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BRE Test Report

BRE Scotland Visitor Centre - Operational Performance Assessment – Window Blind Case Study

January 2017

Introduction

The Visitor Centre was the first building constructed on the Innovation Park at Ravenscraig. It is a high performance building in its own right, designed to meet BREEAM Outstanding. It utilised an off-site manufacturing process which allowed for fast on-site craned erection and safer assembly. The Visitor Centre is constructed of home-grown timber and incorporates a number of locally sourced materials. The Visitor Centre has a low energy design and includes water saving measures. An on-going building performance evaluation is monitoring energy and water consumption and internal environmental performance.

Figure 1: The Visitor Centre at the Innovation Park @Ravenscraig

Innovative features

A wide range of innovative products and technologies has been incorporated into the design of the Visitor Centre. Home-grown timber has also been utilised.

A 4.5 kW photovoltaic (PV) array (south facing, 30o tilt angle) is located on the roof of the Visitor Centre. This consists of 18 Suntech 250 W panels (STP250S – 20/Wd). The system features a Victron Energy Phoenix Inverter to convert the DC current produced by the panels to AC current. This can either be used to meet the electrical load in the Visitor Centre or sold back to the grid. The PV system also features a comprehensive battery facility for storing energy.

The heating system at the BRE Visitor Centre combines an 8.5 kW Air Source Heat Pump (ASHP) with underfloor heating throughout the building; and a Mechanical Ventilation Heat Recovery (MVHR) system which serves the whole building.

A 3.3 m2 flat plate solar thermal collector (south facing, 30o tilt angle) is located on the roof of the Visitor Centre. The pump and control unit (Solar Logic Controller) are located in the plant room. This is connected to a Willis Solasyphon heat exchanger, and is used to meet the domestic hot water (DHW) demand of the Visitor Centre.

Glass mineral wool insulation from Knauf installed using the Blow-in-Blanket System (BIBS). Previously known as Perimeter Plus, Supafil Frame insulation was blown into the Visitor Centre timber frame in the CCG factory.

Noxite roofing membranes purify harmful NOx particles effectively from the air, converting harmful NOx into harmless nitrates that are washed off the roof in rainwater events. It improves public health, and the environment, as the harmful pollutant is neutralised from the environment.

CoolZone ceiling tiles incorporate BASF Micronal phase change material (PCM) into Armstrong's plain metal ceiling tiles. The phase change material encased in the cassette stores and releases large amounts of energy, reducing cooling costs and maintaining a comfortable temperature within a building.

Cross Laminated Timber (CLT) has been used to create an internal feature wall within the Visitor Centre. CLT is an engineered timber product with good structural properties and low environmental impact (where sustainably sourced timber is used). It can provide dry, fast onsite construction, with good potential for airtightness and a robust wall and floor structure suitable for most finishes internally and externally.

The Mastertop Flooring System is a polyurethane and epoxy based resin which is suitable for decorative or industrial uses.

Greenline Lining Boards from Fermacell absorb and neutralise volatile organic compounds (VOCs) from the air. This improves the air quality in a building, improving the working and living environment.

More recently, Renson external roller blinds have been installed to mitigate summer overheating problems. The installation is shown below in figure 2.

Figure 2: Renson external roller blinds installed on south façade

This report summarises the benefits of the external blind installation in terms of reducing the predicted overheating and improving occupant's thermal comfort.

The analysis presented in this report is based on the dynamic simulation of a virtual representation of both the building and blinds. To improve the accuracy and robustness of the building model, a number of physical tests were carried out including air tightness and U-value tests.

Physical testing

The building was designed to achieve an airtightness of 1 $m^3/m^2/h$. This ambitious target was not achieved by the first round of testing however, by taking some remedial reaction, the air tightness was close to this target.

In-situ U-value tests found the external walls and roof to be in accordance with the design intent, i.e. 0.15 W/m^2K

Building energy model

The dynamic building simulation model is then developed and calibrated against the in-situ U-value test and blower-door test results.

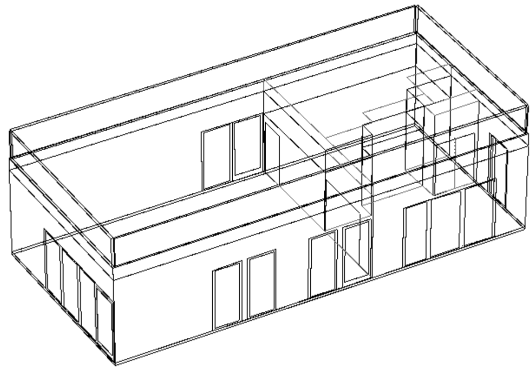

Figure 3: Representation of the geometry of the building energy model

Performance assessment as-built

Simulations were run on the calibrated model. The results have been used to assess the summer overheating risk within the office and meeting areas of the building, taking into account normal building usage and a representative climate file.

