

THE SINGAPORE ENGINEER

MAY 2025
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HVAC Engineering

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SUSTAINABLE
ENGINEERING**

COVER STORY:

A circular economy approach to combat sea level rise – ver 2.0





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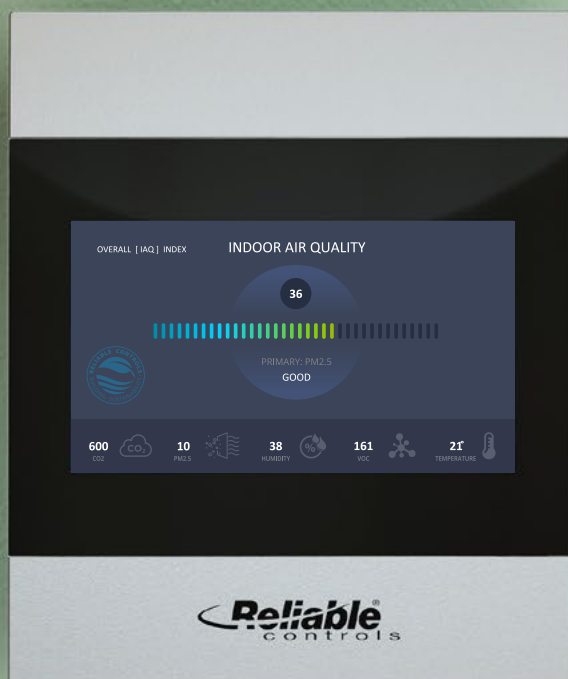
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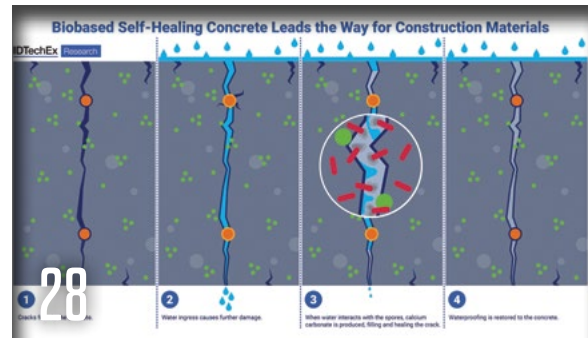
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A warm welcome to our new members!

The Institution of Engineers, Singapore (IES) warmly welcomed its latest cohort of new members at the New Members Welcome Reception held on 25 April 2025 at the IES Academy (IESA), Devan Nair Institute for Employment and Employability.

The evening commenced with a welcome speech by Er. Joseph Goh, Vice President and Chair of Professional Accreditation & Membership, who encouraged members to take full advantage of their IES journey through professional development, committee involvement, and active participation in the institution's upcoming events and initiatives.

As part of the evening, Er. Goh also presented each new member with a specially curated welcome package, consisting of an IES ball cap, polo T-shirt, and tote bag – symbolic tokens of their entry into the IES community.

The programme continued with insightful presentations on IES and IESA by Mr Chow Kok Wah, Programme Director, IESA,



Insightful presentations on IES and IESA were delivered by Mr Chow Kok Wah, Programme Director, IESA, as part of the New Members Welcome Reception.

who shared valuable information on the institution's mission, development pathways and training opportunities. Members were introduced to various initiatives such as the Engineers Leadership Programmes and the upcoming IES Digital Academy.

The evening concluded with a networking session, providing new members the chance to connect with fellow engineers and IES leaders in a friendly and engaging setting. The reception fostered meaningful conversations and a strong sense of belonging,



The reception concluded with a networking session.

setting the stage for continued involvement and growth within the IES community.

IES receives May Day Award!

The Institution of Engineers, Singapore (IES) is pleased to be named a recipient of the Partner of Labour Movement Award at the 2025 May Day Awards.

Presented by NTUC, this prestigious award recognises IES's steadfast commitment to advancing the engineering profession by enhancing career development opportunities, championing lifelong learning and driving workforce transformation.

From spearheading the Engineers Progression Pathway to becoming the first U Associate to sign a Company Training Committee (CTC) agreement with NTUC, IES has tirelessly empowered engineers at every



Mr Syafiq Shahul (right) Executive Director, IES, receives the Partner of Labour Movement Award at the 2025 May Day Awards.

stage of their journey.

