IMPLEMENTING SUSTAINABLE DESIGN FOR CITY RAIL LINK

Digital engineering drives embodied-carbon reduction throughout the project

Reducing embodied carbon within infrastructure assets is essential in the transition to net-zero carbon societies. Auckland, New Zealand's City Rail Link (CRL) project—the largest transport infrastructure project ever undertaken in the country—has set an embodied-carbon reduction target toward achieving its sustainability objectives.[1]

Embodied carbon refers to the total greenhouse gas emissions generated to produce a built asset—from extraction and manufacturing processes, the transport of materials and components, and construction; it also applies to the maintenance, renovation and end-of-life stage of the asset.[2]

To understand how the Link Alliance is meeting the embodied-carbon reduction target established for the CRL project and how digital engineering is advancing sustainability into the future, we spoke with Dean Burke, Digital Engineering Lead for WSP in New Zealand and Digital Engineering Manager on the Link Alliance.

At completion, expected in 2024, the CRL project — a 3.45-kilometre (2.14-mile) twin-tunnel underground railway—will link to existing lines on Auckland's rail network to connect more areas of the city and support the region's rapid population growth. The project is being delivered through the Link Alliance, a consortium of companies delivering the design and construction of stations and tunnels, a connection with the existing Western Line, and complex rail systems. WSP is a core member of the project alliance contributing to the delivery of a variety of design services across multiple disciplines.

What embodied-carbon reduction target is the CRL project striving to meet, and can you describe the process the Link Alliance is following to reach it?

Dean Burke: The CRL project identified carbon-emissions reduction as a key aspect of its sustainable design, including whole of life emissions from energy use and embodied-carbon emissions from construction phase materials. The Link Alliance is striving to achieve a 15-percent embodied-carbon reduction, based on the original pre-tender reference design and pre-Link Alliance design initiatives being applied to the project. The 15-percent embodied-carbon reduction was set by the client as a feasible but challenging target to meet and was incorporated within the contract of the Link Alliance.

[1] City Rail Link Health, Safety, Environment & Sustainability Report 2020, p. 23

[2] As distinguished from operational carbon: carbon emissions from the in-use phase of an asset

Selection of materials, design concepts and construction methodologies all contribute to reducing embodied carbon emissions. There are many ways to influence sustainability throughout all phases of a project, including water use, waste to landfill, efficient delivery of materials to site, to name a few.

The Link Alliance Team has set out to achieve this 15-percent reduction target through a hybrid system that includes cutting-edge cloud-based technology, data being applied to digital models via automation, instantaneous reporting and a dedicated sustainability team. This system provides feedback and embodied-carbon-emissions metrics to both design and construction teams at all stages of the project.

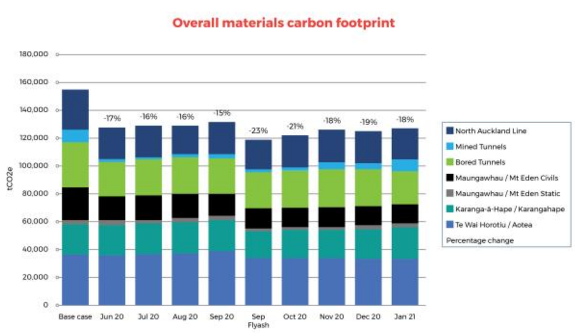

Figure 1 - Tracking the embodied carbon footprint as the design is refined; percentage changes reflect comparison to the baseline of the original reference design.

What has traditionally been the greatest obstacle in the design phase of infrastructure projects to reduce carbon emissions?

Dean Burke: Traditionally, infrastructure projects have predominately been 2D-based deliverables. The extraction of metrics, such as quantities, types of material and, furthermore, the associated carbon, has been a manual process with less opportunity to closely track use and emissions, especially during the design phase and as key decisions are made on the project.

The Link Alliance leadership and the sustainability team have found the hybrid system immensely beneficial; it keeps the project on track toward achieving the sustainability targets.

Digital engineering tools and initiatives are enabling us to integrate data across all aspects of the project. Embedding aligned metadata into the digital twin models has been a game-changer for all parties involved, allowing us to interrogate for both quantities of materials used and associated carbon emissions, utilizing an automated process to feed information into the Infrastructure Sustainability Council of Australia [ISCA] materials calculator. ISCA is an industry-led system used to deliver sustainability performance by benchmarking key metrics across a project's lifecycle. We then report the calculation through a Microsoft Power BI dashboard, which is a digital canvas allowing insights into the underlying database through various visualizations and graphs. We share data across multiple cloud-based platforms on a weekly basis and have an automated quality assurance process in place to validate the digital models. This structured metadata also allows the digital twin models to include cost centres, thereby bridging the gap between design and construction reporting.

The transparent way in which we share information across the alliance has made this process both possible and viable. All stakeholders are engaged and informed; designers, constructors and management can stay focused on the carbon "bottom line."

How does the alliance contracting model support efforts toward meeting the project's embodied-carbon reduction target?

Dean Burke: The structure that the alliance contracting model puts in place—shared risk and reward across all parties—enables a highly collaborative environment. We rely on each other and proactively solve problems as a team across all parts of the project. This highly innovative and interactive environment allows the undertaking of processes which traditionally would not have been achievable; we collaboratively address everything from document control and construction methodologies to maintaining the data-and-asset-rich digital twin models. These digital twin models ensure close monitoring and feedback so that continued embodied carbon reduction can be realized on a real-time basis.

With the increasing use of digital twins in transport and infrastructure projects, where do you see opportunity to further support sustainability?

Dean Burke: Digital twins can be used to assess and improve sustainability performance through lifecycle assessment (LCA) across a wide spectrum of areas, such as water use, waste output, and impacts on ecology. Broader application could also cover social, cultural and economic metrics—for example, creating a more inclusive and affordable transport system. Together, these measures will enable enhanced holistic approaches to support sustainability and develop a resilient infrastructure system that falls within planetary-health boundaries.

The integration of sustainability measures during the early planning and design phases of projects is essential to reveal potential opportunities and enhance performance. We expect to see fully integrated live metrics across the entire lifecycle of an asset. This lifecycle perspective extends beyond design, construction, maintenance and operation, to the end-of-life stage—how assets, materials and components are re-purposed throughout the built environment. There are no barriers to applying digital twin technology to advance sustainability today, and we're excited about achieving even greater positive impact.

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