Submission to World Wide Fund for Nature (WWF) Australia

In response to its 2020 report and follow-up webinar
on decarbonizing building and construction materials.

https://www.wwf.org.au/ArticleDocuments/353/WWF-Decarbonising%20Building%20and%20Construction%20Materials%20report.pdf.aspx?Embed=Y

PERSONAL THOUGHTS ON TACKLING EMBODIED CARBON IN THE BUILDING AND CONSTRUCTION SECTOR

REFLECTING ON EXPERIENCE FROM THE MULLUM CREEK ECO-HOUSING PROJECT VICTORIA

As an architect, I've been deeply involved in trying to understand and reduce the environmental impact of materials in construction for 40 years now, not so much in a public policy/advocacy setting (where I'm not strong) but moreso in architectural practice and education.

Between 2002 and 2019, I worked quite intensively on a 56 lot eco-housing project Mullum Creek in Donvale (an outer suburb of Melbourne). The developers for that project were a family of environmental philanthropists Sue, Steve and Danny Mathews. Their vision and steadfast commitment to the project paved the way for what I think are some excellent outcomes effected via:

- Core requirements, set by S173 agreement placed on sale of residential lots, and administered through my office that served as the formal committee of design review and construction oversight.
- Design guidelines, practical info-sheets and step-by-step one-on-one advice that we were able to provide lot owners, architects/designers and builders.

Whilst not a large housing estate, in don't know of another in Australia that has taken environmental initiatives (certainly as they relate to materials selection) anywhere near as far as has Mullum Creek. We learnt a great deal from this project (both good and bad) and are desperate to share these learnings as well as all our guides and info-sheets, as widely as we can.
https://mullumcreek.com.au/
https://mullumcreek.com.au/app/uploads/presentation-to-ecocity-2017.pdf

In the webinar last week, there seemed to be a concentrated focus on embodied carbon amongst the big end of town (government infrastructure projects, Lend Lease et al). But I couldn't help thinking that they're operating in an eco-system that's so incredibly complex, ultimately profit-driven and lacking the scaffold of good leadership from national government. Such a hard nut to crack.

Meanwhile, more than half of all material and embodied carbon that goes into building and construction, goes into housing. And in Australia, the vast bulk of that is still low to medium rise (say 1-6 storeys). It's specified and procured by a vast web of comparatively small firms (designers, builders and sub-contractors) and DIYers. And it then becomes the direct asset and the burden of individuals and families, present and future, facing their 'social contract' with environmental ethics.

From my experience in architectural practice, I've found that prospective home owners have a more direct and emotionally invested influence on the environmental impact of materials that go into their builds. What they lack though is knowledge on this subject which, for the most, is not hard to impart with smart and commercial-free information exchange and the right social messaging. It'd be a shame to see our address of embodied carbon concentrated with government and big business not include also the many other small but collectively more impacting players in the building industry and broader community.

In responding to your webinar and report, I'm deeply coloured by the consensus amongst climate scientists and ecologists that what we do in the next 5-10 years, by way of reductions to carbon emissions and biodiversity protection, is the most of what counts going forward. Beyond then, the danger of natural forcings (runaway climate change and biosystem collapse) will become ever more present. And it'll become so much harder to claw our way back to a natural world able to support a good life as we know it. So that truly puts us on the footing of existential emergency which, by its complexity alone, pales COVID to relative insignificance. Best then I start with the simpler aspects of this almighty conundrum … materials as discrete ingredients for construction.

TARGET MATERIALS FOR EMERGENCY ADDRESS

In my work, I've found that tools for design-stage assessment of life-cycle environmental impact (including embodied carbon) draw from back-end databases containing often problematic assumptions and simple errors. Their outputs can be at odds across software platforms and generate front-end recommendations distorted by further problematic assumptions. Give me a call if you'd like and I can explain this in better detail.

