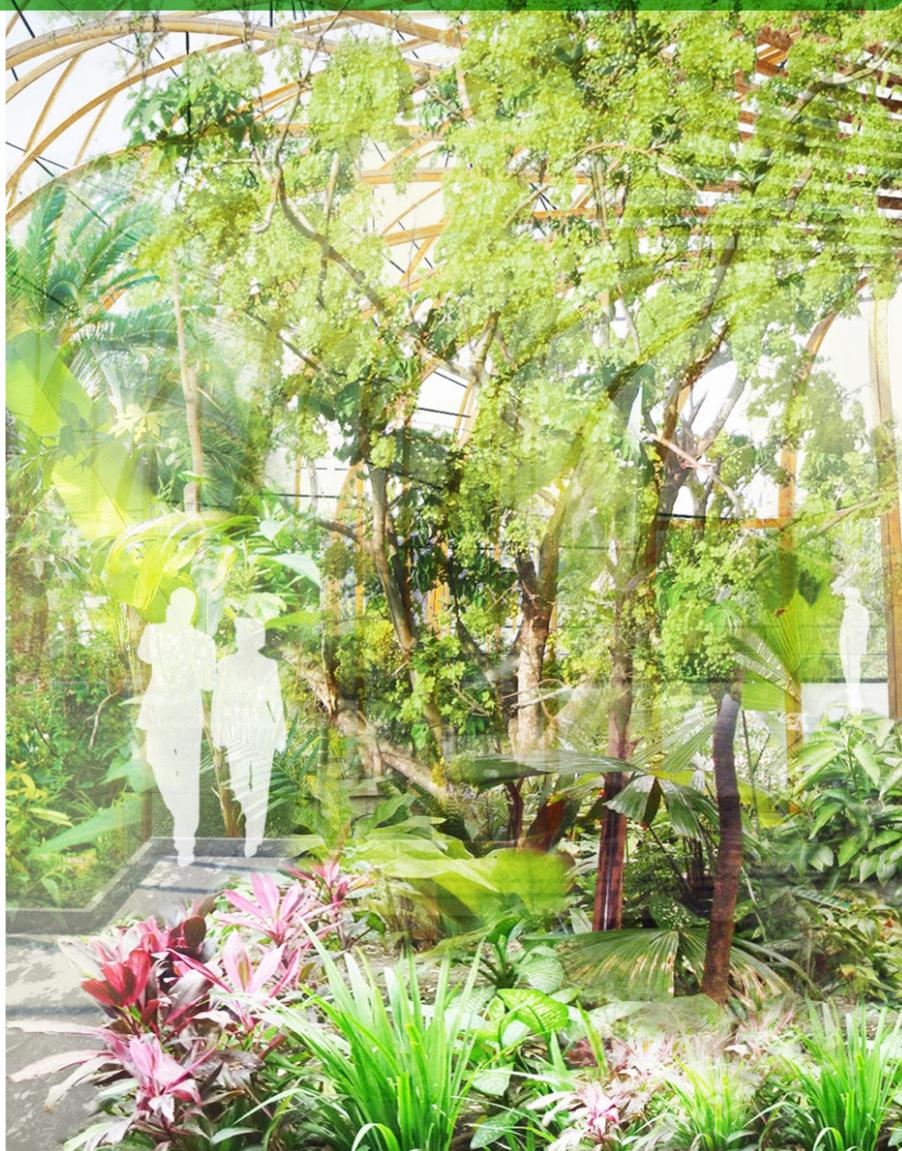
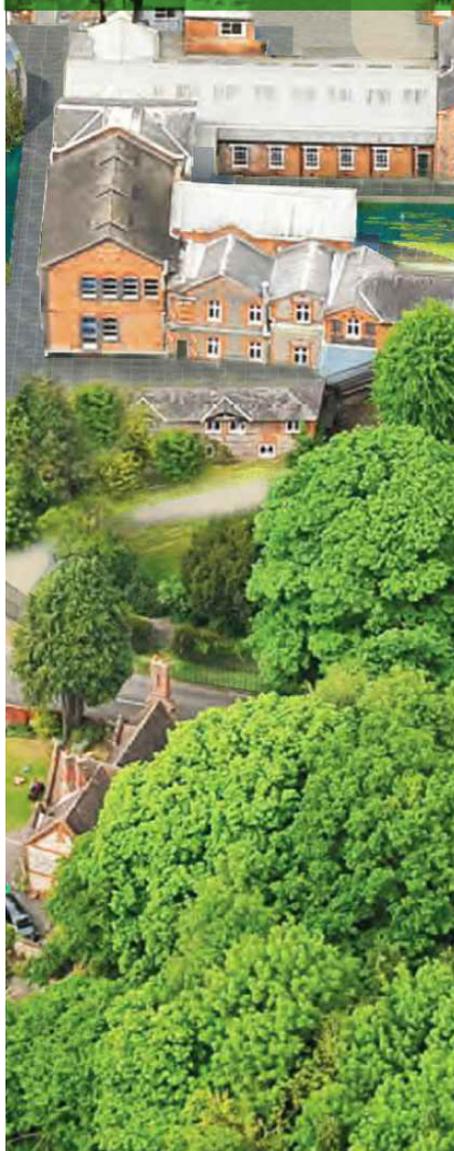


