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EVALUATION OF USING A LOCAL WASTE RECYCLING TECHNOLOGY IN THE MANUFACTURE OF SANDWICH PANELS FOR A FOAM HOUSES

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Abstract:

The manufacturing of the panels was done using waste recycling technology by using industrial cork waste as a basic material in the installation of the sandwich panels, then the characteristics of these panels were studied, the most important of which was the adhesion of the manufactured material with the upper and lower panels of the sandwich panel, and then we proceeded in our study to study the waffle panel. The manufacturing process takes place by converting industrial cork pieces brought from local market waste into small particles that are often clusters using rubbing with a rough surface, then introducing these industrial cork pellets into a mixture consisting of two materials; the first of which is a urethane polymer, which considered an incubator. Industrial cork pellets are included in the damaged construction materials, as is the second material used in the installation, Fursan tile fix brand ceramic adhesive. The best quantities of the mixture were obtained, allowing for the preparation of samples and models with very good mechanical, thermal, and chemical properties in terms of durability and by examining the properties of compressive strength, thermal insulation, and resistance to acid and base chemical corrosion. The results showed that the prepared product has an extremely high compressive capacity. Just as the thermal insulation value is comparable to that of white thermiston bricks, the prepared product's resistance to chemical corrosion is very high, and the corrosion process is almost non-existent, giving the new product a wide range of desirable properties. particularly in the field of construction, not to mention a critical feature such as speed. The preparation is high because it falls within a maximum range of thirty minutes, with ease of manufacturing and molding to the required shape, lightweight, and the ability to cast in very large areas. After more than a year of production, the mechanical properties were measured, and it was discovered that the mechanical properties increased significantly and noticeably with the increase in progress in the field.

Keywords: *polymer, Sandwich panels, Recycle, Compressive, Combustion, Foam Houses.*

INTRODUCTION:

In the modern world, the conservation of energy is accenting because it helps to achieve of many benefits goals, like the cost and reducing non-renewable fuel usage. The use of lightweight materials is a significant requirement of the vital ways to conserve energy, such as polymer matrix composites, which marketing reach tens of billions of dollars.[1]

Sandwich panels are known to be manufactured in a variety of sizes, with length, width, and thickness varying depending on the requirements and technical specifications. ICON sandwich panels are constructed from a high-quality, environmentally friendly polyurethane thermal insulation material that is injected from multiple points between two layers of corrugated iron or particleboard and finished with a suitable external finish.[2-5]

Sandwich panels are notable for their exceptional thermal insulation as well as their hardness and lightness. Cladding, ceilings, and walls in industrial complexes and private facilities such as cold and freezing rooms, quick-equipped buildings, caravans, spacecraft, planes, trains, cars, boats, and others are among the applications for the panels.[6-8]

In addition to the aforementioned characteristics, other undesirable qualities in these plates can be summarized as changing their shape with continuous pressure, especially if the spongy foam used between the two plates is of the solid type, as well as its low heat capacity and little resistance to combustion in the case of using solid spongy foam and shape deformation when exposed to high temperatures.[9-12] It is worth noting that the basic principle on which sandwich panels are built is (that the front panels, which can be corrugated iron sheets, pressed wood panels, aluminum panels, or stainless steel panels, bear the bending pressure to which these panels are subjected, while the injected polymeric material between the front and back plates supports shear stress.[13-15]

Instead of relying on polyurethane as an intermediate material between the two panels, modern research has included the use of high-density polyethylene, polyester, or polystyrene in the manufacture of these panels. Recently, research has shifted toward the use of glass fibers to develop the properties of these panels, specifically their thermal, mechanical, and acoustic properties, while another trend has emerged to use vegetable fibers such as hemp and sisal due to their high strength, abundance, and low cost.[16]

In this study, we focused on waste recycling technology by using industrial cork thrown away as waste as a material in the middle layer of sandwich panels, where we used a polyurethane mixture with industrial revolving cork balls.

