

# The ecological design of timber buildings



Timber is a funny one. On one hand it is the epitome of environmental design, and on the other, the indiscriminate use of timber is responsible for some of the worst excesses of environmental degradation. Timber is renewable, unlike most other modern building material components, but this implies only a potential advantage. To realise this potential, there is a bit of work to do. **Chris Morgan** explains ...

To attain any semblance of 'sustainability', the use of timber on a building must compare favourably with four criteria. These are: **source, transport, treatment and detailing**. If any one of these four criteria cannot be met, then the term 'sustainable' should not be applied.

## Source

Timber must come from a sustainable source. Easy to write, but very difficult to define and establish in practice.

A sustainable source is one where the growing, management, harvesting and re-planting of trees is socially, environmentally and economically sustainable. The forestry must be profitable enough to sustain communities, who can afford to stay, raise families, manage and re-plant appropriately, maintain and even enhance soil conditions, avoid erosion and nutrient loss and generally improve the conditions of the local area.

Experience all over the world, and throughout history, suggests that this is not easy to achieve. De-forestation due to lack of replanting, soil erosion, fires (and firewood collection) conversion to agriculture, lack of management and a host of other reasons, along with subsequent de-population of rural areas is often the norm.

Certification schemes have developed to try to account for these many variables because of widespread global concern of the damage being caused, and there is no doubt that great advances, not least in understanding of the issues, have been achieved. None of the schemes claim to be 100% water-tight, and there is still a very long way to go.

The main scheme operating in the UK is the FSC (Forest Stewardship Council) and it is worth noting that all Forestry Commission forests in the UK are certified under this scheme.

## Transport

Transportation of timber is an issue largely because of the pollution associated with it, but also because of the failure to realise the potential of (re-) vitalising local economies, which is inherent in the worldwide trade in bulk timber.

The scale of the pollution associated with transported timber is often under-estimated.

Table 1. Energy Requirement for Manufacturing and or Producing Selected Building Materials

Material	KWh/tonne	KWh/cu.m
Timber-local air dried	200	110
Timber-local green oak	200	220
Timber-imported softwood	1,450	7,540
Non-fletton bricks	860	1,462
Lightweight blocks	500	600
Steel	13,200	103,000

Consider the information in Table1.

In other words there is more pollution associated with imported timber than there is with other, supposedly 'less green' materials. And so, it makes sense to look at the use of UK sourced timber because only then can it be said with confidence that the timber is anything like sustainable. In doing so, a number of other advantages become clear. Using homegrown timber:

- stimulates UK forestry and related rural industries,
- creates and/or maintains employment in rural areas, and promotes good woodland management in the UK, which also benefits the local ecology.

Such considerations rarely show up on 'green building' checklists and assessment schemes, but these aspects are important, and the potential capacity of the construction industry to engage with and benefit local forest industries is vast.

There is no doubt that homegrown timber is the 'greenest' choice for UK construction, but there is a snag...

*Far left: The use of heartwood of European larch sawn face boards for both wall and roof cladding. None of the timber used is treated with preservatives as the timber heartwood is naturally durable. The pink coloured larch turns silver grey. This project is near the coast on the West of Scotland*

*Right: The use of poor quality softwood as cladding, while natural paint finishes do the work of keeping off the moisture and innovative 'non-touching' cladding allows the boards to dry out quickly. Using lower quality timber enables locally supplied wood to be used. This project is in the extreme North-West of Scotland, on the coast.*

There is no way in which the UK construction industry (let alone the paper, fencing, pallet and other industries) could source all its own timber from within the UK.

Annually, the UK consumes around 50 million cubic metres of timber. In the same period, it produces only 7.5 million cubic metres of timber. In other words, we produce only 15% of what we consume, and we import the remainder at an annual cost to the nation of around £7 billion (not to mention the environmental cost in CO<sub>2</sub>).

