University of Salford MANCHESTER

THERMAL MEASUREMENT LABORATORY

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Traceable Test Report

Thermal Resistance of Shadow Line+ including Surface Air Layer

The Millboard Company Ltd

Project: **00346** **Test No.:** **3250**

Your Order No.: 45642 Date of Issue: 1 August 2024

Signed: A. Simpson Approved:

Dr. A Simpson
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1. Test Results

Test standard:	ISO 8302:1991 / BS EN 12664:2001
Product Standard:	Not Applicable
Measured Sample Thickness:	38.25 mm
Conditioned Sample Density:	712.6 kg/m³

Mean Temperature [°C]	Effective Thermal Resistance to mid airspace R_{eff} [m²K/W]	Thermal Resistance including whole airspace R_t [m²K/W]
12.0	0.216	0.306

The results only apply to the sample tested as described in this report.
Calculations for the above resistance values can be found in Appendix A

THIS IS NOT A UKAS ACCREDITED TEST REPORT

2. Client

The Millboard Company Ltd, Unit A Castle Court, Bodmin Road, Coventry, CV2 5DB, UK.

3. Sample Details, Preparation and Conditioning

Miscellaneous Product supplied and identified by the client as ''Shadow Line+, Shadow Line+ board, Batch: MC516275509012023, Production Date: 09.01.2023'' was received by the Thermal Measurement Laboratory on the 1 May 2024. This was conditioned at 23°C and 50% RH for 6 days to constant mass. The board was then machined flat on the non profiled face. The flat face was mounted against the hot plate of the apparatus with thermocouples attached to the highest and lowest points of the profiled face and a 21mm airspace applied between the surface of the specimen and the cold plate.

Measured specimen thickness:	0.03825	m
Measured mean board thickness	0.01675	m
Relative thickness change during test:	0.00	%
Dimensions:	0.305 × 0.305	m
Relative volume change during test:	0.00	%
Mass before test:	1110.3	g
Mass after test:	1110.3	g
Relative mass change during test:	0.00	%
Relative mass change during drying:	N/A	%
Relative mass change during conditioning:	-0.02	%
Density of conditioned material as tested:	312.0	kg/m³
Density of conditioned board as tested	712.6	kg/m³

4. Methodology

LaserComp FOX 304 Instrument, single specimen heat flow meter apparatus, located in the Thermal Measurement Laboratory

Heat flow meter method to ISO 8301:1991 / BS EN 12664:2001

Serial Number: 1311644-F304

Heat flux direction: Vertically upwards

Edge heat losses minimised by additional edge temperature controls.

All temperature, dimensional and heat flow measurements are traceable to national standards.

5. Thickness Measurement

The mean measured thickness was determined by the FOX 304 Instrument by measuring the hot and cold plate separation at each corner. The separation was checked with calibrated electronic calipers.

6. General Test Details

Start date and time of test:	19 June 2024 at 15:06
Finish date and time of test:	20 June 2024 at 10:09
Ambient laboratory temperature during the test:	23 °C
Type and pressure of gas surrounding specimens:	Air at atmospheric pressure
Interface medium between specimen and plates:	None
Water-tight envelope surrounding the specimen:	None

7. Setpoint Details

To measure the thermal conductivity of the specimen at the required temperatures, a single setpoint was programmed into the test apparatus software with the results being as follows:

Mean Temperature:	12.0	[°C]
Temperature difference between the hot and cold plates:	16.06	[°C]
Temperature difference between sample surface and mid-air space:	4.75	[°C]
Density of heat flow rate:	52.40	[W/m²]
Setpoint duration:	19:03	[hh:mm]

8. Date of Last Heat Flow Meter Calibration Check

The heat flow meter calibration was checked on 3 June 2024 using Item 1) and found to be within specification.

Calibrations are used that are based on:

1) Stable, aged greater than 25 years; 50mm EPS with thermal resistance at 10°C of 1.41m²K/W, which was last calibrated in the University of Salford UKAS accredited guarded hotplate in 2019.
2) 34mm IRM-440 Resin Bonded Glass Fibre Board, ID No: S312 with thermal resistance at 10°C of 1.13m²/K/W. Last calibrated at IRMM. Valid from July 2014 and is due to be recalibrated in July 2032

9. Errors in measured property

The maximum expected error in the measured Thermal Resistance is within 5.7%. This includes errors arising from non-compliances.