This award also reflects a decade of meaningful progress in building a resilient, future-ready engineering workforce in Singapore. We have trained over 1,000 engineers through our leadership programme



Mr Syafiq Shahul and Mr Chong Kee Sen, IES Emeritus President and Chairman of IES Academy Board, with the Award.

and attracted more than 600 engineers to join NTUC as members.

Thank you NTUC and all our partners who have journeyed with us. Here's to deeper partnerships, a stronger profession and a brighter future for Singapore.

IES and the Singapore Army to jointly promote professional recognition for army engineers

IES is honoured to collaborate with the Singapore Army to advance professional recognition for army engineers through structured accreditation pathways under the Army Engineering Professional Pathway (AEPP).

The Memorandum of Understanding (MoU) was signed on 25 April 2025 by Mr Lew Yii Der, Deputy Chairman for Chartered Engineering Board, on behalf of IES, and Commander Combat Service Support Command (CSSCOM) Military Expert 7 (ME7) Tan Mu Yen, representing the Singapore Army. The signing was witnessed by Brigadier-General (BG) Cai Dexian, the Chief of Army, and Mr Mervyn Sirisena, Vice President & Chair of Professional Development, IES.

This landmark agreement seeks to strengthen the academic and career development of army engineers, empowering them to make greater contributions to the Singapore Army. Through the MoU, army engineers will be supported in attaining IES Chartered Technologist and Chartered

Engineer certifications, bolstering their expertise and enhancing operational readiness.

As part of this five-year collaboration, IES will enhance technical competencies through conferences, educational workshops and seminars; encourage engagement via community-building and

networking initiatives; and promote professional standing through industry outreach and public awareness efforts.

Together, IES and the Singapore Army are committed to shaping a resilient, future-ready defence engineering corps equipped to meet today's demands and tomorrow's challenges.



The MoU was signed by Commander Combat Service Support Command (CSSCOM) Military Expert 7 (ME7) Tan Mu Yen (seated, on left), on behalf of the Singapore Army and Mr Lew Yii Der (seated, on right), Deputy Chairman for Chartered Engineering Board, on behalf of IES. The signing was witnessed by Brigadier-General (BG) Cai Dexian (standing, on left), the Chief of Army, and Mr Mervyn Sirisena (standing, on right), Vice President & Chair of Professional Development, IES.



Officers of the Singapore Army and IES representatives, at the MoU signing ceremony.

Guiding Singapore property owners towards enhancing flood resilience

PUB, Singapore's National Water Agency, has launched an Alliance for Action (AfA) to co-create a Flood-Resilient Developments (FRD) guidebook that can be used to enhance the resilience of premises to inland and coastal flooding. The AfA will draw upon the industry experience and expertise of the members to create a practical, user-friendly guidebook for property owners, developers and industry professionals.

Announced at the Ministry of Sustainability and the Environment's Committee of Supply (COS) debate in March this year, the new FRD guidebook will complement PUB's Code of Practice (COP) for coastal protection. It will contain guidelines to assist building owners and developers in enhancing the flood resilience of their developments, a toolkit of measures that landowners can consider adopting for their premises, and case studies of how such measures have been adopted.

Guidebooks for implementing flood-resilient developments have been published in other countries, including the US, Netherlands and Japan. The AfA will reference these publications when developing the FRD guidebook for Singapore's context.

The 11-member AfA committee comprises a mix of architects, engineers and developers and is co-led by Mr Ong Tze-Ch'in, PUB's Chief Executive, Ar Melvin HJ Tan, the Immediate Past President of Singapore Institute of Architects (SIA), and Er. Lim Peng Hong, President of Professional Engineers Board (PEB). The AfA will:

- Develop a user-centric guidebook with guidelines and good practices for the planning and designing of flood-resilient developments.
- Provide advice on development-specific flood resilience measures

