Chapter 5
Materials selection

In which we seek to give the reader a sound and broad grasp of the issues and priorities affecting materials selection in the design of sustainable places, buildings, services and objects and a realistic perspective on the range of issues, including their invisible qualities, which should affect decision-making.

'Hygroscopic building materials are 9 times more effective than mechanical ventilation in controlling indoor relative humidity'

VTT Espoo Finland

Contents

(Facing page)
Andersen House
The moisture from the building is vented behind this sacrificial timber layer (Architects: Dag Roalkvam and Rolf Jacobsen; photo: Dag Roalkvam

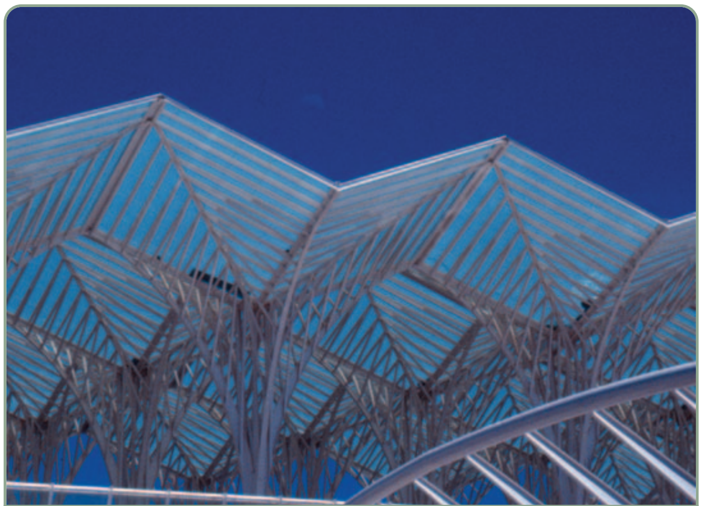
(Previous page)
Solid timber roof at Glencoe visitor centre
(Photo: Michael Wolshover; photo permission: Gaia Architects)

Materials selection

Introduction

Ecological building design is characterised by the use of natural materials with a minimum of processing and transportation; and an emphasis on healthy, non-toxic specification to minimise pollution. Ideally materials should also contribute to passive forms of environmental control.

Many attempts have been made to create a coordinated and comprehensive analysis tool for materials in the construction industry that can enable those specifiers, who are minded to do so, to make objective decisions about material selection. Many of these take a life cycle approach. A number of the techniques are helpful, and there is ongoing improvement as information evolves, but none are comprehensive. Nor are they ever likely to be so.



Lisbon Expo Station
Materials selection does not exclude any architectural style
(Architect: Santiago Calatrava; Photo: the author)

Kamen, Germany
Housing development, part of Emscher Park regeneration designed using 100% eco-labelled materials
(Architect: Joachim Eble Architects; Photo: Howard Liddell)

In part this is because of the complexity of the issues but also because the 'sustainability' of most materials owes much to the sourcing and handling, the way in which they are used, and the care that goes into their detailing and maintenance. This cannot as yet be completely covered by any analytical process that is reliant on being uniformly applicable.

A contributory factor is doubtless to do with the relationship between products and design, and the opportunities for added value. There is still widespread ignorance about how to use materials in their natural state and many manufacturers prefer to avoid scrutiny.

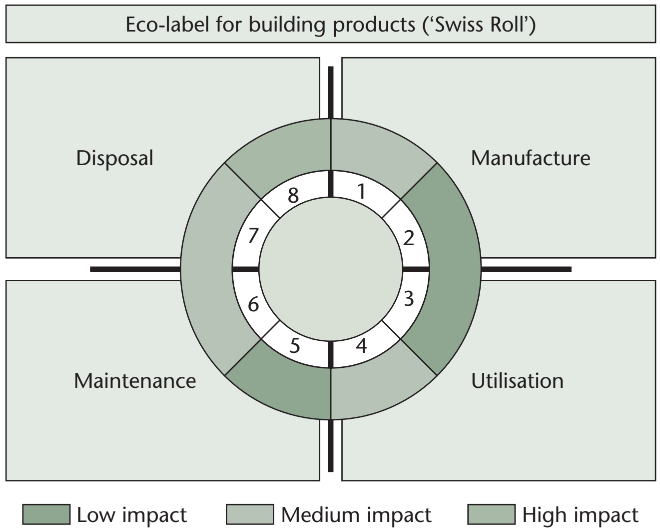
The most valuable approach in most circumstances is to be cogniscent of the issues and have access to up-to-date guidance. It will generally be necessary to compare options and relative impacts in a particular circumstance. These issues therefore remain within the realm of compromise and judgement, a realm familiar to designers. However it extends the territory such that distance, manufacture, human rights, biodiversity and pollution might all be part of a balanced judgment. Importantly this should not be restrictive on design, if thought about intelligently, but should open up new creative opportunities. For example thinking about the future of a rare or energy intensive material is as important as looking at its past.

The life cycle approach

The main questions to ask of a material specification choice are:

1. *What is the Resource Base?* – Where is it from and how much is left?
2. *What is the Embodied Pollution?* – What has been done to it and by whom? – There is often an ethical component.
3. *What is its Impact in Use?* – What effects does it have on people and the wider environment?
4. *What is its Final Destination?* – What will happen to it at the end of its life?

