materials

Contents

Key

Different development sectors are colour coded below. To aid navigation through the case studies in this Guide, the colour codes denote the applicability of case study sustainability solutions to each of the various development sectors. The colour coding can be found in the bottom corners of each of the case studies.

Hertfordshire materials facts

Around 420 million tonnes of materials are used by the UK construction industry each year, and approximately 120 tonnes becomes waste. (www.wrap.org.uk)

A target of 10 - 15% recycled content by value is commonly being set for new buildings, although actual performance is frequently higher. (http://rcproducts.wrap.org.uk/)

Construction materials account for: 20% of the UK's ecological footprint; 19% of the UK's total greenhouse gas emissions; and 30% of all UK freight transport. Cement manufacture accounts for around 2% of the UK's carbon dioxide emmissions. (www.sitelines.co.uk)

It is mandatory for all new government funded homes to have a Code for Sustainable Homes rating. One of the aims of the Code is to encourage the use of materials with lower environmental impacts. (www.breeam.org)

The **largest component of construction minerals are aggregates**, principally crushed rock (limestone, igneous rock and sandstone) and sand and gravel. Other minerals used in construction are clay, chalk and limestone for cement making, brick clay, gypsum, slate and building stone.

Aggregates make up over 50% of construction materials, some 240 million tonnes per year. Having been introduced in 2002 at £1.60 per tonne, the levy has since increased for 2010-11 to £2 per tonne. (Institute for Fiscal Studies)

An estimated 532,000 tonnes of construction and demolition waste was generated in Hertfordshire in 2003/04. (Waste Core Strategy Submission, January 2008)

The UK construction industry is responsible for 32% of landfill waste. A further 29% of waste to landfill is generated by mining and quarrying. (www.wrap.org.uk)

Recycled and secondary aggregates supply over 25% of the UK's requirement. (www.mineralsuk.com)

The Olympic Delivery Authority has pledged to recover, reuse or recycle 90% of construction waste on the 2012 Olympic site. (www.london-2012.co.uk/ODA/)

Since April 2008, it has been a legal requirement for a construction project in England worth more than £300,000 to have a Site Waste Management Plan. (www.netregs.gov.uk)

The Strategy for Sustainable Construction, June 2008, set a target of 50% reduction of construction, demolition and excavation waste by 2012, compared to 2008. (www.berr.gov.uk) WRAP (the Waste and Resources Action Programme) is promoting this campaign, and has obtained a commitment to halving waste to landfill from over 500 signatories. (www.wrap.org.uk)

Basic principles

Principles of materials

Hertfordshire has considerable sand and gravel deposits and mineral extraction is an important contributor to Hertfordshire's economy. However, even well managed minerals extraction generates noise, dust and waste, uses significant amounts of energy and manifests itself in the form of heavy goods vehicles on the roads.

The production of cement results in a significant proportion of greenhouse gas emissions in the UK. For each tonne of cement produced, a tonne of carbon dioxide is released into the atmosphere.

Although timber is a sustainable material, it is essential that forests are well managed to avoid deforestation, associated loss of habitats and changes to the character of the landscape and ground conditions. Risks of flooding and landslides can also increase.

UK consumption of construction resources 2007

Material	Vol (000 tonnes)
Clay	5752
Concrete products	62343
Insulation	655
Other cement	18902
Plastic	771
Raw materials	277300
Rubber	168
Slate	156.5
Steel	3120
Timber	6511
TOTAL	375,678.5

Principles of sustainable materials

re-use and efficient use of materials

Re-use of materials and/or use of environmentally friendly materials should be viable on any project, whatever its scale, location or functional specification. Materials reuse can be challenging, as it requires careful deconstruction and storage of materials until such time that the materials are required for reuse. However, use of new materials that are 'environmentally friendly' is now commonplace as most greener materials no longer cost any more than 'standard' materials; nor do they differ in terms of aesthetic or functional qualities.

environmentally friendly materials

Materials with the lowest environmental impact tend to have only minimal processing requirements. Examples of this include the use of timber and insulation made from sheep wool.