Briefing Paper

Sustainable Refurbishment of Heritage Buildings – How BREEAM helps to deliver

Kiruthiga Balson, Gavin Summerson and Andrew Thorne



Executive Summary

This briefing paper will help readers to understand the levels of environmental performance that can be achieved in heritage buildings – i.e. listed buildings and buildings in conservation areas. For these types of building there can be several inherent restrictions which limit the potential improvements that can be delivered. This paper provides an overview to planners, owners and aspirational designers on ways to achieve challenging BREEAM targets for such projects. In addition, BREEAM assessors and BREEAM Accredited professionals can use this information in providing appropriate advice to their clients when seeking BREEAM ratings in heritage buildings.

In terms of overall BREEAM assessments, refurbishment projects typically achieve lower ratings than new build projects when comparing the performance of buildings assessed under the BREEAM 2008 version. Feedback from BREEAM Assessors suggests that, for refurbishment projects, fewer credits are available than for new construction projects. This is because features such as location, orientation, fabric and form cannot be altered and other constraints may exist. This is considered to be particularly relevant for listed buildings, where there may be further limitations on design options and specific requirements attached to a buildings appearance. However, this research indicates that refurbishment projects for heritage buildings perform much better than refurbishment projects in other types of building.

This paper outlines barriers encountered by 16 heritage buildings and solutions developed in refurbishing to a BREEAM standard. It indicates which issues and which credits within BREEAM are most (and least) commonly achieved for refurbishment projects in heritage buildings, together with reasons for targeting (or not targeting) specific BREEAM credits. This paper describes how this learning has been applied to the development of the 2014 version of the BREEAM Refurbishment and Fit-out scheme, to provide a more appropriate version of BREEAM for heritage buildings.

Introduction

Improving the performance of existing buildings is often challenging and many of the issues to address are amplified for buildings which are formally listed or in a conservation area. It is important that useful and reliable information is available to support sustainable refurbishment as the market shifts from new build to major refurbishment. This is going to be particularly relevant over the next few years as the market heads towards the 2018 deadline where it will become unlawful to rent properties with an EPC band F or G, which will include a significant number of heritage buildings.

The issues surrounding sustainable refurbishment are perceived to be more of a challenge in heritage buildings where inherent restrictions can be much more pronounced because of the need to preserve the layout and appearance of the original building, and where materials and finishes must be chosen to match those used during the building's original construction.

The aim of this research was to explore and identify how projects overcome potential barriers for the sustainable refurbishment of listed buildings and buildings in conservation areas. These are referred to as 'heritage buildings' within this paper.



Research Methodology

This investigation is based on a retrospective review of 16 heritage buildings (See Table 1) which were undergoing, or had been refurbished. The data was collected through a combination of desk based review of design information, and in-depth interviews with the BREEAM assessors and project teams.

Three out of 16 buildings had set themselves a target of BREEAM Excellent or above. At the time of this review, these schemes were at different stages in the construction cycle, which provided a closer perspective of unique features, challenges and opportunities at outline/ concept design, detailed design, and post-completion.

Additional information was sought through various approaches, including workshops and with project teams, follow-up telephone interviews with BREEAM assessors, designers and national heritage organisations such as English Heritage and National Trust.

