GREEN COUNCIL
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Webinar:
Building and Construction – What are the missing hotspots?

Contribution of Bamboo in Carbon Net Zero, Limitations in Hong Kong and Way forward

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CONTRIBUTION OF BAMBOO IN CARBON NET ZERO, LIMITATIONS IN HONG KONG AND PROPOSED WAY FORWARD

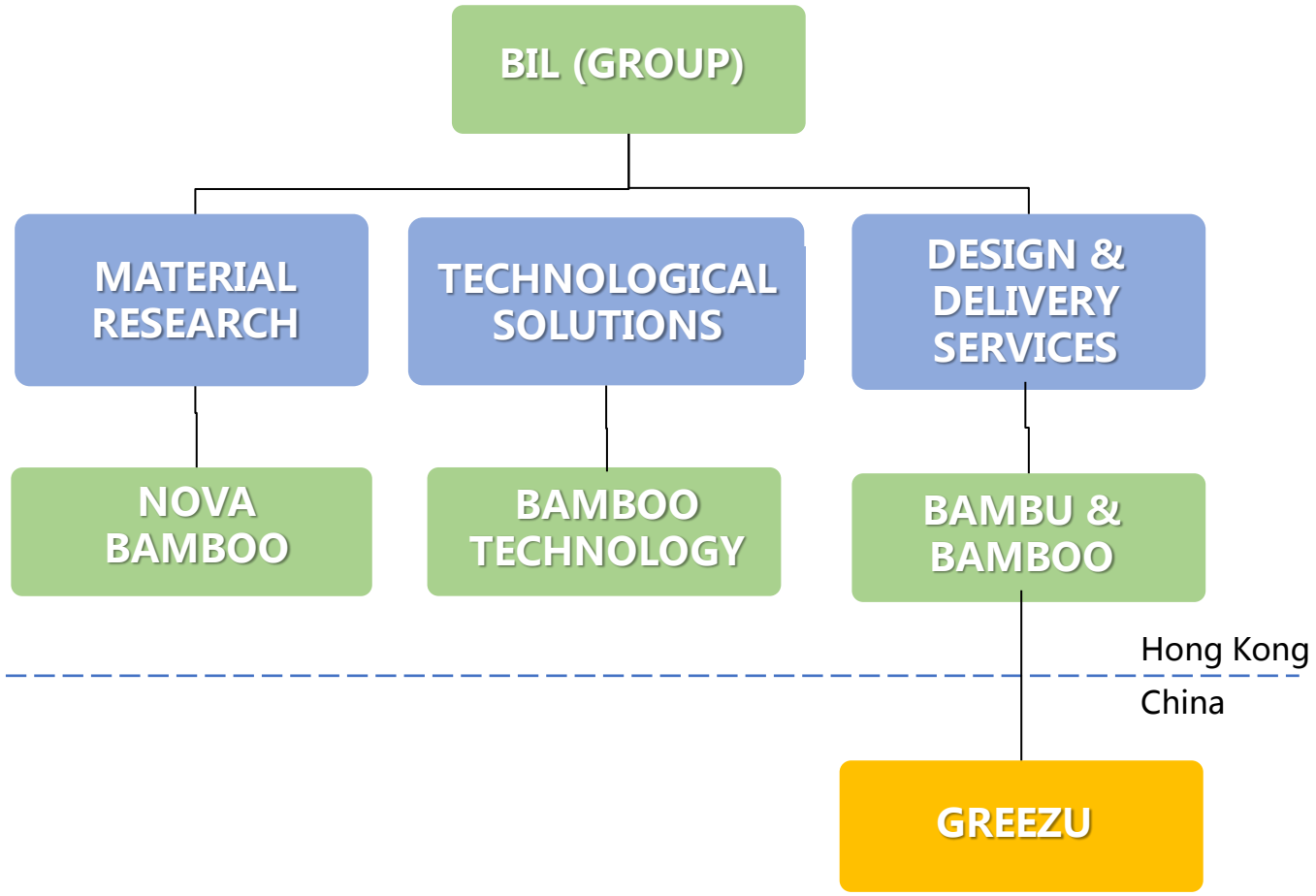
nova bamboo

Bamboo Technology

BIL

ABOUT BIL

BIL GROUP OF COMPANIES



A FULLY INTEGRATED BAMBOO PLATFORM – CONTRIBUTION TOWARDS CARBON NEUTRALITY

At present, there are three main business lines:

1. Bamboo design and delivery services
2. Bamboo related technological solutions
3. Bamboo material research and production

