

Sample	Ratio (%) PP : Glass	Tensile Modulus (MPa)	Tensile Strength (MPa)
NN1	100	642.128	29.627
NN2	80 : 20	577.727	18.133
NN3	70 : 30	631.941	22.878
Coir	70 : 30	550.013	14.685
Sugarcane Dregs	70 : 30	491.333	11.035
Coconut Fiber	70 : 30	401.523	13.524
Corn Cob	70 : 30	336.921	15.262
Asbestos	-	355.142	10.183

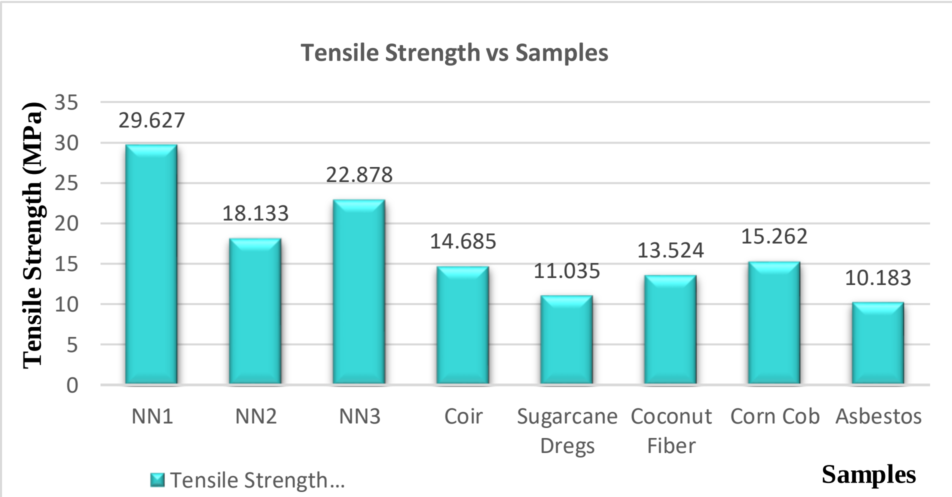

Figure 5: Tensile Strength versus Samples

Figure 5 shown the comparison of tensile strength versus sample. The NN1 sample has the highest tensile strength of 29.627 MPa followed by sample NN3 and NN2. This is because polypropylene (from Plastic waste) is high and delaying in cracking. Product studied (NN1, NN2, NN3) shows significant in tensile strength among its rival. Finding shows that asbestos has the lowest value for tensile strength which is only 10.183 MPa.

4.2 Flexural strength test

The parameters tested for bending strength are the modulus of elasticity (MOE) and modulus of rupture (MOR) while the data units are in Mega Pascal (MPa).

Table 4.2: Flexural Strength for Modulus Elasticity (MOE) and Modulus of Rupture (MOR)

Sample	Ratio (%) PP : Glass	MOE (MPa)	MOR (MPa)
NN1	100	1059.353	28.504
NN2	80 : 20	1236.927	30.230
NN3	70 : 30	1432.227	29.447
Coir	-	3193.333	63.682
Sugarcane Dregs	-	1997.980	30.968
Coconut Fiber	-	1545.304	28.188
Corn Cob	-	2137.338	35.534
Asbestos	-	2836.237	46.534