Table 1 List of buildings reviewed

Development	Grade I	Grade II	Grade II*	Conservation area	BREEAM 2008 Rating (scheme / stage)
64 Sloane Street		■			Offices - Excellent
City of York Council West Offices			■		Offices (Post Construction) – Excellent
Wellington House				■	Offices (Post Construction) – Very Good
116 High Street			■		Offices (Post Construction) – Very Good
1 Southampton Street (formerly Manfield House)				■	Offices (Post Construction) – Excellent
Royal Arsenal Office		■			Offices (Post Construction) – Pass
Edinburgh Centre for Carbon Innovation		■			Education Outstanding (at D&P stage)
The Witham, Barnard Castle		■			Bespoke (Interim) – Very Good
Somerset House East Wing	■				Bespoke (Interim) – Excellent
Senate House, London		■			Bespoke (On-going target: Excellent)
Bombay Sapphire Visitors Centre Buildings		■			Bespoke (Interim) – Outstanding
The Stable Yard, Morden Hall Park				■	Bespoke (Post Construction) – Excellent
Bombay Sapphire Distillery Process Buildings				■	Industrial (Interim) – Outstanding
Royal Riverside Arsenal, 10 Major Draper Street		■			Offices (Post Construction) – Pass
Olympia Glasgow			■		Bespoke (Design stage Excellent)
Savoy Place		■			Bespoke (On-going target: Very Good)

The refurbishment challenges

Generally, refurbishment projects are awarded fewer BREEAM credits than new build: less than 10% of refurbishment projects have achieved a BREEAM Excellent rating compared to more than 30% of new build projects – see Figure 1¹.

This is not unexpected because improving the environmental performance of existing buildings is complicated by physical factors such as the building's existing condition, structure, fabric and built form. The discussions highlighted that a number of sustainability issues may not be adopted as a result of budget restrictions rather than due to physical or heritage constraints. For example, several renewable energy systems and energy efficiency measures, although technically viable, were not deemed to be cost effective, where similar measures could potentially be accommodated within a new build project at lower cost.

Some of the physical and functional constraints faced by the schemes are as follows:

- Limited options to improve thermal performance of windows and walls
- Ensuring breathability of traditional constructions
- Location and size of windows restricting daylight provision
- Restricted layout and provision of view out
- Identifying space for cycle storage
- Increase in proposed occupancy levels and performance requirements impacting on measures required to achieve higher building regulations performance levels.

¹ Note: The sample of refurbishment projects is smaller than new build but does represent a large sample: of 40,000 projects assessed, almost 15% of buildings are refurbishment projects.

