

Knowledge File: Sustainability in Building Refurbishment Choice of Materials

Introduction

Around 30% of UK industrial energy is consumed annually in the manufacture and transportation of building materials. This equates to approximately 10% of the UK's total energy consumption, which is contributing to global warming and its consequent effects. By choosing materials and finishes which require a reduction in the energy levels for their manufacture represents an opportunity to contribute towards reducing the environmental impact of even refurbishment projects.

Embodied Energy

The embodied energy of a building material or product can be defined in a number of ways. '*Cradle-to-Grave*' is defined as the primary energy consumed, and the amount of carbon released, from the extraction of materials, manufacture & transportation of the finished product measured over its lifetime. Alternatively '*Cradle-to-Site*' includes the consumption of energy up until the product has reached site, while '*Cradle-to-Gate*' only includes the primary energy consumed up to the product/ materials leaving the factory.

Trying to establish what is the embodied energy of a material or product can be fraught with difficulties. It is often difficult to obtain reliable information from primary sources. A recent study undertaken by Professor Geoff Hammond & Craig Jones¹, University of Bath, were only able to collect data from secondary sources within the public domain.

The University of Bath study which forms the ICE-Database¹, containing over 1,700 records, uses the '*Cradle-to-Gate*' as it was the most common used in the original data. The embodied energy of materials/ products is given in MJ per kg or kg of CO₂ per kg of material. It is easier to calculate the mass of some materials than others due to the difficulty of obtaining information on material weights or cross sectional areas etc. The ICE-Database can be obtained from the University of Bath² through the link given below.

Green Guide to Specification

Due to the limitations in being able to accurately calculate embodied energy of products an alternative approach is to use a third party database of materials/ construction elements that have already been assessed with regard to their potential environmental impact. One such database is the BRE's Green Guide to Specification³ which is available on line & free to use with registration.

¹ Professor Geoff Hammond & Craig Jones 'Inventory of Carbon & Energy (ICE)' (2008); Sustainable Energy Research Team (SERT), Department of Mechanical Engineering, University of Bath, United Kingdom

² ICE-Database link: <http://www.bath.ac.uk/mech-eng/sert/embodied/>

³ BRE Green Guide to Specification link: <http://www.thegreenguide.org.uk/>

The Green Guide assesses building materials and components in terms of their environmental impact across their full life cycle, a 'Cradle-to-Grave' approach, within comparable specifications. The building elements covered includes external walls, insulation, windows, roof & upper floor constructions, internal walls, and landscaping, providing a representative range of commonly used generic UK specifications. It is not always obvious which building element has the biggest environmental impact. In office building floor finishes have the biggest environmental impact, over its 60 year life, because they are replaced so frequently.

The Green Guide provides a summary rating for these building elements which is created by the aggregation of thirteen individual impacts for each specification, which are then normalised and weighted for their relative importance, and then added together. They are assigned a rating from A+ down to E, with an A+ rating having least environmental impact. In a commercial type building, some typical building elements have the following ratings:

- External Walls: Typically brick & block cavity wall construction, cement render on block walls or timber/ steel framing, insulated render on block walls, timber boarding on either timber or steel framing, can all receive A+ Ratings. Many insulated metal cladding systems can achieve A Ratings. On the other hand no curtain walling, even timber ones are only B Rated & some systems as low as D Rated.
- Insulation: A wide range of insulation products are A+ Rated, included some expanded polystyrene products.
- Windows: Generally only timber windows can achieve A+ Ratings.
- Roof Construction: The only flat roof, warm deck, constructions that achieve A+ Ratings are those laid over a steel deck, supported off a steel structure, with a range of waterproof layers. No concrete roof construction achieves anything above a B Rating & many are lower. Metal pitched roofs can achieve either A or A+ Ratings.
- Upper Floor construction: Some concrete floor constructions (pre-cast, in-situ on troughs, beam & block) can achieve A+ Ratings.
- Internal Walls: While timber stud plasterboard partition achieves A+ Rating, plasterboard on steel studs still achieves A Rating, decorated blockwork walls generally achieve B ratings & lower.