The use of petrochemicals in materials have significant environmental impacts as they are derived from fossil fuels and can have further implications for indoor air quality and occupant health. The specification of alternatives is a more environmentally friendly approach and examples include, amongst others:

- water based paints
- insulation from organic sources or from naturally occuring minerals, such as cellulose or cork board, or mineral wool

demolition

Demolition should be carried out as a last resort, where the building has deteriorated beyond the point where it can be reused. Wherever practicable, demolition should take the form of careful deconstruction to maximise the potential for re-use of materials.

local sourcing

Transport of building materials involves energy use, which counts towards the overall environmental impacts of the material. The amount of energy used for transport, particularly in the case of heavy or bulky materials, can be significant.

The most effective way in which to reduce these impacts is to limit the distances that materials are transported. A best practice approach would be to limit the radius for sourcing high mass materials to a radius of, for example, 30 miles. Alternative good practice measures include:

- avoidance of international sourcing, for example use of UK rather than Chinese slate

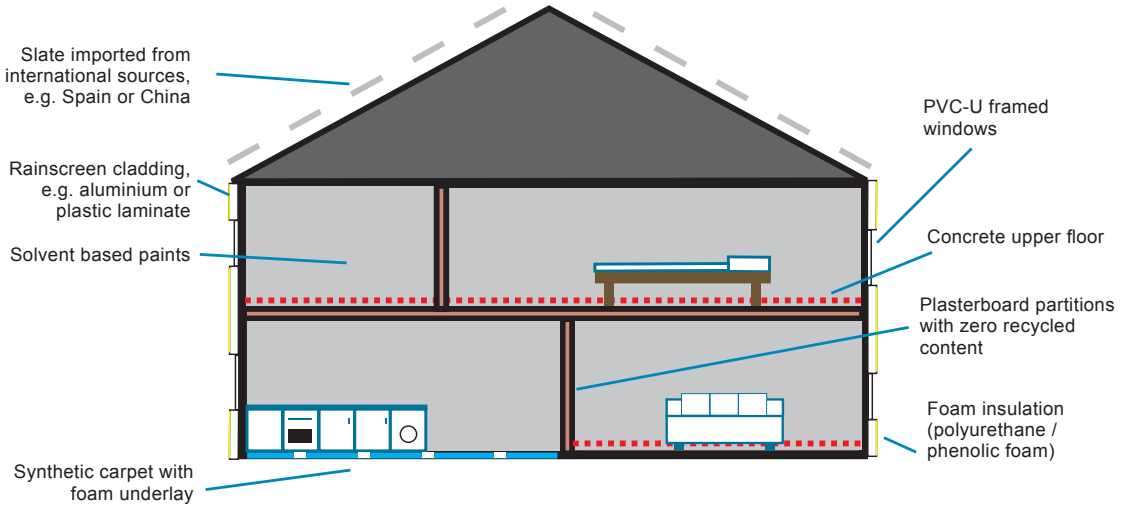
- organisation of deliveries to ensure that lorries have another load to transport on the return journey

Benefits of sustainable material management

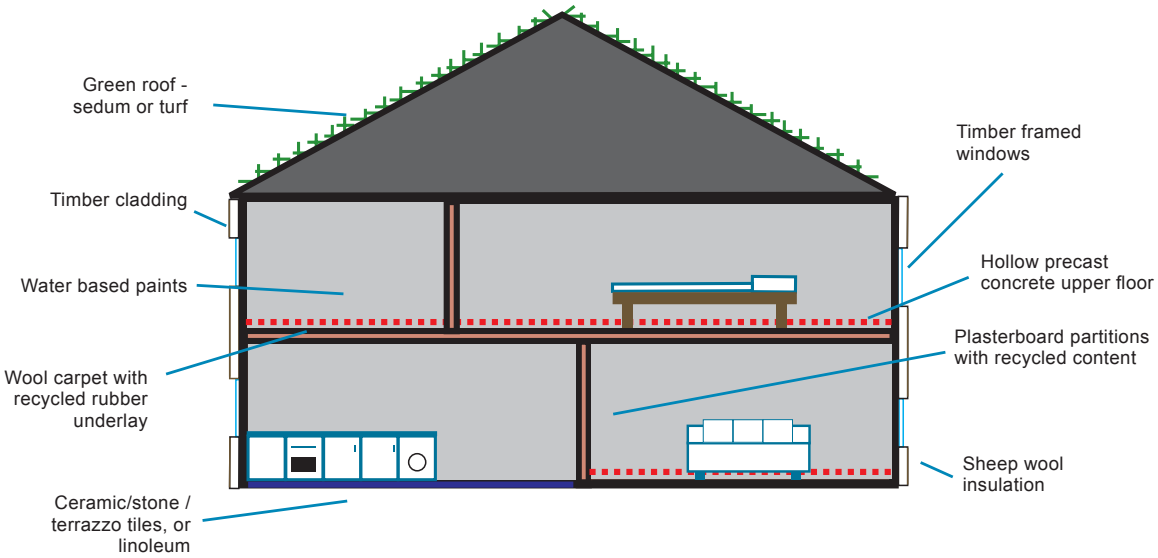
Sustainable material management delivers lots of benefits!