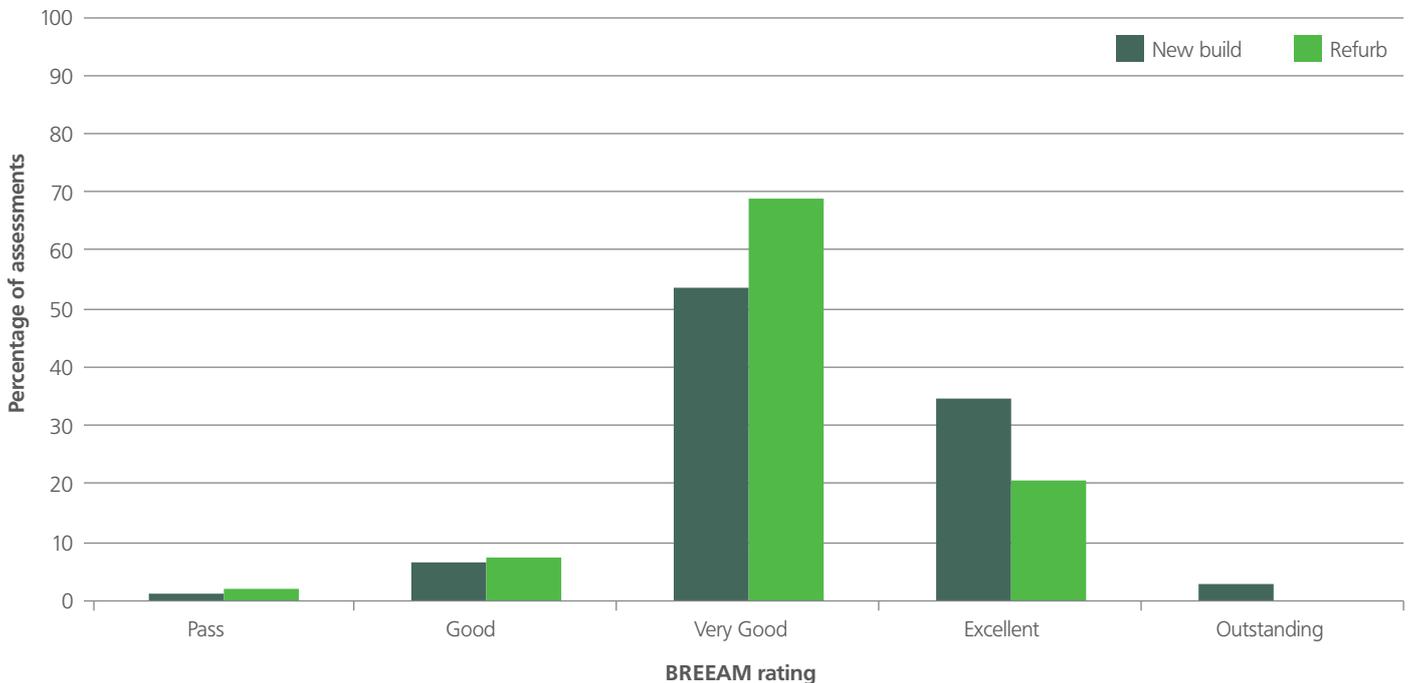


Figure 1 Average BREEAM Assessment Ratings for new and refurbished buildings assessed against BREEAM 2008

BREEAM Scores: How do heritage buildings compare to general refurbishments?

The general perception is that, because of heritage and conservation considerations, it will be more difficult to achieve higher BREEAM ratings for listed refurbishments. As seen above, although there are specific challenges associated with sustainable refurbishment, the detailed study of case study buildings highlighted that it is possible to achieve a BREEAM Excellent rating. In fact, this research has found that heritage building refurbishments have achieved higher ratings than those typically achieved by other refurbishments in BREEAM assessments, and in some instances the BREEAM ratings of heritage building refurbishment can exceed that for new buildings.

Figure 2 demonstrates this by comparing the performance across individual BREEAM categories for a sample of 577 buildings (468 new buildings, 96 general refurbishment projects, and 13 heritage refurbishment projects). This shows that for some of the

BREEAM headings (e.g. Energy), the number of BREEAM credits awarded for 'listed refurbishment' projects is often greater than that for 'general refurbishment' projects and can be comparable with those awarded for 'new build' projects. Due to the sample size, there is greater uncertainty surrounding the listed refurbishment projects than the other categories, and a larger sample, if available, may provide different overall results.

Listed refurbishment projects tended to score relatively well in the categories of: Management, Energy, Transport and Materials. Conversely, the categories that appear to be more challenging for listed refurbishment projects are Waste and Health and Wellbeing. The ranking of performance, 1 being better performing and 3 the lower scoring, under each BREEAM category for each type of project is shown in Table 2.

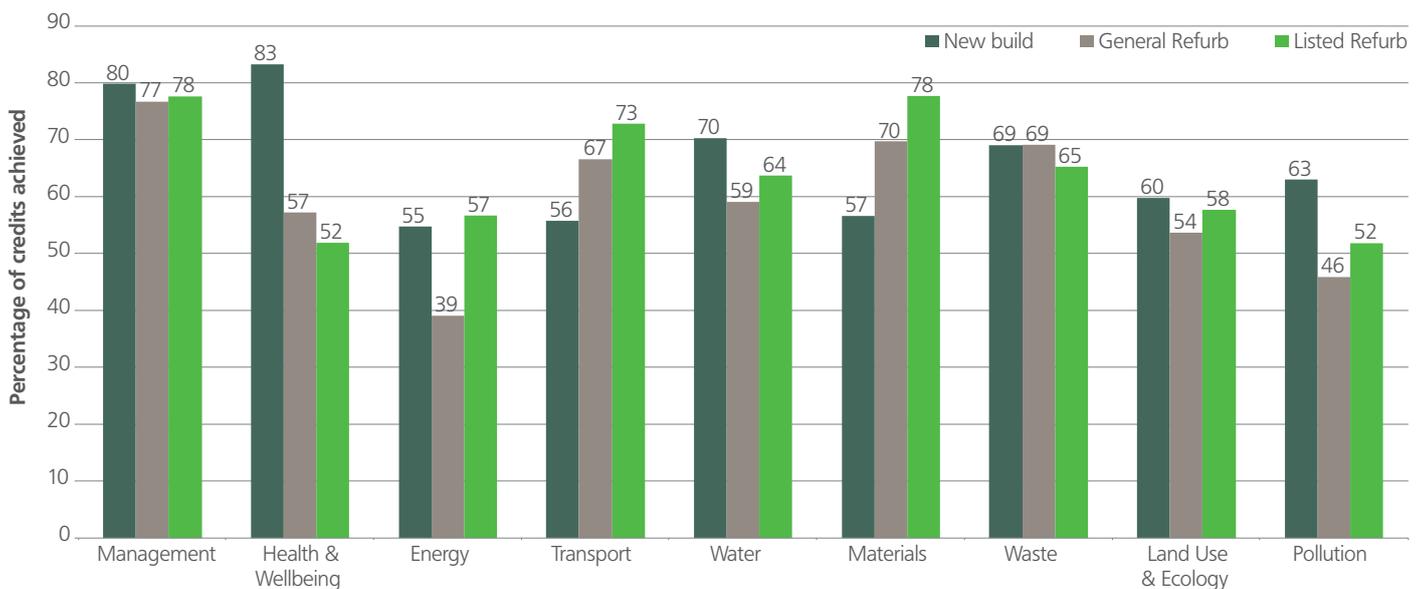


Figure 2 Average BREEAM category scores - listed or historic buildings vs new build and general refurbishment