While the Green Guide is accessible and uses reliable information, the specifications used are only generic in nature. In addition a number of building elements covered in The Green Guide to Specification: 3rd Edition⁴ are not currently covered on the on-line Green Guide. These include Floor Finished & Coverings, Suspended Ceiling & Ceiling Finishes, Doors & Internal Paint Finishes.

Some manufacturers have gone to the expense of having their products assessed by BRE to have a specific Green Guide Rating allocated to them. For instance Marley Eternit has a range of roof tiles/ slates⁵ which have been assess to have A Ratings. Kingspan have not only had their TEK timber insulated panels rated but also their EcoSafe metal composite panel⁶ has an A Rating. There are a number of flooring manufacturers like Altro Flooring⁷, Tarkett Flooring, Polyflor Ltd⁸, Freudenberg

⁴ Jane Anderson & david Shiers, with Mike Sinclair 'The Green Guide to Specification: 3rd edition' (2002), published by Blackwell Publishing

⁵ Marley Eternit link: <http://www.marleyeternit.co.uk/breem.aspx>

⁶ Kingspan link: <http://www.kingspanpanels.com/News-Events/Custom-Newsletter/Architects/e-bulletin-October-2007/Safeguarding-the-Future.aspx>

⁷ Altro Flooring link: <http://www.altro.com/Flooring/Key-features/Hygiene.aspx>

⁸ Polyflor link: <http://www.polyflor.com/JH/News.nsf/NHP?Openform&Mode=WN&Key=7bam8j&>

Bausysteme KG rubber flooring⁹, Forbo-Nairn linoleum flooring¹⁰ & Gerflor Ltd¹¹. Similarly with soft flooring manufacturers such as InterfaceFLOR¹², Milliken Carpet¹³ Burmatex Ltd¹⁴ & Heckmondwike FB¹⁵ have had some of their products assessed.

Materials with Recycled Content & Recycled Materials

One way to reduce the embodied energy of materials being specified is to use materials which either have a recycled content or in fact recycled themselves. Many construction products contain a proportion of recycled content, but competing brands may contain different proportions. The Waste & Resources Action Programme (WRAP) have undertaken a number of case studies which indicate that, by simple product substitution, the recycled content of products can be significantly increased without increasing cost. The environmental benefits of this approach include placing less demand on finite natural resources, the diversion of waste from landfill, and helping to create stronger markets for the materials that contractors want to send for recycling. WRAP have found that the potential for diversion from landfill, in school and housing projects, has been estimated to increase ten-fold by using higher recycled content available at competitive costs.

Examples of products which use recycled material includes steel reinforcement used in concrete, which is generally made up of 100% recycled content. Main structural steelwork can also contain large amounts of recycled materials. Corus state that the average recycled content of new steelwork sourced from within the EU, during 2006, was 56%. They also state that steel is 100% recyclable¹⁶. This highlights an issue where care sometimes needs to be taken when considering the level of recycled content in some materials due to the way it can be calculated. The ICE-Database¹ adopted the *recycled content approach* methodology, which splits materials into recycled materials & primary materials when it calculated the level of embodied energy. So if 40% of recycled metal is used in new metal products then the recycled content is classed as 40%. Some industries, however, use a *recyclability approach* which credits the potential act of recycling at the end of the life of a product/ material. So if 85% of a metal product has the potential to be recycled at the end of its life then it is said to have 85% recycled content.

It is possible to investigate relative amounts of recycled material within different brands of products by using WRAP's on-line search engine¹⁷, which can filter by product or project type or by supplier. In addition there is additional printed guidance, which can be downloaded, to the recycled content of mainstream construction products¹⁸ & reclaimed building products¹⁹. This can be quite useful as it is sometimes difficult to determine the recycled content of products even on a

⁹ Freudenberg Link: <http://www.nora.com/>

¹⁰ Forbo link: http://www.forbo-flooring.co.uk/ModuleFiles/mod_doc_download_center/130/sustainable%20brochure.pdf

¹¹ Gerflor link: <http://www.gerflor.co.uk/uk/contract-flooring/product-search/ranges.html>

¹² InterfaceFlor link: http://www.interfaceflor.eu/internet/web.nsf/webpages/52951_EN.html

