U-value Report 1

Church Street, Ton Pentre,

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Report by: ArchiMetrics Limited

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Introduction

As part of a larger retrofitting scheme, the solid stone external walls of Church Street, Ton Pentre have been insulated with a new experiment insulating plaster, Thermulon, a lime-based product with an aerogel addition. ArchiMetrics have been commissioned to carry out interstitial hygrothermal and U-value monitoring to assess the performance of the insulated wall over a three-year period.

This is the first report which presents early-stage findings of a measured in situ U-value for the wall. It should be noted that retrofitting work at Ton Pentre was completed around the end of 2021 and the building only occupied (and heated) from mid-February 2022 onwards. The wall has been subject to new internal plaster and external render, both wet processes and it is clear from interstitial moisture monitoring that construction moisture is, unsurprisingly, still present within the fabric and that little drying has yet taken place. Therefore, this first measured U-value is likely to be higher than that found once the wall has dried down and should not be taken as an indication of the long-term performance of the insulated wall.

Wall & Monitoring Description:

The wall at Church Street appears to be constructed of local stone from the Pennant Sandstone formation, these include feldspathic, micaceous, lithic arenites types of sandstone as well as underlying beds of mud and siltstone (see Figure 1).[1] These stones are bedded in a lime mortar with a high proportion of coal dust waste used as an aggregate or filler. The stone component of the wall is approximately 455 mm or 1 ½' thick. As part of retrofitting work, the external wall face has been rendered using an air lime product, Vivus No.2 Render Basecoat to a nominal thickness of 30 mm and internally a lime-based aerogel insulating plaster, Thermulon, has been applied to a depth of ≈ 40 mm creating an overall wall thickness of about 525 mm.

[1] See British Geological Survey https://webapps.bgs.ac.uk/lexicon/lexicon.cfm?pub=pes

In September 2021, the installation of interstitial hygrothermal gradient and U-value monitoring equipment commenced in the east facing external wall at first floor level at Church Street in a room used as bedroom (Figure 1).

Monitoring commenced in 14th December 2021 and the house was occupied in mid-February. The measurement of in situ U-values requires an average 10˚C internal/external temperature difference over a set period, around 14 days or longer and therefore is more successfully carried out over the winter months with internal heating in operation. The measurement reported on here follows the conventions set out in BS ISO 9869 *Thermal insulation — Building elements — In-situ measurement of thermal resistance and thermal transmittance* and covers the period 19th February – 11th March 2022.

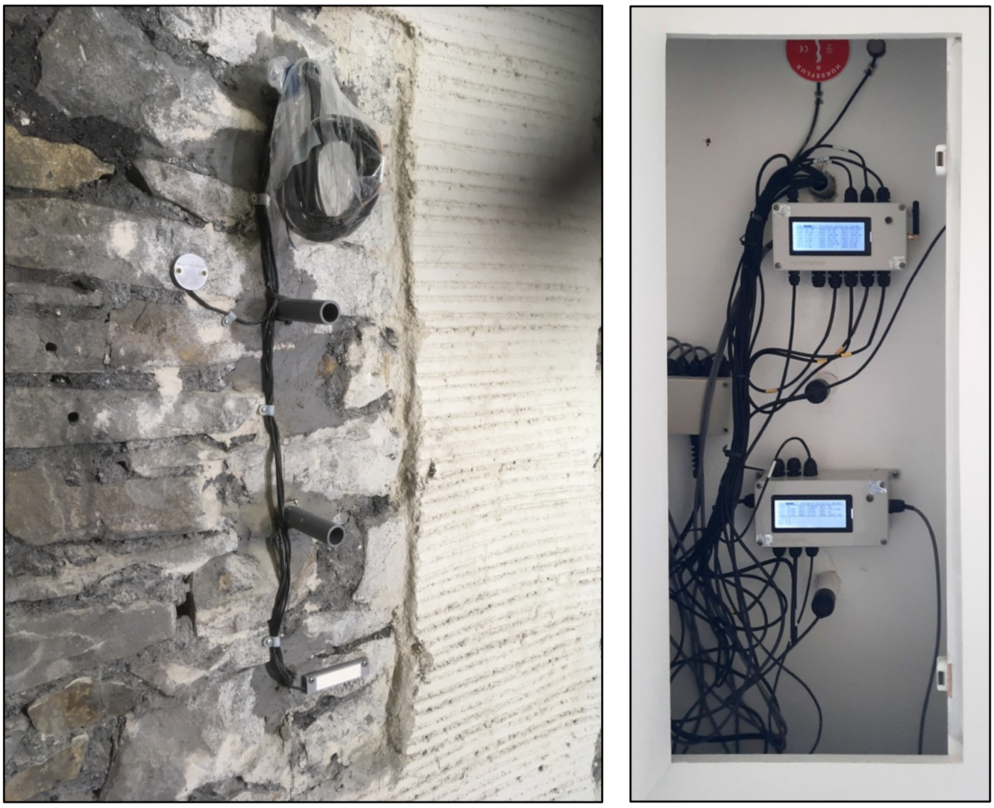

Figure 1. IHGM and U-value monitoring equipment, Church Street- mid-install and within completed cupboard enclosure.