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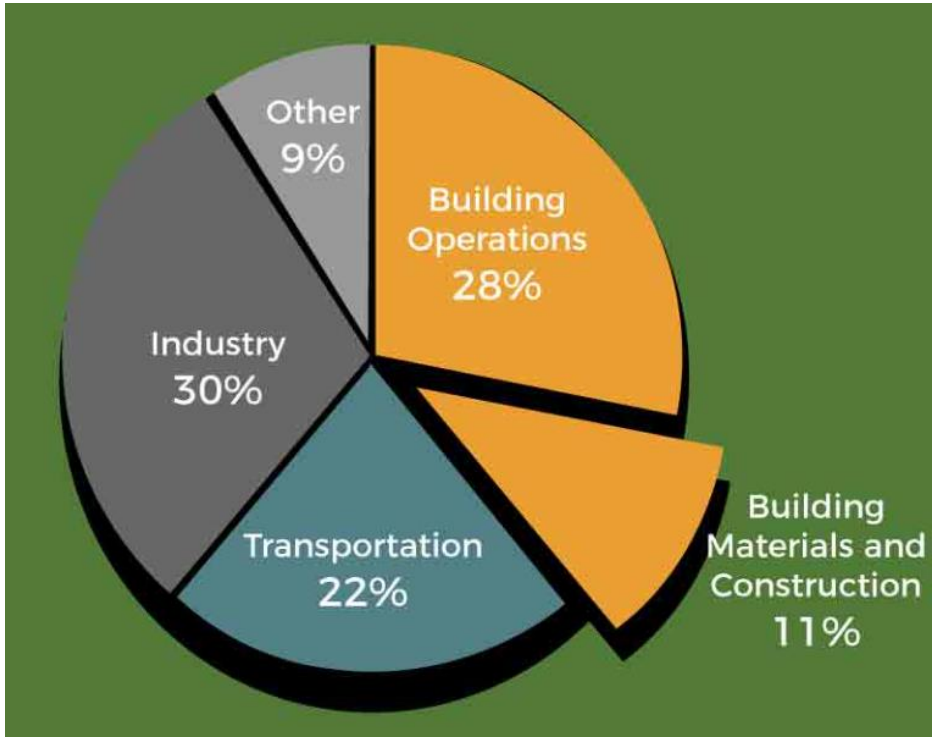
BACKGROUND

TO ACT NOW TO TACKLE EMBODIED CARBON



Historically the building community has been focusing on operational carbon, including the use of relatively high embodied carbon materials, such as insulation, for long-term operational carbon saving. Recently it is recognized that the focus must be on saving in both embodied and operational carbon:

1. **Accelerating climate crisis**: The world is already at a stage where we must tackle the carbon problem within a short time frame. We can no longer "front-load" future operational carbon saving into the construction of our buildings.
2. **Trend of increasing embodied carbon**: As we build buildings with lower operational carbon loads, embodied carbon is accounting for an increasingly higher percentage of carbon impact. Based on a "business as usual" projection, the total carbon emissions of embodied carbon will catch up and be equal to operational carbon in 2050.

CHINA LEADING THE WAY

China fully recognizes the urgency of tackling embodied carbon in building materials:

- In October 2022, the Ministry of Finance, Ministry of Housing and Urban-Rural Development and Ministry of Industry and Information Technology have jointly issued the Circular on Extending the Implementation Scope of Policies on Government's Procurement of Green Building Material to Improve Building Quality (关于扩大政府采购支持绿色建材促进建筑品质提升政策实施范围的通知);
- In November 2022 the Central Government issued a leading policy directive "the Action Plan on Peaking Carbon Dioxide Emissions in the Building Materials Industry" (建材行业碳达峰实施方案), which aims to control the total carbon emissions in building materials;
- **Particularly China has identified bamboo as the mainstay in the reduction of embodied carbon**. The National Forestry and Grassland Administration, the National Development and Reform Commission and eight other Ministries jointly issued a policy paper in November 2021: "Accelerating the Innovation and Development of Bamboo Industry" (林改发〔**2021**〕**104**号文件) to establish a clear policy direction:
  - Establish China as a world leader in the bamboo industry by 2035, anchored by a group of internationally competitive bamboo companies; and
  - Reach RMB700 billion and RMB1 trillion in total economic output from the bamboo industry by 2025 and 2035, respectively.

ENGINEERED BAMBOO

ENGINEERED BAMBOO – THE INDUSTRIAL PROCESS

Transportation

Sizing of the Raw Material

Splitting of bamboo culms

Rough shaving

Fungus treatment colors

Drying

Moisture content control

Precise shaving

Color sorting

Application of glue

Assembling

Hot press

Transportation

Bamboo Harvesting

ENGINEERED BAMBOO – PHYSICAL PROPERTIES & COMPARISON WITH TIMBER

ENGINEERED BAMBOO – Nowadays engineered bamboo is widely used in Europe and the US. As a building material, bamboo is robust, stable, and relatively maintenance friendly.

