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Studying the effect of using quarries wastes in Bani-Walid as a partial substitute for fine aggregate on the compressive strength of concrete

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Abstract: This research studies the extent to which the product of lime brick production waste in Bani Walid affects the compressive strength of concrete if it is used as a partial substitute for sand. Lime brick dust is a powdery substance from the product of lime brick waste. It is usually used in many applications. Lime brick dust mainly consists of Of calcium oxides, silicon oxide, magnesium oxide and aluminium.
Given the urgent need to use concrete in implementing some modern construction projects, the main objective of the research is to present a laboratory study on adding lime brick powder available in the city of Bani Walid (Al-Mardoum Quarry).
To achieve the goal of this study, 36 cubes of six mixtures were made, knowing that the mixing ratios are fixed and the only variable is the percentage of lime brick dust powder, which was used as a partial substitute for sand. The first sample was (C1- 0%), the second sample was (C2- 5%), and the third sample was (C3- 10%), the fourth sample (C4- 25%), the fifth sample (C5- 50%), and the sixth sample (C6- 100%), and then mixed and processed in laboratory conditions by immersing it in water for 7 and 28 days, where a drop test was performed on all samples and a compression test was also performed on all samples at the end of 7 and 28 days.
It was concluded through these tests that the slump value decreases when the amount of brick dust increases, and that the pressure values increased at (C2- 5%), (C3- 10%), and (C4- 25%), and the highest compressive strength value was at (C4- 25%). At (C5- 50%) it began to decrease, and the lowest compressive strength was at (C6- 100%).

Introduction

The history of limestone brick quarries in Libya goes back to ancient times, when it was used in building the most famous archaeological sites, the most important of which is the historic city of Leptis, located in northwestern Libya, as well as in the Roman era, when it was used in building cities, theatres, baths, and the Acropolis.

Manufacturing and cutting limestone for the purpose of using it in various construction works is one of the thriving industries in Libya to this day, as it is used in building houses and other facilities. There are lime brick quarries in most cities on the western coast of Libya, in addition to Bani Walid and Ajdabiya.

As is known, the process of producing limestone bricks results in very large quantities of waste in quarry sites, which constitutes a burden on the owners of these quarries, in addition to the lime dust carried by the wind, which causes great damage to the areas surrounding these quarries.

This study aims to try to use these wastes as an alternative building material to fine aggregate (sand) in the concrete industry.

Preparing this powder does not go beyond crushing and screening to obtain a gradation

that matches the specifications. Thus, it is good from an economic standpoint when compared with natural sand, which may contain harmful materials such as clay materials, salts, iron compounds, and organic materials] 1[.

A laboratory study was conducted using different percentages (25%, 50%, 75%, 100%)

of lime brick powder as a partial replacement for fine aggregate, in addition to different percentages of cement. The amount of water needed to give good workability in the cement mortar was measured and the samples were tested. To determine the compressive strength at 3 and 7 days of age and the tensile strength, the results showed its suitability for the cement mortar resulting from the use of limestone waste powder and for all percentages of additions, as it gave good workability and compressive and tensile strength compared to the required specifications(2).

Laporatory program:

The aim of this study is to investigate the effect of using lime brick powder on the compressive strength of concrete. To achieve this goal, a practical program was prepared that included the preparation of a standard mixture that achieves compressive strength (25 MPa) and five other mixtures containing different proportions of lime brick powder, which were used. As a partial replacement for fine aggregate, according to Table (1), 6 cubes were prepared for each mixture. 3 cubes were tested after 7 days, and 3 cubes were tested after 28 days, according to Table (2).

Table (1) shows the components of concrete mixtures

Lime stone brick powder Kg	Water Litter	Cement kg	Fine aggregate kg	Coreas aggregate kg	Limestone brick powder ratio%		Mix symbol
0	5.42	8 Kg	18 Kg	26.25 Kg	%0	of cubs	C1
0.9 Kg	5.42	8 Kg	17.1 Kg	26.25 Kg	%5		C2
2.7Kg	5.42	8 Kg	15.3 Kg	26.25 Kg	%10		C3
4.5 Kg	5.42	8 Kg	13.5 Kg	26.25 Kg	%25		C4
9Kg	6	8 Kg	9 Kg	26.25 Kg	%50		C5
18 Kg	8	8 Kg	0	26.25 Kg	%100		C6

Table (2) shows the number of cubs of each mixture.

Concrete mixture materials:

Basic materials were used to implement concrete mixtures, such as ordinary Portland cement, coarse aggregate, fine aggregate, lime brick powder, and water. Below we discuss the properties of these materials.

Cement:

Ordinary Portland cement, supplied by the Arab Union Zliten factory, was used to implement all the study mixes, which conforms to Libyan specifications (340/1997).