This may seem a lost cause, but there are reasons to be positive about the future. First, the amount of timber produced in the UK is set to increase from 7.5million to 16 million cubic metres by 2020. The challenge is to create a larger market share for this timber in the construction industry.

Most of the timber used in construction (by



volume), does not need to be particularly good quality, studs, joists and rafters, battens and so on could all be readily sourced from homegrown softwood, though designers may need to alter their practices to account for weaker timber, by specifying lower strength classes, closing up on spacings, increasing section sizes and so on. Choosing to use C16 grade timber at 450mm centres rather than C24 timber at 600mm centres, for example, is a small price to pay for being able to cut all the pollution associated with importation, and benefit our own forestry industry.

Some have already started to look at initiatives to realise the potential of this extra timber, and various investigations are underway such as high-tec jointing, gluing, de-knotting, heat treatment and so on. These initiatives will doubtless benefit the industry, but there is far greater potential simply by adjusting our expectations and design practice to suit the material we have to hand.

One excellent technique, particularly suited to the UK timber supply, is solid wood panel construction. Pioneered on the continent where it is usually known as 'Brettstapel' construction. One London practice specialises in the technique, but the potential to produce very strong, insulating, structural panels with excellent environmental credentials is huge.

Insulation can be made direct from timber – one product on the market now is timber based

and imported from Finland,<sup>1</sup> even the binder is timber based. Woodchip and sawdust can be combined with clay and lime to produce insulating wall mass, as described in the article on low impact construction elsewhere in this book. Locally supplied woodchip can also be used for fuel. Insofar as this normally replaces fossil fuel alternatives, it is one of the most significantly beneficial uses of timber now available in the UK. Almost all wood pellet fuel is currently imported. With only 12% of the land in the UK under forest, just one third of the EU average, we could always plant more trees...

## Treatment

The chemical treatment of timber makes it unsustainable for two reasons. First, these chemicals can be harmful to human, as well as other biological life. Second, treatment takes a completely natural, biodegradable material (one of the few available to the modern designer), and turns it into toxic waste which at the end of its useful life will have to be disposed of at approved sites. The UK has a huge waste disposal problem which is becoming worse, and timber treatment adds to it.

Apologists for the treatment of timber will argue that this is all very unfortunate but sadly unavoidable. Others claim that treatment makes timber more durable – so fewer trees have to be cut down – and people like me ought to be very

*Fig.1 VOC emissions from building products: Sources, testing and emission data: Digest 464 Part 1 (BRE)*

*The possible emission of VOCs and formaldehyde should be an important consideration during selection of a building product. Timber studs, frames, and beam supports usually have been treated and can contain organic solvents in the timber fibres as preservatives and natural terpene compounds. High VOC emissions can be released from the treated timber and from coatings.*

<i>Materials</i>	<i>1 day TVOC emission rates</i>
<i>Typical VOCs</i>	<i>(pg m-2h-1)</i>
<i>Timber beams, frames &amp; studs</i>	<i>145 - 25,648</i>
<i>Aldehydes (eg formaldehyde, acetaldehyde, C4-C,, aldehydes, benzaldehyde) ketones (eg acetone, MIBK, 2-heptanone, pentan-3-one, pentan-9-one, 2-methyl-2-butanone, cyclohexanone, acetophenone), terpenes (eg pinenes, carene, myrcene, limonene); linalool; geraniol; a-terpineol; a-cedrene; linalyl acetate; acetic acid; propanoic acid; pentanoic acid; hexanoic acid; benzoic acid; C-, C, alcohols; cyclohexanol; 2-ethylhexanol; benzyl alcohol; 1,2-propanediol; esters (eg ethylacetate, butylacetate, isobutylacetate); C-, C,, alkanes and branched alkanes; cyclohexane; methylcyclohexane; benzene; toluene and alkylbenzenes; styrene; glycols (eg carbitol, triglyme, butyl glycol, 2,2-butoxyethoxyethanol, 2-phenoxyethanol); 2-ethoxyethyl acetate; 2,2,4-trimethyl-1,3-pentanediol monoisobutyrate; phenol; 2,6-di-tert-p-cresol; naphthalene; acenaphthene; trichloroethylene; tetrachloroethylene; chlorobenzene; dichlorobenzenes; 1,1,1-trichloroethane</i>	

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grateful for it! The answer to both these points is that, with a few exceptions, the treatment of timber is avoidable, and once you know how to avoid it, the continued use of it all around you appears unforgivable.

