Iraqi Journal of Science, 2022, Vol. 63, No. 7, pp: 2980-2986
DOI: 10.24996/ijs.2022.63.7.21

ISSN: 0067-2904

Study of Limestones from the Nfayil Formation in Bahr Al-Najaf Depression and Suitability for Thermal conductivity

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Received: 12/7/2021 Accepted: 23/9/2021 Published: 30/7/2022

Abstract

The evaluation of the Nfayil limestones in Bahr Al-Najaf Depression as construction materials was done on 15 sites distributed over a region. The study included field and laboratory aspects. The field side included collecting information about the study area and samples. As for the laboratory side, laboratory tests were conducted to study the thermal conductivity of samples by a device called Lee's disc in the Tikri University. The thermal conductivity results ranged between 2.34 and 0.27. The rocks are of high thermal insulation at low temperatures and low insulation at high temperatures according to the specifications of the suitability of limestone for thermal conductivity standards (ASTM C 1057-03-2010).

Keywords: Limestone, Nfayil, Najaf, Thermal conductivity,

دراسة صخور الحجر الجيري لتكوين النفايل – منخفض بحر النجف وصلاحيتها للتوصيل الحراري

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الخلاصة

تقييم صخور الحجر الجيري للتوصيل الحراري لتكوين النفايل في منخفض بحر النجف بواقع 15 محطة موزعة على منطقة الدراسة, اشتمل البحث على الجوانب الميدانية والمخبرية. في الجانب الميداني شمل جمع المعلومات حول منطقة الدراسة وتم جمع العينات, أما الجانب المخبري فقد أجريت فحوصات عملية لدراسة التوصيل الحراري للعينات بواسطة جهاز Lee's disc في جامعة تكريت حيث تراوحت نتائج التوصيل الحراري بين (2.34–0.27). من خلال هذه الاختبارات وحسب مواصفات صلاحية الحجر الجيري للعزل الحراري في تلبية متطلبات العزل الحراري القياسي.(ASTM C 1057–92–2010) حيث كانت الصخور جيدة للعزل الحراري في درجات الحرارة المنخفظة وغير جيدة في درجات الحرارة العالية

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1. Introduction

Due to the great importance of thermal isolation for reducing the consumption of energy used to cool facilities, recent years have seen a great trend for many countries to manufacture heat-insulating building materials. This mainly includes lightweight concrete, as it represents the most influential aspect of thermal conductivity and is lightweight with less loading on the foundation, thus reducing the use of rebar. Since the weight of rough aggregate (gravel) in concrete represents 70-75% of the weight of concrete [1]. The Cobourg limestone has a very low porosity rock consisting of lighter nodular regions, predominantly calcite and darker regions consisting of calcite, quartz, dolomite, and an appreciable clay fraction [2].

Using thermal insulating materials in service buildings is one of the most critical economic methods used to reduce the growing consumption of energy [3]. Thermal insulation is defined as the use of materials that have properties that help minimise thermal leakage and heat transfer from inside to outside buildings in winter, and vice versa in summer, through walls, ceilings, floors, and ventilation openings [3]. There are thermal-insulating materials in many forms, including those found in nature, such as rocks. Some are industrial materials, such as corks, raw materials, etc.

One of the essential solutions adopted by Arab architecture in the production of the constituent units of urban construction is the use of building materials. It was noticed in traditional architecture that its dependence on local building materials in the region made it a part of this environment. It had a character and identity that distinguished it from others, so it has urbanisation that expresses the culture of this society.

Rocks are one of the materials that are used in thermal insulation. It was used to construct Islamic architecture in mountainous regions, providing good thermal insulation. Limestone was used to help the internal spaces retain their cold air most of the daylight hours during the high air temperature outside [4]. As for the clay pots provide a porous property and achieve the thermal and structural load on the building. Also, a good heat insulator was used in the ceilings in hot areas. Many materials were used in thermal insulation. The thermal conductivity of solid insulation materials is carried out by phonons, the only thermal energy carrier. At high temperatures, phonons play the leading role in the thermal conductivity of all types of solid materials [5].

2-Location of Study Area:-

The study area is located in the middle part of Iraq, west of Najaf Governorate (Bahr Al Najaf depression) between the longitudes in the east (44° 02′ 33″- 44° 01′ 44″) and latitudes north (31° 58′ 22″ - 31° 58′ 01″) as shown in Figure 1.