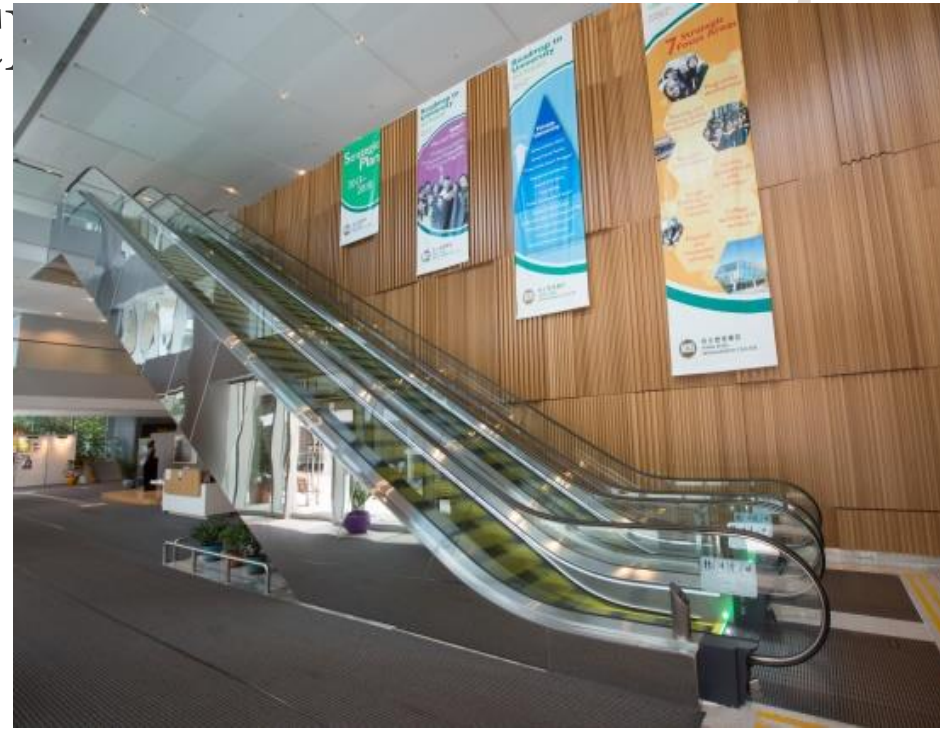
ENGINEERED BAMBOO vs TIMBER (engineered bamboo is more robust than most timber in building application) :

	Density(kg/cm)		Compression(MPa)		Tension(MPa)		Shear(MPa)	Bend(Mpa)	
Solid bamboo	686		77		90		16		77-83
Strand woven bamboo	1163	86		120		15		119	
Sitka spruce timber	383		36		59		9		67
Douglas-fir timber	520		57		49		11		68

In addition to the above-mentioned, engineered bamboo is also tested in compliance with the following standards, providing technical justifications for a wide range of building applications:

(1) Compliance with fire retardant test (BS 476 part 6/7)
(2) Compliance with the US fire standard (ASTM E119)
(3) Resistance against termite (EN 117)
(4) Resistance against mould fungi (not infested under DIN EN ISO 846:1997-10)
(5) Durability (Class 1 under EN 350:2016 and CEN/TS 15083-2)
(6) Resistant against 20:80 cleaning bleach chemical (ISO 26987:2008)

ENGINEERED BAMBOO – BIL EXPERIENC



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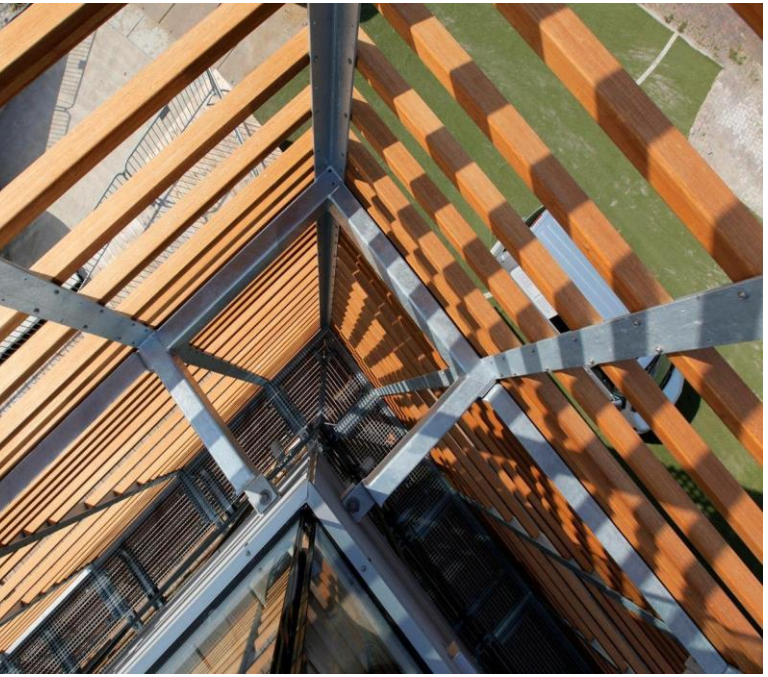