BRE Digest 464 Part 1 (see Fig.1) gives an indication of the chemicals to be found in all that innocent looking, 'environment friendly' treated timber.

VOC emissions from building products: Sources, testing and emission data: Digest 464 Part 1 (BRE)

The possible emission of VOCs and formaldehyde should be an important consideration during selection of a building product. Timber studs, frames, and beam supports are usually treated and can contain organic solvents in the timber fibres as preservatives. High VOC emissions can be released from the treated timber and from other coatings.

There are locations and uses where timber is unavoidably at risk and chemical treatment is one answer. Choosing another material which is not liable to decay is also possible, and often preferable. However, the majority of situations can be designed so that timber may be used safely without treatment. There are three main tactics to avoid treatment and these are covered in the next section, which deals with good practice in detailing more generally.

## Detailing

Good detailing and specification are critical. If the timber installed only lasts a few years because of poor detailing, most of the effort (and money) has been wasted, and the whole affair can hardly claim to be sustainable.

There are three main tactics worth following to avoid timber treatment and still ensure good durability of timber, all of which need to be considered at the design stage, though of course some of the following is applicable for existing buildings.

The first and by far the most important is good design detailing and specification, the second is moisture transfusive construction and the third is species choice. This is in some ways part of the first, but is worth mentioning separately.

**Good detailing** for durability is well covered by

organisations such as TRADA, BRE and others. Many specialist publications offer guidance, as well as magazines, trade literature from manufacturers, conference proceedings and other sources of advice. The references list, at the end of this article, gives some of these sources.

The key to good detailing in general is to avoid any build-up of moisture which cannot escape. It doesn't matter too much if timber gets wet, but it matters very much if it stays wet. Stopping it getting wet is normal, but making sure that once wet, it can easily and quickly dry off again can be more important. One of the most common ways timber stays wet is because it is touching, or within about 4mm of another material. Where this happens capillary action can keep moisture in, and so this sort of detail needs to be avoided wherever possible. Since timber usually has to be fixed to something, it is clear that different forms of detailing start to emerge.

It is also important to allow for movement of timber as it responds to varying ambient humidity levels. Grooves can help reduce shrinkage cracks, which externally at least can be a significant cause of decay, leaving at least 6 or 7mm between boards externally will overcome capillary action (even allowing for board expansion), and sawn faces tend to evaporate moisture more readily than planed finishes, so may be used with advantage on external boards and cladding.

The important thing about timber coatings in external situations is that they are vapour permeable and allow the timber to move without peeling off. Some coatings achieve this by being somewhat elastic, others, like oil and wax based coatings do not form a skin in the same way and so are not vulnerable to movement. Light, opaque coatings protect timber better (from UV and thermal movement) than darker and more translucent coatings.

**Moisture transfusive construction** – well known as the 'breathing wall' is a useful tactic not only in controlling moisture movement, but in so doing, protecting the timber used from decay. Because moisture in a 'breathing' wall, floor or ceiling will tend toward the outside and safely evaporate, there will be no build-up of moisture which could lead to decay, and so timber studs and so on may be safely left untreated.

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**Species choice** can have a significant effect on the durability of timber elements, and in many cases the cost difference is negligible since most of the cost is in the machining of elements. Oak and European larch heartwood, for example is quite durable externally and may be used without preservative treatment for decking, cladding and so on. Softwood external joinery normally needs to be treated but some hardwoods do not, though bottom beads on windows are best protected, or replaced with aluminium, and cills, which are more prone to the destructive effect of UV radiation, need extra protection.