EXPERIMENTAL PROCEDURE:

The industrial cork flakes have been obtained in the form of small-sized pellets by rubbing synthetic cork with a rough stone several times followed by collecting pellets in a container. The mixture of sandwich panels is the preparation of polyurethane foam, which is prepared by adding an amount of diisocyanate and polyhydric alcohol in a ratio of 1:1 and then mixing these materials with (12) grams of industrial ceramic adhesive paste. The mixing process of these three materials continues for (3-4) minutes, where synthetic cork pellets are gradually added to the mixture. After that, the whole mixture that contains synthetic cork pellets is cast in a bowl in a parallel rectangular shape to form the sandwich panel. The initial fluffing process takes ten minutes, and we take note of the high adhesion during the preparation process. It was obvious that the dough formed had filled the space or the total volume between the upper and lower plates with great regularity and high adhesion on both the upper and lower sides. The obtained sample panel of paste shown in Figure (1), a three same copies of sample of sandwich core were made to avoid the inaccuracy in manufacturing and the investigation the results processes.

Figure 1: The obtained panel.

RESULTS AND DISCUSSION:

All tests were done on the sandwich core samples, were the burning characteristics of prepared the sample had to be studied because the results obtained in this field revealed that the prepared model can self-extinguish. The prepared model was exposed to the flames of fire from the Bunsen lamp for one minute, and then the flame was lifted, revealing that the fire was extinguished from this source after a short time.[17-18] The model demonstrates the self-extinguishing property, where we observe the emission of white smoke and the absence of flaming sparks on the experiment ground, and how the emission of these gases contributed to protecting the prepared model from combustion, as shown in Figure (2).

After being burned, the prepared model was extinguished, and the fire was only superficial. As shown in Figure (2) and Figure (3), after dividing the model into two pieces, the interior of the model remained intact and was not exposed to burning (2). It was confirmed by splitting this burning model to see inside the model and determine whether it was burning or not, as the flame did not reach the inside or the surface close to the model's outer surface. Table (1) shows the percentage of losses caused by fire.

This demonstrates that the average loss in combustion is approximately 3% of the samples original weight, where the obtained results are the average of three readings. In comparison to other sample that do not use cork pellets, the combustion rate is 2%, this is due to cork being a burning factor, which contributed to a 1% increase in the combustion rate.

Figure 2: The combustion test of fabricated panels core.

Table 1: The burn loss in mass ratio panels core.

Sample	Burn loss ratio
1	4.7 %
2	2.56 %
3	2.85 %

Figure (3) depicts the mechanical properties of the prepared sandwich panels, which were measured by using the German Zwick-Roell for the mechanical properties of polymers measurements. Figure (4) shows that the compressive strength reaches 6.38 MPa, which is comparable to the compressive strength of the mixtures concrete because these panels will be used to build a polymeric house, we measured their mechanical properties using the cement cube method. As previously stated, the compressive strength of cement cubes is measured by cutting cubes with dimensions of 5 cm by 5 cm and calculating the resistance ratio on the area to obtain the amount of compressive strength of these cubes. This is what happened when we measured the compressive strength property of the prepared models at the University of Basrah, College of Engineering, Department of Civil Engineering, and the average results obtained for three of the prepared cubes were 4.38 MPa. which is a good result, with the need to note that the molds measured in this manner do not break or suffer from cracks or defects, yet the compression of the models to a lower height of up to 2 cm, noting that these samples maintain their strength except in terms of a decrease in height, which is attributed to the fact that the process of pressure by the piston arm leads to the exit of gas and air bubbles from the measured sample and then pushing them out. The layers of the sample are stacked on top of one another and converge, causing the sample to compress in the direction of the applied pressure.[17]