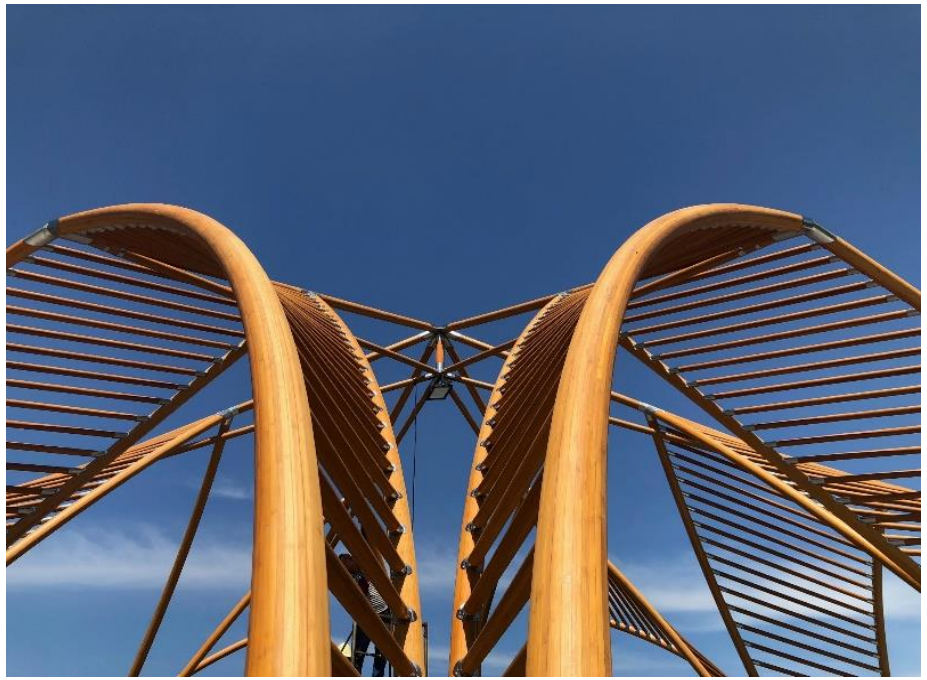

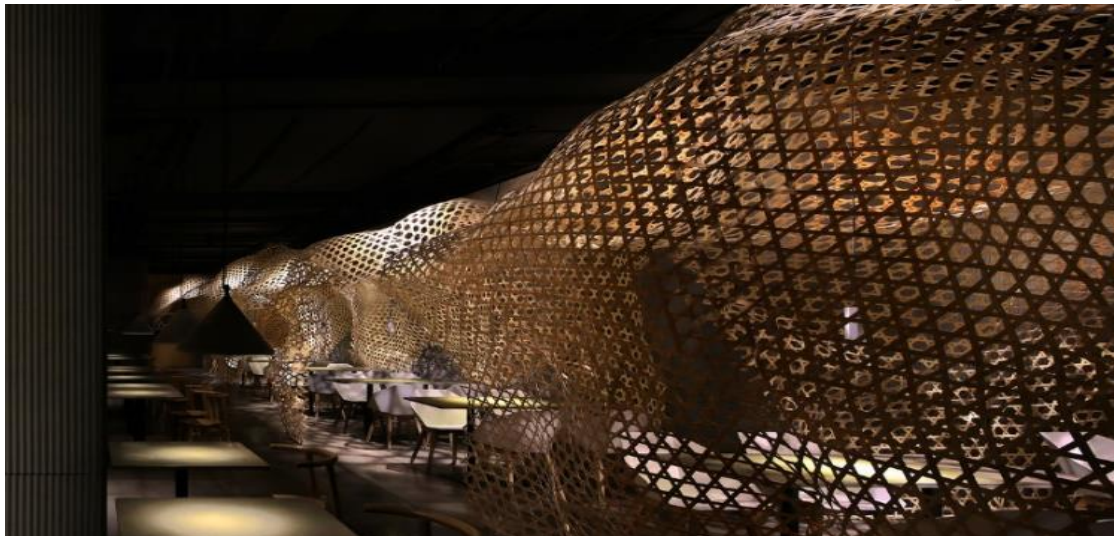

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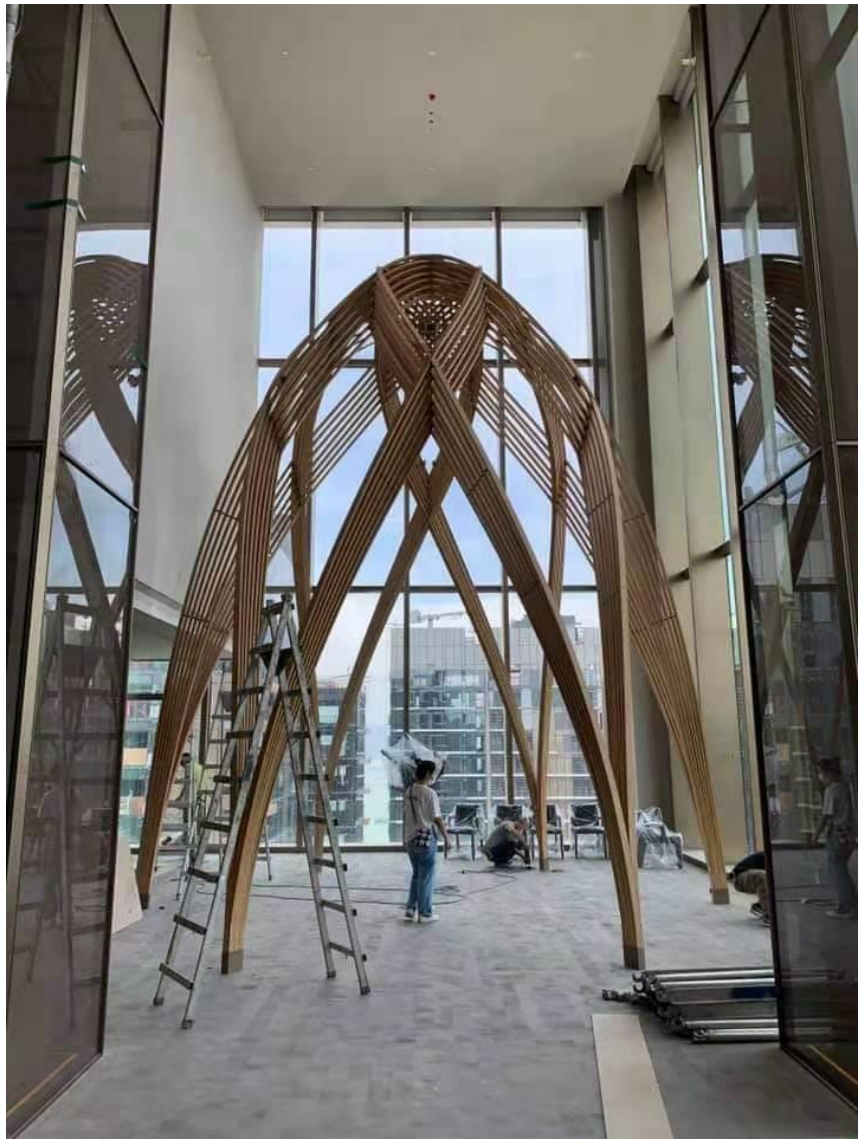

