

LOCAL PROJECT

The Ridge CLT façade: Strong engineering and design rationale

Compiled by Tarren Bolton

Cape Town's newest 6-star Green Star Design awarded commercial building, the Ridge in the V&A Waterfront, incorporates cross-laminated timber (CLT) in its façade, facilitating natural indoor temperature control, and speaks to the sustainability ethos of the developers.



ARAH DA PINA

The Ridge – showing the unique feature of the CLT façade.

Using timber as both the structural façade element as well as the internal and external finish is a first for South Africa and one that has contributed significantly both to the overall architecture as well as reducing the overall carbon footprint of the building.

The Ridge deploys some of the most advanced sustainable building technology available globally. Borne from the V&A Waterfront's vision to set new standards for the future of commercial office buildings, the final design was the result of the creative inputs of the project's multi-disciplinary design team.

David Green, CEO of the V&A Waterfront, explains that this project showcases the capabilities of the Waterfront as a developer in providing custom designed office or mixed-use accommodation to the highest standard in line with the needs of the customer.

The Waterfront's Development Director and project leader for the Ridge, Mark Noble, explains why the office work experience is exceptional and how the Ridge's bespoke features set it apart from other commercial buildings.

"We designed the Ridge to be a world-class living, breathing building by incorporating a number of standout features, some of which are firsts for South Africa:

Air quality: The building operates on mixed mode interior climate control system, which includes the following features:

"Natural ventilation, which significantly raises the indoor air quality and is controlled by the occupants. This means that office workers may open the windows to let in fresh air for up to 80% of the year round.

"An impressive atrium runs from ground to the third level of the building. Referred to as the 'central street', it helps to pull air through the building, in through the windows and out through the rooflights, while also bringing many other benefits to workers and visitors inside the building."

Minimal HVAC (air conditioning) usage: The building incorporates passive (non-energy consuming) temperature control mechanisms several of which are unique, "A virtual sum of parts that leads to a greater whole", says Noble.

The zigzag shaped engineered timber façade ingeniously orientates the glass windows towards the north or south, which prevents lower angle sun from the east or west from entering the office spaces. This provides natural daylight while reducing glare and patches of hot sunlight.

"This has a major impact in promoting both fresh air quality and the saving of energy", says Noble.

"All these measures mean that people inside the building will experience steady indoor ambient temperatures which respond slowly to outdoor temperature variations. The mixed-mode system design aims for the building's conventional air conditioning system to be active for only 20% of the year.

THE TIMBER FAÇADE

The façade on the top two floors of the building is constructed from locally sourced cross laminated mass timber (CLT) together with the more standard glass and aluminium panels in a unitised system. This is a very significant feature.

"Using timber as both the structural façade element as well as the internal and external finish we believe is a genuine first for South Africa and one that has contributed significantly both to the overall architecture as well as reducing the overall carbon footprint of the building by 60 tonnes CO₂ (equivalent) from the atmosphere," says Noble.

"Our impact on the environment was a key consideration throughout the building project and therefore the 6 Star rating is an incredible achievement. Achieving certification means that we have succeeded, through collaboration with the development team, in building a high-performing, productive workplace that is healthier for our people and the environment," says Wayne Megaw, Operations Leader, Deloitte Africa.

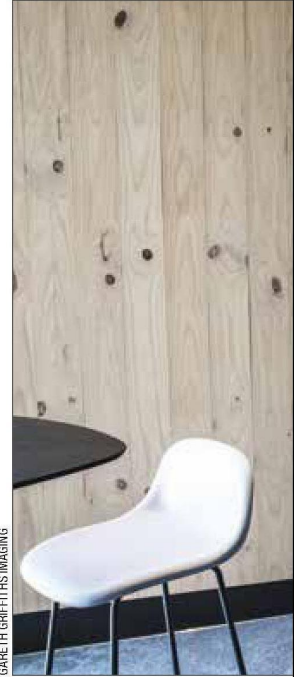
The building is designed to be as comfortable as possible without needing air conditioning to heat or cool. The façade plays a very important part in a range of measures facilitating natural indoor temperature control and fresh air inside the building, instead of conventional air-conditioning, for most days of the year. This yields not only savings in operating costs for heating and cooling, but also greatly benefits the health, productivity, and well-being of building users. Tessa Brunette, the lead project engineer from Arup, says that the use of CLT is a large contributor to the green credentials of this building. "Together with the buildings' intrinsic thermal mass, the façade is the most important 'machine' (controlling indoor environment) in the building. We reached our design response using first principles, in close collaboration with StudioMAS, the architects.