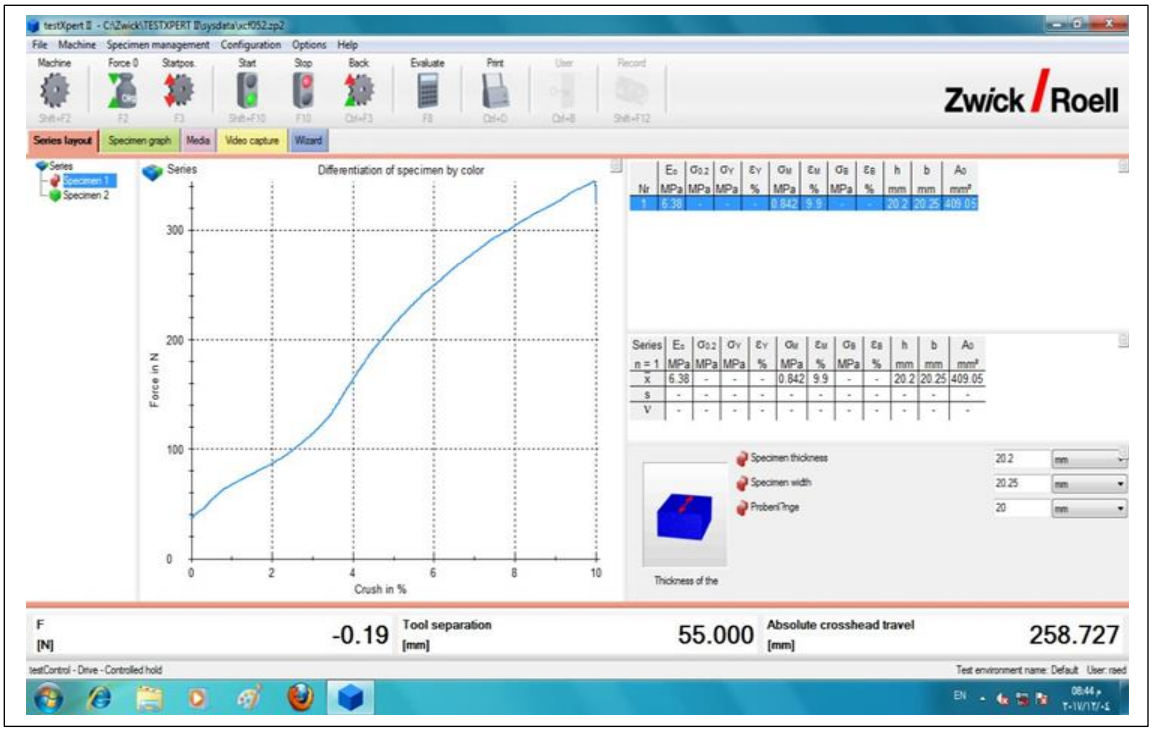

Figure 4: The panels core after the compression test.

To determine the extent of the new product's resistance to acids and bases, calculate the weight difference as a function of immersion time and temperature, as shown in Table (2) below, which shows a significant improvement in the chemical resistance of the developed mixture of strong bases and acids according to Iraqi Standard Specification No. 1555 of 2000 and the first amendment for the year 2002.

We notice a very small amount of weight loss in both strong acids and bases, indicating the high resistance to acids and bases, a feature that concrete and other types of floors lack, and the nature of the alignment within the material, which prevents penetration by the attacking chemical elements.

Table 2: Weight changes of the immersed model in hydraulic acid (5 M) and sodium hydroxide (5 M) as a function of immersion time.

Immersion time (day) / Media of Corrosion	1	2	3	4	5
HCl	1.275	1.275	1.275	1.275	1.25
NaOH	1.35	1.35	1.35	1.325	1.325

CONCLUSIONS:

As the obtained results, the prepared sandwich panels have the following properties:

1- It is characterized by lightweight, low cost, large area, ease of manufacture, handling, and transportation.
2- It can be handled manually and by simple carpentry and blacksmithing tools for cutting with the possibility of forming by molding compared to counterparts of radioactive shielding materials such as lead.
3- It is characterized by the abundance of raw materials in Iraq, in a very large and cheap way, with the excellence of these materials with a great ability to resist chemical and biological corrosion.
4- It is characterized by high volumetric stability with the possibility of availability in different forms such as blocks, plates, and slices.
5- Ease of molding the required shapes.
6- An environmentally friendly material as it is non-toxic and does not interact with other materials.
7- It has a relatively long life.
8- It is characterized by the ability to load other additives with different weight ratios, which gives it a variety of properties and thus expands the quality of applications.
9- Its excellence in resisting combustion when compared to the currently used prefabricated building panels, which use polyurethane polymer as a basis for the panels.
10- It is characterized by an increase in the compressive strength with time.