I'm not suggesting we give up on using and refining these tools. But while we continue to deliberate on them in this state of emergency, it makes sense (as someone in the webinar flagged) to also move forward with haste on the assumption that concrete, steel, fired clay and timber products alone contribute to the bulk of carbon emissions embodied in the construction of buildings in Australia today. I'd go on to argue that impacts embedded in construction will amount to more than all operational impacts from buildings through their service life (on average). The impacts of construction materials are effectively locked in on our planet the moment contract specifications leave our desks. Operational impacts on the other hand can be lowered through the service life of buildings by decarbonisation of operational energy sources and upgrade to services systems. This reasoning informed the approach on embodied carbon applied to the Mullum Creek project about 10 years ago. https://mullumcreek.com.au/materials/

CONCRETE

All wet-mix concrete, spraycrete, rammed earth wall binders and mortars used on the Mullum Creek estate contain a minimum 30% fly ash and/or slag in lieu of Portland cement. We set this requirement under S173 agreement and with design guidelines (V1) back in 2013.
https://mullumcreek.com.au/app/uploads/161004-V8.2-MCDG.pdf … (pp. 33-34)

At the time, few local batching plants or bagged cement suppliers had SCMs available, but those that did, were confident with the performance of their products. At first, structural engineers, concretors, rammed earth wall builders and spraycretors were all resistant to change. But once construction on the estate gained momentum and builders and tradespeople realised that these required SCM products offered equivalent if not better performance at the same price, everyone started to relax.

Today it's simply a given that, at Mullum Creek, SCMs are a requirement … builders and tradespeople just get on with it. Most batching plants local to the estate now have a 40% SCM wet mix readily available. Checks on delivery dockets for all wet mix and a glance at bagged product in use on the estate confirms for our Design Review Committee (DRC) that the project's requirement re cement has been satisfied.
https://mullumcreek.com.au/concrete-and-cement-2/
https://mullumcreek.com.au/app/uploads/Concrete-Cement-Products-Guide.pdf
https://mullumcreek.com.au/app/uploads/Exposed-aggregate.pdf

Based on this experience, if we could amend the Mullum Creek Design Guidelines to make their requirements more onerous after prospective residents have bought in (which we can't), I'd confidently bump up the SCM requirement to min. 60% for all wet mix (including for honed slabs where some resistance remains amongst concrete grinders) and 50% for all bagged cement. And I'd seek further expert advice from a few awesome engineers on staff at a large wet mix supply company and local cement manufacturer, who quietly go about their product development work and draw new knowledge and confidence from better advancements overseas.

There's no problem with future availability of Portland cement substitutes (see BZE report re same) and I don't think anything much needs upgrading at batching plants to switch the content in hoppers.

The main thing missing for across-the-board take-up of high SCM content (certainly across the low-rise housing sector) is requirement.

Too many consulting structural engineers we came upon through Mullum Creek remain resistant to specifying SCM for wet mix, even though the supplier takes responsibility for delivering on strength and slump. Suppliers now also have good control over workability and curing of SCM mix as delivered. I'd put risk aversion, lack of professional development and a dose of arrogance as the likely cause of engineers' ongoing resistance at this point.

I'm also stunned by architects (even those marketing themselves as eco) who have been active at Mullum Creek and noted the at least equivalent performance/price/availability of SCM concrete, yet report that they haven't specified this for their subsequent work beyond Mullum Creek.

Some simple mechanism to force wholesale uptake is needed, whether via NCC amendment that begins to address also embodied carbon, via frameworks and grants tied to the Commonwealth Government's Carbon Pollution Reduction Scheme, or some other device.

That said, advocacy for replacements to Portland cement will fix only the first part of a broader environmental problem with concrete.

Around the world, with the still extraordinary growth in use of concrete, we're now getting to 'peak-aggregate'. Sharp angular stone and sand are becoming ever harder to source and we're going into places with ever more delicate and irreplaceable biodiversity to mine them. In countries with poor governance, this is particularly problematic. From what I understand, recycled aggregate lacks those angular properties required for structural concrete. Some urgent R&D needs to happen to tackle this.

Also it's important to consider concrete as an ingredient to a composite construction element. In high-rise buildings by Lend Lease and Multiplex, the overall embodied carbon in reinforcing steel is way higher than that in the concrete encases it. It's easy to do the sums on this.

STEEL

Despite Australia's natural advantage, it'll be some years before we see good volumes of steel available here manufactured using energy that's environmentally benign. Clearly this needs urgent R&D. Meanwhile how can we dramatically reduce our use of steel in construction?