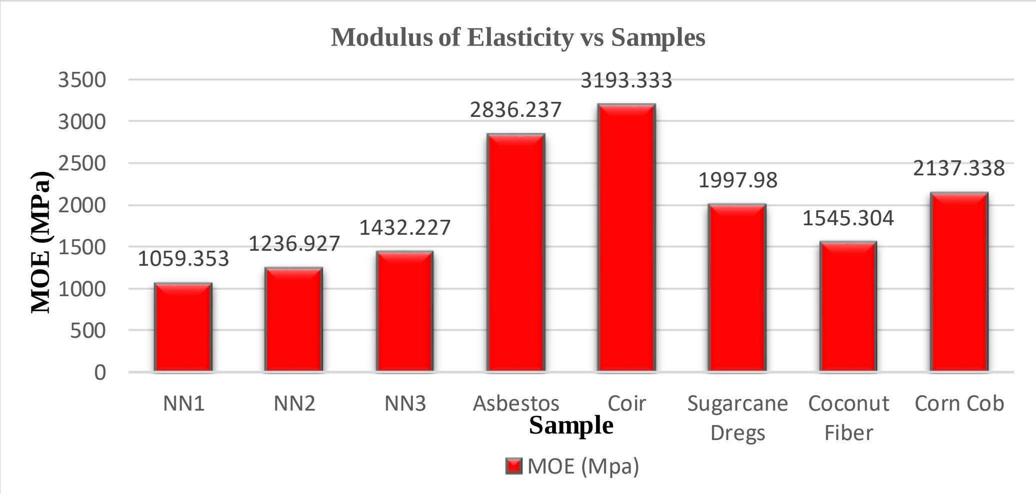

Figure 6: Modulus of Elasticity for Each Samples

Figure 6 illustrate the modulus of elasticity versus sample. The highest values for modulus of elasticity is in agri-waste sample that is 3193.333 MPa followed by asbestos which is 2836.237MPa compare to other sample. However, for the NN1 sample with the lowest values of MOE showing that the sample do not combine with other material.

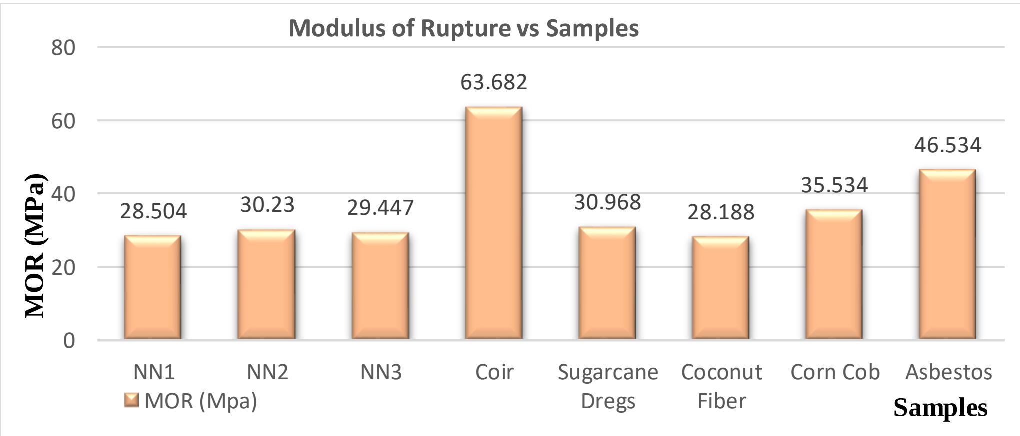

Figure 7: Modulus of Rupture for Each Samples

Figure 7 shown the comparison modulus of rupture versus sample and the coir shows the highest modulus of rupture compare with other sample. On the other hand the ratio 100% polypropylene is the lowest due to the strength of the material.

4.3 Density

Figure 8 shows that the density for asbestos ceiling is the highest among all. The sample NN1, NN2, NN3 have a lowest density which is 945.639 kg/m3, 830.529 kg/m3 and NN3 is 914.124 kg/m3 respectively. So the lower the density value represent the lighter the sample is which ease the installation work. NN2 have the lowest density among its rival