Coarse aggregate:

Aggregate was used from the Al-Mardoum area and its nominal size is 20 mm. This type was used alone without mixing it with any other type of aggregate because its granular gradation curve fell within the limits of the gradation curve for coarse aggregate in the Libyan standard. The sieve analysis was conducted in accordance with the Libyan specifications. Table (3) shows the results of the sieve analysis and the figure. (1) shows the sieve analysis curve for coarse aggregate according to Libyan specifications(3).

Libyan specification standard	Percentage of passing %	Percentage of cumulative received weight (%)	Cumulative Received weight (gm)	Received weight (gm)	Sive opening (mm)
100	100	0	0	0	19
90-100	92.34	7.663	153.25	153.25	14
50-85	52.48	47.524	950.48	797.23	10
0-10	1.33	98.674	1973.48	1023	5
-	-	-	-	19.5	pan
Total weight=2000gm			Maximum aggregate size=20mm		

Table (3) Sive analysis for Coares aggregate.

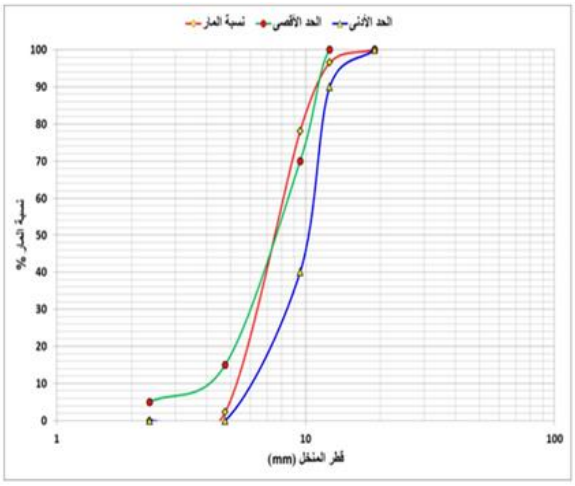


Figure (1) Sive analysis curve for Coarse aggregate.

Fine aggregate:

The fine aggregate used was brought from the city of Zliten and is of the type commonly used in our region. The table (4) shows the results of the sieve analysis and the figure (2) shows the sieve analysis curve according to Libyan specifications(3)

Libyan specification standard (49/ 2002)	Percentage of passing %	Percentage of cumulative received weight(%)	Cumulative Received weight (gm)	Received weight (gm)	Sive opening (mm)
- - -	99.976	0.024	0.486	0.489	5.00
100-80	99.927	0.073	1.458	0.972	2.36
100-70	99.878	0.122	2.43	0.972	1.18
100-55	97.934	2.066	41.31	38.88	0.60
70-5	51.4	48.6	972	930.69	0.30
15-0	7.32	92.680	1853.604	881.604	0.15
				140.454	Pan
Total weight=2000gm			fine coefficient=1.44		

Table (4) Sive analysis for fine aggregate.

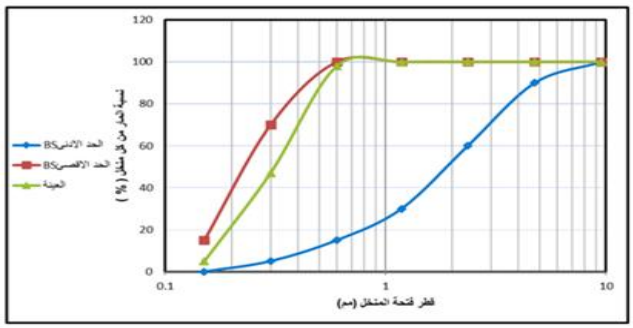


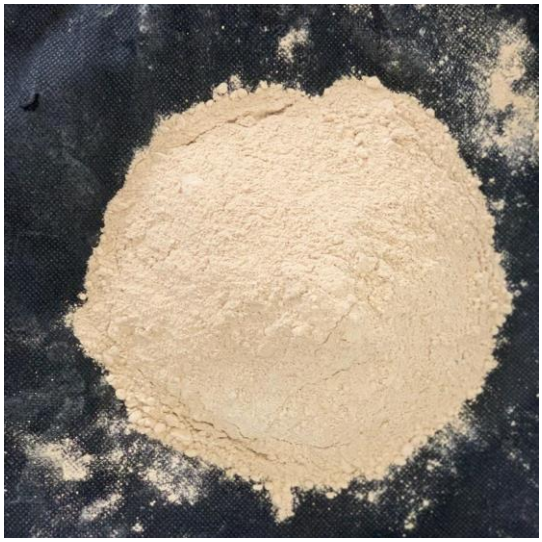
Figure (2) Sive analysis curve for fine aggregate.

water:

used in concrete mixes is safe to drink, free of organic materials and impurities. Man-made river water.

