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Manufacturing Optimum Fiberglass and Sawdust Panels as a Plywood Alternative Technique

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***Abstract* - Due to the development of the construction industry and some of the problems of wooden and metal formwork, we used glass fibers and formed them in the form of panels similar to plywood panels for the purpose of benefiting from the properties of glass fibers and producing panels with better specifications and efficiency and a longer lifespan than wooden and metal panels. Four models of glass fibers and sawdust were manufactured as a filler. The models were made with different specifications in terms of the amount of filler and layers of glass fibers for the purpose of studying and comparing them with wooden and metal panels in terms of weight, resistance to bending, absorption and cost. It was concluded from the laboratory tests that the best model in terms of weight is M_1, the best model in terms of bending resistance is M_2, and the best model in terms of absorption M4 and in terms of cost, the M_1 model. After comparison, we found that the best model M_4 Through the results obtained, we recommend the manufacture of fiberglass panels and their dissemination in the labor market.**

Keywords: formwork, fiber glass, plywood, wooden and metal panels.

I. INTRODUCTION

The construction industry is a vital global sector with complex processes and multiple stakeholders, facing challenges throughout project lifecycles. Multiple parties are involved, making it a large and significant industry worldwide (Abu Hammad, 2023).

It encompasses designing, studying, and implementing projects across sectors like buildings, dams, roads, and railways, characterized by large-scale products, geographical dispersion, uniqueness, and non-standardized production patterns (Alhusni, 2015; Hendrickson, 1989).The industry's significant budget, approximately 46% of global countries' annual budgets, drives the need for innovation to reduce costs and enhance efficiency. This involves adopting modern labor management techniques and utilizing new materials for equipment manufacturing (McConstruction, 2020).

Advanced technologies are transforming construction, enabling more effective, powerful, and efficient structures, while improving site safety, productivity, collaboration, and project complexity (Goulding, 2017; Li & Wu, 2019). Concrete is a principal construction material in building industry. Formwork plays an important role in assisting geometry realization and strength development of concrete elements. It is also one of the major costs in the construction of concrete structures (El-Mashaleh *et al* 2018).

Formwork is a mold, either temporary or permanent, that holds and shapes concrete until it hardens and can support itself and additional loads. Temporary formwork is removed after the concrete gains sufficient strength, whereas permanent types become integral parts of the structure (Hurd, 2005; Wang *et al.*, 2022). Sustainability of Formwork has become a crucial concern in civil engineering and construction industries due to the increasing pressure on the world's resources and the effects of climate change (Grebenkov2022; Eštoková 2022)

Formwork accounts for 35-60% of total costs in concrete construction projects (Kreiger, 2019). Managing these costs is crucial for project success. This involves understanding formwork material costs, labor costs, reuse and recycling, and how technology impacts costs.

II. PROBLEM STATEMENT

When using wooden formwork, we may notice some defects related to the high waste rate due to weather factors and poor storage and handling, and it consumes a lot of time to implement the formwork. Also, one of its disadvantages is its ability to absorb water, which reduces its lifespan.

When using metal formwork, we also face difficulty in storing and transporting it due to its heavy weight, as well as the problem of rust and its relatively high price. The concrete

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casting produced with this type of formwork may also be more prone to sagging.

Due to these defects, a new material other than wood and metal was sought to manufacture formwork that avoids the aforementioned defects. Fiberglass and wood shavings were chosen for their unique properties not found in plywood and metal.

III. METHODOLOGY

Four fiberglass panel models were manufactured as shown below:

Model M_1: The first model, (M_1), consists of two fiberglass layers and one sawdust layer, with dimensions of 2x10x50 *cm.*

Model M_2: The second model, (M_2), consists of four fiberglass layers and three sawdust layers, with dimensions of 2x10x50 *cm.*

Model M_3: The third model, (M_3), consists of five fiberglass layers and four sawdust layers, with dimensions of 2x10x50 *cm.*

Model M_4: The fourth model, (M_4), consists of four fiberglass layers and one sawdust layer, with dimensions of 2x10x50 *cm*.

Comparison Model B: A plywood piece with dimensions of 2x10x50 cm, denoted as B.

IV. MATERIALS

4.1 Fiber Glass

Fiberglass fibers were collected from the Blue Nile factory in the Khartoum popular market, which specializes in manufacturing water tanks and septic tanks, as shown in Figure 1. The properties of the fiberglass are summarized in Table 1 below.

Table 1: The specifications of the fiberglass

Product name	Glass chopped strand mat
E6CRMC450	1270-E01+F
AREA WEIGHT	450GSM
WIDTH	1270MM
NET/GROSS	WEIGT 40/42KG

Figure 1: fiber glass used in research

4.2 Resin

A liquid material used with a hardener to form the adhesive and solid material for panel formation, as shown in Figure 2 and the properties are listed in Table 2.

