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THERMAL RESISTANCE TEST REPORT

CLAY BRICK ASSOCIATION of SA (CBA)

Determination of the Thermal Resistance of Thermally Insulated Building Envelope Systems using CBA Bricks in accordance with ASTM C 1363-05: *Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.*

TEST APPLICANT: Clay Brick Association of SA (Pty) Ltd

INTRODUCTION

Thermal Test Laboratory CC has been retained by The AAAMSA Group to test and determine the Thermal Resistance of four different clay brick wall systems, of which some includes specific thermal insulation measures, by means of a Rotatable Guarded Hot Box (RGHB) and in accordance with ASTM C 1363-05.

STANDARD TEST CONDITIONS

The standard test conditions for the RGHB tests were selected based on the requirements of ASTM C1058 - 03(2008): *Standard Practice for Selecting Temperatures for Evaluating and Reporting Thermal Properties of Thermal Insulation*. The standard test conditions used for these tests are as follows:

Room side (metering box)

Air temperature:	21 ºC (Cold climatic conditions)
Flow velocity:	0.3 m/s downward

Climate side:

Air temperature:	- 5.0 ºC (Cold climatic conditions)
Flow velocity:	5.5 m/s upward

Mean temperature of specimens for cold climatic conditions: 8.0 °C

OVERVIEW OF RGHB BUILDING ENVELOPE SYSTEM TEST APPROACH

Since the thermal resistance of the clay brick walls to be tested can only be determined in a system test, four test specimens of nominally 1.5 m (h) x 1.2 m (w) were constructed. The specimens were constructed in Supawood frames mounted inside adjustable steel frames (see Appendix A) to ensure that the dimensions of the specimens are within the 1 mm tolerance allowance. The specimens were allowed to dry for a period of 28 days.

The specimens are removed from the steel frames prior to testing and mounted in the aperture of the surround panel. It is then instrumented with up to 28 calibrated thermocouples mounted at selected positions on both surfaces of the specimens. An extruded polystyrene (XPS) probe, instrumented with 6 equi-spaced type T thermocouples mounted along its length, is then mounted near the centre of the test specimen. It is used for measuring the dynamic specimen core temperatures of the specimen to determine whether stable conditions have been reached.

After setting the test parameters, the cooling system is initiated and the system is allowed to saturate and reach stable conditions where it has to stay for a period of at least four hours within very tight tolerances. The thermal resistance and thermal transmittance of the test specimen are then determined by analysing the recorded test data.

DESCRIPTION OF THE TEST CONSTRUCTION

The specimen dimensions are 1 185 mm (width) x 1 485 m (height) with the depth varying per specimen. The clay brick specimens are built inside test frames made from 12 mm thick Supawood.

The following systems were tested**:**

- **WALL 1**: A double clay stock brick wall with 12 mm mortar joints and with 12 mm plaster on both sides (painted white), with single wall brickforce with galvanised ties tying the skins together every fourth course.
- **WALL 2**: A double brick wall made from perforated clay stock brick on the room side and perforated face brick masonry units on the climate side with 12 mm mortar joints and with 12 mm plaster on only the room side, painted white. The specimen has single wall brickforce with galvanised ties tying the skins together every fourth course.
- **WALL 3**: A double brick wall made from clay stock brick on the room side and perforated face brick masonry units on the climate side with 12 mm mortar joints, separated by 30 mm thick Isoboard insulation panels tied to the room side skin, with a resultant air cavity of 20 mm. The wall has 12 mm plaster on only the room side, painted white.
- **WALL 4**: A double brick wall made from clay stock brick on both the room side and the climate side and with 12 mm mortar joints, separated by a 30 mm Expanded Polystyrene insulation panels tied to the room side skin, with a resultant air cavity of 20 mm. The wall has 12 mm plaster on both surfaces, painted white.

