Pavilion Exhibition

26 May –
26 July 2022

Marina Barrage
8 Marina Gardens Dr,
Singapore 018951

27 August 2022
onwards

EHL Campus (Singapore)
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Singapore 258672

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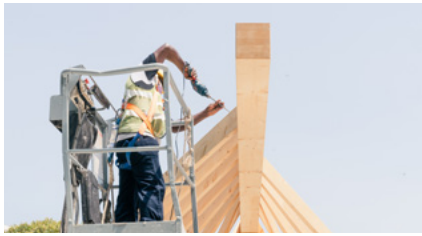
Content Page

Jump to...



Section

Why Build Different? →

Section

The Genesis →

Section

+Pavilion's Spatial Highlights →

Section

Designing A Sustainable Built Environment →

Why Build Different?

back to

next section

As cities continue to emerge and expand, the world is at a tipping point — the current ways of production and consumption are putting an unsustainable strain on the natural resources, temperature and biodiversity of this planet.

The +Pavilion exhibition seeks to unpack what a sustainable built environment entails, and how thoughtful design can ensure that buildings serve its community's needs in an enduring yet everchanging fashion. It illustrates what is waiting in the wings, poised to build a better and greener future.

As we confront the growing effects of climate change, we hope that the +Pavilion represents the best of human creation: breathing life into our buildings through alternative approaches, the use of local and emerging Earth-friendly materials, and designing for both the present and future.

The Genesis

back to
previous section
next section

Like most buildings, +Pavilion started as a conversation around construction: in May 2021, Haring Timber Technology received an invitation from the organizers of Archifest21 to educate their audience on sustainable and innovative wood construction and applications. They decided that this topic deserved to be expanded into a larger discourse on sustainable construction, and quickly assembled a team of like-minded partners, including Deloitte Center for the Edge, Affordable Abodes, and Studio SKLIM.

Leading up to Archifest21, they were soon joined by the Embassy of Switzerland in Singapore, Hilti Construction, and EHL Campus (Singapore). The Embassy of Switzerland suggested that the team gather feedback to conceptualize the +Pavilion project, with the goal to present the project as part of the Swiss Weeks in Spring 2022.

To officially kick-start +Pavilion, the team organized a workshop on innovative sustainable design solutions in conjunction with Archifest21, inviting the public and potential partners to join this bottom-up initiative. The initial design and concept of the +Pavilion around sustainable materials in building and construction was very well received, and inputs from the workshop participants were crucial for the next stage of the project.

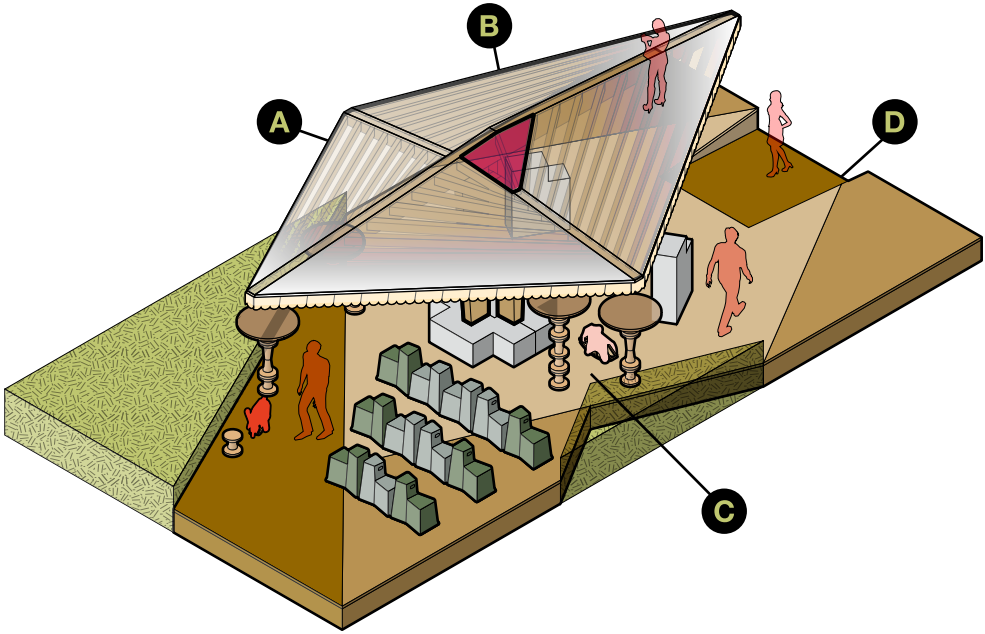
Over the next half a year, this +Pavilion team found that they were not the only organizations interested in promoting sustainable built environment; Vitra, Nespresso and key

partner, UBS, also came on board. This coalition of partners — large and small, private and non-profit — then put their minds and hands together to create the +Pavilion, which the Marina Barrage (under PUB Singapore) graciously agreed to host as their first big event since the Covid-19 pandemic.

