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The Comparison Between Cellulose Gypsum Board and Gypsum Board by Using Fire Resistance Test, Moisture Content Test and Noise Insulation Test

Nuratikah binti Seman & Muhammad Azfar bin Azri

[a] Architecture Programme, Department of Civil Engineering, Politeknik Port Dickson, Km 14 Jalan Pantai, 71050 Si Rusa, Negeri Sembilan, Ministry of Education Malaysia, Malaysia.

[b] Civil Engineering Programme, Department of Civil Engineering, Politeknik Port Dickson, Km 14 Jalan Pantai, 71050 Si Rusa, Negeri Sembilan, Ministry of Education Malaysia, Malaysia.

Abstract

Gypsum board is a panel made of gypsum. The plaster gypsum pressed between two sheets of ivory manila. Use to make interior walls and partition wall. Also known as wallboard, drywall, and plasterboard. The use of gypsum board is spread all over the world. Manufactures highlight many of its positive aspects but users are still reticent and even have some complains, especially concerning its sound insulation ability, fire resistant ability and moisture resistant ability. From the result and analysis, our product has been lots of advantages against the control drywall by doing three types of testing which is Fire Resistant Testing, Moisture Content Testing and Noise Insulation. We could tell that our product is better in Fire resistant which is from the testing cause of the gypsum and cellulose, the cellulose fiber has some function such as air trap that can keep the drywall from getting burnt easily. Cellulose Gypsum Board took 7 minutes, 27 seconds to fully burnt while Gypsum Board took 4 minutes, 27 seconds to fully burnt. It was 63% more resistant to fire than gypsum board. Next, our product gives us advantage to prevent water from getting into the drywall easily because of the epoxy resin and wire mesh which is the epoxy resin function is water resistant and keep the drywall from mildew. Wire mesh give us a better in flexural in moisture content. Moisture content for Cellulose Gypsum Board was 55% compared to 66% for Gypsum Board. It was shown that Cellulose Gypsum Board resistant to water ability was 17% higher than gypsum board. From the comparison, we can conclude the control drywall already break as we dry the drywall while our product can prevent the break problem cause of the wire mesh. Lastly, our product has better soundproof than the control drywall cause of the gypsum board and the cellulose. The noise insulation for Cellulose Gypsum Board is 87.4dB compared to 105.5Db for Gypsum Board. that was meant this product has better sound proof than control sample. The cellulose makes the drywall more soundproof than the control because the main function of the cellulose is to prevent sound from pass the board. We can conclude our product benefits by using these three types of testing. We have achieved our product can give a better impact from the normal drywall by using fire resistance testing, moisture content and noise insulation testing.

Keywords: Cellulose, Gypsum Board, Partition Wall, Drywall, Ivory Manila

1.0 Introduction

Drywall (also known as plasterboard, wallboard, sheet rock, gyp rock, gypsum board, or gypsum panel) is a panel made of calcium sulfate dehydrate (gypsum), with or without additives, typically extruded between thick sheets of facer and backer paper, used in the construction of interior walls and ceilings. The plaster is mixed with fiber (typically paper, fiberglass, asbestos, or a combination of these materials), plasticizezer, foaming agent, and various additives that can reduce mildew, flammability, and water absorption. Drywall construction became prevalent in North America as a time and labor-saving alternative to traditional lath and plaster.

Problems we found are the used of asbestos in construction industry can affect human health. Next, waste material such as cellulose are not been reuse because of lack of knowledge about cellulose fiber. Lastly, drywall can be easily affected when directly contacted with water. Objective of this research are to design cellulose gypsum board by layered it with gypsum and wire mesh, to produce cellulose gypsum board by put some extra item such as epoxy resin, cellulose and wire mesh, and to study the fire resistance and noise insulation on cellulose drywall. There is some problem that we will faced in construction when making wall. We have listed some problem that is the used of asbestos in construction industry, waste material such as cellulose are not been reuse because of lack of knowledge about cellulose fiber. Lastly, drywall can be easily affected when directly contacted with water.

2.0 Background

According to Healthy House Institute (2011), one of the functions about the gypsum board is it can be fire retardant. But, we have search that the gypsum board cannot take a lot of time in fire for a long period. For the problem, we need to upgrade the gypsum board by using cellulose at the front surface of the gypsum. Cellulose can resist the fire for a long time period from the pure gypsum board. Thus, by using the cellulose we can prevent that sound wave by reaching to our ear (soundproof). The cellulose that we have upgrade to the gypsum board makes the gypsum board become thicker that the usual.