CONTRIBUTION OF A BAMBOO BASED MATERIAL DIET TOWARDS CARBON NET ZERO

BAMBOO MATERIAL DIETS FOR CARBON-NEUTRAL CONSTRUCTION

Recently in Europe there have been active research on **“Building Material Diet”.** Research has shown that the next area for significant reduction in global carbon footprint lies in replacing, where possible, with building materials having a lower cradle-to-grave emissions.

Through life cycle assessments (LCA), we understand that bamboo is one of the lowest carbon emission materials that exist, and that a **“bamboo based material diet strategy” could potentially lead to carbon neutrality in construction.**

Therefore, the use of bamboo as a substitute for timber or other high carbon emissions building materials must be the next big plan for the World and Hong Kong to achieve carbon neutrality.

ENVIRONMENTAL Science & Technology

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Article

Material Diets for Climate-Neutral Construction

Olga Beatrice Carcassi,* Guillaume Habert, Laura Elisabetta Malighetti, and Francesco Pittau

Cite This: https://doi.org/10.1021/acs.est.1c05895 Read Online

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ABSTRACT: The climate crisis is urging us to act fast. Buildings are a key leverage point in reducing greenhouse gas (GHG) emissions, but the embodied emissions related to their construction often remain the hidden challenge of any ambitious policy. Therefore, in this paper, we explored material GHG neutralization where herbaceous biobased insulation materials with negative net-global warming potentials (GWPs) were used to compensate for building elements that necessarily release GHGs. Different material diets, as well as different building typologies, were modeled to assess the consequences in terms of biobased insulation requirements to reach climate neutrality. Our results show that climate-neutral construction can be built with sufficient energy performance to fulfill current standards and with building component thicknesses within a range of 1.05−0.58 m when timber- and bamboo-based construction is chosen. Concrete-based ones require insulation sizes that are too large and heavy to be supported by the dimensioned structures or accepted by urban regulations. Moreover, a time horizon of 20 years is more appropriate for assessing the contribution of material shifts to biobased materials in the transition period before 2050. This paper demonstrates that this is technically feasible and that climate neutrality in the construction sector just depends on the future that we choose.

KEYWORDS: *climate-neutral construction, embodied GHG, fast-growing biobased material, GWP_{bio}, material GHG compensation*

1. INTRODUCTION

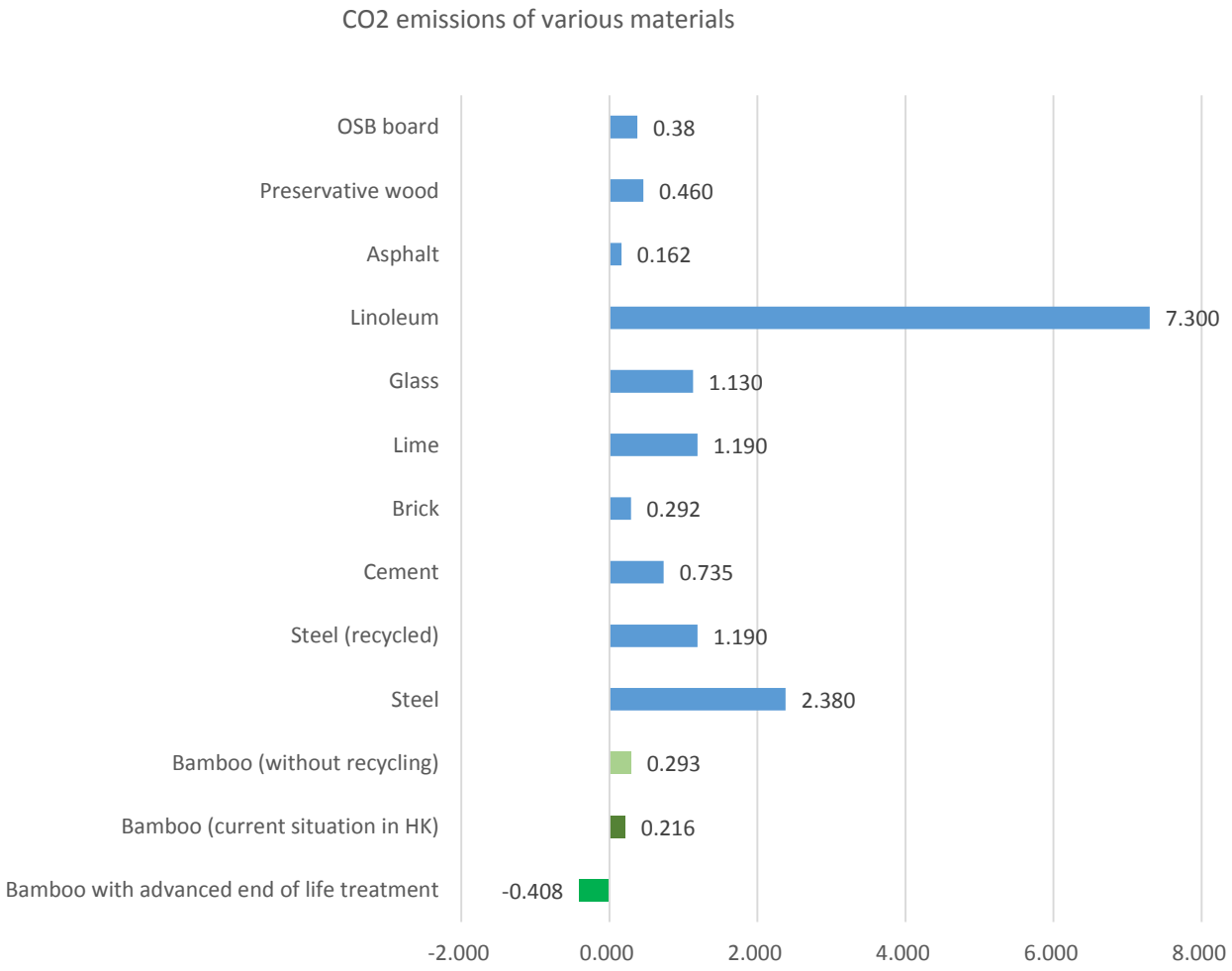
The climate crisis is prompting an intensive examination into the reduction of anthropogenic greenhouse gas (GHG) emissions.[1] Because the latest IPCC report highlighted that limiting warming to close to 1.5 °C or even 2 °C will be beyond reach without immediate, rapid, and large-scale reductions in GHG emissions,[2] the question of budgets and orientations for future industries has become more stringent.[3] The new Green Deal in the EU[4] and many national climate-neutral initiatives have been engaged.[5,6] Although current efforts are still clearly not in line with planetary boundaries,[1] the objective of a net-zero emission target by mid-century is an accepted goal.