By harnessing a diverse pool of resources and talents to address sustainable goals, the organizers of +Pavilion are offering both a sustainable vision for the future, as well as the critical steps that we need to take now to leave a better planet for generations to come.

+Pavilion symbolizes the ‘sum of parts’ approach that is needed to tackle climate change as a whole: starting small, coming together as an ecosystem, and collaborating to turn ideas into reality. This project is just the beginning of something bigger, a showcase of our hopes to transform the way we build.

Pavilion's Spatial Highlights



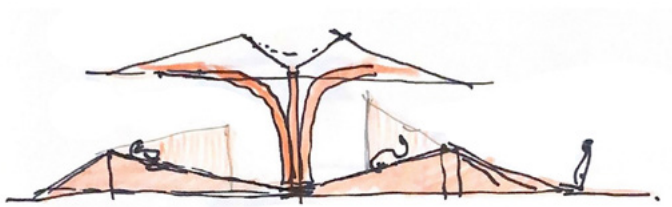
A. Witness the structural capabilities and timeless aesthetic of wood. Pay special attention to the long cantilever at each side, a testament to glulam's structural performance, and the twisting members in the middle, showcasing design flexibility and precision engineering.

B. Look up and see the beautiful central skylights and rain eaves on the roof, made from kenaf fiber biocomposites. Also head over to the Kenafcrete(R) brick exhibit that showcases a 90% biomass replacement for concrete.

C. Take a seat and enjoy the comfort that innovation, longevity, and sustainability can bring. Also look out for the creative use of cork and rattan, blending old and new, and mark your thoughts on sustainable design on the Cork Tree leaves made from upcycled catalogs!

D. Experience the sturdy, yet flexible platform that modular construction and prefabrication can create. Peek at the base to see how the mighty structure is anchored, and note the sustainable reuse of up-cycled decking to finish the platform.

STRUCTURE



The +Pavilion, designed by Studio SKLIM and Haring Group, is structurally supported by two ‘nested’ main members, inspired by the Swiss cross. The main structure is made from Haring Group’s glued-laminated timber — ‘glulam’ — a structural engineered wood product. Glulam provides more design flexibility than traditional timber, and is a renewable and competitive alternative to steel and concrete. The high strength and stiffness of varying grades of timber laminations enable glulam to span large distances without intermediate columns.

Glulam is also one-tenth the weight of steel and one-sixth the weight of concrete; which allows for shorter installation time, lower installation cost and a faster return on investment. Mass timber products, such as glulam, that use raw materials from sustainably managed forests, provide an effective decarbonization solution to the built environment.

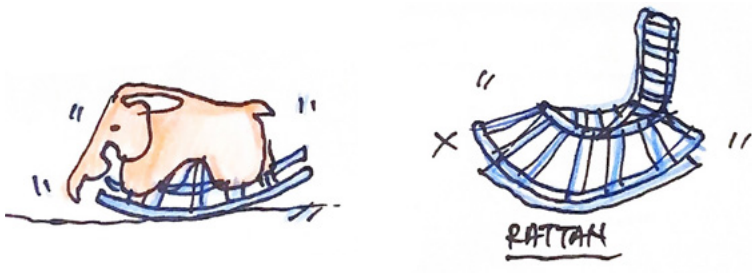
SKIN

The roof, or ‘skin’, of the +Pavilion is partially cladded with kenaf biocomposite segments built by Affordable Abodes and Studio SKLIM. Kenaf is a triple-crop per year tropical plant whose stem can be processed into a natural fiber as an alternative to artificial fibers such as fiber glass. The harder kenaf core can be combined with an industrial waste lime slurry to produce a natural alternative to concrete.

Kenaf plantations themselves act as carbon sinks, and locally grown kenaf can reduce its transportation carbon footprint. The use of kenaf in construction can therefore reduce the environmental impact of the built environment.

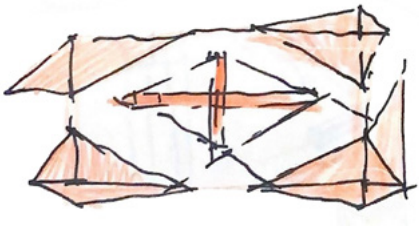
PROGRAM

The +Pavilion is designed to attract attention, and encourage engagement with fellow visitors. The furniture on the pavilion, while providing a place to sit, relax, and interact, were curated to demonstrate different aspects of sustainability, from natural to recycled materials. Cork and rattan furniture are creatively used to highlight natural materials, and Vitra's Tip Ton RE chairs demonstrate the capabilities of recycled polypropylene, made from a mixture of recycled household waste.