REFERENCES:

1. A. Noor, and M. A. Ur Rehman, A mini-review on the use of plastic waste as a modifier of the bituminous mix for flexible pavement, Science Direct, Cleaner Materials, 4, 100059, (2022).
2. A. May-Pat, F. Aviles, and J. O. Aguilar, Mechanical properties of sandwich panels with perforated foam cores., J. Sandw. Struct. Mater., 13, 427-444, 2011.
3. 3- K. Niu, and R. Talreja, Buckling of a thin face layer on Winkler foundation with debones. Journal of Sandwich. Structures and Materials, 1, 259–278, 1999.
4. 4- G. Zi, and Z. P. Bazant, "Eigenvalue Method for Computing Size Effect of Cohesive Cracks with Residual Stress, with Application to Kink Bands in Composites", Int. J. Eng. Sci., 4113-14, 1519-1534, 2003.
5. 5- J.J. Carruthers, A.P. Kettle, and A.M. Robinson. Energy absorption capability and crashworthiness of composite material structures: A review, Applied Mechanics Reviews, 51,10, 635-649, 1998.
6. 6- OT. Thomsen, Sandwich materials for wind turbine blades - present and future. J Sandwich Struct. Mater., 11: 7-26, 2009.
7. 7- S. Hou, S. Zhao, and L. Ren, Crashworthiness optimization of corrugated sandwich panels., Mater Des, 51: 1071-1084, 2013.
8. 8- A. Marshall, Sandwich construction. In: Peters ST (ed). Handbook of composites, USA: Springer, 254-290, 1998.

9. 9- A. K. Mohanty, Mubarak A. Khan, and G. Hinrichsen, Surface modification of jute and its influence on performance of biodegradable jute-fabric/Biopol composites, Composite Science and Technology, 60, 7, 1115-1124, 2000.
10. 10- T. Lendze, R. Wojtyra, L. Guillaumat, C. Biateau, and K. Imielinska,"Low velocity impact damage in glass/polyester composite sandwich panels", Advances in Materials Science, 6, 26-34, 2006.
11. 11- P. M. Schubel, J. J. Luo, and I. M Daniel, "Impact and post impact behavior of composite sandwich panels", Composites Part A: Applied Science and Manufacturing, vol.38, no.3, 1051-1057, 2007.
12. 12- F.Xia , and X.Wu,"Work on impact properties of foam sandwich composites with different structure", Journal of Sandwich Structures and Materials, vol.12,no.1, 47-62, 2010.
13. 13- P. Compston, M. Styles, S. Kalyanasundaram, "Low energy impact damage modes in aluminum foam and polymer foam sandwich structures", Journal of Sandwich Structures and Materials, 8, 5, 365-379, 2006.
14. 14- M. Akil Hazizan, and W. J. Cantwell, "The low velocity impact response of foam-based sandwich structures", Composites Part B: Engineering, 33, 3, 193-204, 2002.
15. 15- G. Zhou, E. R. Green, and C. Morrison, "In-plane and inter laminar shear properties of carbon/epoxy laminates", Composites Science and Technology, 55, 2, 187-193, 1995.
16. 16- A. Gomez, S. Sanchez-Saez, and Enrique Barbero, Experimental analysis of the impact behaviour of sandwich panels with sustainable cores, Composites: Part A 166, 107383, (2023).
17. 17- S. Wi, Y. U. Kim, J. Y. Choi, B. Shin, and S. Kim, Active protection against fire: Enhancing the flame retardancy of sandwich panels using an expandable graphite layer formation, International Journal of Thermal Sciences 195, 108658, (2024).
18. 18- A.W. Giunta d'Albani, L.L. de Kluiver, A.C.J. de Korte, R.A.P. van Herpen, R. Weewer, and H.J.H. Brouwers, Mass loss and flammability of insulation materials used in sandwich panels during the pre-flashover phase of fire, FIRE AND MATERIALS, Fire Mater.; 41:779–796, (2017).