Figure 4, below, summarises the maximum and mean temperatures in the office and meeting areas respectively over a typical summer week. It also presents the number and percentage of hours where the internal temperature is great than or equal to 24 °C over the same week.

Zone	Max T (°C)	Mean T (°C)	Hours ≥ 24 °C	% Hours ≥ 24 °C
Office	30	21.5	29	17.3
Meeting	23.9	19.66	0	0

Figure 4: Overheating risk (without external blinds)

It can be seen from the table above that temperatures are generally acceptable in the meeting area. However, it should be noted that simulations were run assuming a low occupancy in the meeting area. Should the meeting area be at full capacity, it's likely that overheating would occur.

It can also be seen from figure 4 that the office area is at risk of overheating during a typical summer week. Predicted internal temperatures are greater than or equal to 24 °C for almost a fifth of the time. This is equivalent to temperatures being greater than or equal to 24 °C for around half of the day, with temperatures being lower at night. These high temperatures during working hours leads to poor thermal comfort for occupants.

Figure 5, below, shows that the internal conditions, based on a percentage mean vote (PMV) analysis, are generally warm and uncomfortable during the day when the office is occupied.

11.5	23.8	24.1	45.	25.8	0.45	0.59	12.	slightly warm, acceptable
12.5	25.3	25.3	38.	26.6	0.63	0.82	19.	warm, unpleasant
13.5	26.3	26.0	35.	27.2	0.75	0.97	25.	warm, unpleasant
14.5	26.2	26.2	34.	27.3	0.75	0.98	25.	warm, unpleasant
15.5	25.8	26.1	34.	27.0	0.69	0.92	23.	warm, unpleasant
16.5	25.2	25.6	34.	26.5	0.58	0.81	19.	warm, unpleasant
17.5	24.5	24.9	36.	26.0	0.47	0.68	15.	slightly warm, acceptable

Figure 5: Thermal comfort assessment of the office area during working hours (without external blinds)

Once construction of the visitor centre was complete and the building was occupied, the overheating risk described above became a reality. Staff and visitors commented on the internal temperatures being too high in the summer, that glare hampered their ability to work effectively or that the internal air was "stuffy."

In 2016, Renson installed an external blind system to the windows on the south façade of the visitor centre in an attempt to mitigate the summer overheating.

Figure 6, below, presents the overheating risk post-installation.

Zone	Max T (°C)	Mean T (°C)	Hours ≥ 24 °C	% Hours ≥ 24 °C
Office	23.45	19.5	0	0
Meeting	20.33	17.91	0	0

Figure 6: Overheating risk (with external blinds)

It can be seen from the table above that the maximum temperature in the office area has decreased from 30 °C to around 23 °C and the mean temperature has also decreased by 2 °C. More importantly, the number of hours where the internal zone temperatures are greater than or equal to 24 °C is now zero for all zones.

The table below presents the average comfort assessment over the same period as in figure 5 post-installation.

8.5	19.3	18.7	66.	21.7	-0.41	-0.29	7.	comfortable, pleasant
9.5	19.6	18.8	65.	21.8	-0.36	-0.25	6.	comfortable, pleasant
10.5	19.6	18.8	63.	21.8	-0.37	-0.26	6.	comfortable, pleasant
11.5	19.7	18.9	58.	21.8	-0.39	-0.26	6.	comfortable, pleasant
12.5	19.9	19.0	53.	21.9	-0.39	-0.25	6.	comfortable, pleasant
13.5	20.2	19.1	50.	22.1	-0.36	-0.22	6.	comfortable, pleasant
14.5	20.3	19.2	49.	22.2	-0.35	-0.20	6.	comfortable, pleasant
15.5	20.3	19.3	47.	22.1	-0.35	-0.20	6.	comfortable, pleasant
16.5	20.3	19.4	46.	22.2	-0.36	-0.20	6.	comfortable, pleasant
17.5	20.3	19.4	46.	22.1	-0.36	-0.21	6.	comfortable, pleasant

Figure 7: Thermal comfort assessment of the office area during working hours (with external blinds)

As expected, the thermal comfort of occupants has improved post-installation, with all occupied hours now described as 'comfortable and pleasant'. Figure 7, along with figure 6, demonstrates that the installation of external blinds has mitigated any summer overheating risk. Staff and visitors have also commented on the vastly improved internal conditions.

It should be noted that, for simulation, blinds were assumed to cover 75% of the glazed area. Essentially, it will be the occupants of the building who will decide how much of the glazed area they wish to cover to achieve their personal optimum internal conditions.

Another major advantage of the shading system installed at Ravenscraig is that, even when the blinds cover 100% of the glazed area, a level of natural light is still allowed to enter the building while removing any glare issues.

Figure 8: Internal space with blinds down