As part of the +Pavilion program at Marina Barrage, multiple workshops and gatherings are planned to drive more discourse around sustainable building design and construction.

BASE



The +Pavilion base platform showcases precision engineering, modular construction, and pre-fabrication using Hilti's bolted modular supports. The supports enable productivity gains during installation, while maintaining high health and safety standards. Anchoring the wide-span cantilevered pavilion requires precision engineering for load-bearing and wind-stress.

Covering that anchor is a platform made with engineered bolted supports: modular components pre-fabricated off-site and assembled on-site. The modularity provides design flexibility to create a wide range of engineered structures, and the pre-fabrication allows precision manufacturing unimpacted by inclement weather.

Both lead to more standardized and efficient assembly, translating to overall savings on building construction cost. The bolted modular supports significantly reduce carbon steel usage, enabling carbon footprint reduction, and reuse for future modifications.

Designing A Sustainable Built Environment

back to
previous section

The built environment of every city and country in the world is collectively responsible for 39% of global carbon emissions. Of which 11% is embodied carbon and the remaining 28% is from building operations. Embodied carbon is the carbon released during the manufacturing, transportation, and construction phases of a building. This means that 11% of global carbon emissions are not recoupable once buildings are constructed. Therefore, to effectively reduce the carbon footprint of the built environment, sustainability and circular design techniques must be key priorities from the start of building design and construction process.

Designing sustainable buildings requires more efficient construction methods, and the prioritization of the reusability and the durability of buildings and building materials. Modular pre-fabricated construction is one such construction method that can reduce the embodied carbon emissions of buildings. The carbon emissions of building operations can also be reduced through

incorporating inbuilt and natural efficiencies into the design of a building. Choosing long-lasting building materials and designing for buildings to be reused rather than demolished can reduce the amount of waste and the consumption of raw materials.

Incorporating green design into a building's life cycle and operations can significantly improve the built environment's resource usage efficiency and lower carbon emissions.

I.
DESIGNING FOR EFFICIENT CONSTRUCTION

The global construction industry is one of the most pollutive industries in the world, creating 30% of the waste produced globally. It is clear that the existing framework of the construction industry is highly detrimental to the global environment.

Technology advances have evolved very powerful ‘digital twin’ softwares that can virtually design and test building configurations before construction. These are instrumental in driving productivity during construction, and also allow changes to be made more easily during post-construction operations. Coupled with value engineering, which integrates precise calculations and geometries with construction engineering, less materials would be required for the entire construction life cycle, reducing its impact on the environment.

A shift towards a more sustainable construction framework, like modular pre-fabricated construction,

also helps. Pre-fabricated construction is a construction method that allows builders to design and construct buildings or parts of buildings offsite, before assembling the building itself onsite.

The assembly of these modular components are also less carbon-intensive than traditional welded systems. Multiple construction projects can also be concurrently completed in these offsite factories, allowing materials for one project to be reused or recycled for another project instead of being discarded. Byproducts from certain materials can even be made into composites to construct other modular structures.

The prefabricated buildings and building components can be mass produced, and carefully controlled for material usage, quality and reliability. Not only is pre-fabrication more cost-effective, by achieving economies of scale, the predictable manufacturing conditions can make production more efficient. These conditions also allow for construction processes to be constantly refined, ensuring the most robust and highest quality structures.

II.
DESIGNING WITH NEW MATERIALS

At the heart of green construction lies sustainable materials. The construction industry is currently the largest consumer of raw materials, consuming up to 40% of all raw materials extracted from the earth. Steel and cement, widely used materials in construction, account for as much as 16% of the world's annual carbon dioxide emissions, equivalent to the carbon footprint of the United States. Cement alone is the source of about 8% of the world's carbon dioxide emissions, more than thrice of the carbon emissions from aviation fuel.

To begin undoing the damage the construction sector has caused, we need to reevaluate the types of building materials being used. The Embodied Carbon Calculator for Construction (EC3) is an open-source tool that reliably tracks and compare the embodied carbon of raw building materials. Companies, like Microsoft, have used EC3 to identify and utilize low-carbon materials in their construction projects to reduce embodied carbon emissions. One of the most effective ways to utilize low-

carbon materials is to use recycled versions of traditional materials, including steel, concrete and glass.

We also need to switch to using sustainable, low-carbon, and non-toxic building materials. Mass timber products like glued-laminated timber (glulam) are a more sustainable alternative to concrete and steel. Glulam requires less energy to manufacture than traditional steel and concrete, and has a negative carbon footprint. Designed for heavier loads, longer lifespans, and formal flexibility, glulam can resist fire induced deformation and possesses a structural strength comparable to steel. Kenaf and hemp are natural alternatives to cement that can be used in building and insulation materials.