10. Non-compliances

The test conformed to the requirements of Standard Test Method ISO 8301:1991 / BS EN 12667:2001, with the exception of the following additional uncertainty:

- An additional uncertainty has been applied to allow for the thickness (non-parallelism) of the sample being 5.08% greater than the maximum 2% of the average thickness.

11. Name of Test Operator/s

Dr. A Simpson, Technical Manager

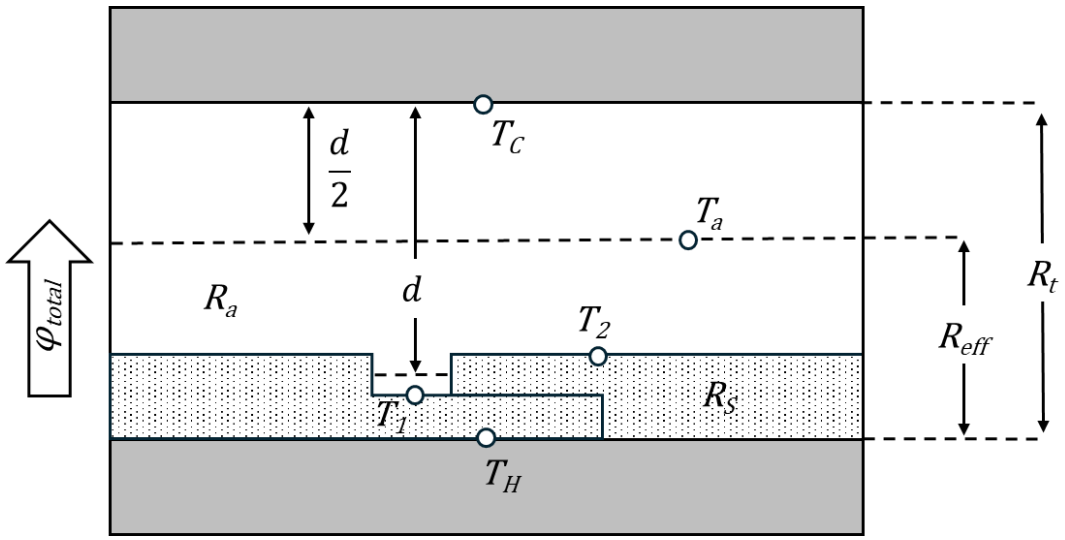
12. Management system requirements of ISO/IEC 17025:2017

The laboratory operates a management system which meets both the technical competence requirements and management system requirements of ISO/IEC 17025:2017 that are necessary for the laboratory to constantly deliver technically valid test results within its accredited scope.

*** Sample Retention Period - Unless advised otherwise by the client, samples will be retained for up to 1month from the test completion date. After this time the samples will be destroyed.**

Appendix A – Calculations

The thermal resistances presented in this report are calculated using the measured parameters of the combined system described in Section 3 of this report. A schematic diagram of the test methodology is presented below:



Where:

φ_{total} = total heat flow through the combined system

T_H = the temperature of the hot plate

T_S = the average temperature of the surface of specimen facing the cold plate

Where:

$$T_S = \frac{T_1 + T_2}{2} \qquad \text{(A.1)}$$

R_S = the average thermal resistance of the sample overall all thicknesses

T_a = the temperature of the of the air at the midpoint between the surface of the specimen and the cold plate

R_a = the thermal resistance of the air between the midpoint of the airspace and the surface of the specimen

T_C = the temperature of the the cold plate

Due to the uneven profile of the specimen, the thermal performance of the specimen described in this report is evaluated by considering the airspace adjacent to its surface. This then allows the calculation of the effective thermal resistance, R_{eff}, it provides.

This has been recreated in the laboratory's heat flow meter, by measuring the heat flow through the total system, φ_{total}, the average surface temperature of the specimen, T_S, and the temperatures of the hot and cold control plates, T_H and T_C, to determing the thermal resistance of the whole system R_t. The effective thermal resistance provided by the specimen, R_{eff}, is therefore considered to be the thermal resistance of the specimen, R_s, and the thermal resistances of half of the total airspace above and adjacent to the specimen and R_a:

$$R_{eff} = R_S + R_a \tag{A.2}$$

where:

$$R_S = \frac{|T_H - T_S|}{\varphi_{total}} \tag{A.3}$$

$$R_a = \frac{|T_S - T_a|}{\varphi_{total}} \tag{A.4}$$

and:

$$T_a = \frac{T_S + T_C}{2} \tag{A.5}$$

with the thermal resistance of the whole system being:

$$R_t = \frac{|T_H - T_C|}{\varphi_{total}} \tag{A.6}$$

END OF REPORT