¹³ Milliken link: <http://www.millikencarpeteurope.com/Europe/Sustainability/BRECertification/Pages/Default.aspx>

¹⁴ Burmatex link: http://www.burmatex.co.uk/default_majestic.asp?section=32

¹⁵ Heckmondwike link: <http://www.heckmondwike-fb.co.uk/WhatsNew/7,BRE-%27A%27-Rating.html>

¹⁶ Corus link: <http://www.corusgroup.com/en/responsibility/cspr/sustainability/>

¹⁷ WRAP Recycled Content in Construction link: <http://rcproducts.wrap.org.uk/>

¹⁸ WRAP Recycled Content Guidance link: http://www.wrap.org.uk/downloads/Const_Product_Guide_Version_4.1.f0e977fc.2962.pdf

¹⁹ WRAP Reclaimed Products Guide link: http://rcproducts.wrap.org.uk/construction/reclaimed_building.html

manufacturer's own web site. For instance, in order to confirm the recycled content of a particular Armstrong Ceilings mineral fibre suspended ceiling tile the data sheets²⁰ of individual tiles needs to be looked at, as there appears to no central list available.

Another aspect of recycling materials/ products that could be considered is the leasing of the carpets. InterfaceFLOR's *Evergreen Lease* scheme²¹ allows the customer to choose any Interface or Heuga carpet product providing a complete service from installation to removal. InterfaceFLOR considers this maximises the lifecycle of the product, aiding them to achieve their ambition of becoming a sustainable and restorative company. InterfaceFLOR have also have developed their *ReEntry* scheme²² which arranges for any InterfaceFLOR carpet to be diverted from landfill for a small cost. InterfaceFLOR claim that any product which cannot be cleaned & re-furbished will, where possible, be recycled into new products or downcycled into other products.

Another strategic approach to increasing the level of recycled materials on a particular project might be to require that at least 10% of the total value of materials specified/ used should derive from recycled and reused content in the products and materials selected.

Responsible Sourcing of Materials & Products

Another aspect of sustainable procurement of materials & products is to look at giving preference to manufactures' of materials & products who demonstrate their sustainable responsibility through third party certification.

Generally this can be done by specifying suppliers who have certified environmental management systems. These should be accredited to either BS EN ISO14001 or BS8555. These standards specify the requirements for environmental management systems to enable organizations to develop and implement a policy and objectives which applies to those environmental aspects that the organization identifies as those which it can control and those which it can influence. It can be quite difficult, however, to find out which suppliers have certified environmental management systems. There is no central register of certified companies, as companies can be certified by a large number of accredited agencies. For instance BRE only list those companies certified by themselves²³.

With regard to all timber products it is important to ensure that even when they are not being obtained from certified sustainable sources they should be legally sourced & the timbers being specified for use are not listed in Appendices I and II of the Convention on International Trade in Endangered Species (CITES). Timbers listed in Appendix III of the CITES list should only be used as long as the timber is not obtained from the country(ies) seeking to protect the species. To avoid this problem it is best to specify that all timber/ timber products (i.e. softwood timbers, temperate hardwoods and timber/paper based products) should be sourced from suppliers who have been accredited by either the Forestry Stewardship Council (FSC)²⁴, Canadian Standards Association (CSA), Sustainable Forestry Initiative (SFI)²⁵, with a certified

²⁰ Armstrong Ceiling link: <http://www.armstrong-ceilings.co.uk/commclgeu/eu1/uk/gb/datasheet.asp>

²¹ InterfaceFlor Evergreen Lease link:

http://www.interfaceflor.eu/internet/web.nsf/webpages/554_EN.html

²² InterfaceFlor ReEntry link: http://www.interfaceflor.eu/internet/web.nsf/webpages/556_EN.html

²³ BRE link: <http://www.greenbooklive.com/search/companysearch.jsp?partid=10007>

²⁴ FSC link: <http://www.fsc-uk.org/>

²⁵ Sustainable Forestry Initiative link: <http://www.sfiprogram.org/>

chain of custody, or from the Programme for the Endorsement of Forest Certification (PEFC)²⁶.