TEST RESULTS

Due to stringent stability requirements, RGHB tests are usually very long, lasting typically a few days per test. The following RGHB data is sampled every second, averaged and recorded every minute:

- The temperature histories for the specimen for each test
- The air flow rates in the metering box and the climate side
- The area-weighted temperatures of both sides of the surround panel
- The spatial temperature distribution of the baffle surface in the metering box
- The spatial temperature distribution of the metering box air
- The output of the thermopile measuring the heat flow through the metering box walls
- The temperature increase of the metering box cooling loop and its flow rate
- The surface temperatures of the specimen
- The temperatures of the XPS probe

The RGHB test data is analysed to determine the air-to-air thermal resistance values of the various specimens. This analyses takes account of the Watts input into the metering box (for controlling the air and baffle surface temperatures), the net thermopile gain/loss, the heat gain/loss through the surround panel and all other losses (or gains) such as flanking losses and possible thermal bridging for which the RGHB has been calibrated in accordance with the requirements of both the National Fenestration Rating Council (NFRC) and the South African National Accreditation System (SANAS).

Although the allowable tolerance on the temperature variation around the average value during the four-hour stable period is ± 0.3 °C as per ASTM C1363, the measured variations for the CBA tests were generally much less (Figure 1).

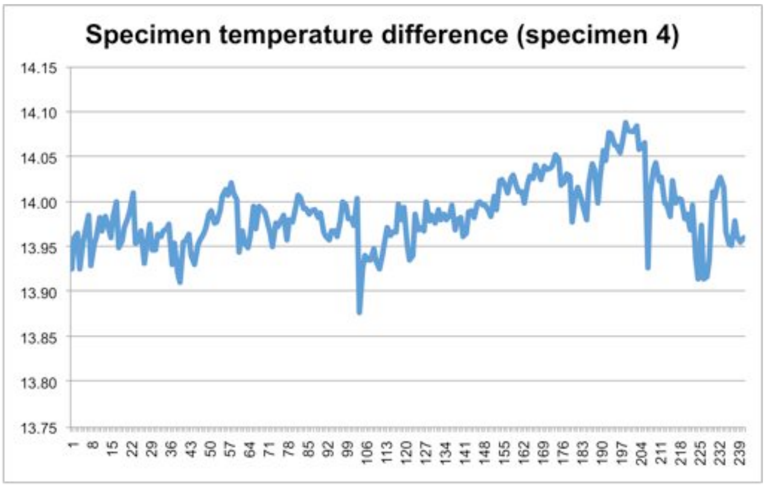


Figure 1: The temperature difference between the average surface temperatures on the two faces of Specimen 4

Similarly, the RGHB power input is also required to be very stable. The one hour averaged data for a typical test (Specimen 1) is depicted in Figure 2 below, together with the trendline for the data.

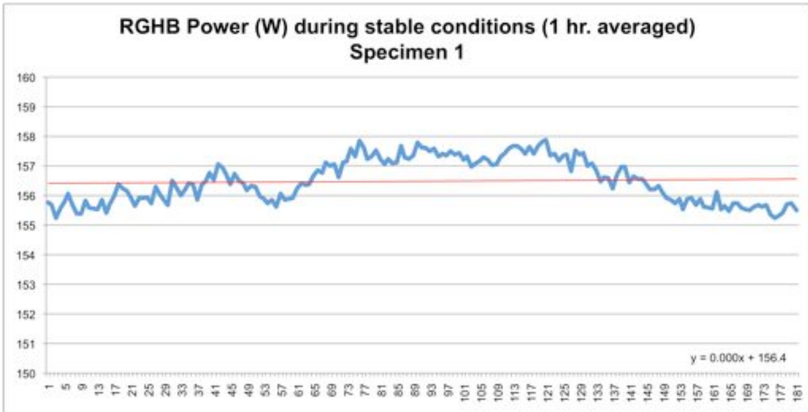


Figure 2: The RGHB power input during stable conditions for Specimen 1.