S/N	Name	Role	Designation and Organisation
1	Ong Tze-Ch'in	Co-lead	Chief Executive, PUB, Singapore's National Water Agency
2	Melvin HJ Tan	Co-lead	Immediate Past President, Singapore Institute of Architects Joint Managing Director and Founding Partner, LAUD Architects Pte Ltd
3	Lim Peng Hong	Co-lead	President, Professional Engineers Board Managing Director, PH Consulting Pte Ltd
4	Richard Lai	Member	Board Member, Board of Architects Associate Partner, ADDP Architects LLP
5	Sunita Dass	Member	Council Member, Singapore Institute of Architects Senior Associate Director, DP Architects
6	Lee Tuck Wai	Member	Committee Member, Singapore Water Association Founder and CEO, Coastal Protection Chapter, Upconverge
7	Nicholas Loh	Member	Representative, Real Estate Developers' Association of Singapore Head of Building Management Services, Singapore Land Group Limited
8	Dillon Lim	Member	Representative, Real Estate Developers' Association of Singapore Senior Project Manager, MCL Land Limited
9	Chan Ewe Jin	Member	President, Institution of Engineers, Singapore Managing Director, ECAS Consultants Pte Ltd
10	Jee Yi Yng	Member	Board Member, Professional Engineers Board Singapore Country Representative, AECOM Singapore Pte Ltd
11	Lee Adam Harryman	Member	Representative, Association of Consulting Engineers Singapore Senior Vice President, CPG Climate Resilience Studio (CRS), CPG Corporation

Members of the AfA committee

applicable to Singapore's built environment.

- Recommend ways to promote adoption of flood-resilient design in Singapore's developments.

Following its kick-off meeting

on 19 May 2025, the AfA will commence work and wrap up its recommendations by the first quarter of 2026.

The FRD guidebook will be launched by mid-2026.

Singapore Rail Test Centre opens for operations

The Land Transport Authority (LTA) recently announced the completion of the Singapore Rail Test Centre (SRTC) in Tuas, which occupies a site of approximately 50 hectares. Fully equipped to conduct rigorous testing and commissioning of trains and core railways systems, the SRTC will support testing requirements for both new and existing rail lines.

Multi-system compatibility and concurrent testing capabilities

Construction of the SRTC commenced in 2021 and was completed in two phases. The first phase, completed in November 2023, saw the opening of a 2.8 km high-speed test track designed with minimal curvature and gradients, to allow trains to reach and maintain maximum speeds of up to 100 km/h for traction and brake testing. Testing and commissioning of new Circle Line (CCL) trains has been going on since November 2023.

The second phase has now been completed and has two more test tracks. One of these is a 2.8 km performance and integration test track with a branched S-track for integrated train testing. The other track is a 3 km endurance looped test track with a section of uphill gradient for Train Mileage Accumulation Tests, to verify the reliability and durability of the train's systems, after running for a specific distance.

The SRTC facility also includes a three-storey building housing an Operations Control Centre, administration offices, workshops, and inspection and maintenance areas to support mid-life upgrading works for trains.

The three test tracks are designed to accommodate various signalling and communication systems used across the MRT network. The high speed test



Overview of the SRTC.

track is also equipped with both third-rail and overhead conductor rail power systems to allow for testing of trains and systems from different MRT lines.

Enhancing rail reliability and efficiency

The SRTC will play a key role in ongoing efforts to enhance rail reliability as efforts continue to expand and renew the rail network. With the completion of SRTC, the testing of trains will no longer rely on overseas facilities or occupy limited engineering hours on the operational rail network.

The SRTC will allow for comprehensive testing of various railway systems, including signalling, communications, power and integrated supervisory control systems, before they are implemented on the main lines. By enabling round-the-clock testing in a controlled environment, without disrupting passenger services or maintenance on operational lines, the SRTC will support the efforts to

strengthen rail reliability.

Beyond train testing, the SRTC will also serve as a hub for research and innovation. It will support the development of new technologies for the rail industry, by providing facilities for LTA, rail operators and rail original equipment manufacturers (OEMs), to test new technologies and systems. Such facilities and partnerships will also create opportunities to deepen operational and maintenance capabilities among the local rail workforce.

Sustainability features at SRTC

The SRTC has been awarded BCA's Green Mark Platinum Certification, with energy-saving equipment incorporated into its design and operations. These include features such as smart lighting control, solar photovoltaic panels and a hybrid cooling system. Bicycle parking lots and sheltered linkways are also provided to promote sustainable mobility within the facility and to encourage walking and cycling.

Bentley Systems partners with Google to improve infrastructure through asset analytics

Bentley Systems Incorporated, the infrastructure engineering software company, recently announced new asset analytics capabilities that leverage Imagery Insights from Google Maps Platform to rapidly detect and analyse roadway conditions.

Unveiled at Google Cloud Next 2025, the new capabilities in Bentley's Blynscsy product offering, which applies AI to crowdsourced imagery for automated roadway asset detection and inspection, will help infrastructure professionals improve roadway maintenance and support disaster recovery.