## Conclusion

Perhaps the defining aspect of the environmental design movement at present is how it manages to remain true to its ideals whilst acknowledging the need to mainstream and influence the majority. The use of timber in buildings, particularly the use of homegrown timber is a useful gauge of this process, but the movement must also develop and deepen its understanding of the issues, and at present there is a great deal of timber used unwisely and unsustainably. We still have a lot to learn on the subject.

## Postscript

One interesting development, which could have huge repercussions for the forest and timber industry in construction and elsewhere, is the idea of timber use as a carbon store. Initial work in Norway and Scotland suggests that using mass timber, and indeed timber generally, contributes more than you might imagine to storing carbon in the medium term, more even than installing pv cells on your roof, for example and this notion may have some currency in the wider carbon sequestration debate. Of course, it depends where it comes from...! ❖

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PEFC Council: [www.pefc.org/internet/html](http://www.pefc.org/internet/html)

Forestry Commission: [www.forestry.gov.uk](http://www.forestry.gov.uk)

UK Forest Products Association [www.ukfpa.co.uk](http://www.ukfpa.co.uk)

TRADA

British Biogen

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Refs:

# Merchant on a mission

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Demonstrating social responsibility is fast becoming a fundamental requirement of organisations in the timber trade. As demand for chain of custody approved materials increases and the attention from media and non-Governmental organisations intensifies, leading UK timber merchants, such as Travis Perkins (TP), have embarked on a crusade to prove their commitment to the environment.

Ian Goldsmith, Group Planning Director of TP, assesses the first steps taken by the merchant to satisfy its own ethics and that of the timber trade.

The amount of work involved in procurement of certified timber products and achievement of chain of custody is substantial. It is agreed, however, that it is the responsibility of the industry to raise the profile of such products and educate customers as to the benefits of using timber from well-managed forests. With growing awareness of the importance of using certified products, future demand will undoubtedly increase; suppliers will be encouraged to invest to produce greater volumes at lower costs, and the mindset of the trade and end user will change.

The reputation of a business dictates its responsibility and accountability to customers for the products sourced and supplied. Travis Perkins has, over the last few years, implemented a major programme of continuous improvement relating to social and environmental performance. It has worked closely with non-Governmental organisations, shareholders and suppliers to understand their view on environmental issues and therefore guide its actions in implementing good practice over and above that required by legislation. This culminated in the accomplishment of an Environmental Management System and the achievement in November 2001 of ISO14001 certification – the first national merchant in the UK to do so.

A range of policies and procedures ensures that environmental issues are considered in all aspects of decision-making and a continuous improvement plan includes targets to increase the percentage of certified timber products available in branches - more than 270 have achieved chain of custody certification nationwide with a roll out to all branches intended by the end of 2004.

In addition, a programme of independent audits on all sources of timber from higher risk areas that are not currently certified has shown that merchants such as TP can encourage and assist suppliers to achieve certification over time. An excellent example of this is the Compensados E Laminados Lavrasul mill in Brazil, which has now achieved FSC certification for its Elliottii Pine Plywood.

Although the UK Government has not made it mandatory, TP has adopted CE marking in its timber procurement as this is deemed the most effective method of meeting the Construction Product Directive.

Travis Perkins has whole-heartedly accepted its environmental obligations; after all, a good business should also be a good citizen. It is also ethically the correct path for the trade to follow and a strong element of a broader social responsibility programme. TP has started its mission and aims to continue leading other merchants by example.

*TP is one of the largest suppliers of timber and building materials in the UK with more than 740 branches nationwide. The company supplies more than 100,000 product lines to trade professionals and self-builders. For details of your nearest branch call the Customer Careline on 0800 389 6611 or log on to: [www.travisperkins.co.uk](http://www.travisperkins.co.uk).*

