Technical Research Paper 09

Materials Selection

city of Melbourne

Study Outline

This study outline summaries key points raised in one of the 10 technical papers in the pre-occupancy study series that investigates the City of Melbourne's world leading Council House 2 (CH_2) office building. Each technical paper has been developed by independent authors from Australian universities as part of the CH_2 Commercial Green Building Technology Demonstration Project. To obtain copies of the full technical papers visit www.ch2.com.au

This project forms a major part of the CH_2 Study and Outreach Program – a coordinated effort to consolidate the various opportunities for study, research, documentation and promotion generated by the CH_2 office building. The primary aim of this program is to raise awareness of sustainable design and technology throughout the commercial property sector and related industries.

The target audience for these papers is professionals involved in the design, engineering, construction and delivery of office buildings, which explains the technical detail, length and complexity of the studies. Although these papers may be of interest to a wider audience, readers who possess a limited knowledge of the subjects covered should obtain further information to ensure they understand the context, relevance and limitations of what they are reading.

Significant funding for the technical papers was provided through an AusIndustry Innovation Access Program grant and supported by cash and in-kind contributions from the City of Melbourne, Sustainable Energy Authority Victoria, the Building Commission of Victoria, the Green Building Council of Australia and the CH_2 Project, Design and Consulting Team. The Innovation Access Program is an initiative of the Commonwealth Government's Backing Australia's Ability action plan.

An Australian Government Initiative
AusIndustry

6 star rating
green star Office Design v1
This rating represents World Leadership

CH_2

Technical Research Paper 09

Study Outline – Materials Selection

Materials used in a building not only have an impact on the environmental performance of that building they can also affect the health of its occupants. The City of Melbourne's Council House 2 (CH_2) building seeks to establish new benchmarks in the selection and use of 'sustainable' building materials in its construction.

Most experts agree the operational energy requirements of a building over its life are by far its biggest environmental impact, overtaking the energy it takes to make a standard commercial building in as little as five to 10 years. However, as Roodman and Lenssen (1995) point out, such figures fail to tell the whole story – particularly as buildings become more operationally efficient and the relative environmental impact of building materials increases. In addition, building materials have other environmental impacts as well as energy, including:

- habitat degradation arising from logging, mining, transport, waste dumping and pollution from various stages of extraction, production and disposal;
- erosion of natural capital through (short) 'one-life' use of most materials;
- greenhouse gas emissions from transportation, production, installation and demolition/disposal;
- impacts of non-construction activities on other parts of the economy, driven by practices used in the construction industry, such as waste. The construction industry constitutes a large part of total economic activity in most countries.

Buildings account for one-sixth of the world's fresh water withdrawals, one-quarter of its wood harvest, and two-fifths of its material and energy flows… Building and construction activities worldwide consume 3 billion tons of raw materials each year or 40 per cent of total global use.

Roodman & Lenssen 1995

Figure 1: Materials and pallet used with permission © Deakin University 2005.

What is a 'Green Building Material'?

There are various definitions of 'green building materials' used in the construction industry, ranging from the simple to the more complex, which include detailed sets of criteria. A good, basic definition is that green materials are environmentally responsible because they consider environmental impacts over the full life of the product (Spiegel & Meadows 1999). Depending on project goals, an assessment of green materials may involve an evaluation of one or more of the following criteria (based on Froeschle, 1999):

Resource efficiency:

- recycled content;
- natural, plentiful or renewable;
- resource efficient manufacturing process;
- locally available;
- salvaged, refurbished, or remanufactured;
- reusable or recyclable;
- recycled or recyclable product packaging; and
- durable.

Indoor air quality:

- low or non-toxic;
- minimal chemical emissions;
- low-volatile organic compound (VOC) assembly;
- moisture resistant; and
- healthy systems or equipment.

Energy efficiency:

- materials, components and systems that help reduce energy consumption in buildings and facilities:
- supports energy efficient performance; and
- low embodied energy.

Water conservation:

- materials, components and systems that help reduce energy consumption in buildings and facilities:
- supports water efficient performance; and
- low embodied water.

Affordability:

- fits within long-term budget.

Techniques for Assessing Materials

There are many international guidelines for assessing the environmental credentials of materials but no overall standard has yet been developed (Berge, 1997; Woolley & Kimmins, 2000; Anderson et al., 2002; Curwell, 2002). One of the most rigorous methods is life cycle assessment (LCA), which enables an assessment of the environmental impacts of a product over its entire life, including all its measurable inputs and outputs.

Material Selection for CH_2

Materials considered for use in CH_2 were evaluated for their environment impact according to three overarching priorities:

- use and adherence to the principle of lowest life cycle cost for the anticipated 100 year life (i.e. maximising durability, minimising replacement, maximising maintainability);
- minimising embodied energy; and
- use of locally grown, sourced or manufactured products and materials.

This process involved extensive data collection in relation to a wide variety of products. A planned approach was undertaken using the CSIRO to assess materials based on a detailed environmental performance questionnaire (EPQ).

However, the EPQs were often beyond the capacity of manufacturers to answer and about 50 per cent of suppliers did not respond to questionnaires in the first instance. Only about 30 per cent of EPQs issued or requested were fully completed. Once the data was collected there was also concern about its quality, which was expressed by one of the project architects:

"My major fear has been relying on a manufacturer's word. I would put at the top of my wish list independent accreditation of products to give peace of mind".[1]

Onsite substitution of materials was another issue the CH_2 team needed to address to ensure the most environmentally sound materials were used. DesignInc proposed the following strategy:

i. The Builder's Environmental Management Plan should contain provisions requiring that no substitution is permitted unless the proposed product has undergone independent vetting using the EPQ and subsequent vetting, and is shown to be equivalent to the originally specified product. The architects have 10 days on receipt of such documentary proof to permit the substitution. If they do not respond it is 'deemed' to be acceptable.

ii. If the architects reject the proposed substitution, no impact on the project is permitted. The onus is on the builder not to suggest substitutions unnecessarily, and if not approved any lost time through delay or scheduling is their responsibility. This creates an incentive for the builder to thoroughly assess all products well ahead of time.

iii. The builder deposits a 2.5 per cent Bank Guarantee as security against making good required by the architect due to non-permitted substitutions.

