CERTIFICATE

| SQM_720_2022 |

DETERMINATION OF THE EQUIVALENT THERMAL CONDUCTIVITY OF TWO MASONRIES MADE OF DIFFERENT CLAY BRICKS TYPOLOGIES, PROVIDED BY THE COMPANY "AL WATANIA RED CLAY BRICKS FACTORY"- KINGDOM OF SAUDI ARABIA

PLACE AND DATE OF ISSUE:	Faenza, 25 th November 2022
COMPANY:	**AL WATANIA RED CLAY BRICKS FACTORY**
ADDRESS:	P.O. BOX 10554 11443 RIYAD KINGDOM OF SAUDI ARABIA
TYPE OF PRODUCT:	*Masonry made of clay Bricks*
STANDARD APPLIED:	EN 1745, EN ISO 6946
DATE OF RECEIPT IN LABORATORY:	July 2022
TESTS EXECUTED:	August 2022
TESTS EXECUTED BY:	CertiMaC, Faenza

NOTE: Results contained in the present test report are exclusively referred to the samples subjected to the tests described hereafter. Moreover, this report is for the exclusive use of the Customer, within the limits set by mandatory legislation and cannot be reproduced, totally or partially (in digital or paper form), without a written approval of the Laboratory.

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Shared capital € 84.000,00 fully paid-up

Shareholders
ENEA Italian National Agency for New Technologies, Energy and Sustainable Economic Development
National Research Council of Italy

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1 Masonry elements and Characteristics

Al-Watania Red Clay Bricks Factory - Equivalent thermal conductivity λ (W/mK)

No	Product Name (Dimensions in [cm])	Temperature range adopted for calculations and modeling	Equivalent thermal Conductivity λ (W/mK)
1	Hollow 10x20x40	Internal temperature 24 °C External temperature 50 °C	0.2801
2	Hollow 15x20x40		0.2800
3	Hollow 20x20x40		0.3197
4	Perforated 20x20x40		0.2752
5	Hordi 20x20x40		0.2654

Materials specifications adopted to design the Masonries configuration

No	Material and specification (ref. to Saudi Code Guidelines)	Declared Thermal conductivity λ (W/mK)
1	Plaster (internal and external) - thickness 10 mm	0.103
2	Mortar (Horizontal and Vertical joint) - thickness 10 mm	0. 103
3	Polystyrene Foam (PS) - thickness 50mm	0.033

Two walls configuration have been considered:

1- Hollow 20x20x40 Bricks + 50 mm PS foam + Hollow 10x20x40 + Plaster + Mortar

2- Hollow 15x20x40 Bricks + 50 mm PS foam + Hollow 10x20x40 + Plaster + Mortar

2 Boundary Conditions adopted for Calculations

Internal Temperature (°C / K)	24 / 297.15
External Temperature (°C / K)	50 / 323.15

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3 U-Values of composite Masonries with PS:

No	Wall Configuration	Masonry U value (W/m²K)	Equivalent thermal Conductivity λ (W/mK)	Masonry Thermal Resistance R_T (m²K/W)
1	Hollow 20x20x40 Bricks + 50 mm PS foam + Hollow 10x20x40 + Plaster + Mortar	0.3321	0.1327	3.0111
3	Hollow 15x20x40 Bricks + 50 mm PS foam + Hollow 10x20x40 + Plaster + Mortar	0.3430	0.1192	2.9150

4 Conclusions according to the Saudi Building Code Requirements:

In Saudi Building Code (601) for non-residential buildings with more than 3 floors, the U-values required for Zone 1, 2, and 3 are: **0.511, 0.591** and **0.698 W/m²K**, respectively.

For residential buildings with more than 3 floors, the U-value requirements for Zone 1, 2, and 3 are **0.454**, **0.511** and **0.591 W/m²K**, respectively. A lower U-value determines a lower heat flow transmitted through the wall.

The U-values of all walls, constructed using "Al watania red clay bricks factory", are compliant with the Saudi Building Code for all areas in Kingdom of Saudi Arabia.

As regard the R-value, the Saudi Building Code (601) requirements for non-residential building with 3 floors or more, ranges from **1.34 to 1.81 m²K/W** and for residential ranges from **1.67 to 2.06 m²K/W**. The desired R-values should be greater than the minimum value as this stated how resistive a material is to heat transfer. Considering the values obtained, it's possible to conclude that "Al watania red clay bricks factory" used for walls are compliant with the Saudi Building Code for all areas in kingdom of Saudi Arabia also for R-value.

The same procedure could be applied to Saudi Building Code (602) for buildings with three floors or less. For buildings with three floors or less, the required U-values are **0.403 W/m²K** (Zone 1), **0.454 W/m²K** (Zone 2) and **0.511 W/m²K** (Zone 3). These limits are higher than the walls made with "Al watania red clay bricks factory". At the same time, for R-values, the requirement is **2.36**, **2.06**, and **1.81 m²K/W** for Zone 1, 2, and 3, respectively. Considering the values obtained, it's possible to conclude that "Al watania red clay bricks factory" are compliant with the Saudi Building Code (602) for all areas in kingdom of Saudi Arabia.

In conclusion, the masonries above calculated and made with "Al watania red clay bricks factory" are compliant with the Saudi Building Code (601) & (602) for all the zones in kingdom of Saudi Arabia included in the guideline. Therefore, "Al watania red clay bricks factory", used in the

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above explained conditions, are appropriate for use throughout the whole Kingdom of Saudi Arabia.

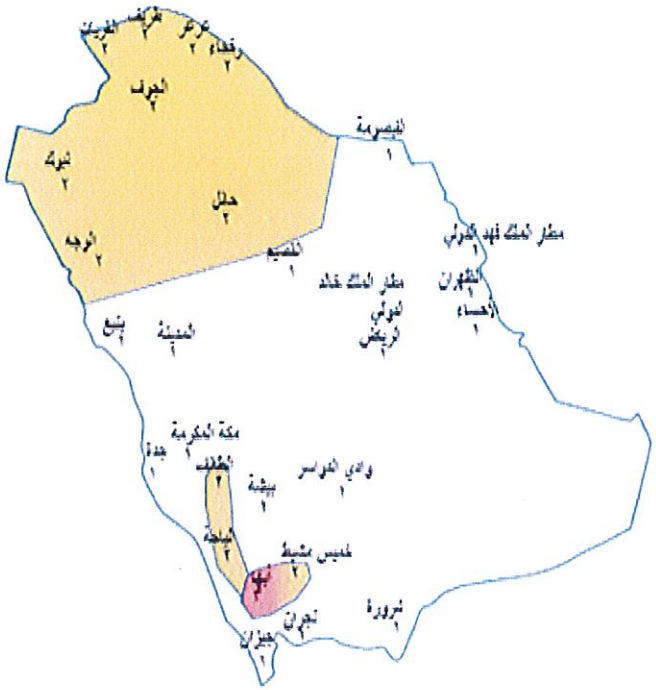

Figure 1. Kingdom of Saudi Arabia Zones according to the Guideline

5 Distribution list

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