Table 2 Ranking of performance under each BREEAM category by project type

	Management	Health & Wellbeing	Energy	Transport	Water	Materials	Waste	Land-use and ecology	Pollution
New Build	1	1	2	3	1	3	1	1	1
Listed Refurbishment	2	3	1	1	2	1	3	2	2
General Refurbishment	3	2	3	2	3	2	2	3	3

Overall performance within the Management category is almost constant across all project types, with heritage refurbishment projects performing almost as well as new buildings. The reason for this consistency is that several of the credits available (e.g. consultation, site management practices, handover arrangements) are not dependant on nature of the construction project.

The changes to BREEAM 2014 Refurbishment 2014 Management and Transport categories are highlighted in the boxes below.

Changes to BREEAM Refurbishment 2014: Management

Life Cycle Costing (LCC): Where the components that can be specified are limited due to the heritage requirements, it is acceptable to exclude this from LCC investigation.

Several credits in categories such as Transport, Pollution and Land-use and Ecology are site dependant. Listed refurbishment projects, on average, achieved one of their highest percentages of available credits in the Transport category, and outperformed both new build and general refurbishment projects. This is mainly because the buildings reviewed were at central locations or sites which are often visited by the public and tend to have established transport connections.

Changes to BREEAM Refurbishment 2014: Transport

Transport: There will no longer be default credits for simply having good transport links. Instead projects will be required to review the existing access to more sustainable travel and then identify appropriate measures in order to encourage more sustainable travel. This includes 8 different sustainable transport options for projects to select depending what may be feasible in their situation e.g. providing video conferencing facilities, charging points for electric vehicles etc.

Where the amount of external space is limited, it is extremely challenging to incorporate ecological enhancements. The scores in the Pollution category are a combination of overcoming site specific issues (e.g. flood attenuation) and provision of less polluting heating and cooling systems. Listed refurbished buildings achieved, on average, half of the available credits for the Pollution category. This is higher than general refurbishments but lower than new buildings.

In new builds and general refurbishment there is scope to implement site waste management plans (SWMPs) during demolition and construction. However, there is often less potential to introduce recycling facilities within listed buildings (depending on space and layout).

The following sections discuss how Energy, Materials and Water categories were delivered in some of the high scoring heritage refurbishment projects and corresponding changes in BREEAM Refurbishment 2014 scheme.



Energy, Materials and Water aspects in high performing buildings

The following sections discuss how credits within the Energy, Materials and Water categories were delivered in some of the high scoring heritage refurbishment projects and corresponding changes in the BREEAM Refurbishment 2014 scheme.

Energy

Energy is one of the lower performing categories across all building types: with listed refurbishment projects performing slightly better than new build projects and significantly better than general refurbishment projects. A heritage report undertaken at the beginning of projects enabled better understanding of what can be achieved. The reports identified feasible physical improvements that could be done to preserve the way the original building was designed (e.g. breathability) and at the same time enhance thermal performance.

Energy measures adopted

- Building fabric first approach with attention to breathability aspects
- Windows upgrade, where possible
- Upgrading existing heating and ventilation systems
- Significant reductions in carbon emissions² were achieved, through combination of measures (See Figure 3). However, better performing buildings had higher reductions through introducing renewable energy with CHP
- Energy sub-metering
- Energy efficient external and internal lighting

Changes to BREEAM Refurbishment 2014: Energy

The way in which BREEAM 2008 awarded credits for carbon reduction has been reviewed and modified within BREEAM 2011, and further refined within BREEAM 2014. BREEAM Refurbishment 2014 assesses energy using a triple metric approach (the % reduction in: CO₂ emissions, energy demand, and primary energy).

To make this appropriate for refurbishment, this considers the current building's performance, its design performance and how that compares to its potential performance which is based upon benchmarking data from actual buildings. A separate scale is provided for heritage buildings to reflect limitations in the scope to reduce energy demand.