The measured Thermal Resistance for the four specimens is as follows:

SPECIMEN	THERMAL RESISTANCE ($m^2 \cdot K/W$)
Wall System 1	0.35
Wall System 2	0.37
Wall System 3	1.14
Wall System 4	1.43

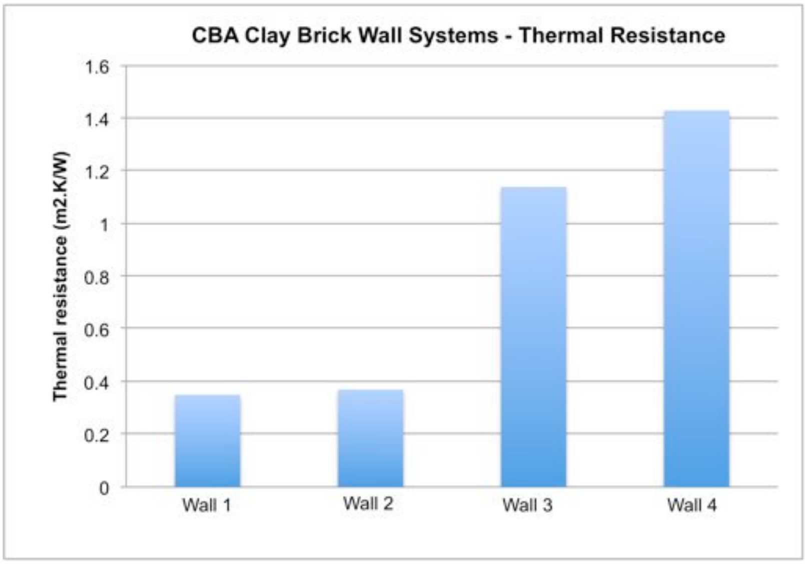


Figure 3: The results of the data analysis phase

DISCUSSION OF RESULTS AND CONCLUSSIONS

In summary, the first two wall systems (Wall 1 and Wall 2) had the same thickness and differed by the type of brick used (stock clay bricks versus perforated clay bricks) and their surface finish on the climate side (plastered and painted white, versus a face brick finish). Their test results ($R_{th,1}$ = 0.35 and $R_{th,2}$ = 0.37) differ by 5%. This implies that the type of brick and surface finish do not make a major contribution to the thermal resistance of the wall systems.

The measured thermal resistance for the third and fourth wall systems tested (Wall 3 and Wall 4) differ notably from wall systems one and two, but also from one another ($R_{th,3}$ = 1.14 and $R_{th,4}$ = 1.43). The physical differences between these two wall systems are in the bricks used for the external wall (perforated face bricks for wall system 3 versus plastered stock clay bricks for wall system 4), and the type of insulation material panels between the bricks. Wall system one contains a 30 mm Isoboard insulation panel, while wall system 4 contains an expanded polystyrene insulation panel. Both wall systems were specified to have the same 20 mm air gap (see Appendix B). The measured difference in the thermal resistance between these two specimens is more than what is expected from the above-mentioned differences.

ADDITIONAL INFORMATION*:*

Sample Conditioning: *The test specimens were maintained at ambient conditions prior to testing.*

Test Procedure*: Please refer to TTL document, RGHB/SOP/01 2009: RGHB Operating Procedures. For the RGHB testing the thermal resistance of the insulation system is determined from air stream to air stream. The airflow condition in the climate side is selected to simulate a 20 km/hr warm or cold wind.*

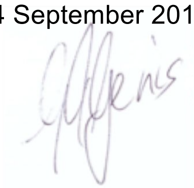
Deviations (if any) from ASTM C 1363-05: *No deviations*

SIGNATORIES

Test Officer*:* *Name:* Dr Gerrit Genis

Date: 14 September 2010

Signature:



*****END OF REPORT*****

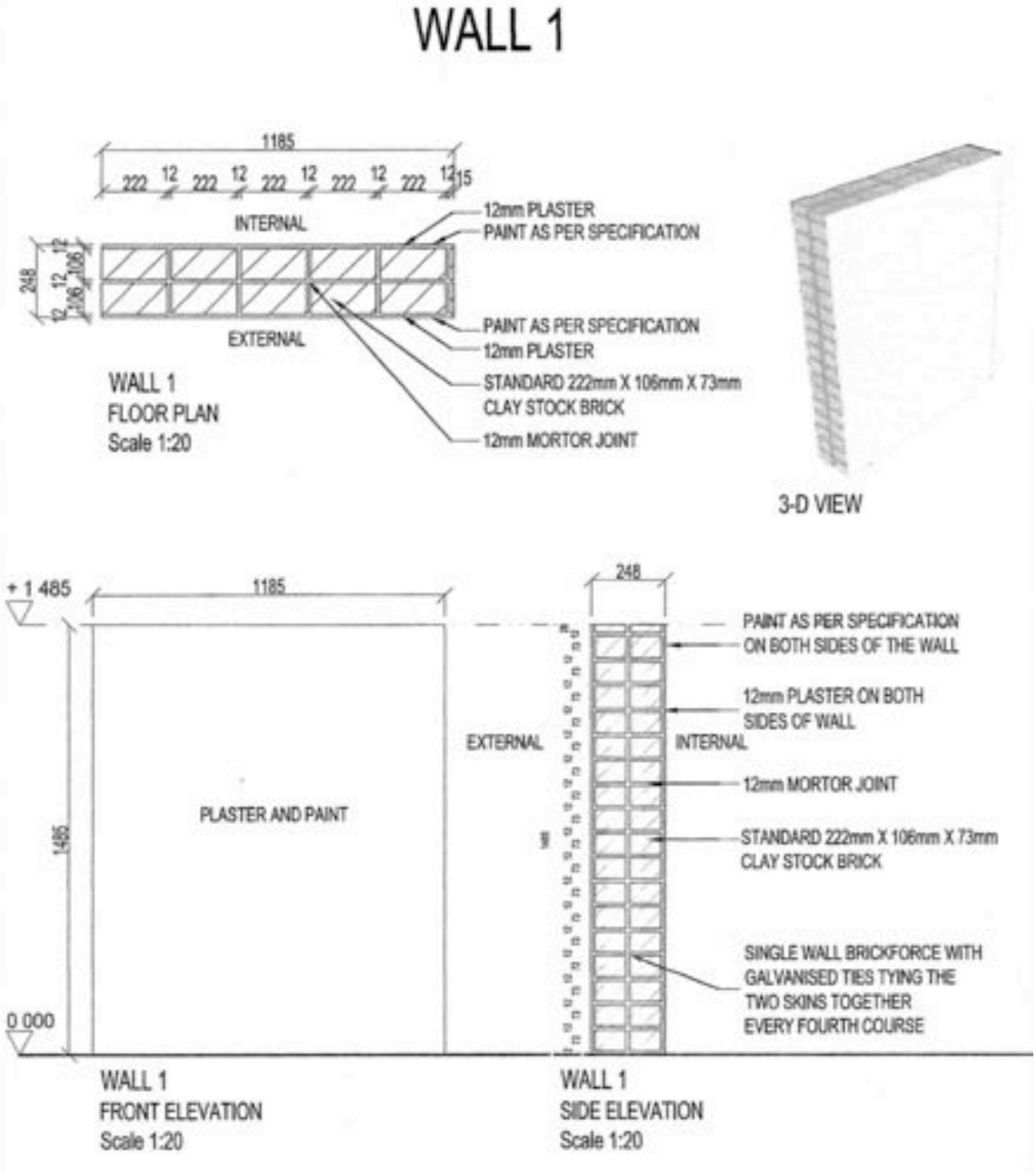
ANNEXURE A: SPECIMEN PREPARATIONS PHOTOS

FIGURE 4: A typical specimen instrumented on the climate side in the steel construction jig before testing (top left), the XPS instrumentation probe used for measuring temperatures at various depths to establish thermal stability (bottom left), and a view of the climate side of an instrumented specimen mounted in the RGHB prior to testing (right).