In the end, points (i) and (ii) were included in the contract. Point (iii) was considered too onerous during contract negotiation and was not included.

The introduction of the Australian Green Building Council's new rating tool, Green Star – Office Design, in 2003 marked the start of a whole new learning curve for the CH_2 project team. Having substantially designed the project, the team now had to ensure it could meet the highest levels established by Green Star. Green Star attributes a relatively modest 15 per cent of available credits for base building materials. Table 1 below summarises these credits based on the version of the tool available at the time.

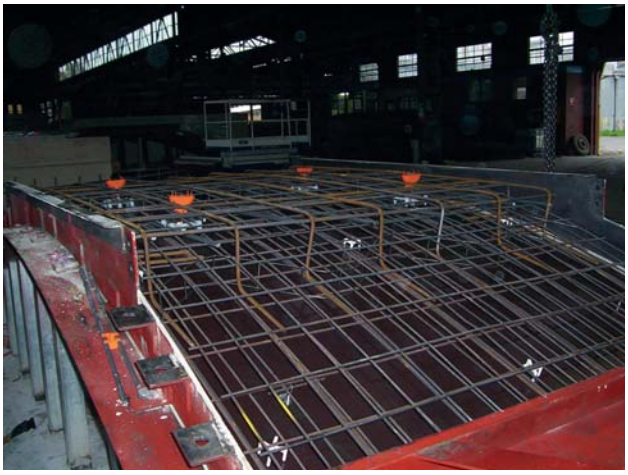
Green Star Credit	CH_2 Design Response
Up to two credits for use of post-consumer recycled steel	Use of 100 per cent post-consumer reinforcement steel from Smorgon Steel. No other recycled steel products could be identified for the project.
Up to three credits for use of high-supplementary content (cement replacements) in concrete	Development of matrix with up to 60 per cent replacement depending on stress grading and curing speed constraints.
Up to two credits for use of sustainable timber	Use of plantation timber products. Use of recycled timber for louvres. Use of FSC-certified timber. Use of responsibly sourced timber with source documentation for window frames*.
Up to two credits for reduced use of PVC	Use of HDPE for most water and other pipe work. PVC used for stormwater pipes. PVC used for power, data and communication cables.

**A contentious product that generated significant debate during the project's construction.*

Table 1: Green Star – Office Design (v1) and CH_2 materials (Green Building Council Australia, 2004).

1 Interview with Claude Bertoni 24/01/2005

A. Pre-cast mould assembly.



B. Reinforcing mesh placed in mould.

C. Pouring concrete into mould.

D. Panel being removed from mould .

E. Turning cast panel over.

F. Finished undulating ceiling panel.

Figures 2: Pre-cast mould and casting of ceiling panels, pictures A, B, C, D, E, F.

Top 10 Lessons for Specifying Preferable Materials

1. Be careful of 'green wash'.
2. You cannot avoid research:
   - allow for time and resources to enable good decision making:
   - use existing tools such as EcoSpecifier, the Environment Design Guide, case studies and the internet;
   - use contacts;
   - attend conferences to keep up to date;
   - develop an in-house assessment system/checklist, and check out the one page materials questionnaire on EcoSpecifier;
   - be patient with, and communicate clearly to, suppliers; and
   - work towards developing an in-house materials database and staff education strategies to learn from the process.
3. Bring materials to the front of the design process.
4. Rethink preconceived notions of material selection and application.
5. Design in solutions that minimise material consumption. Maximise natural/integrated, not applied finishes.
6. Understand what you are specifying so you don't get caught out later:
   - be prepared for some items to cost more due to availability, as demand will eventually bring prices down; and
   - ensure the product is suitable for the intended application.
7. Collaborate with local environmental groups as they can be a good source of information.
8. Be more amenable to variations in visual finish control to minimise material wastage through rejection:
   - develop a good relationship/ with the builder to ensure project objectives and quality are delivered;
   - where options exist, choose a process that gives a good result with the least risk of material wastage; and
   - where a more refined finish is required, limit it to smaller areas.
9. Be realistic about life span design considerations. For example, if the design aims at flexibility or is faddish, then demountability, recyclability and reuse may be more important than long-term durability.
10. Don't get lost in the enormity of the project:
    - take small steps and don't feel the need to reinvent the wheel every time. Making a small improvement is better than none at all.

A. Single panels North façade in foreground.

B. Panels awaiting delivery to construction site.

Figures 3: Pre-cast façade panels to cover ventilation ducts, pictures A and B.

Other Studies in this Series:

1. **Nature and Aesthetics in the Sustainable City** – form, function, flora, fauna and art;
2. **Workplace Environment** – people, the built environment, technology, and processes;
3. **Lighting and Physiology** – artificial and natural lighting and its relation to the human body;
4. **Air and Physiology** – internal air quality in relation to what the human body needs;
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6. **Energy Harvesting** – economic use and efficiency;
7. **Water** – reducing consumption and increasing harvesting;
8. **The Building Structure and the Process of Building** – engineering, transport, construction and structural elements;
9. **Materials** – selection based on an eco-audit that factors in embodied energy, process toxicity and off-gassing considerations;
10. **The Business Case for Sustainable Design** – economics, payback, productivity and efficiency.

For more information and access to a complete set of studies, visit the CH_2 Web site at:
www.CH2.com.au

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