Table 2: Shows the specifications of the Resin

UNNO	1866
CLASS	3
BATCH	63670
MFG DATE	09’08’2020
FLASH POINT	34C
NET WT	225.00KGS

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Figure 2: The resin used (Saudi Arabia resin)

4.3 Sawdust

Sawdust from Muski wood was used in this study. It's a small, versatile wood particle with various applications, rich in organic materials, and easy to shape, as shown in Figure 3.

Figure 3: The Sawdust used in research

4.4 Wax

It is a greasy substance used to coat the mold or the surface onto which the fiberglass is to be cast, to facilitate the easy separation of the fiberglass from the mold.", as shown in Figure 4.

Figure 4: The Wax used in research

4.5 Gelcoat

It is a liquid substance used with fiberglass on the surface to provide a smooth texture with the addition of a hardener, as shown in Figure 5.

Figure 5: The Gelcoat used in research

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V. RESULTS AND DISCUSSION

5.1 Results

Fiberglass samples were manufactured (as in Figure 6.0) and tested for bending resistance using the machine shown in Figure 6. A comparison was made between fiberglass samples and plywood in terms of bending resistance, cost, weight, and water absorption, as shown in the tables and figures below.

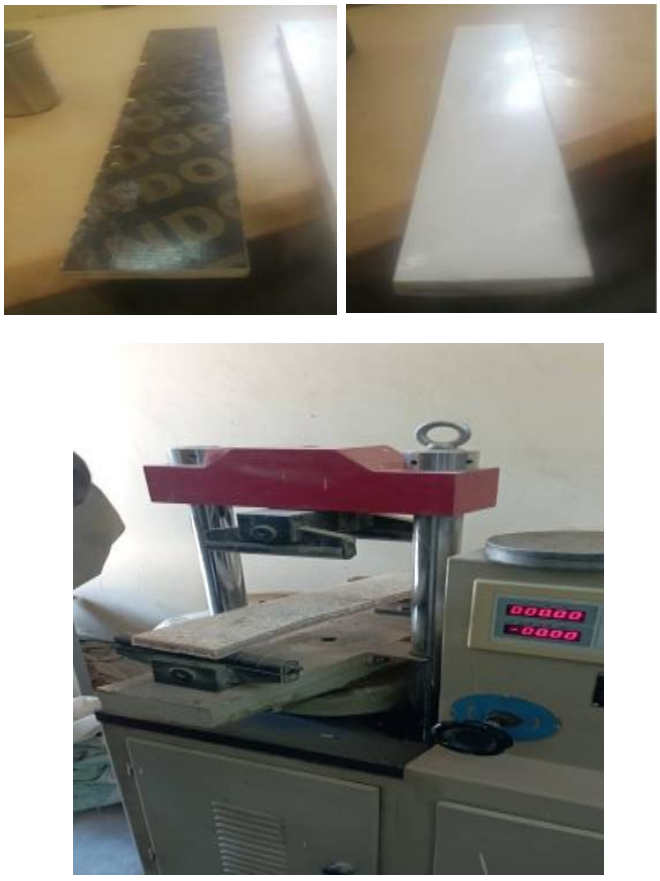

Figure 6: Plywood and fiberglass panels and bending resistance machine

5.1.1 Bending Resistance Test Results

Table 3 and figure 7 showed the bending resistance results for the plywood board and the four fiberglass panel samples, including the type of deformation (fracture).

Table 3: Bending Test Results for Comparison Sample and Manufactured Samples

Mold	Reading at fracture (*ton*)
B	0.01
M_1	0.14
M_2	0.30
M_3	0.28
M_4	0.27

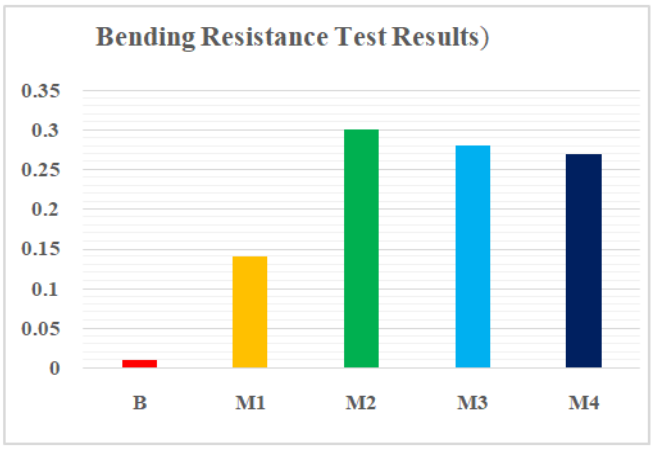

Figure 7: Bending Resistance Test Results

5.1.2 Manufactured Samples Cost Results

Table 4 and figure 8 presented the costs of the manufactured fiberglass molds compared to the plywood sample.

