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NATURAL FIBRE INSULATION

An introduction to low-impact building materials

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This Information Paper provides a broad view of the benefits and limitations of natural fibre insulation for those considering its use in construction projects.

Natural fibre insulation covers a variety of insulation products that are derived from natural products such as wood fibre and cellulose, wool, hemp, cotton and flax. Natural fibre insulation products can often be used as replacements for mineral- or petrochemical-based insulation. When used appropriately, natural fibre insulation materials can deliver thermal and acoustic insulation comparable to other insulation materials, but with a lower or potentially negative carbon footprint and fewer health issues during installation. They can also assist in regulating relative humidity, and can provide a vapour-permeable system. This multi-functionality should be borne in mind when specifying natural fibre insulations in order to ensure maximum value and benefits.

This is one in a series of five Information Papers and parallel case studies on low-impact building materials. The others cover hemp lime, straw bale, unfired clay masonry and cross-laminated timber.

While individual products vary in the choice of source material, natural fibre insulation is commonly derived from co-products of other processes, and hence generally has a low environmental impact. Materials such as hemp and flax (linen) are a co-product from long-fibre linen production or from crops grown from seed. Other co-products include sheep's wool, paper, cotton, coconut fibre and wood fibre. Overall, natural fibre insulations are currently derived almost entirely from organic, renewable supplies rather than oil- or mineral-based materials.

Figure 1: Timber-frame Passivhaus, Ebbw Vale, Wales, using rigid wood fibre insulation on walls both internally and externally
(Courtesy of bere:architects)

However, there is considerable variation between products, so environmental impact should be examined on a product basis rather than on a generic basis.

Natural fibre insulation is typically processed to form rigid or semi-rigid rolls or loose insulation materials (Table 1) for a variety of uses in construction. The processes vary, although most result in a fibrous material of varying stiffness, dependent on use. Typically, natural fibre insulation has to be treated with a fire retardant, often ammonium salts or sodium borax, although the latter may be phased out by forthcoming European legislation. Non-toxic salts are usually added as a solution to ensure good dispersal.

Natural fibre insulations offer a vapour-permeable construction layer and, if specified and installed correctly, can be part of a vapour-permeable wall, roof or floor system (Figures 2–5). Vapour-permeable systems can

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Table 1: **Properties of insulation materials**

Material	Typical thermal conductivity (W/m/K)	Commonly available formats
Natural materials		
Wood fibre	0.038–0.050	Boards, semi-rigid boards and batts
Paper (cellulose)	0.035–0.040	Loose batts, semi-rigid batts
Hemp	0.038–0.040	Semi-rigid slabs, batts
Wool	0.038–0.040	Semi-rigid boards, rolls
Flax	0.038–0.040	Semi-rigid boards, rolls
Cork	0.038–0.070	Boards, granulated
Synthetic materials		
Mineral fibre	0.032–0.044	Boards, semi-rigid boards, rolls
Glass fibre	0.038–0.041	Boards, semi-rigid boards, rolls
Extruded polystyrene (XPS)	0.033–0.035	Boards
Expanded polystyrene (EPS)	0.037–0.038	Boards
Polyurethane (PUR)/polyisocyanorate (PIR)	0.023–0.026	Boards

offer considerable benefits in terms of robustness of fabric and indoor air quality. They are particularly useful where there is unplanned moisture ingress into external fabric, eg through rain penetration or large air leakage, as they reduce the risk of moisture build-up and consequent moulds and bacterial activity. It is important to note that breathability is a function not only of vapour permeability, but also of both hygroscopicity (the ability of a material to absorb and release moisture from the atmosphere as relative humidity rises and falls) and capillarity (the absorption and release of water as a liquid). Mineral wool, for example, has good vapour permeability, but poor hygroscopic and capillary qualities. Natural fibre insulations have very good hygroscopic qualities but variable capillary qualities, and are all vapour-open. Vapour-permeable systems are particularly useful where the structure is vulnerable to moisture decay (eg timber-frame constructions, timber roofs and light steel constructions).

Natural insulations are not suitable for use below the damp-proof course level unless fully protected by a damp-proof membrane. Natural fibres have a high specific heat-storage capacity and can be used to assist strategies to reduce overheating in buildings. The use of the high thermal mass of natural insulations in roofs can be particularly significant. The higher density and complex microstructure of natural fibre insulations can also provide good acoustic insulation. The multi-functionality of natural fibre insulations is a major benefit of the products and should be borne in mind when specifying or costing products.

