SUSTAINABILITY CASE STUDY

Difficult task of choosing materials wisely

Even with the benefit of experience, it's a challenge choosing environmentally preferable materials for a house. We continue our series looking at the process of building a more sustainable urban house in Hamilton by focusing on material selection.

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Choosing environmentally preferable materials in a house is important. Ideally, when comparing and choosing like materials for their function, their whole lifecycle should also be considered. Thus, a material's extraction, manufacturing, transport to site, installation, maintenance and final removal and recycling/disposal should be examined. All the inputs (energy and material inflows) and outputs (pollutants and material wastes outflows) should be accounted for at each stage. This is a complex procedure, even when materials have minimal processing.

Lifecycle assessment

The systematic examination of material, energy and waste flows is called inventory assessment and has been standardised by the ISO14040 series of standards. It is part of a wider environmental assessment system called lifecycle assessment (LCA), which can be used to examine the environmental attributes of building materials more objectively.

Currently, there is no extensive independent, LCA-based resource on New Zealand building materials. However, BRANZ has been actively involved in the development of an lifecycle inventory (LCI) for the Australian building industry and recently a similar project has been initiated in New Zealand.

In the absence of this information, 'hot spot analysis' was used, which highlights environmental issues (negative or positive) that have the highest impact relevant to the product category. These 'hot spots' were determined using independent agencies, such as the UK's GreenSpec (www.greenspec.org.uk), Australia's ecospecifier (www.ecospecifier.org) and New Zealand's Environmental Choice specifications. From the results, we derived the top two or three preferred materials for any one application.

Guidelines for choice

The agencies above only cover the environmental and health aspects of materials. The concept of sustainability is considerably wider and should also take into account social issues (for example, buildability issues) and practical as well as economic issues (such as lifecycle costs and durability). As a result, our guiding philosophy was to select materials with a good mix of environmental attributes including:

- a recognised third party environmental/performance accreditation
- minimal lifetime maintenance requirements
- minimal (if any) compromises in performance
- simplicity of style/aesthetic, to avoid trend-driven products
- reuse/recycling of available materials as appropriate
- ease of replacement/recycling at end of life
- low lifecycle cost (initial purchase and on-going maintenance)
- more than one function.

No right choice

The main building products chosen are listed in Table 1, along with reasons for selecting them. Of course, the materials selected are site-specific, and a different (but equally valid) choice may apply for a similar set-up. There is no one 'right' choice for any application; there are always trade-offs in the various sustainability qualities.

In the end, choosing one material over another is a personal choice. However, often 'social' or 'economic' aspects win the day on site if environmental issues have not been used in the selection framework.

The darkened, polished concrete slab floor is an example of a material that has several functions – heat store, replacement floor covering and structural role

The real deal, not just the good oil

One of the goals of this series is to provide frank information on more sustainable planning, specifying, building and monitoring. It is only by providing an honest overview of products, systems and approaches that we can rapidly progress the knowledge base and learn from the mistakes and successes of others.

Table 1 contains the positive sustainability-related aspects of the various products. To gain an appreciation of the complexity of materials specification, here are some of the negative aspects, in no particular order.

- ZnAl wall cladding – a BRANZ study comparing lightweight cladding materials found ZnAl cladding to have a comparatively high lifetime CO_2 footprint, when examined against other lightweight materials.
- Concrete floor polishing – the final polishing is done using a polishing pad lined with industrial diamonds. It is doubtful whether there would be many building-related materials

with a higher embodied energy intensity.
- Macrocarpa balcony – although more durable than *Pinus radiata*, it still requires frequent application of mould inhibitors, which contain reasonably toxic materials. A better environmental solution may have been to use an engineered composite that requires no treatment.

This list could easily be extended, but it demonstrates the environmental, economic and social trade-offs that typically need to be made, even among preferred materials.

End of life considerations

Rapidly demountable systems were investigated for ease of salvaging materials at the end of their, or the building's, life for reuse or recycling. Realistically, for this type of construction, *easily* salvageable materials would include:

- long-run roofing (clamp-fixed) and long-run walls (screw-fixed)
- screw-fixed kitchen bench, vanity bench and vanity tops
- insulated entry and back doors
- double glazing units and aluminium framing
- ceramic and stainless steel washing basins
- steel support framing for solar hot water, header tank and photovoltaic panels
- steel portal frames for three lintels.

Items that are *more difficult* (but still possible) to salvage are:

- reinforced concrete floor
- first storey flooring (T&G rimu on plywood)
- roof and wall insulation (perhaps – given its protected environment)
- cabling (electrical, telecommunication and IT)
- cupboards and drawers from composite board.

Post occupancy

Hopefully, the clean internal aesthetic will age well and so minimise the refurbishments needed during the building's lifetime. Also, a good maintenance programme will help prolong the materials' lifetime.

A future article will explore setting up systems post construction to minimise resource use.

Table 1: Summary of main building materials and the site-specific reasons for their selection for this house.

Product or element	Primary reason(s) for selection	Secondary reason(s)
External		
Long-run ZnAl (walls)	Multiple functions (cladding and a supplementary internal heating source)	Very low lifetime cost
Fibre-cement sheet (walls)	Low lifecycle costs and aesthetics	
Open matrix cavity batten system	Multiple functions (weathertightness and good vertical air flow for the solar heating wall)	
Long-run ZnAl (roof)	Multiple functions (water collection, profile allows easy walkway, renewable energy fixing)	Very low lifetime cost
Macrocarpa balcony and patio	Durability, salvaged material, aesthetics	Renewable resource
Stone and concrete hardscaping	Reuse of existing hardscaping on site	Aesthetic
Concrete rainwater tank	Ability to install in ground (spatial constraints and low aesthetic impact)	Low lifecycle cost
Within-wall		
Thermally broken aluminium windows with low e coating	High thermal performance to cost ratio and low maintenance	Simple aesthetic
Polyester thermal insulation[1] (walls/ceiling)	High performance (R-values), non-irritant installation and independent (BRANZ) performance appraisal	Made from recycled material
Polypropylene piping for almost all plumbing	Independently rated green credentials, independent (BRANZ) appraised and excellent track record	Recyclable at end of life
Internal		
Exposed, darkened and polished concrete with river-stone aggregate	Multi-functional with great heat store (thermal) properties	Aesthetics
Densified concrete floor topping	Durability (very high scratch and stain resistance) and multi-functional (does away with additional floor coverings)	Lower lifetime cost
Rimu benchtops, upper storey T&G flooring, stairs and handrails	Recycling of existing materials (from deconstructed house) and aesthetics	Small cost savings
Plywood finish	Aesthetics/simple style	
Soft-board ceiling lining lower floor	Very good acoustic performance (to counteract concrete flooring) and low costs	Aesthetics
Enviro-Choice plasterboard lining for walls and upper ceiling	Not many alternatives with a similar finish	Independently rated environmental credentials
Enviro-Choice certified, near white, acrylic paints for the interior and the bulk of the exterior	Independently rated environmental credentials	Human health and environmental impact (low odour)
Water-based polyurethane for all timber surfaces	Human/environmental health (super low odour) and very good performance history	Easy cleanup, quick dry and easy to work with

[1] Insulation is unusual as its in-situ use is exclusively environmentally beneficial. The key goal is to realise its maximum possible in-situ R-value by making sure the R-value has been independently verified and ensuring correct installation.