IQ-TEST - IMPROVING QUALITY IN TESTING AND EVALUATION OF SOLAR AND THERMAL CHARACTERISTICS OF BUILDING COMPONENTS

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ABSTRACT

IQ-Test is a Thematic Network supported by the European Community under the EESD Programme. The objective of IQ-TEST is to further develop common quality procedures for the PASSYS/PASLINK test cell facilities that exist in 12 European countries. This should consolidate the network, integrate the new test sites and strengthen its common approach of support for new product developments in the field of innovative building components.

Round robin tests are underway to assess both the inter-site quality of testing and analytical procedures of the participants. Two components were designed: (1) an opaque, well insulated, homogeneous panel and (2) a window, which is used to replace the central section of the first component.

Common test procedures have been designed and quality procedures have been implemented at each test site. The data sets generated by each team will be made available for cross-validation by another team. The results available so far on the first component indicate good agreement between sites. Variability in the window test results may be explained by site-to-site climatic variation.

A complete evaluation and synthesis of the test results and analysis will be presented at the EPIC/AIVC Conference.

KEYWORDS

IQ-Test, PASLINK, PASSYS, test cells, thermal performance.

INTRODUCTION

IQ-Test is a Thematic Network supported by the European Community under the EESD Programme. The objective of IQ-TEST is to further develop common quality procedures for testing, calibration, data gathering, cleaning and analysis, interpretation of test results and scaling/replication to real buildings, and the maintenance of the test infrastructure (i.e. the PASSYS/PASLINK test cell facilities) which exist in 12 European countries. This should consolidate the network, integrate the new test sites and strengthen its common approach of support for new product developments in the field of innovative building components through semi-standardised tests and pragmatic, practicable and affordable but accurate procedures. More information about IQ-Test may be found on the PASLINK website: www.paslink.org.

As part of the work of the Network, round robin tests are being performed as part of a feasibility study for standardisation activities. The objective is to assess both the inter-site quality of testing and analytical procedures of the members, with a view to developing standards for outdoor testing. High quality data for model calibration will also be generated.

Two components were designed, incorporating flexibility, in order that the first component could be used as a platform for the second component. The first component is an opaque, homogeneous with a removable central section. The thermal properties of the panel are very well defined. The second component is a window, which is used to replace the central section of the first component.

The objective of testing the first component is for each participant to determine the thermal transmission coefficient of the panel by both 1-D heat flux measurements and an energy balance on the test cell. For the second component: the whole wall U-value and solar aperture estimated from the test cell energy balance and the window U-value and solar aperture.

Common test procedures have been designed and quality procedures have been implemented at each test site. The test work is nearing completion and the data sets generated by each team are being made available for cross-validation by another team.

This paper describes the components and procedures and summarises the results to date.

THE TEST COMPONENTS

Given the number of organisations involved in the Thematic Network it was decided at the beginning that it was impractical to circulate one component for testing for the following reasons:

- Variation in the test aperture size of test cells between sites.
- High transportation costs.
- Likely difficulties in keeping to a strict timetable, given the use of the test cells for other tests.

The approach adopted was for each organisation to construct its own component(s) according to strict instructions regarding the selection of materials, manufacture and instrumentation.

Component 1 – The Opaque Wall

The first component is an opaque, homogeneous panel consisting of a sandwich of insulation between plywood, with a replacable central section 1500mm (h) by 1250mm (w). The thermal properties of the panel are well defined and the required materials are available in the locality of each participant. Expanded polystyrene (PS30), with a density of 30kg/m^3 and a nominal thermal conductivity of

0.033W/mK, is used to form an insulating panel of thickness 200mm. A white exterior finish is used on the plywood.

It was agreed that each team should measure the heat flux and temperatures in two profiles through the wall (Figure 1), with one in the centre of the removable section (A) and the other mid-way between the edge of the wall and the removable panel (B).