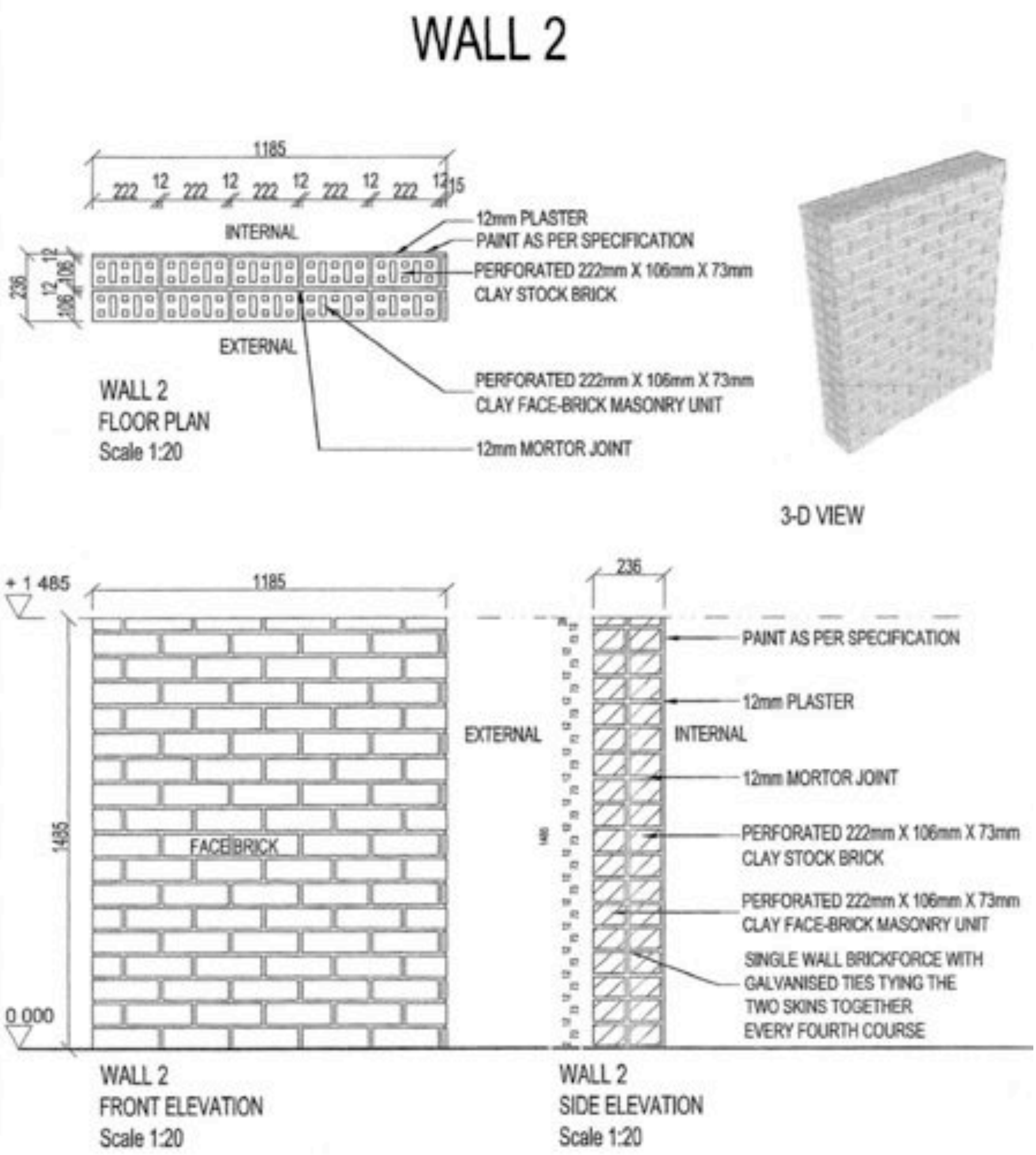
ANNEXURE B: SPECIMEN CAVITY DIMENSION

Wall system 3 was inspected after testing and its critical dimensions were checked. It was noted that the width of the cavity is equal to 18 mm on average. The cavity was partially filled with mortar spillage from the side of the external skin.