In general it will not be practical, or possible, to arrive at definitive answers to all or any of these considerations. Nor is it feasible for most specifiers to assess each and every component against each and every consideration. In the face of such limitations, more important is a genuine commitment to achieving the best result. A basic knowledge of the issues and opportunities can readily lead to sensible assessments and substitutions. Conversely, a basic disregard for good sense, pollution and ethics undermines the serious advances that are possible. Ultimately, the assessment is made by the environment.



"Swiss Roll"
A material and product assessment method that looks at cradle to grave issues

Traditional timber fascia detail, nineteenth-century railway station, Killin Pier
(Photo: Howard Liddell)

Resource base

Certain resources are becoming extremely rare and the use of remaining stocks should be treated cautiously, especially where they are known to support threatened habitats or where there are known to be uses that should take precedence.

Most rare materials used in construction can be substituted by other, less rare or renewable materials. However, there are few absolutes. These guidelines have to be taken within the context of what is appropriate and possible.

- Renewable materials should take precedence over non-renewable ones.
- Reused or recycled materials or components should take precedence over equivalent 'virgin' elements.
- Sourcing of materials from areas that are particularly fragile – in respect of their aesthetic, community or ecology should be avoided.
- Materials with significant reserves remaining should be used in preference to those with smaller reserves.
- Materials should be used as efficiently as possible and allow for their eventual reuse or recovery – especially where using a material with minimal reserves.

Many metals commonly used in the construction industry have extremely limited estimated reserves. World Resource Institute estimates suggest that we may have only a further 10–12 years supply of lead and zinc. This compares poorly with an estimated 210-year supply of bauxite – the main source of aluminium, which would be a good substitute in most circumstances. Also, recycling of aluminium is extremely well developed.

Most plastics derive from the world's oil reserves. The use of recycled plastic components makes environmental sense, except where recycling contributes to additional and avoidable pollution. However, many recycled materials remain more expensive than 'virgin' equivalents and meeting appropriate building standards may require pre-planning, which should be allowed for.

Materials selection, timber
Timber from a local source, used in an untreated form and detailed for long life, is a good choice. However, if brought huge distances, treated with polluting materials such as CCA and poorly detailed, it is not (Photo: Howard Liddell)

Embodied Toxicity
Plastic is being recycled into a range of useful components, such as this 'squidgy tarmac', but we have to be careful about embodied toxicity (Photo: the author)

Embodied pollution – what has been done to it and by whom?

Huge damage is done to the local and global environment and to the health of workers and others through the extraction, production and distribution that make up the construction industry supply chain. Some manufacturers are involved in ethically questionable practices, whilst others have explicit and forward thinking policies on environmental and social issues and may be willing to provide good information on their impacts, and strategies. It is up to the specifier to determine the relevance and priorities. It is notable that purchaser power is increasingly responsible for changes in government policy and that increasing numbers of companies are developing guidelines to address their responsibilities.

All materials contain embodied energy, which is a form of embodied pollution, but many conventional building materials also contain additional elements, as a consequence of chemical processing, which are known to be toxic to humans and or wildlife.

This includes concrete, PVC, MDF, most glues, paints and finishes. This "embodied pollution" can impact throughout the product life; on employees in the manufacturing process, to building occupants through off-gassing or leaching in use and eventual pollution through recycling or disposal.

Case Study 5.1:

Timber College, Lyss

Architects: Itten and Brechbuhl, 1998

This forest training centre in Switzerland was visited in 2005 by a group of Scottish and Scandinavian building designers interested in new developments in wood construction.

The building, occupied in 1998, is owned by a foundation from 11 cantons. It was originally intended to be a concrete construction but, with the timber industry in decline, the director insisted on a timber construction.

The primary construction comprises 300 silver fir columns with steel consoles. The floor construction comprises suspended MDF acoustic ceilings below rough pine roundpole and cheap tiles made of recycled materials. All the furniture is red heartwood beech. In total, about 2000 m^3 of timber was used, equivalent to 1.7 hours Swiss forest growth. It is heated from a wet wood biomass boiler using in total 650 m^3/annum.

Photo: the author

Case Study 5.2:

Prisma mixed development, Nuremberg

Architects: Joachim Eble Architects, 1997

Despite being in the centre of a German city and having to comply with stringent building control and fire regulations, this nine-storey mixed development manages to achieve a very high standard of specification in terms of environmentally sound materials – notably the finishes. Where possible, floors are of mass timber to form an equivalent to concrete beam and block flooring. Concrete is used only where absolutely necessary. Timber finishes are used throughout, and the paint and other surface treatments are all low or zero emission.

This is probably the world's largest complex that can be defined as an ecological design project. The ground floor is a shopping precinct, the next three floors are offices and the top floors are residential.

The inner courtyard offers a secure environment for a kindergarten, which serves the on-site housing. All the commercial properties get their preconditioned ventilation from the large solar atrium.

Passive solar and natural ventilation strategies utilise water flows and planting in atrium spaces. The water strategy is based on catching, conserving and recycling on site.

This scheme sought to use as many recycled or reclaimed materials as possible, sourced within budget and time constraints. The aluminium roof has the potential to be reused as a high value material in perpetuity but there may be energy penalties.

The housing scheme comprises a three-storey block of flats, a row of houses and cottage flats. The block of flats face south and the L-shaped plan forms a semi-private enclosed garden and children's play area.

Photo: Joachim Eble Architects