Buildings are clearly identified by policy makers as a key leverage point to reduce GHG emissions.[7] Current research has traditionally focused on the use-phase emissions of cycle,[12] the operational emissions can be cut with the energy transition toward low-carbon alternatives and virtuous user behavior.[11] In addition, the production and construction emissions are actuated in the early building life-cycle stage according to today's energy mix and material production technologies without the possibility of being diminished.[11,15,16] In fact, embodied emissions are manifested as a "carbon spike", that is, a consistent amount of emissions occurring now in a short span of time,[17,18] with the risk of consuming the remaining GHG budget that should be employed to manufacture low-carbon energy production plants and meet the climate neutrality target for 2050.[19,20]

1.1. Existing Climate-Neutral Strategies for Construction. Strategies for mitigating embodied construction emissions currently focus on the reduction of building construction and demolition waste,[21] on the enhancement of material efficiency[9] or by choosing alternative materials

Reference: https://doi.org/10.1021/acs.est.1c05895
Authors: Olga Beatrice Carcassi / Guillaume Habert / Laura Elisabetta Malighetti / Francesco Pittau

ENGINEERED BAMBOO AS A BUILDING MATERIAL HAS THE LOWEST EMBODIED CARBON



Source: Hypothetical assessment of embodied carbon content (NP026472-00) by Dr Dong Liang

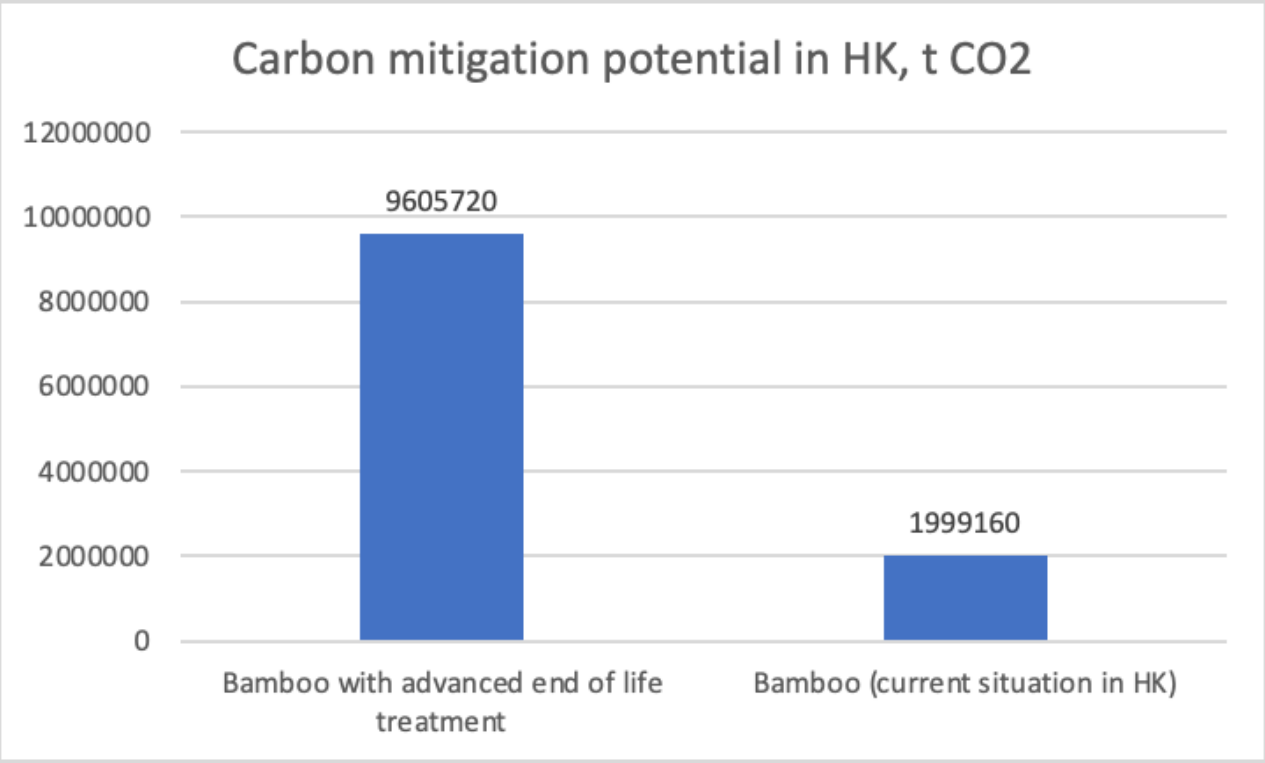
In a local Consultancy Report in which a full life cycle carbon emissions (embodied carbon) assessment of engineered bamboo was carried out.