Findings

Measured in situ U-value

The measured in situ U-value found for the east facing 525 mm insulated stone wall at Church Street is **0.64 W/m²K** (*Figure* 2). As above, it should be borne in mind that construction moisture added to the wall at the time of rendering and plastering is still present within the fabric, therefore this U-value is likely to change and be lower once the wall has dried. Thus, this U-value should be seen as an interim, early-stage indication of the overall heat loss (thermal transmissivity) of this wall assembly.

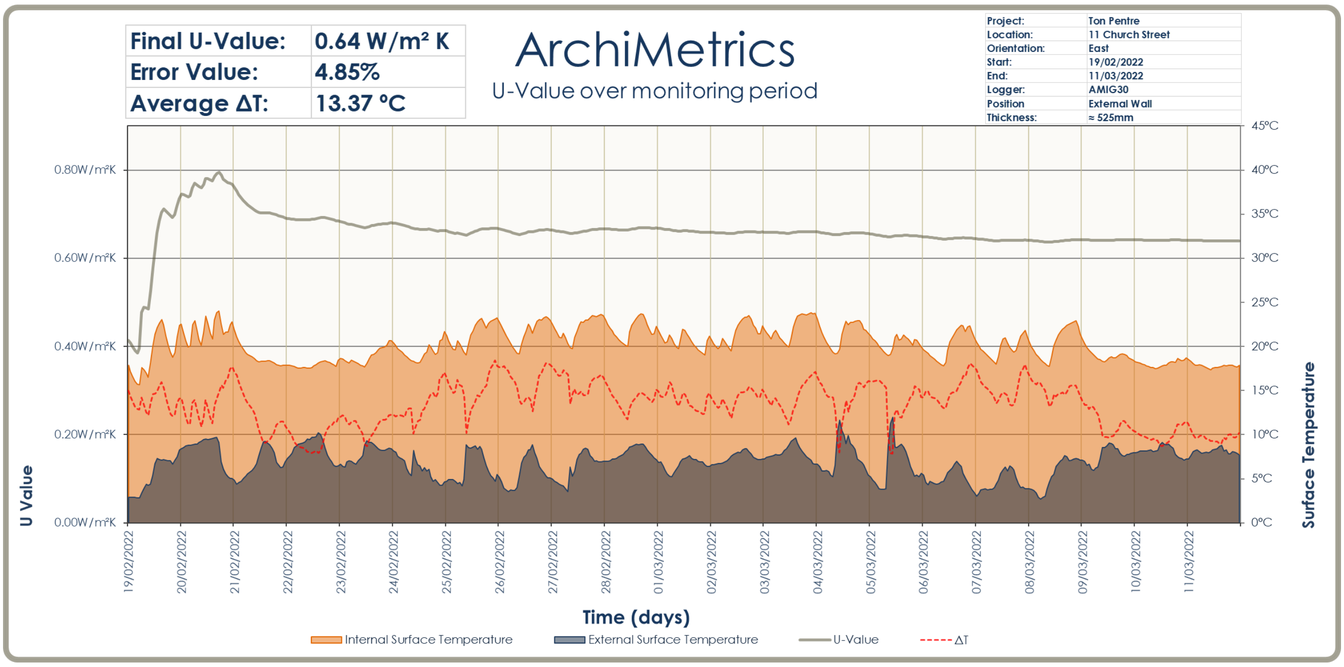

Figure 2. Measured in situ U-value, February – March 2022, Church Street, Ton Pentre.

Calculated U-value

For comparative purposes a range of 'standard' U-values (following BS EN ISO 6946 *Building components and building elements — Thermal resistance and thermal transmittance — Calculation method*) have also been calculated for this wall. A range is necessary because the properties of the existing wall materials, in particular the stones, are not well defined. For the calculations we identified a 'low', 'middle' and 'high' possible spread of densities for 'Pennant Stones' with an associated thermal conductivity value, scaled in relation to density; 1800 kg/m³ – 1.2 W/mK, 2400 kg/m3 – 2.3 W/mK and 3000 kg/m³ – 3.8 W/mK. As a traditionally-built solid stone wall, a proportion of the structure comprises of lime mortar. In order to account for the contribution this makes to the overall thermal performance of the wall it is necessary to identify a ratio which might describe the proportion of mortar to stone within the wall build-up. This was done by mapping an area of the internal wall surface to calculate the quantity of stone within the selected area, Figure 3. Using this method, we determined a 30:70 mortar/stone ratio for the Church Street wall. Table 1, below, provides details of the quantities used in each of the U-value calculations and the subsequent result.