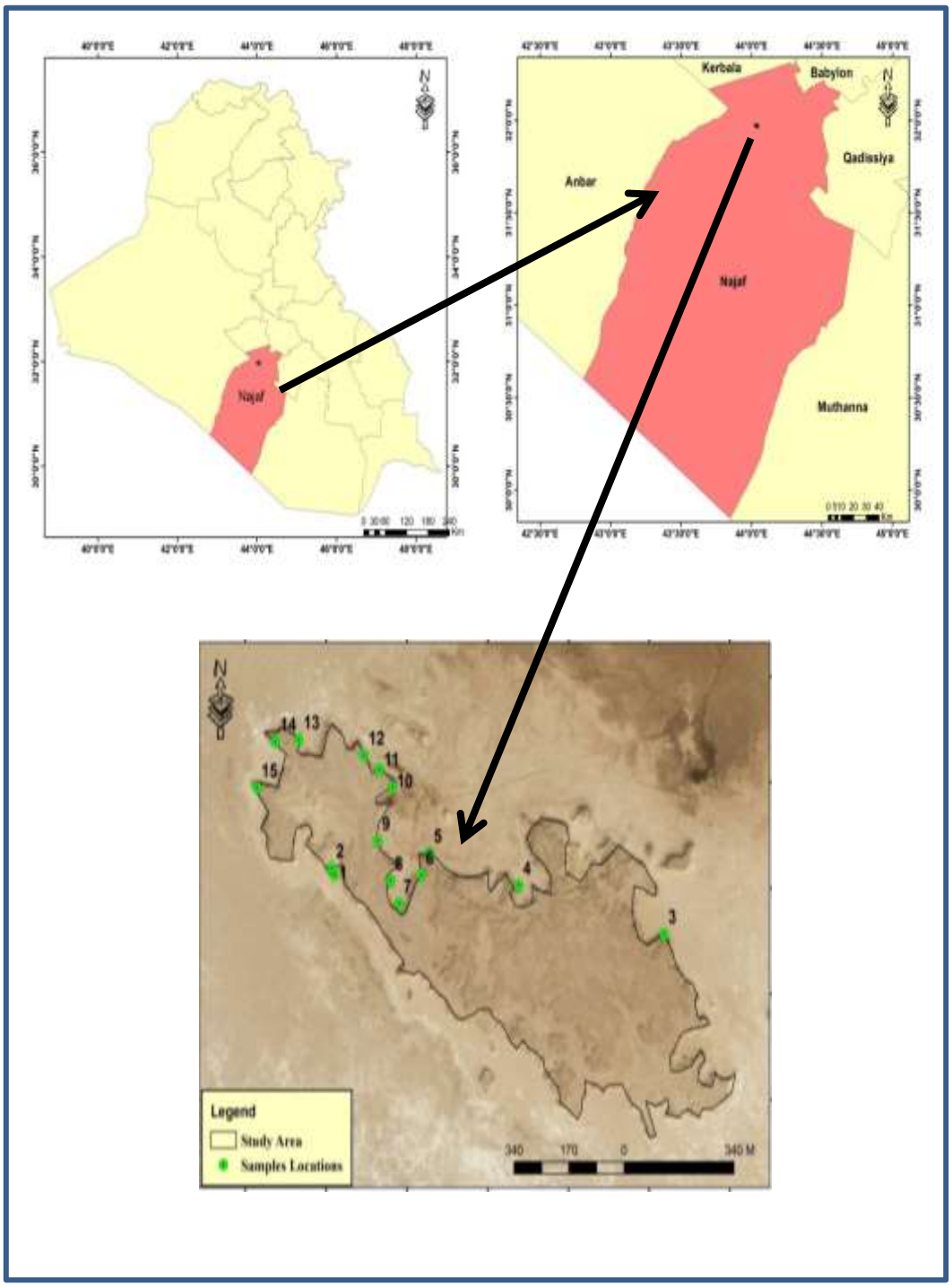

Figure 1- Location map of the study area represents the location samples.

3-Aim of Study

The objective is to study the Nfayil limestone collected from the Najaf depression and evaluate its suitability for thermal insulation.

4-Methodology:

In this study, Fieldwork and laboratory work are conducted as follows:

4-1 Fieldwork

The fieldwork is continued for five days (25-30 September 2019) to study the geology, stratigraphy, and geomorphology of the Nfayil Formation (Bahr-Al-Najaf depression). Fifteen

samples from limestone bed from 15 locations were collected along the study area's Nfayil formation track (Figure 2).

Figure 2- Limestone bed in the Nfayil Formation at the study area

4-2 Laboratory Work

Sample Preparing for Thermal conductivity Tests

The limestone samples were prepared with regular geometric dimensions according to the shape of the required specifications after removing the soft and exposed parts to obtain a fresh sample (Figure 3).

Figure 3- Limestone testing for thermal conductivity using device Lee's disc

5-Thermal conductivity

Thermal conductivity is the body's ability to transfer heat through its molecules on one side and the other side, or the transfer of heat from a heat source in contact with the body that conducts the heat. It is also known as the amount of heat transferred in a unit of time through the unit area of a homogeneous building with a unit thickness when the difference between the two temperatures of the two surfaces is one degree and is measured in units (W /m ºC) [6]. The amount of thermal conductivity is a characteristic of that material, and it represents a measure of the rate at which heat is transferred through the unit area of a homogeneous material of a certain thickness [7].

Thermal conductivity is a form of the most important physical test for insulating materials. There are many methods of measuring thermal conductivity depending on the type of material and the nature of its use [7].