- reduced use of virgin materials
- reduced waste generation
- reduced environmental impacts associated with materials production and transportation

Typical practice



Good practice



Solutions

The opportunities to use materials efficiently can be very specific to the site or project. Consequently, some of the following solutions are best practice principles, rather than technical advice.

efficient use of materials

Construction materials are chosen for a number of reasons, including:

- cost
- availability
- performance
- aesthetic quality

Increasingly, projects are including environmental performance as a specification consideration. The environmental performance of materials can be assessed in a number of ways, these are described in the table provided.

Material	Example
Reclaimed/reused	Reuse of a brick as a brick Reuse of reclaimed slate tiles on roofs
Recycled	Reuse of a crushed brick as aggregate Reuse of timber beams as street furniture
Materials with recycled content	Plasterboard that is made with 85% recycled gypsum Blockwork that is made with 50% recycled aggregate
Environmentally labelled	BRE Green Guide A+ rated materials – the Green Guide provides a simple online guide (www.thegreenguide.org.uk) to the environmental impacts of building materials.
Low embodied energy	Use of plywood boards instead of chipboard Use of glasswool insulation instead of polystyrene
Locally produced materials	Sand and gravel from available sources in Hertfordshire. Use of UK sources for all other materials.
Natural materials	Using natural slate rather than artificial slate Using thermafleece (sheep wool) or mineral wool rather than foam insulation
Materials with good whole life performance	Use of aluminium faced timber windows rather than PVC windows

reclaimed/reused and recycled materials

Substitution of primary/virgin materials for reclaimed or recycled materials improves the sustainability of buildings by:

- reducing the reliance on primary materials
- reducing construction and demolition generated waste, (or waste from other industries if the materials are sourced externally)

A number of material types lend themselves well to reclamation, notably those that have a high economic value or particular aesthetic quality such as:

- hardwood flooring
- timber structural joists and steel beams
- stone (e.g. York stone, limestone)
- high value cladding (e.g. granite or marble)
- brickwork

The Waste and Resources Action Programme (WRAP) provides an environmental rating framework for materials, according to their recycled content. Product recycled content (as defined by ISO 14021), is measured as a percentage of total material mass.

Did you know?

WRAP provides a database listing products with higher recycled contents (rcproducts.wrap.org.uk/). WRAP also provides online tools to calculate a building's overall recycled content. At early project stages the Designing out Waste Tool for Buildings (dowtb.wrap.org.uk/) can be used. Where full specification details are available the Net Waste Tool (nwtool.wrap.org.uk/) can be used.

Did you know?

The variability in recycled content is high, and a best practice approach is to set a conservative target of 10-15%, with an additional requirement to adopt the top 5-10 cost competitive product options as identified by WRAP's Net Waste Tool. Recycled Content is calculated as follows: % RC by value = RC material mass (tonnes) x material cost (£)

Examples of products that inherently have a high recycled content are listed below. The products listed do not incur additional cost or impact upon other project considerations such as programme, aesthetic quality or functionality.

However, in some instances, products with a higher recycled content raise technical issues. For example the use of cement replacements (e.g. pulverised fuel ash) increases concrete curing time.

Product	Typical recycled content	Best practice recycled content
plasterboard	36%	84%*
blockwork	0%	90%
concrete	1) 20% of course aggregate 2) 50% of cement replaced by GGBS*	1) 100% of coarse aggregate 2) 70% of cement replaced by GGBS*
vinyl floor finish	12%	100%
roof concrete tiles	0%	22%
mineral/ rock wool insulation	25%	50%

* ground granulated blast furnace slag

environmental labelling

The Green Guide to Specification contains environmental information on more than 1200 materials used in buildings (e.g. for external walls, roofs). It summarises their relative environmental impacts using an A+ to E ranking system, where A+ represents the best environmental performance (least environmental impact), and E the worst environmental performance (most environmental impact).

