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A New Method For Modifying The Compressive Strength Of Thermo Stone Using Polymeric Composite

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Abstract:

In this study, we test a new method to modify the compressive strength of Thermo stone where we used the Thermo stones made in Kuwait to be the land of test before and after the modification. The new method is based on the idea of reinforced concrete columns. Firstly, the column was made by drilling a cylindrical hole into the Thermo stone cubes. A composite consisting of Three items (Polyurethane foam, Aluminum powder, and petrified cement). That kind of composite chose to be a replacement for cement or concrete used in usually civil engineering. Three cases were investigated to determine how the compressive strength of a cylindrical hole filled with that composite is affected. The first case is how to determine the appropriate diameter for that hole, where the obtained results revealed that one cm is the most suitable diameter. The second case was to determine the appropriate number of holes per one cube, and it was discovered that one hole is the effective number rather than two or four holes. The third case was to see how the aging of the composite affects the compressive strength over time, and it was discovered that the compressive strength increases with time. The obtained results were explained in terms of the pressure of a composite column and how that pressure changes depending on its width and strength. The best results

Keywords: compressive, Thermo stone, cylindricaldrill, petrified cement, waste.

Introduction:

As the name implies, a composite material aims to create new materials by combining two or more different materials, resulting in a new one with improved characteristics and performance. Its constituents individually (1-3)

The use of composite materials has a long root in ancient civilizations, where Mesopotamians first used the first composite as a construction material to form new building materials since the use of mud has no suitable properties to create strong constructions, Furthermore, they glued wood strips at various angles to make plywood.

Composites, on the other hand, have the following properties as a class of materials: high strength; high modulus; low density; excellent resistance to fatigue, creep, creep rupture, corrosion, and wear; and a low coefficient of thermal expansion. (6-11).

These composite products have been used to provide design solutions that raw materials do not provide. There are many materials available today, and some have even become commonplace, with polymers enhanced by fiber being the most common (12-15). The use of composite materials instead of traditional building materials is typically done to provide a high weight value (16).

One of the main benefits of composite materials is to modify the construction materials to widen their range of use in life. One of these construction materials is Thermo stone. Thermo stone is a lightweight cement-based material with many gas bubbles evenly distributed in the volume, produced by blending and maturing a mixture of cement, sand, lime, water, agent generating cells. The lighter unit weight allows for easier handling, lower floor/foundation loading, insulation, and fire resistance. (17-19)

In this paper, we investigated the use of a composite to modify the compressive strength of Thermo stone. The modification of the compressive strength of Thermo stone by adding that composite inside a cylindrical hole made in the Thermo stone brick.

Experimental and procedure:

We used Iraqi Thermo stone bricks to carry out this experiment. The first step was to divide the Thermo stone bricks into many cubes of 10 cm in length. To use composite to modify the compressive strength of Thermo stone cubes we tunneled a central cylindrical hole from one face of the cube to another one. The radius of this cylindrical hole was first 0.5 cm, and then we extended that radius to be 1, 1.5, 2 cm. The idea beyond using that cylindrical hole is to inject them with a polymeric composite

and study how that composite affects the compressive strength of the Thermo stone cubes. For that purpose, we used petrified cement and Aluminum powder as a filler to modify the polyurethane foam. The Aluminum powder was brought from the garbage of the Aluminum furniture company. The effect of that composite on the compressive strength of the Thermo stone cubes was done by filling the cylindrical hole with that modified foam. It is worth noting that polyurethane foam was created by reacting diisocyanates (part B) and polyols (part A). A 1:1 (50:50) ratio was used. The synthesis of modified polyurethane foam began with the mixing of 80 g of part A and 70 g of part B in a container, followed by the addition of 50 g of petrified cement and 50 g of aluminum powder. It takes 2 minutes to mix everything together.. Leaving the modified cube for one week and then measuring the compressive strength and taking the average of three similar modified cubes. This test was also repeated for the cubes with 2 and 4 holes instead of one hole. Figure (1) shows the modification process of Thermo stone cubes while figure (2) shows the cube shape after modification process.

Figure (1) the modification of Thermo Stone cubes by composite

Figure (2) the shape of Thermo stone cubes after the modification process

Results and Discussion:

As we mentioned before, the experiment fundamentally depended on the diameter of cylindrical holes and how this diameter affects the compressive strength. Thus, the first test was to make many cubes of Thermo stone with different diameters of these holes and measure the compressive strength after one week of modifying the cubes with the composite. The obtained results are shown in figure (3) and table (1). The cubes with one cm hole were the best radius with compressive strength of 2.11 N/m^2 combined with 115.306 % of the compressive strength increment. Also, the results show that the more increase of the diameter of holes leads to less compressive strength.