2.1 Properties of Cellulose

The cellulose paper treated in proportional mixture systems showed higher liquid absorption compare to only EtOH and MeOH treatments. It was approximately 40-70% and 50-91% higher for EtOH-NaOH and MeOH-NaOH treated papers, respectively. All conditions apparently bring about an effect of decreased strength for papers. The lowest tensile strength of 13.0 N/mm was found with EtOH and NaOH treated samples after 5^{th} repeating wetting-drying stage. But some conditions gave approximately 21-59.5% higher stretch than untreated samples. The pore size distributions of papers were evaluated with Simons stain procedure and experimental results usually consisted with sorption data. The less intense CH2-CH2- vibrations (1450-1700 cm-1) and C-C and C-O-C peak areas in FTIR spectra indicates lowering H-bonds in solvent treated and dried paper network structure as said by Halil Turgut Sahin (2008).

2.2 Previous research on Gypsum

Gypsum is a mineral found in sedimentary rock formations in a crystalline form known as calcium sulfate dehydrate CaSO4•2H2O. One hundred pounds of gypsum rock contains approximately 21 pounds (or 10 quarts) of chemically combined water. Gypsum rock is mined or quarried and transported to the manufacturing facility. The manufacturer receives quarried gypsum, and crushes the large pieces before any further processing takes place. Crushed rock is then ground into a fine powder and heated to about 350 degrees F, driving off three-fourths of the chemically combined water in a process called calcining. The calcined gypsum (or hemihydrate) CaSO4•½H2O is then used as the base for gypsum plaster, gypsum board and other gypsum products. Synthetic gypsum, commonly known as the FGD (Flue Gas Desulphurization) gypsum or DSG (desulphurized) gypsum may also be used in the production of gypsum board. This product is primarily derived from coal-fired electrical utilities which have systems in place to remove sulfur dioxide from flue gasses. These systems capture the sulfur dioxide by passing the gasses through scrubbers that contain limestone (calcium carbonate) which absorbs and chemically combines with the sulfur dioxide to form pure calcium sulfate, or gypsum. The synthetic gypsum is then transported to the gypsum board manufacturer; the production process for calcining synthetic gypsum is largely the same as with mined gypsum only no primary crushing is necessary as said by Amy Tikkanen (2016).

2.3 Gypsum as fire Resistance

According to Bethany Halford (2009), gypsum board is an excellent fire resistive material. It is the most commonly used interior finish where fire resistance classifications are required. Its noncombustible core contains chemically combined water which, under high heat, is slowly released as steam, effectively retarding heat transfer. Even after complete calcination, when all the water has been released, it continues to act as a heat insulating barrier. In addition, tests conducted in accordance with ASTM E 84 show that gypsum board has a low flame spread index and smoke density index. When installed in combination with other materials it serves to effectively protect building elements from fire for prescribed time periods. The fire resistance of gypsum board can be described using three distinct terms: regular core, type 'X' core and improved type 'X' core. Regular core gypsum board is made of a noncombustible core material composed mainly of gypsum. Although it does not have the specially enhanced fire-resistive properties of type 'X', regular core gypsum board affords a degree of natural fire resistance.

2.4 Gypsum as Sound Attenuation

According to Jose Alberto Soto (2015), control of unwanted sound transmission to adjoining rooms is a key consideration in the design or renovation stage of a building or residence. Gypsum board wall and ceiling systems help control sound transmission. Suggested systems for sound attenuation and sound control are described and illustrated in GA-600, Fire Resistance Design Manual along with recommended procedures to obtain sound control.

2.5 Previous Research on Wire Mesh

i. Wire mesh is so common because it is the least expensive and most effective tool for so many applications. Its versatility and wide array of opening sizes makes it perfect for many jobs both around the home and in commercial scenarios. Easy to install and work with, wire mesh is a quick solution for many pest problems, both large and small. Its durability, however, will ensure that this solution, while speedy, is not shoddy. For outdoor use, wire mesh comes galvanized to reduce corrosion (and, in turn, increase its life expectancy) as said by Knox, Frank M. (2015).

ii. Wire mesh, which is also referred to as wire cloth or wire fabric, is an extremely versatile product that has thousands of different applications throughout the world. What makes wire mesh such an adaptable product is that is can be produced in a countless number of specifications. Depending upon manufacturing capabilities, there are almost endless combinations of opening sizes and diameter wires that can be produced, either in a woven or welded construction. Wire mesh is commonly used in industrial applications when separation or filtration is needed; it is also popular for use in commercial applications, like insect screening or animal fencing. More widespread applications for wire mesh include: various types of security mesh, like window, machine and stairwell panel guards, fireplace screen, bird screen, gutter guards, ventilation and RFI shielding. More recently, wire mesh has emerged into the architectural field and the art scene as told by Juan Rodriguez, (2018).