"These design responses were then tested and refined by using advanced computer modelling methods. These included the testing



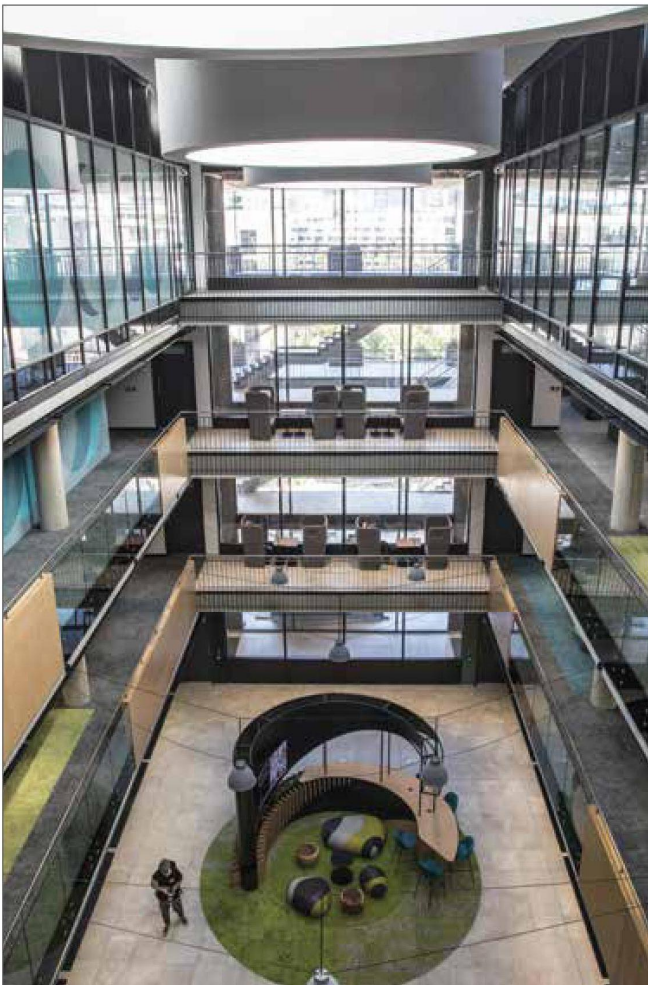


GARETH GRIFFITHS IMAGING



GARETH GRIFFITHS IMAGING

The function of the sawtooth CLT façade corrects the north-south line, meaning that the sun in the east strikes the CLT panel and can't directly enter the building.



GARETH GRIFFITHS IMAGING

The atrium, referred to as the 'central street', helps to pull air through the building, in through the windows and out through the rooflights.

of different glazing types, orientations and shading types. Thus, we identified the optimum combination of orientation vs shading vs glazing type.

“Through an iterative process with many stages of analysis, modelling and interpretation initial modelling, the various options were refined to assess which combinations worked best in conjunction with the architecture and budget.

“Modelling confirmed that the zigzag (pleated) façade that we adopted for building levels 2 and 3 performs as well as a straight deeply shaded façade and allows for more glazing without external shading devices that could obstruct views to the outside and reduce the amount of internal natural light.

“So, the design significantly reduces the amount of direct sunlight entering the building, which in turn means that the internal spaces can largely rely on our mixed mode system and not need air conditioning to remain comfortable,” she adds.

ARCHITECTURAL CRITERIA

“Our role as architect is to combine the logic and practicalities of engineering with the creative arts,” says Sean Mahoney, the Ridge Project Lead Architect, StudioMAS.