The Green Guide is an integral part of the Code for Sustainable Homes and BREEAM (the BRE Environmental Assessment Method) as the Green Guide ratings are used to quantify the credits awarded within the material section of these assessments. The Green Guide can be accessed via a simple on-line guide (www.thegreenguide.org.uk).

The Green Guide ratings are used to quantify the material credits in BREEAM and the Code for Sustainable Homes. Details of BREEAM and the Code for Sustainable Homes are available online at www.breeam.org.

Many standard elemental specifications are A+ rated for example the standard external wall specification ‘Brick on outer leaf, insulation, aircrete blockwork innerleaf, cement mortar, plaster, paint’ is A+ rated.

Building type	Category/Element	
Domestic	Roof Construction	pitched roof timber construction
	Structurally insulated timber panel system with OSB/3 each side, roofing underlay, counter battens, battens and concrete interlocking tiles.	
Retail	Insulation	Insulation
	Cavity blown glass wool insulation - density 17kg/m³	

Building type	Category	Sub category	Element
Industrial	External wall	Brick, stone and block work, cavity wall.	Brick or stone block work, cavity wall.
		Brick on outer leaf, insulation, aircrete, block work, inner leaf, cement mortar, plaster, paint.	

Many standard elemental specifications are 'A' rated, these include:

Material

Brick outer leaf, insulation, dense blockwork inner leaf, plasterboard
Aluminium insulated composite cladding, galvanised steel rails, dense blockwork, plasterboard

Internal Walls

Steel/timber stud, plasterboard, wool insulation, paint
Aerated block, plasterboard, paint

Roofing

Flat roof, inverted deck: Galvanised steel deck, asphalt, insulation, paving slabs
Pitched roof: concrete tiles, battens, sarking felt, on timber roof structure with insulation between rafters

Floor Finish

Hardboard sheathing, linoleum
Wool/nylon carpet, natural fibre underlay

timber certification

The timber industry has developed a number of sustainable certification schemes for individual forests and plantations. These provide independently certificated guarantees that these were managed in a sustainable way (i.e. as per widely recognised sustainable forest management criteria, such as biodiversity, recognition of local community and indigenous right, and so on). The sustainable certification schemes (with a valid Chain of Custody for the product purchased and the appropriate supplier) that are recognised by the BREEAM and Code for Sustainable Homes schemes are listed opposite.

Scheme	Recognised label/ acronym
The Forest Stewardship Council (FSC) www.fsc-uk.info	
Programme for the Endorsement of Forest Certification schemes www.pefc.org/internet/html/	
Canadian Standards Association www.csa-international.org/	
Sustainable Forestry Initiative with Chain of Custody www.aboutsfi.org	
Malaysian Timber Certification Council www.mtcc.com.my	

low embodied energy materials

Embodied energy is the energy used to extract, process and transport a material (from cradle to factory gate). For example, the embodied energy of a brick is the energy consumed by all the processes associated with a brick, from the acquisition of natural resources to product delivery.

Generally, higher mass materials are subjected to intensive manufacturing processes and require extensive transportation energy (e.g. HGV diesel); and therefore have higher embodied energy.

However, embodied energy can be offset by using materials with a higher recycled content.

The following tables denote comparison examples of different options by material type (insulation) and by function (structure).

Insulation	Embodied energy
Extruded Polystyrene	HIGH 
Rigid Urethane	
Expanded polystyrene	
Mineral Wool	
Thermafleece	LOW

Structure	Embodied energy
Steel	HIGH 
Portland Cement	
Concrete - 50% GGBS	
Timber Studs and Headers	
Blockwork	LOW

local materials

The use of local materials presents three notable benefits:

- support for the local/UK economy and skilled tradesmen
- reduced environmental impact associated with road haulage
- aesthetic qualities that complement local character distinctions Hertfordshire is known for its weatherboard cladded houses and chiltern brick

natural materials

Natural materials typically create a lower environmental impact than synthetic alternatives; however, some can cost more and some have shorter lifespans. Example products and associated impacts/benefits are set out in the table below.