2.9 Previous Research on Ivory Manilla

Manila paper is a relatively inexpensive type of paper, generally made through a less refined process than other types of paper. It is typically made from semi-bleached wood fibers. It is not as strong as Kraft paper but has better printing qualities. Manila is buff-colored and the fibers are usually visible to the naked eye. Manila is most commonly used for making file folders and envelopes, called manila folders and manila envelopes respectively. Some fashion schools and people in the fashion industry use large rolls of Manila to create finalized clothing patterns. Because this paper is generally inexpensive, it is commonly given to children for making art. Manila paper was originally made out of old Manila hemp ropes which were extensively used on ships, having replaced true hemp. It was made from Manila hemp (also called abaca) or Musa textiles which is grown in The Philippines and hence the association with Manila, the capital of that country. Abaca is an exceptionally strong fiber, nowadays used for special papers like teabag tissue. It is also very expensive, priced several times higher than wood pulp, hence the change to that fiber for what is still called Manilla—usually with two "ll"s. More recently new wood pulp has often been replaced with a high proportion of recycled fiber. True manila hemp folders would have been much tougher and long lasting than modern folders. (KNOX, FRANK M, January 2015)

3.0 Methodology

3.1 The Manufacturing Process

Fabrication of drywall consists of placing the gypsum core material between two layers of paper, drying the product, and finishing it into panels of standard size.

3.1.1 Blending of Additive

Depending on the assortment of wallboard being created, certain added substances are mixed with the mortar of Paris that will frame the center of the drywall. Each extra fixing adds up to under one-half of one percent of the measure of gypsum powder. Starch is added to help the paper facings stick profoundly, and paper mash is added to build the center's elasticity (protection from the long way weight). Unexpanded vermiculite is included while delivering heat proof evaluations of gypsum board; now and again mud is likewise included. Water is added to the mortar of Paris blend to frame a slurry of the best possible consistency. A black-top emulsion and additionally a wax emulsion is added to accomplish the ideal dimension of dampness opposition in the last item. A frothing operator, for example, a cleanser is incorporated, and amid the blending procedure air is entrained into the material. The completed gypsum board will be over half air; this limits the board's weight and makes it less demanding to cut, fit, and nail or screw to the confining. Glass strands are added to the wet center material when making fire rated gypsum board.

3.1.2 Making the Sandwich

The gypsum slurry is poured onto a layer of paper that is unrolling onto a long board machine. Another layer of paper unrolls on top of the slurry. The sandwich then passes through a system of rollers that compact the gypsum core to the proper thickness. The most common thicknesses are 0.37 inch (9.5 mm), 0.5 inch (12.7 mm), and 0.62 inch (15.7 mm).

3.1.3 Finishing the Edges

Automated assembly lines in gypsum board plants range from 300-800 feet (93-247 m) long. As the drywall continues along the conveyor belt, the edges are formed. Various shapes of edges are possible, depending on the final use of the panel. Options include the traditional square edge, a tongue and groove type, tapered and/or beveled edges, and even rounded edges. The face paper is wrapped snugly around each edge and sealed to the back paper

3.1.4 Cutting the Panels

By the time the edges have been shaped, the plaster core has set sufficiently for a knife to slice the continuous strip into standard panel sizes. The board, generally 48 inches (1219 mm) or 54 inches (1572 mm) wide, is usually cut into panels that are 8 feet (2400 mm) or 12 feet (3600mm)long.

3.1.5 The Drying Process

The panels are transferred to a conveyor line that feeds them through a long, drying oven. At one plant, for example, the gas-fired oven is 470 feet (143 m) long. Panels enter the oven at 500°F (260°C) and are exposed to gradually decreasing levels of heat during the 35-40 minutes they travel through the system. Humidity and temperature are carefully controlled in the dryer.

3.1.6 The Finished Product

After emerging from the drying oven, the dry wall panels are visually inspected before being bundled into "lifts" of 30 or 40 boards and transferred to the warehouse for the shipment.