These results highlight the significant carbon mitigation potential of engineered bamboo due to its high carbon sequestration and the relatively low carbon input in the manufacturing process, in contrast with most other common building materials.

POTENTIAL IMPACT OF A BAMBOO MATERIAL DIET IN HK

The same Consultancy Report also simulates the potential carbon benefits if engineered bamboo is used to substitute for wood-based materials for all the buildings in Hong Kong. The results show that the carbon mitigation could be as high as 9,605,720 ton CO2 (based on Europe and Japan advanced end of life treatment) and 1,999,160 ton (based on current situation in Hong Kong), amounting to 28.42% and 5.91% respectively of the total CO2 emissions in Hong Kong in 2020.

It is obvious that if we expand the scope of material diet considerations to other high carbon emitting building materials such as PVC and aluminium, the impact could be even more significant



Source: Hypothetical assessment of embodied carbon content (NP026472-00) by Dr Dong Liang

Note:

1. "Advanced end-of-life treatment": assumed 90% bamboo waste used for power generation and 10% to landfill
2. "Current situation in HK": assumed no bamboo recycling

LIMITATIONS IN HONG KONG & PROPOSED WAY FORWARD

OBSTACLES IN BAMBOO APPLICATION IN HONG KONG

1. A conservative culture and a lack of initiative to move away from "known devils": Engineered bamboo, far from being an inferior material to wood or wood composite, is simply a relatively unknown quantity lacking in HK project reference. We suggest the Government leads the way in considering engineered bamboo and other low embodied carbon building materials solely on its technical merits and demerits, instead of prioritising project reference as a key factor of consideration, which will only deny any chance of industrial innovation – "innovation" by definition does not contemplate previous project reference.

2. **Lack of regulatory framework:** There is currently no regulatory framework for the building submission of engineered bamboo. Unfortunately, the Buildings Department is not open to any engineering approach to consider engineered bamboo on its technical merits, nor to consider relevant bamboo related ISO or ASTM standards, though we know that low-rise structural bamboo is technically feasible based on the experience in other parts of the world.

3. **Fire regulatory compliance:** Currently in Hong Kong, all building materials must comply with BS476 part 4 non-combustibility for building façade and certain other applications. This requirement essentially rules out all bio-based materials. We query the technical justification of the differences in requirements when we are aware that engineered bamboo façade and structure are not uncommon in the US and Europe. Given that the fire safety of engineered bamboo is not beyond the realm of what is internationally acceptable, we ought to revisit our technical requirements for fire regulatory compliance to ensure we are not unduly inhibiting innovation in our local markets.

PROPOSED WAY FORWARD

1. **Encourage bamboo plantation in public spaces**

- **No existing regulatory barriers:** As bamboo is part of the grass family, there are no regulatory barriers in Hong Kong for the plantation of bamboo in any green belt, slope, public park or other outdoor facilities.
- **Low maintenance:** Bamboo thrives in the Southern Chinese geographies and is suitable for the climate of Hong Kong. We encourage Government Departments including ArchSD, AFCD and CEDD to consider natural bamboo plantation. Unlike trees, bamboo plantation is low-maintenance and does not require rigorous management.
- **Alleviate air pollution:** Based on Government statistics, all the major pollutant concentration levels in Hong Kong fall short of the goals set by the World Health Organization (WHO) except sulphur dioxide. Bamboo can improve the general air quality in Hong Kong through release of negative oxygen ions (2 times concentration compared with evergreen broad-leaved trees).
- **Solution for problem soils:** Bamboo thrives on problem soils. It could be an efficient and effective measure in restoring degraded lands in the New Territories.
- **Natural soil retaining alternative:** The strong soil retaining ability of bamboo root system makes it a viable natural low carbon alternative to soil retaining measure, thereby reducing the usage of high carbon emitting materials such as steel and concrete.
- **Natural noise barrier:** Bamboo plants along vehicular roads could function as natural low carbon noise barrier instead of traditional carbon intensive metal barriers.