Table 4: Costs for Comparison Sample and Manufactured Samples

Mold	Cost ($)
M_1	10.88
M_2	12.7
M_3	14.4
M_4	14.13

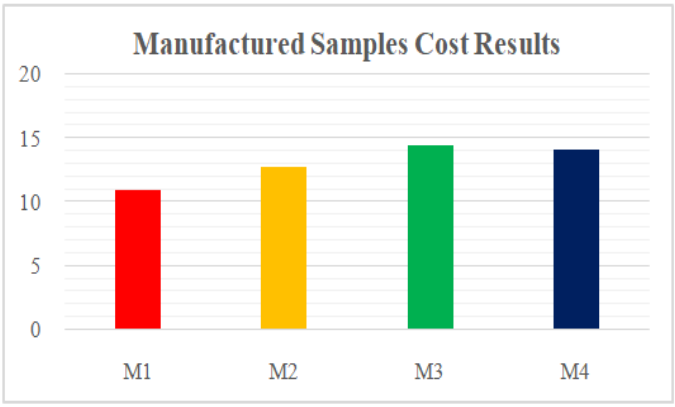

Figure 8: Manufactured Samples Cost Results

5.1.3 Results in terms of weight

Table 5 and figure 9 presented the comparison in terms of weigh for the plywood board and the four fiberglass panel samples.

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Table 5: Weight Results for Comparison Sample and Manufactured Samples

Mold	Weight (*kg*)
B	0.441
M_1	1.251
M_2	1.337
M_3	1.304
M_4	1.295

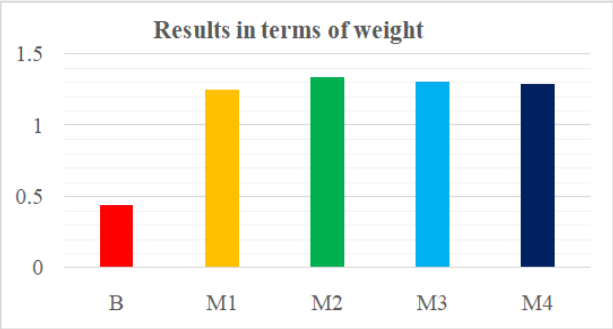

Figure 9: Results in terms of weight

5.1.4 Results in terms of Water absorption (%)

Table 6 and figure 10 showed the comparison in terms of Water absorption (%) for the plywood board and the four fiberglass panel samples.

Table 6: Weight Results for Comparison Sample and Manufactured Samples

Mold	Water absorption (%)
B	15.3
M_1	1.19
M_2	1.1
M_3	1.5
M_4	0.38

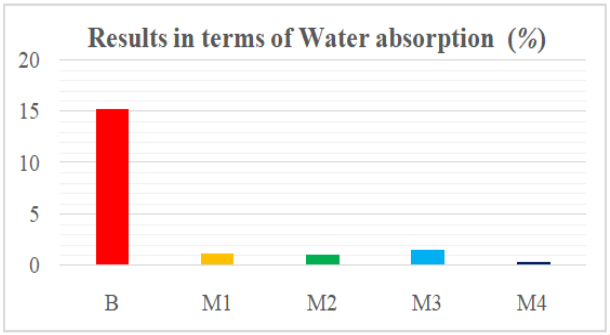

Figure 10: Results in terms of Water absorption (%)

5.2 Discussion

Four samples of fiber glass panels with sawdust as a filler material were manufactured. Through testing of compressive strength and water absorption rate, it was found that:

- According to Table 3 and Figure 7, sample M_2 has the best bending resistance. The most cost-effective samples are M_4 and M_3.
- Referring to Table 5 and Figure 9, the best sample in terms of weight is M_1.
- All samples are much better than plywood in terms of water absorption, and the best type in terms of water absorption is M_4.

VI. CONCLUSIONS AND RECOMMENDATIONS

Fiberglass panels have a relatively light weight compared to wooden panels, and they don't absorb water, preserving the mixing water quantity. Their smooth surface produces concrete with a beautiful finish that may not need plastering. Deformation caused by load can be removed by removing the load. However, their manufacturing cost is high compared to other panels, but they have a longer lifespan and can be recycled when damaged.

Best models:

- M_2: Best in bending resistance.
- M_1: Best in weight.
- M_3 and M_4: Best in cost-effectiveness.

We recommend that construction companies sponsor the manufacturing and use of fiberglass panels in the market, given their advantages such as light weight, water resistance, and longer lifespan.

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