The thermal conductivity of the samples selected from different sites is examined by controlling the power value in watts that are transferred to the heater as in the equation

$K= Q*\Delta x/A*\Delta T$

k = Thermal conductivity

Q= Capacity

x= Sample length

A= Sample area

T= Temperature difference between the two ends of the sample

6-Thermal Conductivity Test

The thermal conductivity of the limestones was examined in the laboratory of the

Engineering College, Department of Mechanics, University of Tikrit. It was tested at different temperatures by controlling the power value in watts transferred to the heater and calculated according to the following equation (Table 1).

Table 1-Results of the thermal conductivity of limestones

Sample no.	Q	ΔT	K
N1	2.6	2.5	0.42
	5.6	3	1.09
	6.7	4	1.73
N2	2.6	2	0.34
	5.6	3	1.09
	6.7	3.1	1.34
N3	2.6	2.3	0.39
	5.6	4	1.45
	6.7	4.6	1.99
N4	2.6	1.8	0.30
	5.6	2.5	0.91
	6.7	4.5	1.95
N5	2.6	1.6	0.27
	5.6	2.4	0.87
	6.7	4.2	1.82
N6	2.6	2.6	0.44
	5.6	3	1.09
	6.7	4.5	1.95
N7	2.6	4.7	0.79
	5.6	5.1	1.85
	6.7	5.4	2.34
N8	2.6	2.4	0.40
	5.6	3.6	1.30
	6.7	4.6	1.99
N9	2.6	1.9	0.32
	5.6	2.5	0.91
	6.7	4.1	1.78
N10	2.6	3.2	0.54
	5.6	3.4	1.23
	6.7	4.2	1.82
N11	2.6	3.3	0.55
	5.6	3	1.09
	6.7	3.5	1.52
N12	2.6	2.8	0.47
	5.6	3.4	1.23
	6.7	4	1.73
N13	2.6	2.1	0.35
	5.6	2.5	0.91
	6.7	3.1	1.34
N14	2.6	2.8	0.47
	5.6	3.4	1.23
	6.7	3.8	1.65
N15	2.6	2.4	0.40
	5.6	3.7	1.34
	6.7	4.1	1.8

7- Thermal conductivity assessment

The thermal insulation of limestone was evaluated based on standard specifications [4], where the results show that limestone has a lower value than the thermal insulation value (Table 2); except for the thermal conductivity at high temperatures, limestone does not achieve good insulation.

Table 2-Thermal conductivity (TC) coefficient of some materials at 23°C (ASTM C 1057-03 2010)

Material	Density (gm/cm^3)	TC (W/mC)
Steel	7.80	45.2
Concrete	2.47	2.43
Porcelain	2.20	1.21
Stone	2.3	0.92
Brick	1.70	0.63
Plastics	1.28	0.25
Wood	0.66	0.13
Fibreglass	0.10	0.046

8-Conclusions

This study discussed the feasibility of thermal insulation of limestone in the Nfayil Formation in the Najaf depression. The study concluded that the limestones have a conductivity of less than 0.8 W/mh, meaning it has a high thermal insulation efficiency except for thermal conductivity at high temperatures than limestone, and it does not achieve good insulation.

9-Recommendations

Conducting a study to measure the extent of the limestone bed and determine their thickness to know the rock quantity in the area and decide on their economic importance

References

[1] M. A. AL-Nuaimi, B. F. Al-kubaisi and S. O. Al-heety, "Manufacture of Spongy Gravel fromObsidian to ProduceLightweight and Thermal-Insulating Concrete" Iraqi Journal of Science, 2021, Vol. 62, No. 7, pp:2287

[2] selvadurai A.P.S. ,and Rezaei Niya, S.M. ,2020, "Effective thermal conductivity of an intact heterogeneous limestone", Journal of Rock Mechanics and Geotechnical Engineering 12(2020) p. 683

[3] Y. A. Al-Qubaili, "Rationalizing energy consumption by improving the specifications of some thermal insulation materials", Master Thesis, Tishreen University - Faculty of Mechanical and Electrical Engineering, 2009, p. 82. (In Arabic).

[4] Kammuna and Abdul Wahed, "The use of local environment resources in the construction of units that make up the urban fabric within the framework of urban heritage preservation", published research, Journal of the Plan and Development, 2010, Issue 22, p. 20.

[5] M. A.S Mohammed and A. S. Saleh,: "Study the Effect of Temperature on Structural, Mechanical and Thermal Properties of PVC/CaCO3Composite, published research, Iraqi Journal of Science", 2018, Vol. 59, No.1A, pp:55

[6] ASTM-C1057-03, "Standard Practice for Determination of Skin Contact Temperature from Heated Surfaces Using a Mathematical Model and Thermesthesiometer1", 2010, P6.

[7] Al-Naimi, T. Abdullah, "manufacture of heat insulators and thermal insulators from gypsum compounds and Iraqi kaolin clays". PhD thesis, unpublished, University of Baghdad, 2000, p. 173 in Arabic.