- By architectural design that avoids gravity-defying and sky-high built forms, which in turn force demanding and resource consumptive structural engineering.
  https://mullumcreek.com.au/app/uploads/Steel-Products-Guide.pdf
- With R&D to develop concrete reinforcements that reduce and/or replace steel content (e.g. Helix, carbon fibre).
  https://mullumcreek.com.au/app/uploads/Helix-Steel-Rebar-Guide-040419.pdf
- By substituting steel with fast-grown locally sourced plantation timber (simply sawn or engineered product).
  https://mullumcreek.com.au/app/uploads/Structural-Timbers-List.pdf

All too often I see the quite unnecessary use of steel in new low-rise building structures, where substitution with local plantation timber would perform equally and at much lower cost. Again, I can't help but attribute this waste to architects' ignorance and/or lack of interest, and to engineers' unjustifiable risk aversion and/or laziness. Builders just erect what's on their certified drawings and clients pay for this upstream nonsense.

At Mullum Creek, via design guideline requirement, we managed to veto the use of cold-formed steel because we were confident from the outset that it could be replaced in all its applications by local plantation softwood.
https://mullumcreek.com.au/app/uploads/161004-V8.2-MCDG.pdf … (pp. 34)
https://mullumcreek.com.au/app/uploads/roof-battens.pdf

We weren't so confident, prescriptive or smart with hot rolled steel. Much of the engineering documentation we reviewed and house frames that rose from the ground contained unnecessary amounts of hot rolled steel. We should have done what we only later learnt Currumbin Eco-Village in QLD had, being to prohibit (also via design guideline requirement) the use of hot rolled steel unless its use was deemed unavoidable by independent engineering review. The burden of that justification requirement had engineers reconsidering their default design approach which then almost fully avoided the use of hot rolled steel across that estate, with LVL and other creative timber solutions substituted. There as well, simple clear-cut upstream design requirements were effective.

FIRED CLAY PRODUCTS

The Mullum Creek Design Guidelines prohibit the use of concrete and terracotta roof tiles unless recycled from a prior construction use. The use of recycled bricks and new clay bricks with lesser embodied carbon (e.g. those from Longford TAS as mentioned in the WWF report) were encouraged via info-sheet but not required. https://mullumcreek.com.au/app/uploads/Clay-Products-Guide.pdf

Nonetheless, fired clay bricks and roof tiles are also major contributors to embodied carbon in Australia's built environment and, as with steel, we wait on a benign energy source for their manufacture.

That said, I get nervous when I hear of bio-energy, biochar and the like (in practice mostly forest wood) as potential 'renewables' for electricity generation or as a replacement for metallurgical coal. The WWF report and BZE's 'Rethinking Cement' report briefly flag these bio- fuels for manufacture of fired clay and steel products and for re-drying of stockpiled slag and fly ash. In principle, wood can be an environmentally responsible energy source as waste from harvest or milling of fast-grown plantation wood established on previously cleared and otherwise low-value agricultural land, so essentially as a crop.

But in practice around the globe, at both large industrial and small domestic scale, it is mostly extracted as hardwood (having generally higher density and calorific value) from natural forests in ways that can be catastrophic to climate and biodiversity.

As a quick but potent example, we can marvel at the UK's achievement in reducing fossil fuel emissions from its electricity sector by 38% since 1990. This has been achieved in part, with substantial government subsidy, by supplanting up to 25% of the coal fed into existing power stations with pelletised wood extracted, sometimes illegally, from biologically diverse broadleaf and conifer forests of Eastern Europe, Russia and Canada. The EU counts this wood energy as renewable with zero net emissions. Trees (as carbon sinks and biodiversity) return so slowly to these often unmanaged cold-climate forests once they've been clear-felled for pellets. Also in Australia, 'waste' from unconscionable native forest logging generates what's tagged as '100% (federal government) accredited renewable power' for the national grid (e.g. Cape Byron Power) and industry push for more of this should not be underestimated. I'd hate to see our decarbonising of non-timber building and construction materials also implicated in further forest destruction.