According to Mahoney, structurally graded engineered timber is the most natural choice for walling on a sustainability building, where the aim is to incorporate biophilic design principles. The developer and client wanted something that would raise the bar into the realm of natural ventilation and people-centric design.

“A surface made from a natural material which is predominately local, sustainable and at room temperature. It is as green as you can get under the design parameters,” says Mahoney. “This was a collaborative process with Arup, best illustrated by the zigzag timber façade and the atrium with its roof light drums. Both

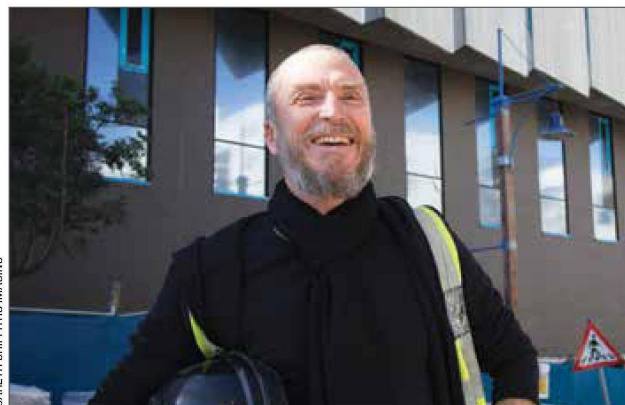


Breakaway area, with a view from the 'inside' of the pleated façade.

these design elements have a strong engineering and design rationale backing them up, but at the same time we have managed to create beauty and joy out of them. They are key to the building's identity and aesthetic and create memorable experiences. These include natural light and natural timber in the case of the façade," he says.

According to Mahoney a major design requirement was the building having an operable façade. This is achieved via the unique pleated (zigzag) façade concept, which fills a vital function from the engineering perspective. He admits that inspiration for the pleated façade came in part from doing origami at his desk in the office. "Triangles as per origami shapes take on a special meaning in this building, as borne out by the façade design and several other design elements. But ultimately the pleated façade is driven by logic: it creates a north-south orientation for the façade, meaning that you can control the effect of direct sunlight.

"Timelessness in architecture is something that many designers strive for. The timber façade itself will evolve and keep functioning over the years, changing colour as it weathers, developing a patina, and making the building stand out as unique."



GABRIEL GRIFFITHS IMAGING

Sean Mahoney, project architect.

The origami concept also plays out in an extraordinary-looking ceiling feature outside the entrance lobby for the building which incorporates a continuum of inverted pyramid shapes.

KEY MATERIAL CONSIDERATIONS

Brunette adds: "It is also vital to make sure that the timber is as durable as conventional cladding materials. This has been done by adding a rain screen of timber cladding outside the CLT structural panels, which are not in themselves weatherproof and are protected by a breathable membrane.

"The rain screen consists of Accoya, a type of board that is made from acetylated South African pine cuts, which have a long service life and are guaranteed by the supplier. They can also be replaced separately, leaving the building still enclosed by the CLT panels so that occupation is not disrupted.

"The glazed and timber saw-tooth façade is prefabricated to enable a swift installation time and ensure a high-quality assembly. Using timber as a key component of the façade allows for the strong but light properties of this material to be taken advantage of in an innovative way, further strengthening the landmark nature of this building as prestigious corporate headquarters. Timber is ideal for prefabrication because it can be machined to very high tolerances."

"Using the initial parametric modelling, we were able to identify a more refined set of options to assess which combinations worked best. It was found that the zigzag façade that we adopted for level 2 and 3 performs as well as a straight deeply shaded façade.

"In essence, orientating the glazing towards the north and south allows for a more glazed façade, without external shading devices that can obstruct views to the outside and reduce the amount of internal natural light. This design significantly reduces the amount of sunlight entering the building, which in turn means that the internal spaces can largely rely on natural ventilation and not air-conditioning to remain comfortable."

