‘REDUCING EMISSIONS IN THE AUSTRALIAN BUILT ENVIRONMENT’

A Focus On Structural And Façade Engineering Solutions
by Matthew Broughton

The reduction of operational energy is typically perceived as purely the domain of MEP (Mechanical, Electrical and Plumbing) engineers; however, façade engineers also have a large role to play in this process due to their involvement in the design of the building envelope. Australia produces the highest operational emissions per capita among OECD countries due to the prominence of fossil fuel production and a lack of sufficient climate policy. Australian buildings are directly responsible for 25% of all national GHG emissions.

Glazing represents a highly inefficient material choice for sustainable designs due to its poor thermal characteristics. On account of user demands and a positive impact on the building end user’s comfort and productivity, the option to remove all glazing from buildings is not feasible. However, the ability to design a sustainable building with a considerably high window to wall ratio (WWR) has been proven to be possible as shown in the Barangaroo C1 and C2 case studies.

IGU systems were demonstrated to improve the thermal performance of glazing significantly. More recent innovations that can continue to improve upon the IGU systems include thermally broken frames and Electrochromic windows. Similarly, thermally broken structures such as concrete slabs have also been shown to be a vital design consideration, particularly in severe climates where thermal masses can significantly increase HVAC energy demands.

On-site energy generation from solutions such as building-integrated Photovoltaic systems are vital in achieving the goal of a net zero industry. As the stringency of design codes reach their limits, and the innovation of thermally efficient materials slows down, it is clear that on-site energy offsets are the key to sustainable buildings.

Despite being outside the scope of design engineers, grid decarbonisation is crucial. All aspects of operational and embodied energy expenditure eventually make their way back to how energy is produced. By relying on fossil fuels instead of renewable energy, meeting climate change goals will not be possible.

The inclusion of embodied energy contribution is necessary when defining ongoing outcomes and working towards a net zero future. When looking at embodied energy, the Whole Building Lifecycle Assessment (WBLCA) needs to be studied. With the inclusion of elements such as manufacturing energy, transportation, construction, maintenance, repair, disassembly, recyclability and reuse, the scope of embodied energy analysis becomes much more complicated, although essential. Structural engineers can play a much more prevalent role in the reduction of embodied emissions, as a majority of carbon is contained within the structure. Despite fulfilling a lesser role in total emissions, the importance of embodied energy reduction will continue to climb due to the past focus on operation energy. High-performance buildings will begin to see the embodied carbon rise to 45% of the total carbon of the building.

Concrete and steel remain statistically the worst contributors when looking solely at emission outputs per material. However, when considering the WBLCA and novel manufacturing methods, steel becomes a much more viable option for sustainable design.

Analysing the share of embodied carbon by building system has provided an insight into where solutions are most needed. However, without adjusting this data for the design life of each element, the results can be misleading. The results of this study once more found that MEP engineers need to play the most considerable role in the changing industry, as their designs are both carbon-intensive and have a lower design life than the systems designed by structural engineers. Despite this, improvements to the work of design engineers remains a necessary part of transforming the industry into a sustainable one.

The traditional method of concrete production can no longer be viable if climate change goals are to be met, as the core calcination process emits 0.82 tonnes of CO_2 per tonne of cement. Innovative geopolymer concrete, using high proportions of SCMs such as fly-ash and GGBS can mitigate the CO_2 emissions of traditional concrete production. However, to achieve a net zero industry, energy offsets will be required. Timber can offset carbon emissions through sequestration, part of the photosynthesis process of trees. Timber is, therefore, the only building material that has the ability to reduce climate change, rather than merely slowing the rise. However, to ensure timber usage is sustainable, rather than compounding the already growing problem of deforestation, designers need to ensure their timber products are certified under forestry management systems such as the AFCS.

High strength Engineered Wood Products (EWP), including LVL, CLT, and Glulam designs, have now been proven to be viable options for building design, as shown in the case study of the Barangaroo C1 and C2 buildings. Innovations in the steel manufacturing industry have proven the ability to replace the key power source of coal, with hydrogen. The traditional manufacturing process of iron extraction can produce 1.8 tonnes of CO_2 emissions per tonne of steel, due to the coal reduction method. The now proven option of hydrogen reduction leads to zero CO_2 generation.

There is an extensive list of design framework options in the Australian building industry, with the most prominent being the NCC, AS, Basix and NatHERS. Recent revisions to the NCC have observed an improvement in building efficiency, however, they have not been enough to meet the climate goals. The homologation of all of these frameworks into one standard will be beneficial for engineers, educators, building owners and developers.

Australian Standards are the most used government-mandated design reference for engineers, however, there is typically no reference to sustainable designs. This is a clear opportunity, that will need to be used. Many of the design solutions outlined in this study could be integrated into Australian Standards to increase the awareness of engineers, and aid in the implementation of innovative solutions. Engineers proactively contribute to the causes and impacts of climate change; therefore, the reduction of GHG emissions should be associated with engineering activities and given absolute priority (Engineers Australia, 2016).

The Sustainable Development Goals were agreed upon by the world's governments to ensure their progress towards addressing issues such as poverty, hunger, sustainable agriculture, and human-induced climate change. To further focus on climate goals, the Paris Agreement was signed by the Australian Government in 2016. Despite these clear goals, analysis has shown that the built environment of Australia is not on track and is still increasing its level of emissions. Hence, it is apparent that the current policies and incentives that are in place are not sufficient.

To understand where and how the industry needs to change, the understanding of current roles and perceptions of all relevant stakeholders is vital. Despite engineers having a minimal impact on the ultimate outcome of building projects when compared to architects, building consultants and construction managers, they are still a vital part of the industry.

A small survey was conducted to better understand the perceptions of working engineers. Based on the results of this survey, the following conclusions can be identified:

- Engineers believe they value sustainability more than the remainder of the industry, despite the average result showing that they merely consider sustainability on an infrequent basis.
- Practising engineers predominantly do not possess a highly accurate knowledge of emissions statistics in the Australian market. Further confirming the importance of increasing education levels.
- The Australian Government was identified as the most impactful stakeholder regarding the industry's adoption of sustainability due to the effectiveness of incentives and sustainable policy decisions.