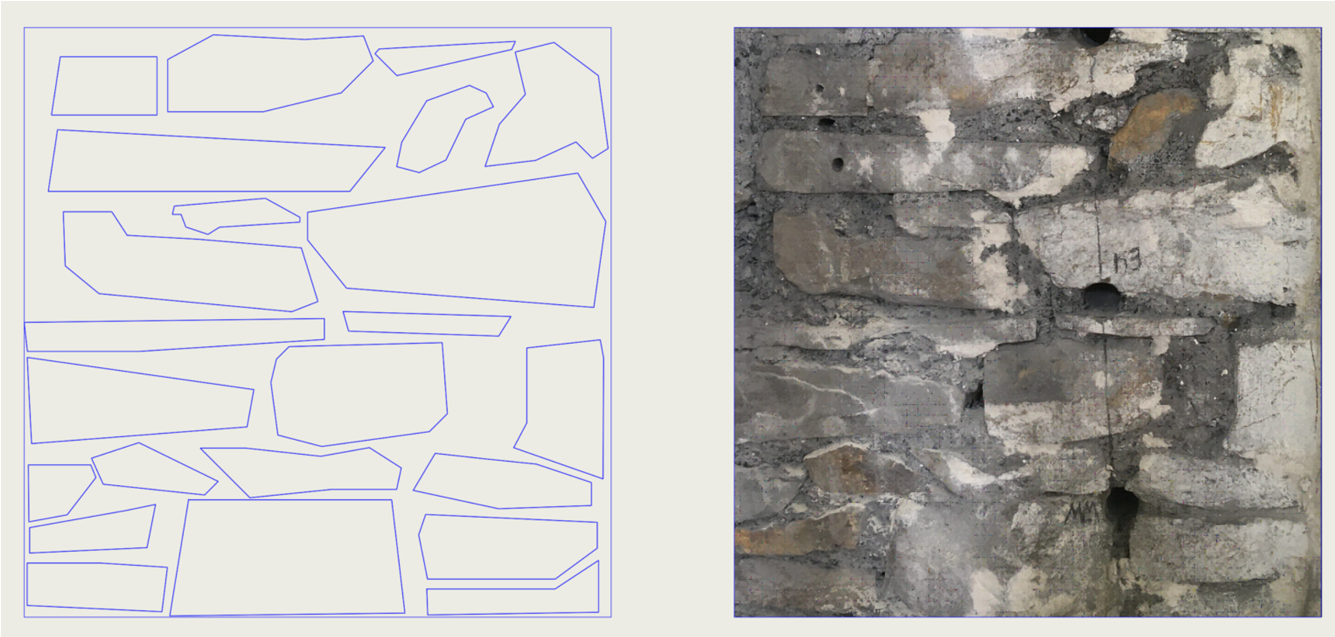

Figure 3. Surface area analysis to determine mortar:stone ratio for the Church Street wall.

Table 1. Quantities used in U-value Calculations for Church Street and calculation results.

Layer	Thickness mm	Material	Lamdba W/mK	Calculated U-value W/m²K
External Render	30	Vivus No.2 Basecoat Render	0.800	
Stone	318.5	Pennant Stone low - 1800 kg/m3	1.200	**0.90 W/m²K**
		Pennant Stone mid - 2400 kg/m3	2.300	**1.01 W/m²K**
		Pennant Stone high - 3000 kg/m3	3.800	**1.07 W/m²K**
Mortar	136.5	Lime mortar	0.1365	
Internal Plaster	40	Thermulon Insulating Plaster		
Total	525 mm			

As can be seen from the table above the U-values calculated for the insulation solid stone wall at Church Street range from **0.90 – 1.07 W/m²K** depending upon the density/conductivity of the stone material selected. Without further investigation of the material properties of the stones used within the wall, which are likely to be extremely diverse, it is not possible to have greater certainty for these calculated U-values. Nevertheless, the process has followed conventional calculation practices and therefore these calculations represent figures that might be used in SAP and other type assessments of performance for this wall assembly. Therefore, it may be of note that the measured U-value indicates lower heat loss, **0.64 W/m²K** than that identified by the conventional calculations.