PROPOSED WAY FORWARD

2. **General building applications**

- **Engineered bamboo is a proven building material.** Engineered bamboo is widely used in the US and Europe. There are numerous test reports confirming that engineered bamboo is a robust building material suitable for a wide range of applications. We encourage ArchSD, Housing Authority and perhaps Hospital Authority to consider a wider application of engineered bamboo based on its technical merits.

3. **Structural applications**

- **There are existing ISO standards for reference.** In 2013, INBAR and ISO Technical Committee of Timber Structures have formed a Working Group focusing on the structural uses of bamboo. To date, there are three published ISO standards on engineered bamboo structures:
  a. ISO 19624:2018: Bamboo structures – Grading of bamboo culm – Basic principles and properties
  b. ISO 22157:2019: Bamboo structures – Determination of physical and mechanical properties of bamboo culms – Test methods
  c. ISO 22156: 2021: Bamboo structures — Bamboo culms — Structural design

PROPOSED WAY FORWARD

3. Structural applications (cont'd)

An important breakthrough was made on 22 June 2022. ISO published a key new standard (ISO 23478:2022) on engineered bamboo structures. The new standard elucidates new test methods for determining the physical and mechanical properties of engineered bamboo products. ISO 23478:2022 contains a suite of methods for testing the "mechanical properties of engineered bamboo products," which can be used to provide a foundation for designing and constructing bamboo structures. In addition, dimensions, moisture content and density are defined. The document is applicable to "prismatic shapes of glued laminated bamboo and bamboo scrimber" intended to ensure structural integrity.

The Buildings Department of Hong Kong should consider adopting the above-mentioned based on technical merits, thereby offering an opportunity for structural bamboo in Hong Kong.

4. **Fire compliance.** Besides British Standards currently adopted in Hong Kong, the Government could also consider referencing other relevant international standards including ASTM standards. For example, ASTM E119 evaluates the duration for which building construction materials and assemblies can either contain a fire, retain structural integrity, or both, and could be a more inclusive standard against which all building materials (including engineered bamboo and other carbon-based materials) can be measured to determine its fire safety.

PROPOSED WAY FORWARD

5. Innovative Bamboo Materials

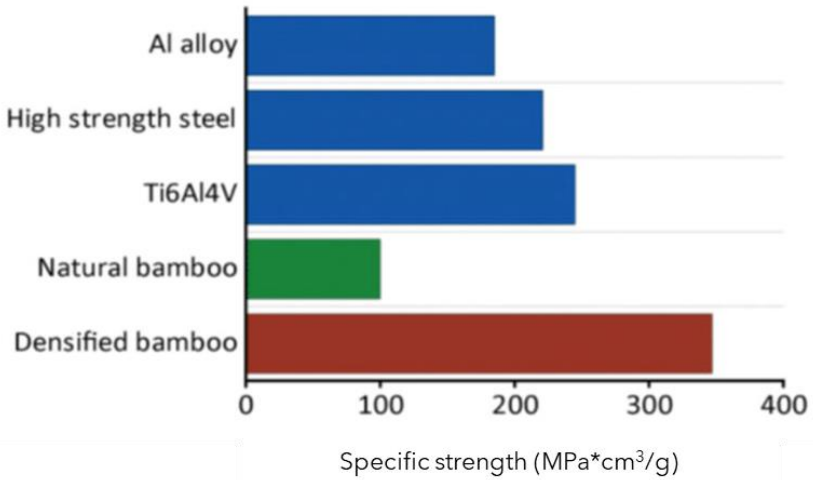
There is clear evidence that R&D can further improve the physical properties and therefore expand the scope of application of engineered bamboo. We understand that a new award-winning engineered bamboo material called “Super Bamboo” is entering the productization phase. Super Bamboo has two key advantages over traditional engineered bamboo:

- Do not require any adhesive to form the final product, and
- Superior strength comparable with steel.

Inventions Geneva **Gold Award** in International Inventions Geneva 2021

Institution of MECHANICAL ENGINEERS **Merit Award** in IMechE Mechanical Innovation Award 2022

- US & HK **Patent** Granted
- Funded by **HKTech300** Seed Fund & Angel Fund. **HKSTP** Ideation & Incubation.



CONCLUSIONS AND NEXT STEP

We can conclude that:

1) We must act now to tackle embodied carbon. China is already leading the way;
2) Engineered bamboo is an internationally proven building material with close to neutral embodied carbon. A wide application of engineered bamboo replacing other high carbon emissions building materials will lead to significant overall reduction in embodied carbon;
3) Based on international experience, there doesn't seem to be any major obstacles, from technical perspective, hindering a wider application of bamboo in Hong Kong. It is more a matter of whether we are willing to commit to bamboo;
4) An internationally competitive local bamboo industry will be a good integral part of the Government's strategic objective to promote local R&D and re-industrialization.

Accordingly, we urge the Government to take immediate action:

1) To include tackling embodied carbon in Hong Kong's Climate Action Plan 2050;
2) The responsible Government departments to actively look into the use of bamboo and other low embodied carbon building materials;
3) To offer policy support in local bamboo industry.

THE END

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