Bentley and Google announced a strategic partnership in October 2024 to integrate Google's high-quality geospatial content with Bentley's infrastructure engineering software to improve the way infrastructure is designed, built and operated.

The unique Imagery Insights combination of Google Street View, Vertex AI and Blynscsy will enhance the ability of departments of transportation and the engineering firms and consultants supporting them, to identify areas of concern and analyse changes in the condition of roadway and transportation assets, over time.

The addition of Google Street View's global panoramic imagery allows Bentley to provide highly detailed analysis of assets along with visual references, while Google's Vertex AI adds the ability to build and maintain models to alert transportation agencies of changes to infrastructure assets before they become safety hazards.

In addition to supporting roadway maintenance activities, these capabilities can also aid in disaster recovery efforts, providing a cost-effective solution for conducting rapid damage assessments, which can help affected communities rebuild faster.



Bentley's Blynscsy AI technology detects a broken highway sign after Hurricane Helene in Florida. Image: Bentley Systems.



Malfunctioning streetlights are detected by Bentley's Blynscsy technology in crowdsourced dash cameras in the Los Angeles area after wildfires caused major damage to critical safety infrastructure. Image: Bentley Systems.

Mark Pittman, Director of Transportation AI at Bentley commented, "We have a history of leadership in applying repurposed imagery for roadway maintenance, and the addition of Google's 360-degree imagery and AI will further enhance the value Bentley provides to transportation departments and engineering firms globally."

"The expansion of our relationship with Google will enable us to further develop our growing infrastructure asset analytics capabilities – initially in the transportation sector, with other industries to follow," he added.

Yael Maguire, Google's Vice President and General Manager for Google Maps Platform & Google Earth, said, "Businesses and cities

have long relied on the fresh and comprehensive information from our maps to get insights about the world."

"As our strategic partner, Bentley combines industry-leading infrastructure solutions with Google's leading AI and mapping technologies, like Vertex AI and Street View, to bring powerful analytics to public and private sector leaders who need mobility insights for making more informed decisions," he added.

Blynscsy is part of Bentley Asset Analytics, a portfolio of products that generate insights into the condition of existing infrastructure assets to optimise their performance. Google's Imagery Insights will be generally available in Blynscsy in 2025.

bauma 2025 provides impetus and creates a spirit of optimism

bauma 2025 was held from 7 to 13 April 2025, at the Munich exhibition center, Munich, Germany.

bauma is the world's leading sector event for construction machinery, building material machines, mining machines, construction vehicles and construction machinery. With a total exhibition area of 614,000 m², bauma takes place every three years.

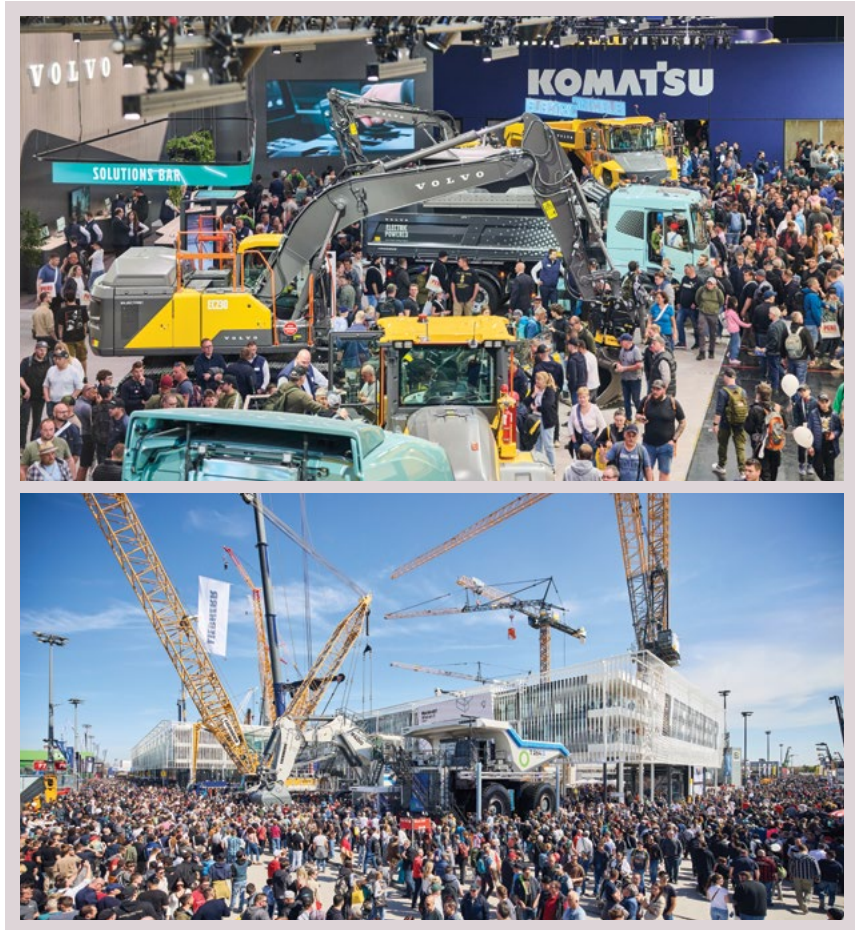
At a time characterised by global challenges, bauma has impressively demonstrated what the industry is capable of. It was not only a stage for pioneering innovations and new partnerships, but also continued to be a key source of inspiration.