Reducing Impact on Climate Change

All insulation materials (both building fabric & services) should be non-ozone depleting, with a global warming potential of less than 5. Global warming potential (GWP) is a measure of how much a given mass of greenhouse gas (which is used in foaming some insulation products) is estimated to contribute to global warming. It is a relative scale which compares the gas in question to that of the same mass of carbon dioxide (whose GWP is by definition 1).

This is not a problem with a large range of insulation products such as those based on the use mineral or glass fibres²⁷ or more natural products such as recycled cellulose from paper²⁸, lambs' wool²⁹ etc. The use of foamed insulation products does need to be carefully considered, while the gases used for blowing the foam can no longer be ozone depleting, some use HFCs which can have a GWP of nearly 4000. If gases products such as butane or propane are used to blow a foam then its GWP will only be 3.

Healthy materials

Occupant health issues can be addressed through specifying materials & products that potentially reduce the level of internal pollution within a scheme.

Building materials and furnishing products can be significant sources of volatile organic compounds (VOCs) which have a strong impact on indoor air quality during the first two years of a new building. Recent BRE Digests 464, Parts 1 & 2: VOC Emissions from Building Products refers to the relationships between VOCs with sensory effects such as odour, and skin and mucous membrane irritation etc. 'Low' VOC paints are now available from most standard mainstream paint manufacturers³⁰ as the emissions of VOCs from paints and varnishes are now regulated by EU Directive 2004/42/CE. Some manufacturers such as Natural Building Technologies³¹ Auro Natural Paints³² & Keim³³ produce paints from what they consider to be more natural products, which have very low or even claim zero levels of VOCs. Care does need to be taken with some 'natural paints', however, as they might not be as robust as some traditional paints in certain locations. They also often take longer to cure between coats. Painting a sample area might help the decision to be made on whether a more 'natural paint' might be suitable.

Wood based products (Fibreboard including MDF, OSB, cement-bonded particleboard, plywood, solid wood panel and acoustic boards) can emit formaldehyde, which is a respiratory and mucous membrane irritant. Risks can be reduced through careful specification. It is possible to specify Medite Ecologique MDF boards³⁴ which have had no formaldehyde added to the softwood fibres during

²⁶ PEFC link: <http://www.pefc.org/internet/html/>

²⁷ Rockwool web site: <http://www.rockwool.co.uk/sw47799.asp>

²⁸ Excell Warmcel insulation web site: <http://www.excellfibre.com/building/products3.html>

²⁹ Thermafleece sheep's wool insulation: <http://www.secondnatureuk.com/>

³⁰ Dulux link: <http://www.icipaints.co.uk/products/ecosure/index.jsp>

³¹ NBT Paints link: http://www.natural-building.co.uk/eco_paint.htm

³² Auro Paints link: <http://www.auroorganic.co.uk/>

³³ Keim link: <http://www.keimpaints.co.uk/development/products.php?cID=36>

³⁴ Medite Ecologique link: http://www.medite-europe.com/en/products_ecologique.php

its manufacture. No wood product can be entirely formaldehyde free, as formaldehyde is found naturally in wood, but the free formaldehyde content of Medite Ecologique is less than 1.0mg/100g (equivalent or less than natural wood) well below general ambient outdoor levels.

In addition may wood based products & floorings with low levels of formaldehyde, wall coverings with low formaldehyde & vinyl chloride monomer content. Vinyl chloride monomers are used in the manufacture of PVC and are known to be very harmful and can cause cancer which can take a long time to become apparent.

Reuse of Existing Facades & Structures

In refurbishments there are opportunities to maximise both the re-use of facades & structure can be significant in reducing the embodied energy content of a design. Over the 60 year life of an office building this might reduce the embodied energy content of the works by about a third.

BREEAM credits are awarded when at least 50% of a final façade (by area) is re-used & at least 80% of the re-used façade (by volume) comprises in-situ material. In BREEAM terms the façade is considered any exposed building face, not just the front elevation, although the definition excludes party walls from being considered.

Similarly a BREEAM credit is also available when at least 80% of an existing primary structure (structural floors, columns, beams, load bearing walls and foundations where required for structural use by a new building) is re-used without significant strengthening or alteration works (where the mass of new material is equal to or greater than 50% of the total mass of the reused structure) & where the re-used structure comprises at least 50% of the final structural volume.