TIMBER

There seems to be a lack of awareness across 'green building' networks that timber can be a very responsible material choice for architecture or it can contribute dramatically to the demise of fragile natural forest ecosystems, depending on how and where it's sourced. It is often not the ultimate renewable as industry would have us believe.
For example, the timbers showcased in the WWF report, heading the section on materials decarbonisation and substitution, are Spruce and Beech from very slow-grown cold-climate broadleaf and conifer forests of Northern Europe, the Baltic States or Russia. Spruce is now prominent as a structural wood for stick-framing of Australian homes, replacing much of the fast grown, temperate climate plantation Pine grown in AUS and NZ. WWF is working hard to protect Europe's last pristine forests from where some of the Spruce and Beech imported here originates. We don't know which because these supply chains are kept extraordinarily opaque.
https://mullumcreek.com.au/app/uploads/Watch-out-for-Baltic-Pine.pdf
https://wwf.exposure.co/saving-the-taiga

As I'm advised, Sydney's new 'super-green' Atlassian Tower will have CLT floors and walls sourced mostly from northern boreal forests. These panels will be inserted as 5-storey 'drawers' to reinforced concrete and steel 'shelves'. Floor cassettes, stick wall frames and plywood linings from simple sawn and engineered AUS or NZ plantation softwood could structurally, aesthetically and more affordably achieve what the bulky CLT will, extracted from northern boreal forests. Just-in-time materials procurement strategies for a (we hope) post-COVID world disadvantage more local AUS/NZ CLT manufacture. And sadly, green fashion trumps environmental responsibility and common sense.

Under S173 requirement, lot owners, designers and builders at Mullum Creek were guided to suitable and affordable timber products for all applications satisfying very strict environmental criteria set for the project. Via three-step review of design documentation and site inspections, we ensured that only timber recycled from prior constructions our sourced from trees purposefully planted on previously cleared land in AUS or NZ made their way into builds on the estate. This left many good timber choices across all architectural and engineering applications and it sent a strong message to local timber suppliers that we accept only wood that's sourced with a high level of environmental responsibility. The approved timber products list and associated info-sheets supporting this requirement have been well used within and beyond the estate.
https://mullumcreek.com.au/app/uploads/Timber-Products-Guide.pdf
https://mullumcreek.com.au/app/uploads/Watch-out-for-CCA-treated-pine.pdf
https://mullumcreek.com.au/app/uploads/Structural-Timbers-List.pdf
https://mullumcreek.com.au/app/uploads/Heads-up-on-timber-scantling-and-truss-suppliers.pdf

The preferencing of responsibly sourced timber for structural applications (where it's used in greatest volume) turned out to be a no-cost no-brainer for builders at Mullum Creek. The only barrier to this extending across all of Australia's building industry is the unfettered importation of wood from countries with poor governance, lax environmental protections and cheap or even indentured labour.

CERES Fair Wood in Melbourne is a not-for-profit social enterprise which, in effect, aggregates supply and demand sides in procurement of environmentally and socially responsible timber. Fair Wood removes itself from the adversarial forest debate and often opaque timber certification schemes, aggregating and retailing timber inside short and transparent supply chains. It buys only wood sourced to the highest environmental and social standards as informed by the Mullum Creek project. This wood comes from small local tree farmers and sawmill operators who are geographically dispersed across Victoria and otherwise struggle to find, sell and deliver to a green demographic that fully appreciates what they have on offer. Fair Wood shares their stories directly with its customers, building and landscape contractors, furniture makers and DIYers. This business builds direct friendships and understandings between city and country folk and encourages farming families to diversify to tree planting and silviculture for conservation and profit.
https://ceresfairwood.org.au/
https://ceresfairwood.org.au/wp-content/uploads/2018/08/CERES-Fair-Wood-fair-dinkum-wood.pdf

QUESTIONING HIGH-RISE

We need to seriously challenge both the environmental and social responsibility of high-rise buildings. They have a global average lifespan of only 41 years due largely to the capital intensity in their prematurely ageing service systems. The material and so also the embodied carbon in the structure of high-rise (per unit usable floor area) is excessive. Alone the steel in its reinforced concrete is intense. Coupled with the social symptoms high-rise buildings impose on their occupants and urban surrounds (certainly in residential settings), Lend Lease, Multiplex and Grocon towers are doomed from the outset in any quest for a sustainable low carbon building future.

REDUCING QUANTITY OF CONSTRUCTION

While the per-occupant physical scale and vacancy of Australian homes, work places, shopping malls and civic spaces continues to rise, the more the overall life-cycle environmental impact of these buildings will continue to grow, and the greater the embodied carbon and biodiversity impacts will be as a proportion of overall impacts. Environmental performance of buildings, both in their construction and operation, is measured per sq.m. gross floor area and this is unreasonable. Until we can procure building materials without negative ecological and climate consequences, we desperately need to subscribe to *less is more* and foster quality over quantity. We need to continue to plead with our clients and community to build and live smaller, explaining why.