Standard product	Impacts and benefits	Natural alternative	Impacts and benefits
Chemical based paint	Production includes complex chemical processes and can be toxic during manufacture and application	**Low VOC paint – water and vegetable oil based paints**	Has low embodied energy and mostly non-toxic
Foam insulation	Good thermal performance and less thickness is needed, but produces toxic substances in combustion	**Wool insulation**	Can be 100% natural (sheep wool) and provide good thermal performance
Chipboard	Has high chemical and adhesive content, but contains recycled timber chippings - difficult to recycle	**Compressed timber composite (plywood, softwood)**	Has no chemical content and provides a good base for finishes
Reconstituted slate	Has high chemical content and high embodied energy but low cost and easy to install and maintain	**Natural slate**	100% natural material with no chemical content. It is non-combustible, resistant to acids and highly durable

whole life performance

The Whole Life Performance of a material is the performance of a material (or building) over a defined period of time. Typically building performance is measured over 60 years. Whole life performance takes into account the following issues:

- capital costs
- maintenance, replacement and repair costs
- facilities management costs
- disposal costs

Whole life costing analysis measures the economic impact of a built asset over its life, taking into consideration design, construction, installation and operation of building systems; rather than focusing solely on initial capital costs.

Whole life considerations also impact upon the selection of materials with low environmental impact. For example, high mass external wall cladding options such as brick have a higher direct environmental impact than light weight timber and steel systems. However, they typically have lower maintenance requirements and a longer life, therefore their whole life costs are lower.

Often, whole life costing analysis demonstrates that investing a little more initially can present very favourable lifecycle savings.

Did you know?

Whole life costing analysis is a mandatory requirement in publicly procured projects.

major lifecycle significant items

Major lifecycle significant items in order of impact are as follows:

- internal finishes consisting of:
  - flooring (carpet, vinyl etc)
  - walls
  - ceilings
  - doors (internal and external)
- emergency lights which include their own batteries
- fixtures fittings and furniture
- automatic building control systems
- closed circuit TV systems
- heating systems
- light fittings
- external windows
- rainwater goods
- external walls

In some instances, it may be appropriate to select lower grade materials where the building or its fit out is expected to be short term (e.g. retail environments).

Items or rooms requiring high levels of maintenance should always be designed so that they are easy to access.

Maximum use of environmentally friendly materials

introduction

Maidenhead and District Housing Association (MDHA) are one of the few UK housing associations to build INTEGER houses. Alpine Close, Greenfields is the largest residential development of its type in the UK. The brownfield site was previously a car park which included 166 parking spaces, most being within pre-cast concrete garages.

description

The £2m development comprises 19 flats and 8 houses. The development contains a number of features to minimise the use of natural resources and the waste generated from construction activity and to maximise the use of recycled materials.

- garages that existed on the site were crushed and recycled as fill under vehicular areas and paths
- recycled cellulose newsprint was used for insulation

The turf roofs are durable and also offer thermal insulation properties. Other benefits of using turf roofs are that they manage rainwater run-off and act as a mini habitat for wildlife.

Photovoltaic panels have been incorporated as part of the building fabric. In addition to creating visual interest, they also generate electricity for the homes.

Other sustainable features include:

- passive solar energy capture from the South West
- a centralised boiler system, with intelligent systems to operate at optimum efficiency
- water recycling/saving including: greywater recycling for use in toilets; collection of surface water for irrigation

project team

Maidenhead & District Housing Association
Bree Day Partnership
i&i limited
Oscar Faber
Anthony Ward Partnership
The Andrews Partnership
Chris Monckton Associates
Bickerton Construction

further information

www.integerproject.co.uk/maidenhead.html

Environmental benefits

avoids depletion of natural resources
demolition material reused on site
building fabric generates power for the houses

Application

refer to key

Cost

£2 million

Other considerations

not applicable

Use of high recycled content materials; Re-use of demolition waste

introduction

DEFRA's headquarters, Nobel House in Smith Square London, underwent a complete internal refurbishment in 2005. As DEFRA's remit as an organisation is the achievement of sustainable development, the refurbishment of their headquarters was an opportunity to achieve an exemplar sustainability standards within construction.