ANNEXURE C: SPECIMEN DRAWINGS

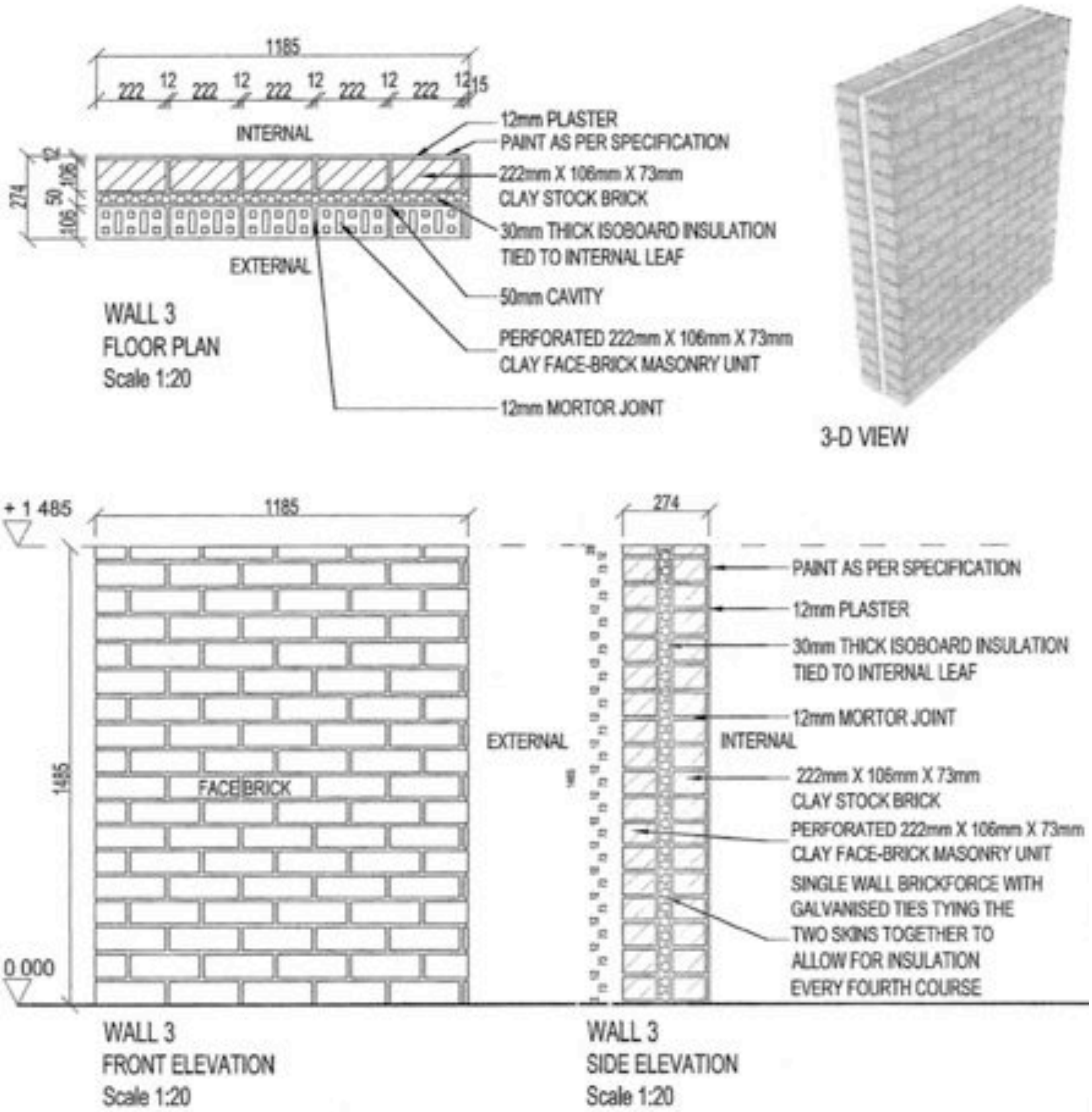


Measured thermal resistance for Wall 1 = 0.35 m^2•W/K

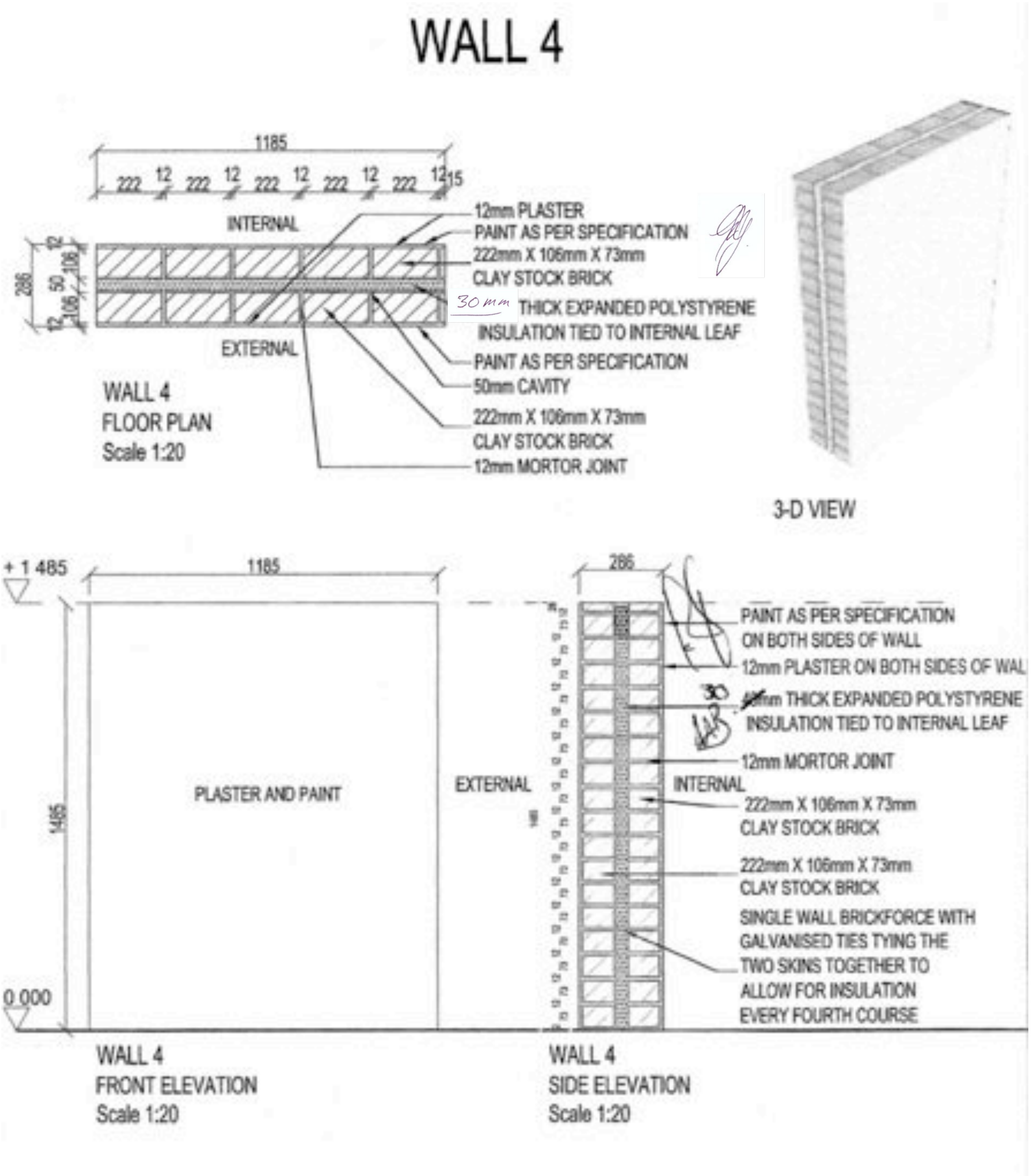


Measured thermal resistance for Wall 2 = 0.37 m^2•W/K

WALL 3



Measured thermal resistance for Wall 3 = 1.14 m²·W/K



Measured thermal resistance for Wall 4 = 1.43 m^2•W/K