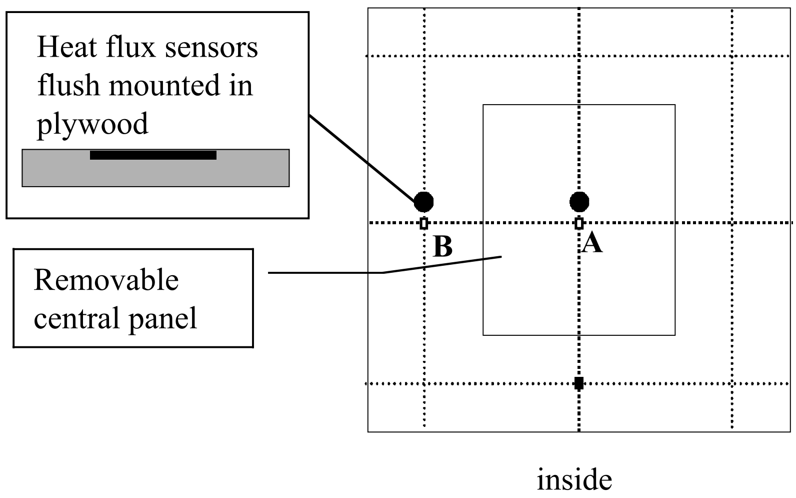

Figure 1: Measurement profiles through the opaque wall.

The objective of testing the first component is for each participant to determine the thermal transmission coefficient of the panel by both

1. 1-D heat flux measurements through profiles A and B
2. An energy balance on the test cell.

The latter value will include edge effects, which will vary depending on the test cell and installation of the test wall at each site.

Component 2 – The Window

The objective of the second component is to introduce a greater degree of complexity by using a window to replace the central section of the first component. The window design incorporates double glazing using ordinary clear float glass in a timber frame. The frames for each participant were produced centrally. Each participant obtained glass from a local supplier and samples were tested centrally to ensure consistency. The spectrophotometric tests have shown that there are differences between the samples in their infrared transmittance, which may give variations in the g-value (solar energy transmittance) of the double glazing between 73.2 and 77.3 %. Figure 2 shows the window installed in the opaque surround.

Figure 2: The window installed in the opaque surround at BRE Scotland.

The objectives of the test are to determine

1. The whole wall U-value and solar aperture estimated from the test cell energy balance.
2. The window U-value and g-value (frame and glazing).

THE TEST PROCEDURES

The procedures are based on the COMPASS Measurement and Data Analysis Procedures (van Dijk and Tellez, 1995). A dynamic test sequence was devised to reduce the overall test duration, whilst maximising information. A heating or cooling regime may be chosen, depending on the local climatic conditions. The maximum power levels were calculated to ensure that the mean test room temperature difference between the low and high power parts of the test sequence should be at least 10K, but preferably 20 K, without exceed the safe operational limits of the test cell. In a "heating" climate a maximum power level of about 250W is satisfactory for the window test: an example of a typical heating sequence is shown in Figure 3, which includes a Randomly Ordered Logarithmically distributed Binary Sequence (ROLBS).

There are three test cell types with different time constants due to their construction. An outcome of the round robin tests will be the optimisation of the test sequence to allow for these differences.

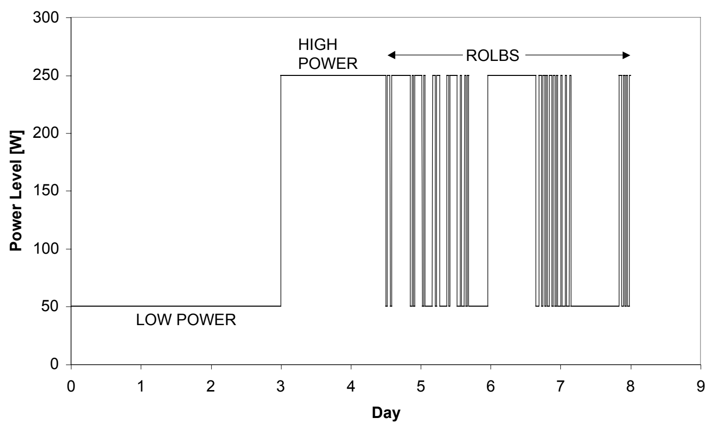

Figure 3: a typical heating power sequence with low power = 50W air circulation fan; high power = 50W fan power + 200W resistance heater.