description

Preliminary BREEAM assessments were undertaken at the design stage of the project. A sustainability charter was then developed to set key targets for the project. The key objectives were:

- specification of materials with high recycled content
- re-use or recycling of excess materials generated by the demolition and refurbishment works
- minimising waste from construction activities
- achieving a BREEAM excellent rating

Product options were assessed by the design and contractors teams against these sustainability criteria:

- economic value of the material
- whole life costs
- suitability for task
- programme implications
- distance travelled
- waste produced
- disposal options

The process identified a number of high recycled content products for use in the project. For example, a high recycled content carpet tile (80%) was chosen from 15 options and utilised across the entire project.

The re-use of waste materials generated from the demolition was also prioritised, with an assessment of the demolition process showing that 70% of all construction waste was recycled or diverted from landfill.

project team

Appleyards Consulting
Atkins
Davis Langdon
Overbury
Lawrence Hewitt Partnership

further information

www.wrap.org.uk

Environmental benefits
use of recycled materials
waste diverted from landfill

Application
refer to key

Cost
£30 million

Other considerations
not applicable

Exemplar sustainable housing

introduction

The Millennium House was designed and built with the aim of demonstrating sustainability features that can be achieved using the latest sustainable construction techniques, showcasing the origins of the INTEGER concept.

The project was completed in eighteen weeks, by a team of volunteers.

description

The Millennium House uses innovative design and construction features in addition to environmental technologies. The intention was to create a showcase for sustainable construction and raise awareness of the possibilities for enviromental design.

The materials chosen for the house represent best practice and include the following:

- a turf roof providing good insulation and a low maintenance alternative to conventional roofing materials
- timber cladding and frame
- solar thermal panels are integrated into the roof to generate hot water for the house

Prefabricated elements were included to minimise environmental impacts:

- off-site fabrication of concrete floor slabs, timber panelling for the super structure minimised waste generated on-site
- bathroom modules originally designed for off shore oil industries were used and were delivered to the site fully completed

Other environmental features include:

- ground source heat pump heating system
- grey water recycling system
- rainwater collection

The project has succeeded in attracting visitors and interest in sustainable house construction. Various features from the Millennium house have now been incorporated in other INTEGER projects.

project team

Cole Thompson Anders, Bree Day Partnership,
Paul Hodgkins Associates
i&i limited
Oscar Faber
The Andrews Partnership
Anthony Ward Partnership
Centre for Performance Improvement in Construction, BRE

further information

www.integerproject.co.uk

Environmental benefits

use of environmentally friendly materials
waste diverted from landfill

Application

refer to key

Cost

not available

Other considerations

not applicable

Further information and references

1	The Demolition Protocol Institution of Civil Engineers 1 Great George Street London SW1P 3AA Telephone: 020 7222 7722	www.ice.org.uk/knowledge/specialist_waste_board.asp
2	Green Guide to Specification BREEAM Materials BRE Garston Watford WD25 9XX Tel: 01923 664000	www.thegreenguide.org.uk
3	WRAP (Waste & Resources Action Programme) & Aggregain (Sustainable Aggregates Information Service) Telephone: 0808 100 2040	www.wrap.org.uk/index.html http://aggregain.wrap.org.uk
4	National Green Specification	www.greenspec.co.uk
5	London Remade 1 Quality Court Chancery Lane London WC2A 1HR Telephone: 020 7061 6360	www.londonremade.com/
6	Eastex - Hertfordshire Materials Exchange	www.eastex.org.uk/herts/index.asp
7	Office for Government of Commerce (OGC) Guidance on Whole LIfe Costing - 7	www.ogc.gov.uk/documents/CP0067AEGuide7.pdf

Further information and references

8	Wood for Good	www.woodforgood.com
9	Timber Trade Federation	www.ttf.co.uk
10	UK Woodland Assurance Scheme	www.ukwas.org.uk
11	Good Wood Guide	www.foe.co.uk/campaigns/biodiversity/resource/good_wood_guide/
12	BioRegional Reclaimed	www.bioregional-reclaimed.com
13	Second Nature UK Limited (Thermafleece) Soulands Gate Soulby Dacre Penrith Cumbria CA11 0JF Telephone: 01768 486285	www.secondnatureuk.com