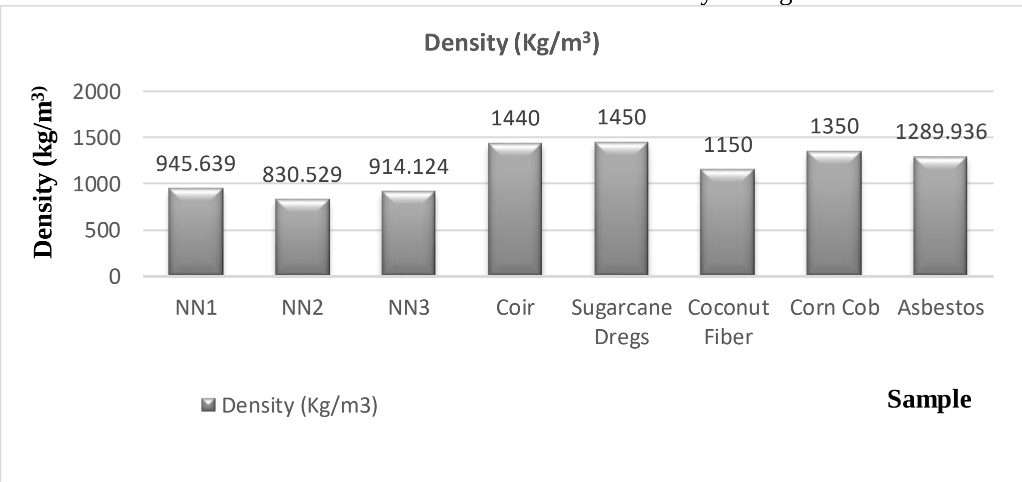

Figure 8: Density for each sample

4.4 Water Absorption Test

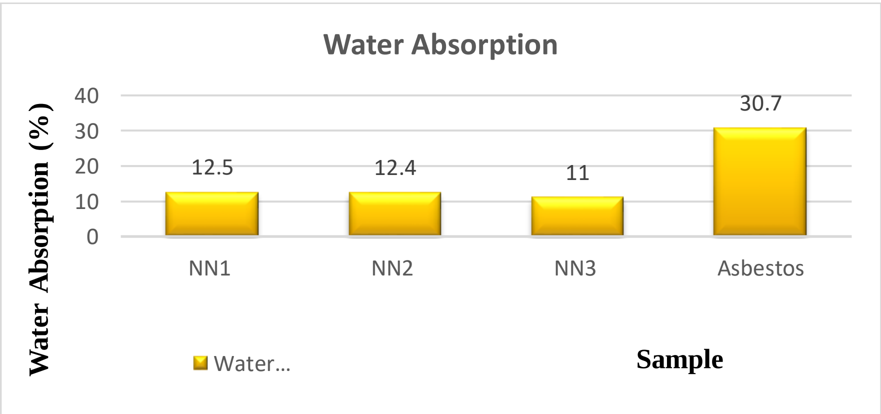

Figure 9: Water absorption for each sample

Figure 9 shows that the three sample which is NNR1, NNR2 and NNR3 has lower value of water absorption which is 12.5%, 12.4% and 11% respectively. The water absorption for asbestos is 30.7%. The water absorption is inversely proportionate to the content of glass in the studied sample (NNR1, NNR2 and NNR3).

4.5 Cost

Figure 10 shows that the Sample of studied product NN1, NN2 and NN 3 requires cost to be produced per square meter of RM 1.40, RM 1.26 and 1.19 respectively. Sample NN1, NN2 and NN3 (Eco ceiling) has the lowest manufacturing cost which is 77% cheaper than the asbestos ceiling which has the total cost of production RM 5.00 per meter square.