Both can be processed into concrete composites for constructing walls and mason blocks, reducing the need for cement. Kenaf plantations are also prevalent in Malaysia and Indonesia, which curtail transportation emissions when used for development projects within Southeast Asia.

III.
DESIGNING FOR GREENER OPERATIONS

The carbon emissions generated by building operations account for 28% of global carbon emissions. While many usually push for greener versions of building fixtures to be installed over regular fixtures, such as greener forms of dimmable lighting and solar water heaters, there are more effective ways to green building operations.

Buildings should be designed to complement their surrounding environment. For example, better insulated walls or green facades can be used to keep buildings cooler, longer, than energy efficient air-conditioning. This is especially pertinent to Singapore, where air conditioning accounts for up to 60% of a building's total energy load. Designs should prioritize environmentally complementary features to create homeostatic building environments that can self-regulate and operate with maximum efficiency. Google's newest Bay View complex near the San Francisco Bay is a great example. The complex contains geothermal wells that can store heat

to warm the building without natural gas, and solar roof panels with a unique textured glass that prevent glare.

Advanced computing power allows us to design, model and test such ‘greener’ buildings better than ever before. Self-regulating buildings are typically augmented with precision environment management technology, like the use of Internet of Things (IoT) systems and sensors to tailor the building’s operations to the occupants’ usage and behavioral patterns to maximize resource efficiency.

The globally recognized Leadership in Energy and Environmental Design (LEED) certification scheme is spearheading the effort to provide a framework for healthy, highly efficient, and cost-saving green buildings. In Singapore, the Green Mark certification scheme provides a similarly comprehensive framework for assessing the overall environmental performance of new and existing buildings to promote sustainable design, and best practices in construction and operations in buildings.

IV.
DESIGNING FOR REPURPOSE

The most sustainable type of construction is actually no construction at all. Instead of demolishing buildings that have outlived their original purposes, we can transition to adaptively reusing and repurposing them instead. Reusing and repurposing buildings can eliminate the energy and resources required to demolish and rebuild the site.

In land and resource-scarce Singapore, it is crucial for the built environment to constantly adapt and cater to the evolving needs of its residents. Designing reusable spaces can provide that type of flexibility, and also maximizes the use of existing land and resources. Repurposing redundant buildings can give them a new lease of life.

Building components can also be reused. Modular construction, which consists of interoperable components that can be flexibly used in a wide range

of design configurations, encourages the repurposing of different building components. This is a big driver to move away from hazardous hot works which don't allow modifications and future reuse.

That said, not all buildings can or should be repurposed. New buildings also tend to be more energy efficient and relevant for modern use. The Edge in the Netherlands, one of the greenest buildings in the world, not only produces more electricity than it consumes but has leveraged on cutting edge technology to optimize operational efficiency.

However, instead of using the indiscriminate wrecking ball approach when demolishing old buildings, the careful removal of individual materials in the existing building for reuse can still reinforce circularity in the construction process. Useful tools, such as Building Information Modelling (BIM), can carefully catalogue materials used in construction, and make it easier to preserve materials in the demolition process.

IV.
FINANCING SUSTAINABLE BUILDINGS

Sustainable finance is the final linchpin in achieving a sustainable built environment. Sustainable finance refers to the practice of integrating environmental, social and governance (ESG) criteria into financial services and investment decisions to achieve sustainable development outcomes.

In the context of the built environment, green financing can be obtained at any part of the development process, from construction to operations. Many financial institutions have set aside financial instruments with preferential benefits dedicated to funding sustainable projects, like green loans and green bonds. Projects that utilize modular and pre-fabricated construction can qualify for green loans with typically lower interest rates, as these construction methods can reduce their carbon footprint.

As financial institutions and investors focus on ESG-aligned investments, their funds would be increasingly

redirected from unsustainable assets, like palm oil plantations, towards climate-friendly assets, like kenaf and hemp plantations, benefitting projects utilizing kenaf or hemp as alternative construction materials. Projects that renovate and repurpose old buildings can typically enjoy public grants and green funding from both the private and public sectors as well.

Sustainable developments that achieve green building accreditations through sustainable design and operational efficiency are typically eligible for green financing from financial institutions. For example, Minergie-certified green buildings can tap on green funds from UBS. In July 2019, Frasers Property secured Singapore's first green loan with a reducing pricing structure linked to the Green Mark, with savings from the second year onwards if the properties maintain the requisite green standards.

Sustainable finance will undoubtedly be a key influence for the construction industry's evolution towards sustainable practices, both in terms of construction methods and the life cycle of the built environment.

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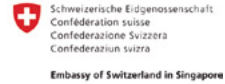

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