Eco-housing developments at Cape Paterson VIC and Currumbin QLD applied S173 agreements to contain the gross floor area of new homes built there to reasonable limits. Mullum Creek took steps to contain scale as visual bulk via limits to site coverage and to preserve inter-lot solar access via 3D building envelopes. Despite my banging on about it, the developers decided not to prescribe limits to floor area, but I think they regret this in hindsight. There are some monster houses on the estate without monster families to occupy them.

REGULATION

But apart from the excessive scale of many homes on the estate, Mullum Creek achieved exemplary environmental gains, much of them via requirement that could easily be scaled up for broader application.

Urgently needed is an expansion of building regulation to capture embodied carbon. Requirements on embodied carbon, as tied by S173 agreement to development of the Mullum Creek estate, could be refined and applied to all new housing estates in Australia via covenant. Local and State Government would have a strong role to play here. Such requirements may seem onerous at first. But, as we found at Mullum Creek, once new work methods in both design and construction practice are established, everyone (except for the odd recalcitrant) just gets on with it and a new normal settles in.

Government could also apply the same requirements to new infill developments via condition on subdivision and/or planning approval.

Such requirement might seem clunky or harsh but it's appropriate in the emergency before us. Over time, embodied carbon and operational carbon limits could be applied in a more refined way, project-by-project within an overall LCA framework. But this adds considerable procedural complexity and risks delays and early subversion. In the interim, a simple BASIX or BESS-style score system that captures the core elements for improvement might be the go. Seven years back, I flagged a template for such a system to the developers at Mullum Creek and would be happy to share it with you if you're interested. Over time, regulation could mature to be informed by a single (at least per building type) government accredited LCA scheme that has bugs and problematic assumptions gradually resolved, much as has occurred with NatHERS over the years.

The privatisation of building regulation administration has not worked in Australia. Certainly, as it relates to urgent environmental restoration, decarbonisation of our industry sector must be underpinned by rigorous review of design documentation and on-site checks that are publically rather than privately commissioned. So no more guns for hire.

MESSAGING TO COMMUNITY

Can we learn to re-love what we already have? Can we delicately rework existing buildings where we can, applying our finest smarts to minimise natural resource depletion and to give our planet a chance to heal?

These questions, on high-rise and how much we really need to build, are sure to threaten building industry associations, the Metricons and the Multiplexes locked in to the near-exclusive commercial paradigms. But we cannot push them aside if we want to seriously tackle embodied carbon in the building and construction industry. With the right new narrative that speaks to a broader and soon explosive wave of community concern, big business should and government might even respond, to address these questions with urgency, not as a threat to business-as-usual, but as an unavoidable social, environmental and commercial challenge, and as a new business opportunity. Environmental NGOs like WWF, Greenpeace, ACF and CERES have a huge role to play in crafting and propagating, as well as demonstrating and educating around, this narrative.

MESSAGING TO INDUSTRY

A National Climate Action Super Forum was held in February, hosted by the Sustainable Architecture Forum (SAF) of the Australian Institute of Architects (AIA). In Q&A, there was a clear call from design professionals attending that new demands on them, to improve environmental performance of buildings as flagged by the forum, need to be proffered in simple, discrete, practical and well-supported packages. This is what we found architects and engineers engaged at Mullum Creek were also wanting. Organisations like Architects, Engineers and Builders Declare would do well to, simultaneously across all three disciplines, drive concerted campaigns of education and support targeting one core building material type (say) each quarter. In doing so, they should actively draw in also the fresh energy and enthusiasm of university and TAFE students, our future building professionals.

BUYERS' ALLIANCE

WWF's idea of a material buyers' alliance is great and CERES Fair Wood offers a good if small example of how supply and demand sides of material procurement can be aggregated and knowledge freely shared. A larger industry-wide buyers' alliance would need to be controlled by a board of representatives from government and environmental NGOs declared free of commercial interest or influence. Environmental product disclosures (EPDs) would need to be prepared by agents nominated by this Board and also deemed free of commercial interest or influence. EPDs are too often prepared by guns for hire who distort the facts.

Knowledge sharing within the host body for a buyers' alliance needs to be free and generous with no room for guarded IP.

Paul Haar
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