The air leakage of the test room is also determined by pressurisation testing before and after the test to ensure that the test cell meets a requirement of 0.5 air changes per hour at 50Pa. It is also recommended that the air leakage be monitored continuously during the test by tracer gas measurements.

Formats for reporting and data set descriptions have been developed, including a statement of errors.

RESULTS

The choice of analysis method is open to each team, however identification software such as LORD, developed for the PASLINK EEIG, is widely used.

Six of the eleven participating teams have so far provided results, although, in most cases, the testing is nearing completion. The available data has been checked, documented and circulated for the cross-validation exercise. The available results are given in Table 1.

TABLE 1
Available test results.

	Component 1		Component 2	
Team	Whole Wall U-value from Test Cell Energy Balance W/m^2K	1-D U-value of Central Panel (Profile A) W/m^2K	Window U-value W/m^2K	Window g-value %
A	0.20	0.18	-	-
B	0.19	0.18	2.53	60
C	0.19	0.17	2.36	53
D	0.17	0.16	2.31	52
E	0.19	0.17	2.61	29
F	0.17	-	2.24	59

Pending a thorough error analysis, the indications are that satisfactory agreement on the 1-D centre of panel U-values have been achieved. The difference between the whole wall and the centre of panel U-values indicates the magnitude of the edge effects of the wall. The results so far on the window component show more inter-site variability. However, a thorough analysis of the environmental boundary conditions under which the tests were carried out is in progress as part of the cross-validation exercise. For example, Figure 5 shows the theoretical variation of the U-value of double glazing with wind speed due to the change in the external heat transfer coefficient.

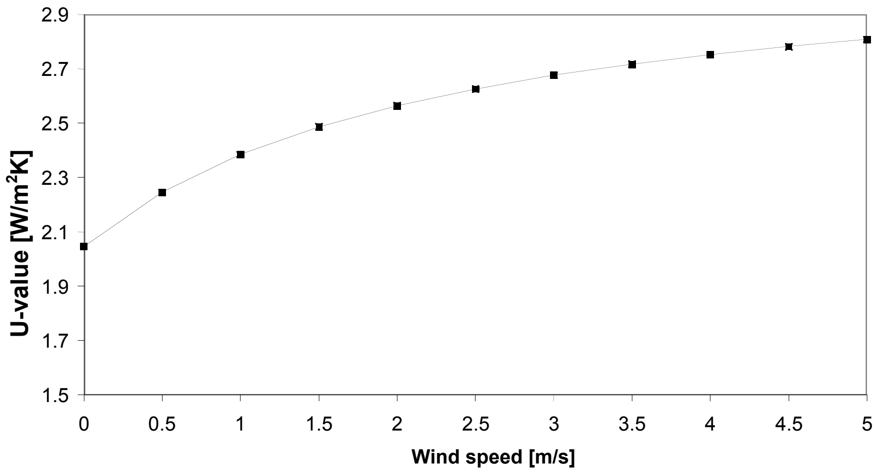

Figure 5: the theoretical variation of double glazing U-value with wind speed.

CONCLUSIONS

The results of the round robin test on the well insulated opaque wall component generally show satisfactory agreement.

There is greater variability in the results from the window test. However, a detailed study of the environmental boundary conditions at each site is being undertaken to determine their influence on the test results, along with a comprehensive error analysis.

A complete evaluation and synthesis of the test results and analysis will be presented at the EPIC/AIVC Conference.

REFERENCE

van Dijk, H.A.L. and Tellez, F.M. (1995) Measurement and Data Analysis Procedures, *Final Report of the JOULE II COMPASS Project (JOU2-CT92-0216).*