In construction, natural fibre insulation is used in a similar way to other insulation within floor, wall and roof build-ups, and similar fixing, cutting and installing techniques can be used. This offers ease of transfer for installers switching from other insulation products and also comparable installation times. Unlike oil- and glass-based insulations, natural fibre insulations are non-toxic and there is generally no requirement for protective clothing or respirators during the installation (Figure 6). This can be particularly appreciated for installation in lofts, where overheating is common and the need for full protective suits compounds installers' discomfort. Natural fibre insulation materials are also comparatively more robust in handling. When used on site, natural fibre insulation off-cuts do not require specialist waste streams and typically can be sent for composting or bio-digestion, rather than to landfill.

***Box 1:* Why specify natural fibre insulation?**

Advantages

- High acoustic performance
- Low to zero toxins, easy to reuse/dispose of, significant health benefits throughout life cycle
- Offers some thermal mass
- Protective clothing and masks not needed, more comfortable for installers and others coming into contact with it
- Renewable materials store carbon throughout usable lifespan
- Robust in handling, transportation and onsite construction
- Vapour permeable, works well with other low-impact materials

Limitations

- Most products manufactured overseas and imported
- Price currently significantly higher than oil- or mineral-based competitors (this may reduce as demand and supply increase)
- Requires thicker walls
- Suitability of rendered external finishes limits application
- Use limited to above damp-proof course or equivalent level

Despite ease of use on site and limited differences between installation techniques, natural fibre insulation materials currently make up a small proportion of the UK market (less than 1%). While there are a number of reasons, cost is perhaps predominant: natural fibre insulation materials are not always price-competitive with mineral- and oil-based products in the UK, although this is changing. Within some systems, and particularly within performance specifications that take account of issues such as overheating, acoustics and breathability of fabric, they can offer a comparable price or even a price advantage. When considering or specifying natural fibre insulation products, it is therefore worthwhile understanding the full technical benefits of these products, as well as checking local supply costs to ensure an adequate budget is provided.

Although not often quoted by some manufacturers, density is a good indicator of properties that are difficult to quantify, such as robustness in handling, resistance to settlement, ability to friction fit (to allow for overhead installation by cutting slightly oversize), acoustic performance and thermal mass. In lightweight construction, the additional heat-storage capacity of natural fibre insulation (twice that of mineral insulation on a weight-for-weight basis) may be beneficial.

There are as yet no conclusive figures on the embodied energy of natural fibre insulation. However, as a natural plant- or animal-based material it benefits from a very low environmental impact in reuse and/or disposal.

Some natural fibre insulation products have been given British Board of Agrément (BBA) approval; details can be found on the BBA website. If using other sources of natural fibre insulation and/or different construction details, the appropriate building/development control body should be contacted before detailed design to ensure acceptability.

FURTHER READING AND SOURCES OF INFORMATION*

BRE and University of Bath. Low-impact materials: case studies. Natural fibre insulation: One Brighton. 2011. Available at: www.bre.co.uk/page.jsp?id=2669.

British Board of Agrément (BBA). www.bbacerts.co.uk.

May N. Breathability: the key to building performance. Oakley, Natural Building Technologies, 2005. Available at: www.natural-building.co.uk/PDF/Case%20Studies/Breathability_in_buildings.pdf.

Woolley T. Natural building: a guide to materials and techniques. Ramsbury, The Crowood Press, 2006.

* All URLs accessed October 2011. The publisher accepts no responsibility for the persistence or accuracy of URLs referred to in this publication, and does not guarantee that any content on such websites is, or will remain, accurate or appropriate.

Box 2: Carbon storage

Whether a co-product or grown from seed, all plant-based natural fibre insulation has the capacity to store carbon throughout its usable life. Carbon is stored during plant growth and remains stored during its use as a building material. At the end of its life, it releases the carbon either through natural decomposition, returning other nutrients to the soil, or through the generation of heat/energy by being burnt as fuel. Either way, this provides a comparatively efficient end-of-life treatment.

Figure 2: Fibre boards being fitted between timber battens (Courtesy of Natural Building Technologies)

Figure 3: Hemp fibre rolls fitted between studwork (Courtesy of Hemp Technology)

Figure 4: Interlocking edging on wood fibre insulation board
(Courtesy of Pavatex)

Figure 5: Fixing wood fibre insulation boards to existing internal walls
(Courtesy of Natural Building Technologies)

Figure 6: Natural fibre insulation is non-toxic and there is generally no requirement for protective clothing or respirators during installation
(Courtesy of Black Mountain Insulation)

Figure 7: Wood fibre insulation was used on One Brighton as part of a vapour-permeable walling system
(Courtesy of Natural Building Technologies)

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