An additional two credits have been developed to reward projects that work with a heritage specialist to develop a report on the potential for improving building fabric and services performance whilst minimising the potential negative impacts of both the historic character of the building, the condition of the building fabric and indoor air quality. This aims to get project teams to explore all the possible options for improving the fabric and services, but at the same time considers responsible retrofit by making sure a risk assessment is carried out to ensure measures do not have any negative impacts on the building's heritage or performance by drawing on best practice.

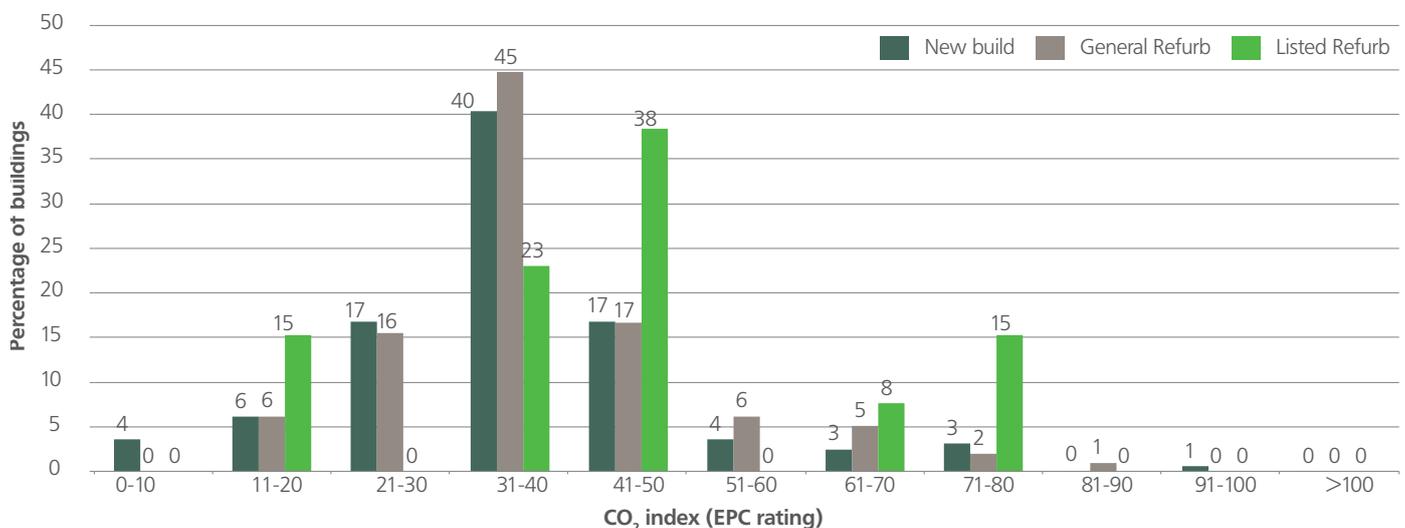


Figure 3 CO₂ index (EPC rating) of listed refurbishments vs new build and general refurbishment

² BREEAM assesses the energy performance of building in terms of energy use, CO₂ emissions and provision of suitable infrastructure to monitor energy use. Ene 01 (Reduction of CO₂ emissions) awards credits based on a CO₂ index (the Energy Performance Certificate - EPC - rating) of buildings

Materials

The materials category is an area where refurbishment projects generally outperform new build projects. The reason for this is that the majority of existing materials are retained, with very few new materials specified, resulting in a number of credits being awarded by default. Heritage buildings often retain their façade and where replacement finishes and materials are used, these replacement materials tend to be similar materials to those used for the original construction which can have low impacts.

Material measures adopted

- Building elemental specification and hard landscaping in accordance with the BRE Green Guide to Specification
- Breathable membrane
- Reuse of building façade and structures
- Responsible sourcing of materials
- Designing for robustness

For detailed information on materials and energy in-use see www.tandfonline.com/doi/pdf/10.1080/13556207.2013.787017

Changes to BREEAM Refurbishment 2014: Materials

Material specification: Under BREEAM Refurbishment 2014 there is an acknowledgement that it is not appropriate to set specific performance targets for refurbishment due to the often restricted nature of the materials that can be selected in heritage buildings. Consequently, a more qualitative approach is to be provided in order to reward projects for the effort taken to work with the supply chain to identify alternative products that have greater environmental accreditation. Credits are awarded where there is evidence to show that products with the lowest impacts have been sought.

Reuse of building elements: Project teams are no longer rewarded simply for only retaining building elements, but for the effort taken in attempting to source and specify sustainable products for any new materials used in renovation. However, where heritage requirements prevent the selection of products that have better environmental credentials, allowances are given for this.