BENEFITS OF THE TIMBER FAÇADE

1. The timber façade forms part of a range of measures facilitating natural indoor temperature control and fresh air inside the building for most of the year, instead of conventional air-conditioning.
2. The use of a natural material instead of brick, concrete or additional aluminium and glass in the façade has greatly reduced the Ridge's as-built carbon and energy footprint by lowering its embodied carbon and energy.
3. The structurally graded, FSC-certified engineered timber used in the production of the CLT is sourced from sustainable plantations largely located within the Western Cape. So, this material is both a net sequestrator of carbon dioxide from the atmosphere and, as sourced within the province, also minimises the transport carbon and energy considerations.

Arup's engineers have calculated that 354Mt of CO₂ has been saved by using timber on this project in lieu of conventional materials (such as brickwork), in addition to the usage of a natural material which itself enters the lifecycle of the project with a negative embodied carbon content.

In total, 960m² of CLT timber panels were used in cladding the building, which is the equivalent to 36 tonnes of timber. The CLT timber panels were fabricated at XLAM, a dedicated factory in Cape Town. This is at present the only CLT factory in South Africa, according to the company's Jamey Smily.

GARETH GRIFFITHS IMAGING



From left: Wayne Megaw (Deloitte), Kirsten Goosen, Mark Noble and Fran Ventura (V&A Development Team), at the roof wetting.

THE RIDGE: CLT FAÇADE

Cross-laminated timber (CLT) is classified as an engineered timber, made into panels and used in the construction of houses and commercial buildings. It is manufactured to specifications issued by the relevant authorities.

First developed and used in Germany, CLT is regarded as a fast-rising star in the use of natural materials in construction. The usage of CLT in Europe grew from the early 1990s and the first national specifications were issued by the Austrian authorities in 2002. Usages included housing and for multi-storey buildings. As recently as 2015, USA's National Building Code incorporated CLT, followed by the International Building Code.

CLT is made by gluing together layers of solid-sawn lumber. Each layer of boards is usually oriented perpendicular to adjacent layers and glued on the wide faces of each board, usually in a symmetric way so that the outer layers have the same orientation.

An odd number of layers (3, 5, 7, and so on) is most common (the Ridge uses 5), although even number configurations do exist. Regular timber is an anisotropic material, meaning that the physical properties change depending on the direction at which the force is applied.

"The Ridge features double carbon savings by adopting CLT timber façade construction, making this mode well worth promoting in an age of climate change. Firstly, by choosing CLT, GHG (CO_e) emissions from concrete, steel and aluminium are avoided, all of which have high carbon footprints. And secondly, the CLT stores the carbon dioxide that was absorbed when the tree was growing and locks it away for as long as the building stands," explains Brunette.

Fast facts:

1. Cross-laminated timber (CLT) is similar to Glulam, or 'shutter-board', but the timber grain runs in perpendicular directions in each layer, imparting great cross-direction strength to the product.
2. CLT has become increasingly popular in Europe, the US and Canada. Building codes and specifications have been issued governing its use. It offers unique benefits to the environmental

performance of a building by way of lowering the building's contribution to greenhouse gas emissions.

3. CLT has a very long lifespan.
4. At the Ridge, the CLT panels installed feature a sacrificial layer of timber skin on the outside, which will weather and produce beautiful colours over its lifecycle. It can theoretically be replaced, although it is unlikely that this will be necessary.
5. CLT is a warm and people-friendly material. Inhabitants of the building will benefit by working in an office that features a low emission and low human toxicity material.
6. The Ridge is one of the first commercial buildings in South Africa to feature a timber exterior and interior cladding.

PROFESSIONAL TEAM:

Professional	Company
Landlord / Developer	V&A Waterfront
Tenant	Deloitte
Architect	StudioMAS
Engineering Team (Comprehensive service)	Arup
Project Manager	Mace
Quantity Surveyor	Smith & Co
Interior Architect	Paragon Interface
Main Contractor	GVK Siya Zama
Geo-tech engineer	Core Geotech
Landscape Architect	Planning Partners
Acoustics	SRL
Ecobricks	V&A Waterfront

Façade design, manufacture and installation team:

CLT fabricator	XLAM
Façade – aluminium and glass fabricator and erector	Geustyn & Horak

ACKNOWLEDGEMENTS:

Gareth Griffiths, materials scientist and professional sustainable construction writer.