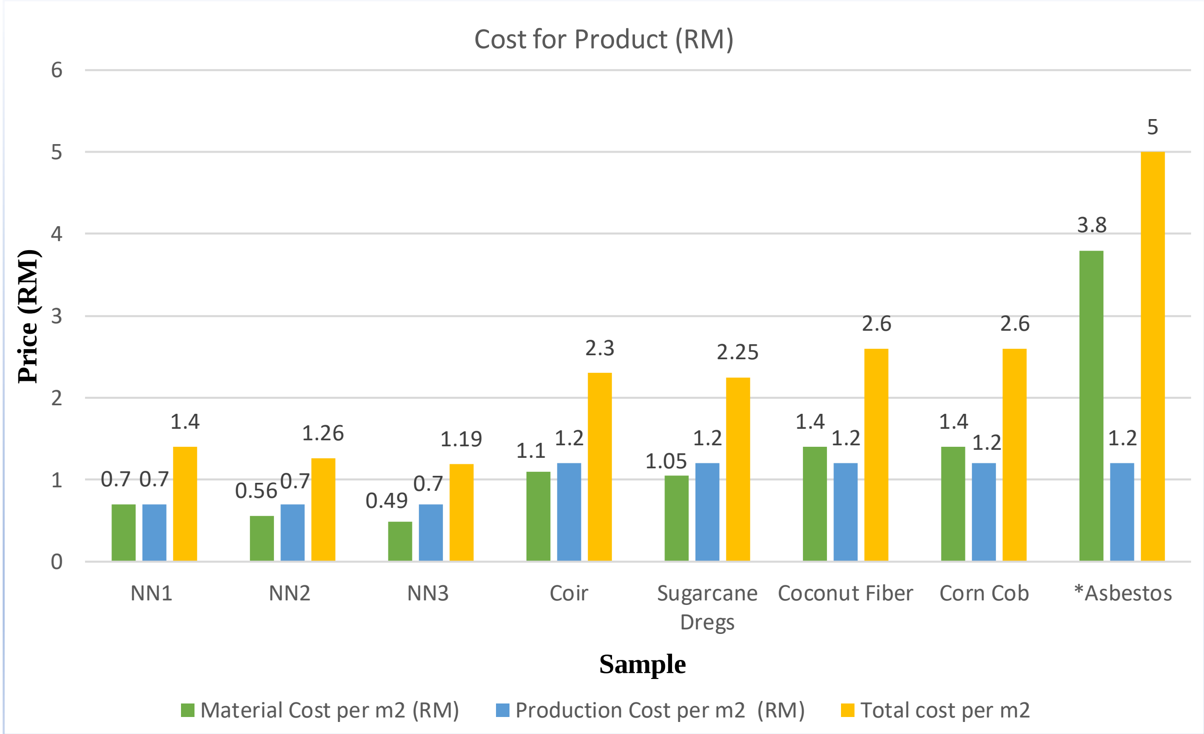

Figure 10: Cost of product for each sample

5. Conclusion

The durability test for ceiling samples tested consists of Flexural Strength Test (MOE & MOR) and Tensile Strength Test. The high value of MOE & MOR and tensile strength test indicate the strength of the sample is high. NN1, NN2, NN3 samples have the highest value for tensile strength which is 29.627, 18.133, 22.878 MPa respectively compared to asbestos with 10.183 MPa. The tensile strength for the NNR ECO CEILLING product is almost double the existing strength of its rivals.

The density of a product plays an important role in the installation work. The higher the density value of a ceiling product, the heavier the product will be. This will complicate the installation work and will further increase the installation time period involving increased costs. The heavier products are easier to drop, this not only allows injuries to workers but also increases wastage and losses. Density value for NNR ECO CEILLING for NN1, NN2, NN3 are 945.639 kg/m3, 830.529 kg/m3, and 914.124 kg/m3 which is 26 – 35% lighter than asbestos which is 1289.94 kg/m3.

Water absorption examine the capabilities of the sample as waterproof ceiling material. The value of water absorption is inversely proportionate to the waterproof level that is the low value of water absorption means the high level of waterproofing. The finding demonstrate that NNR ECO CEILLING are the best sample for waterproofing ceiling which has only 11 – 12.5% of water absorption compared to asbestos ceiling with 30.7%.

In term of production cost, NNR ECO CEILLING are the cheapest ceiling product among all. With the cost ranges from RM1.19 – RM1.40 per meter square, it appears the cheapest product in the market with savings of 72-77%. The NNR ECO CEILLING product is not only strong, light and cheap but it is also one of the most innovative ways to preserve nature and help the nation towards sustainability while increasing the 'income from waste to valuable products'.

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