Designing for durability and resilience: Exemptions are allowed, where the choice of materials may be limited - reducing the scope to design the building to meet the criteria for durability and residence.

In **Morden Hall Stables** magnesia board was specified in preference to gypsum plasterboard for its fire resistance, moisture resistance, mould and mildew resistance. 75% of insulating material in ground floor, roof, walls and building services was made from natural and/or recycled material including cork, hemp, products made of wood fibres without glue or preservatives, recycled insulation products made from recycled carpet waste and blend of recycled polyester and British sheep's wool and aerogel.



Intelligent membrane

(© National Trust Picture Library/Jon Whitehead Source: Journal of Architectural Conservation).

Water

The performance of listed refurbishment projects for water more closely matches new build projects than general refurbishment projects. The uptake of metering and leakage detection, low water appliances, and sanitary supply shut off to toilets/showers, is higher in the sample of listed refurbishment projects than in general refurbishment projects.

Water measures adopted

- Water efficient fittings
- Water meter
- Leak detection systems
- Sanitary supply shut-off valves
- Water recycling systems
- Irrigation systems

The **Stable Yard, Morden Hall Park** was the only case study building to achieve the water recycling credit. This was achieved by specifying a 3,000 litre rainwater harvesting tank for 100% of toilets, combined with dry urinals, low flow taps & showers.

An interview with the Water Advisor for National Trust highlighted the advantages and disadvantages of reducing the mains pressure as a result of installing water efficient fittings. Whilst this is generally advantageous for old pipework, there could be issues with certain boiler types. Some of the existing features in historic buildings, such as water storage units under stable yards for fire prevention, are conducive to reducing potable water use. These storage units can then be linked to filters and re-connected for irrigation and toilets.



Morden Hall Stable Yard (© Louis Sinclair taken source: http://nationaltrust-mordenhallpark.blogspot.co.uk/2013_02_01_archive.html)

The Edinburgh Centre for Carbon and Innovation (ECCI)

building is installed with water efficient fittings including a dual flush of 4/2.6 litres, effective flush of 2.95 litres, fulfilling the first part of BREEAM credits Wat01 and Wat02. Delay fill ball valves were not necessary for achieving the credit but were also installed. Further guidance was included with the signage package for the WC flushing device to ensure its effective maintenance and use. Self-closing taps with a maximum flow of 5l/min were used throughout the building.

The pressure can be controlled to between 1 and 3 bar (0.3MPa) with the 4.7 LCM PC fitted. Urinals were fitted with proximity sensors. Taps to all WCs have a flow rate of 6 litres per minute, controlled by lever handles. The wet room shower has a flow rate of less than 9 litres per minute at 0.3 Pa with an ideal standard flow limiter, shower valve limiting flow to 8 litres per minute. Changing room showers were fitted with ideal flow limiter for an 8litre per minute output. A rainwater harvesting system was designed to collect rainwater from the roof of the building. The collected water is used for flushing WCs throughout the building in order to reduce the amount of mains potable water that the building consumes.

The capacity of the water harvesting facility had originally been designed to be far bigger. However, the discovery of the remains of Black Friars Monastery and adjacent graveyard underneath what was previously a car park, incurred restrictions. Edinburgh Council specified that an archaeologist must be on hand for a standing brief at all times, and having found the grave of a wealthy 13th/14th century knight, both public and private archaeologists were brought in to investigate the site. This limited the space available to implement design plans. The restricted rainwater harvesting facilities were still sufficient for use in the WCs; however, the more extensive SUDS plans were replaced with attenuation measures.

A water meter and a leak detection system were also specified to monitor water consumption and to minimise water wastage. These are housed in accessible plant rooms and a cleaner's cupboard. Furthermore, the project gained an exemplary credit with regards to water consumption. The kitchen will be monitored and is expected to utilise only 10% of the entire building load.



Challenging BREEAM category: Health and wellbeing

This research has highlighted some inherent challenges in meeting the BREEAM criteria for health and well-being credits for refurbishment projects.

- The scope to influence daylight levels and view out are restricted by the original building's form and plan depth.
- It is harder to achieve the criteria for thermal comfort and controls than new build projects, particularly where the occupancy of the building is changing from that originally intended.
- Natural ventilation throughout existing buildings is often impractical with existing glazing and air flow routes. Similarly, it is often not possible to provide air from 'clean' sources (not adjacent to roads/ sources of pollution)
- Refurbishment projects generally require a full internal refurbishment in order to meet the criteria for acoustic performance. In listed buildings this is quite often not possible due to the requirement to retain existing features.