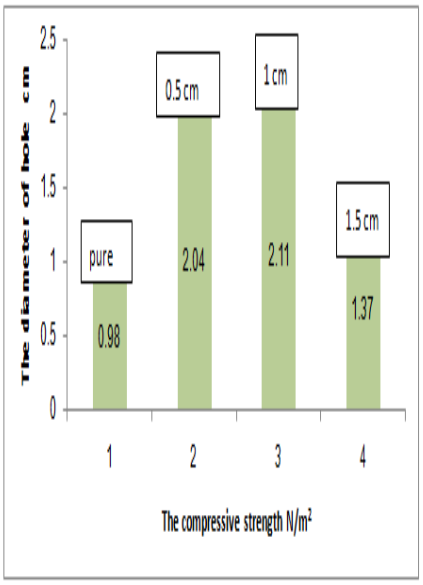

Figure (3) the effect of the diameter of holes on the compressive strength.

Table (1) the percentage increase of compressive strength related to the hole diameter.

diameter of holes cm	0.5	1	1.5
The compressive strength increment %	108.163	115.306	39.795

The second approach we take to see how drilling holes in Thermo stone cubes affect compressive strength is to increase the number of cylindrical holes and set the diameter of these holes at one cm. The selection of one cm depends on its best compressive strength in comparison to other holes. In this case, the curing time is combined with the quality of the diameter of the cylindrical holes used.

Setting the diameter and increasing the number of cylindrical holes yields the results shown in figure (4) and table (2). The highest compressive strength was obtained with one hole, and the increase in compressive strength is equal to one hole of one cm diameter mentioned in the first case. In general, two and four holes have lower compressive strength than one hole. All compressive strengths are higher more than pure ones.

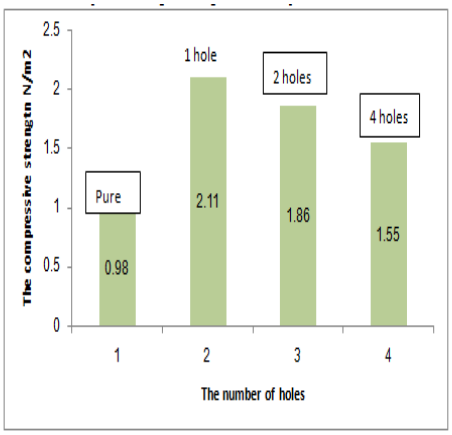

Figure (4) the effect of the number of holes on the compressive strength.

Table (2) the percentage increase of compressive strength related to the hole diameter.

Number of holes	1	2	4
The compressive strength increment %	115.306	89.795	58.163

The aging effect has been taken as the third case to see how the cylindrical holes affect Thermo stone compressive strength. Of course, we take the best diameter which is one cm to be the standard for the measurements in the aging case.

The aging effect was chosen as the third case to investigate how the cylindrical holes affect the compressive strength of Thermo stone. Of course, in the aging case, we use the best diameter, one cm, as the standard for measurements. Figure (5) and table contain the results (3). The compressive strength increases over a one-week to four-week aging period, with the third week having a greater effect on compressive strength than the first two weeks and a lesser effect than the fourth week.

The results show that drilling holes in the Thermo stone cubes and filling them with that composite causes the holes to behave like reinforced concrete columns. This column is fighting against the compression that has been applied. This result is supported by Figure (5), which shows that the composite column's strength has increased as the modified cubes take a wide time to hug the composite. More cement particles react during the aging process(20-22), increasing the rigidity of the composite used inside the drilling hole.The wider that cylindrical holes take the less fight of composite against applied pressure since the area of that composite is larger than before and reacting force is pushing against the applied force.

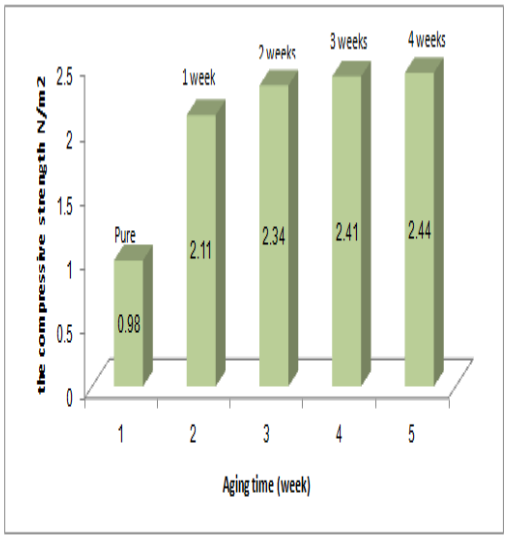

Figure (5) the effect of the aging on the compressive strength.

Table (3) the percentage increase of compressive strength related to the hole diameter.

Aging time (week)	1	2	3	4
The compressive strength increment %	115.306	138.775	145.918	148.979

Conclusion:

In general, the whole effect of drilling cylindrical holes in the Thermo stone cubes leads to a total increase in compressive strength this increment differs from one cube to another depending on the number and diameter of holes, The compressive strength is getting higher with the increasing aging of modifying the cubes with the composite due to the increase of the cross-linking density of that composite. Finally, the increase in compressive strength is less than other techniques.

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