Limestone brick powder:

Limestone brick powder was supplied from quarry waste in the Al-Mardoum area (Bani Walid), where it was crushed and screened to be within the size range of fine aggregate as shown in the picture (1). Limestone brick powder is a powdery substance resulting from grinding white bricks. White brick dust consists mainly of calcium oxide, silicon oxide, magnesium oxide, and aluminum.



Picture (1) Limestone brick powder

Tests results:

A compressive resistance test was conducted to determine the properties of concrete, which express its quality and mechanical properties, and to determine the extent of the effect of different percentages of lime brick powder instead of fine aggregate on this property and for all concrete mixtures that were prepared. The table (5) and the curve (3) show the results of the compressive resistance tests after 7 days of Concrete age, table (6) and curve (4) show the results of the compressive strength test after 28 days, and table (7) shows the relative variation of the test results compared to the standard mix.

Averge compressive strength after (7days) (Map)	Mix
18.56	C1-0%
22.0	C2-5%
26.4	C3-10%
24.3	C4-25%
20.9	C5-50%
12.3	C6-100%

Table (5) Compressive strength of concrete after 7 days.

figure (3) Compressive strength of concrete after 7 days.

Averge compressive strength after(28days) (Map)	Mixture
28.2	C1-0%
27.9	C2-5%
28.9	C3-10%
30.7	C4-25%
25.9	C5-50%
15.6	C6-100%

Table (6) Compressive strength of concrete after 28 days.

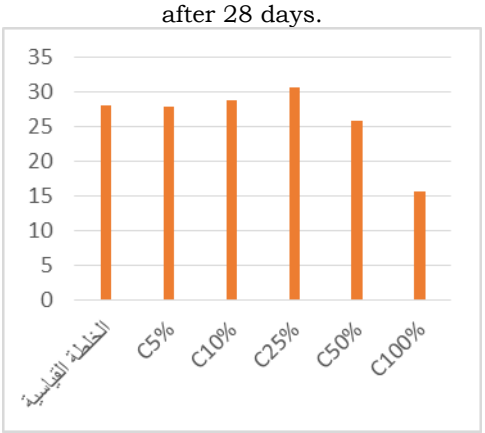


figure (4) Compressive strength of concrete after 28 days.

Change of compressive strength ratio after 7days%	Averge compressive strength after(28ays) Map	Change of compressive strength ratio after 7days%	Averge compressive strength after(7days) (Map)	lime brick powder ratio %	Mixture
0	28.2	0	18.56	%0	C1-0%
-1.06	27.9	18.53	22.0	%5	C2-5%
2.48	28.9	42.22	26.4	%10	C3-10%
8.86	30.7	30.92	24.3	%25	C4-25%
-8.15	25.9	12.6	20.9	%50	C5-50%
-44.68	15.6	-33.72	12.3	100 %	C6-100%

Discussing test results:

Referring to the results of the compressive strength tests for concrete shown in Table (), which show a noticeable improvement in varying percentages in the compressive strength of the mixtures C2, C3, C4, and C5 compared to the standard mixture, it was found that the mixture with a 10% replacement ratio for lime brick powder showed the highest increase in strength. The pressure increased by 42.22%, while it was observed that the mixture with a 100% replacement ratio decreased the compressive strength to 33.72%.

Referring to the results of the tests for compressive resistance after 28 days, an improvement in the compressive resistance of the mixtures C4 and C3 was evident. It was shown that the C4 mixture, which had a 25% replacement rate, had the highest increase in compressive strength, by 8.68%, while the C4 mixture showed an increase of 2.48%. C6, which had a replacement rate of 100%, decreased the compressive strength to 44.68%. It was also observed that lime brick powder caused a decrease in the workability of the mixtures C5 and C6, which had a replacement rate of 50% and 100%, which required raising

Conclusions:

1. Laboratory experiments showed that mixtures to which lime brick powder was added significantly improved, with varying percentages, the compressive strength of concrete after 7 days of concrete life for mixtures C2, C3, C4, and C5, provided that the replacement percentage does not exceed 25%.
2. An improvement in the compressive strength of concrete was observed after 28 days of concrete life if the replacement percentage did not exceed between 10% and 25%, while it was found that increasing the replacement percentage leads to a decrease in the compressive strength of concrete.

3. The results of the study showed that lime brick powder produced from quarries in Bani Walid can be used as a partial substitute (in limited proportions) for fine aggregate in concrete mixes.

Recommendations:

1. More studies need to be conducted to know the chemical composition of lime brick powder and the chemical components of cement.
2. More studies must be conducted using additives and their relationship to improving the properties of concrete that has replacement ratios of lime brick powder.
3. We recommend further testing by changing the mixture ratios (coarse aggregate, fine aggregate, cement, water).

Refrences:

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