Changes to BREEAM Refurbishment 2014: Health and wellbeing

Daylighting: A new set of criteria have been developed for daylighting to better reward projects where there may be limited scope to improve daylighting. Rather than the credits only being awarded where 80% of spaces achieve a specific daylight factor, the credits can be awarded where 40% or 60% of spaces achieve the daylight factor.

Many heritage buildings do benefit from good daylighting but this may not be across the whole space so this rewards projects that are partially compliant and encourages projects to optimise the use of areas that do benefit from good daylighting. Specific credits have also been developed to reward projects that improve existing daylighting by 15% or 30% which may still not be feasible for heritage projects but may provide a driver for general refurbishment projects to consider how daylighting may be improved.

Exceptions are allowed in meeting standard criteria in the following circumstances:

Visual comfort: Where existing fittings may need to be retained preventing achievement of credits for lighting zones

Indoor air quality: Where specific paints are required for grade 1 and 2* listed buildings that don't meet BREEAM VOC requirements

Thermal comfort: Where alternative thermal comfort requirements are imposed by heritage bodies

Acoustic performance: Where the Suitably Qualified Acoustician confirms that the building is as compliant as is feasible within the constraints of requirements set by a heritage specialist

Actions for higher BREEAM performance

This investigation highlighted a range of rationale for the relative better performance of heritage refurbishment projects when assessed using BREEAM 2008. The project teams indicated the following actions enabled the schemes to achieve higher BREEAM performance.

- Ensuring that the project delivery team understood not only the BREEAM requirements but also incorporate it in the design from the initial stages.
- A need to preserve or reproduce a building's original features or appearance, which can result in the use of sustainable materials (e.g. using locally sourced materials or natural materials that were used during their original construction)
- Extensive consultation with English Heritage, local Council and the community to generate interest, support and wider project buy-in.
- Fabric first: Preserve and improve some of the best of original design features which complement daylighting, breathability and natural ventilation of old buildings.
- Improve building services, informed through long term whole life cost based approach and effective means of reducing CO₂ emissions.
- Detailed Brief: which encouraged high performance specifications and detailed room data sheets;
- Greater consideration of whole-life operational requirements: to ensure the delivery of a facility that the community can sustain in an efficient manner;
- Exceeding minimum building regulation requirements: to ensure the building performs at optimum efficiency levels in terms of energy and environmental performance.
- Construction Phase Monitoring: to ensure quality and robust delivery;
- Other requirements which specifically drive the environmental performance (e.g. Client's requirements, local planning considerations) to deliver an exemplary project.

BREEAM Refurbishment 2014

As well as changes to particular criteria as detailed above, a fundamental rework of the overall structure of the BREEAM Refurbishment 2014 scheme has been introduced in order to provide flexibility for projects. The 2014 scheme will have four new parts that clients can seek certification against, depending upon the scope of their works, these include:

Part 1: Fabric & structure

Part 2: Core Services

Part 3: Local Services

Part 4: Interior Design

This structure will therefore allow clients to seek certification against the parts relevant to the scope of works. For example, a Grade 1 listed building, where no fabric measures may be feasible, could choose to only gain certification against parts 2, 3 and 4. Or a fit-out may only seek certification against Parts 3 (local services) and 4 (interior design).

Conclusion

Although there were constraints associated with the heritage status, costs and timescale, this investigation has demonstrated that sustainable refurbishment of heritage schemes is possible and it can be delivered to a high BREEAM standard. The sample reviewed in this study scored higher than general refurbishment projects, and in fact closer to the performance achieved by new build schemes.

In order to address sustainability issues, and to achieve high BREEAM ratings, it is always necessary to consider mitigation of all negative impacts at the earliest stage of a project. This needs to be managed throughout the construction process. For existing buildings this can be complicated by the need to phase refurbishment activities, or to undertake the works while the building is occupied. Several renewable energy systems and energy efficiency measures, although technically viable, are deemed not to be cost effective, where similar measures could potentially be accommodated within a new build project at lower cost. For one of the case studies the initial aspiration to achieve 'Excellent' rating was relaxed to 'Very Good' due to budget and timescale limitations and the need to make fundamental changes as the design of the scheme evolved.

BREEAM 2014 and BREEAM Refurbishment 2014 have been updated in light of this research and this should make the environmental assessment of sustainably refurbished heritage buildings more representative of actual performance by taking account of the specific challenges faced by each project.



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BRE Global

Bucknalls Lane
Watford
United Kingdom
WD25 9XX

T +44 (0)333 321 8811
E breeam@bre.co.uk
www.breeam.com

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