3.2 Schematic Diagram of Cellulose Drywall

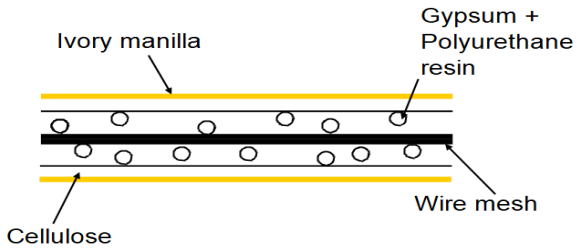

Figure 3.1 Shows a details about Cellulose Drywall

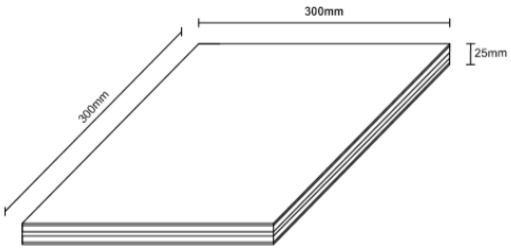

Figure 3.2 Shows the details on dimension of this Cellulose Drywall

3.3 Testing

3.3.1 Fire Resistance Test

Resistant to fire that for a specified time and under conditions of a standard heat intensity it will not fail structurally or allow transit of heat and will not permit the side away from the fire to become hotter than a specified temperature

3.3.2 Moisture Content

Is the quantity of water contained in a material, such as soil (called soil moisture), rock, ceramics, crops, or wood. Water content is used in a wide range of scientific and technical areas, and is expressed as a ratio, which can range from 0 (completely dry) to the value of the materials' porosity at saturation. It can be given on a volumetric or mass (gravimetric) basis.

3.3.3 Noise Insulation

Sound insulation is a kind of measure to prevent the sound waves from permeating. It is demonstrated by the sound transmission loss which is expressed by the difference of decibels between the incident sound and permeated sound. The higher the numeral is, the better the sound insulating property is.

3.4 Costing

Material	Weight/Size	Price (RM)
Ivory Manila	230g (40sheets)	22.00
Cellulose Fiber	1kg	45.00
Gypsum	1kg	20.00
Wire mesh	1m x 1m	9.00
Epoxy resin + Catalyst	200g + 100g	43.00
Total for 4 samples		139.00
1 samples		35.00

4.0 Results & Discussion

Result had been concluded from three type of testing that are fire resistance test, moisture content test and noise insulation test. This three testing helps to determine that our product better than the gypsum board control.

4.1 Result

4.1.2 Fire Resistance

Name	**Cellulose Gypsum Board**	**Gypsum Board (Control)**
Times	**7 minutes and 27 seconds**	**4 minutes and 18 seconds**

4.1.3 Moisture Content

Name	**Cellulose Gypsum Board**	**Gypsum Board (Control)**
Dry Gypsum Board	**1095.5**	**1163.5**
Wet Gypsum Board	**1967.0**	**1742.0**
Moisture Content	**55%**	**66%**

4.1.3 Noise Insulation

Name	**Cellulose Gypsum Board**	**Gypsum Board (Control)**
dB	**87.4**	**105.5**

From the result and analysis, our product has a lot of advantages against the control drywall by doing three types of testing which is Fire Resistant Testing, Moisture Content Testing and Noise Insulation. We could tell that our product is better in Fire resistant which is from the testing cause of the gypsum and cellulose, the cellulose fiber has some function such as trap air that can keep the drywall from getting burn easily. Next, our product gives us advantage to prevent water from getting into the drywall easily cause of the epoxy resin and wire mesh, the epoxy resin function is water resistant and keep the drywall from mildew. Wire mesh give us a better in flexural in moisture content.

From the comparison, we can conclude the control drywall already break as we dry the drywall while our product can prevent the break problem cause of the wire mesh. Lastly, our product has better soundproof than the control drywall cause of the gypsum board and the cellulose. The cellulose makes the drywall more soundproof than the control because the main function of the cellulose is to prevent sound from pass the board. We can conclude our product benefits by using these three types of testing.

5.0 Conclusion

In conclusion, we managed to solve all the problems statement and achieve our objectives such as we already design cellulose gypsum board by layered with gypsum and wire mesh, produce cellulose drywall by adding epoxy resin, cellulose and wire mesh. We have achieved our product can give a better impact from the normal drywall by using fire resistance testing, moisture content and noise insulation testing. We hope cellulose can be accepting by all company and be used in construction industry. After we do some upgrade, we hope the cellulose drywall will be better than a control drywall and can be used in construction for a long period. Furthermore, we highlight that the cellulose need to do some research by reuse this fibre such as waste mattress, pillow and soft blanket from hotel. Lastly, we need more time to make the testing because each testing need 1 to 2 days to complete the actual result. Our recommendation is first, Heavyweight Gypsum Board can give boast the strength by using a small size of expanded metal mesh and decrease the cellulose and gypsum ratio. Secondly, Size for testing, we need to do some research for actual size before doing flexural test and compression test. Next, using Polyurethane glue instead of Epoxy resin. The polyurethane glue is cheaper than epoxy and have the same result. Lastly, the time for testing, we need one day to do the Fire Resistance testing and we need 24-48 hours to do the Moisture Content.

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