With around 600,000 visitors from more than 200 countries and 3,601 exhibitors from 57 nations, bauma 2025 proved to be a stable foundation and forward-looking platform in turbulent times.

Stefan Rummel, CEO of Messe München, organisers of bauma, said, "We hosted around 600,000 visitors from more than 200 countries and regions. bauma is the heartbeat of the industry and has once again shown how crucial exchange and personal encounters are for progress and global trade. The Munich exhibition center sends out a strong signal of confidence for the entire industry."

Many exhibitors confirmed that bauma sets the pace for the industry both in terms of content and emotion – especially with regard to sustainability and future topics.

Erich Sennebogen, owner of Sennebogen, said, "bauma 2025 showed a strong heart of the industry – with SENNEBOGEN representing its green core. We are delighted with the positive atmosphere in the sectors, which we had not expected in this form. For this reason, bauma can be a positive stimulus for a revival in the construction industry, as well as in the material handling sectors, both



bauma 2025 featured the products and solutions from 3,601 exhibitors from 57 nations and attracted around 600,000 visitors from more than 200 countries. Images: Messe München GmbH.

in Germany and internationally."

Emphasising the relevance of bauma as a leading trade fair and innovation platform, Holger Schulz, Managing Director at Zeppelin (CAT), said, "The who's who of the German, European and international construction and extraction industries meet at bauma. Once again, it demonstrated its status as a leading trade fair and proved to be the beating heart of the industry."

Steffen Günther, a member of the Board of Directors of Liebherr-International AG, said, "At bauma, we showcased a number of important future topics, such as drive technology and autonomy.

For us, bauma is much more than just a trade fair – it is the platform where the future of the industry is made tangible."

The event also emphasised the fact that bauma is not only a meeting place, but above all, a driver of business.

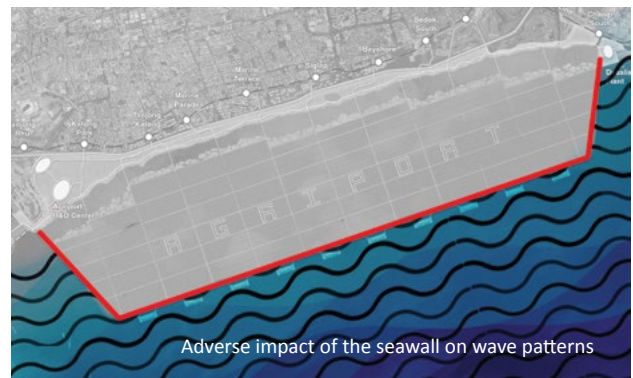
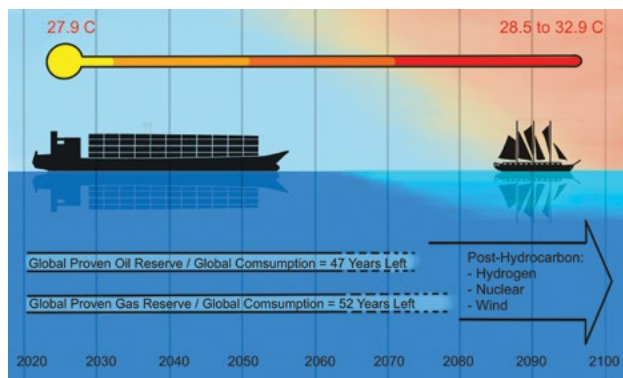
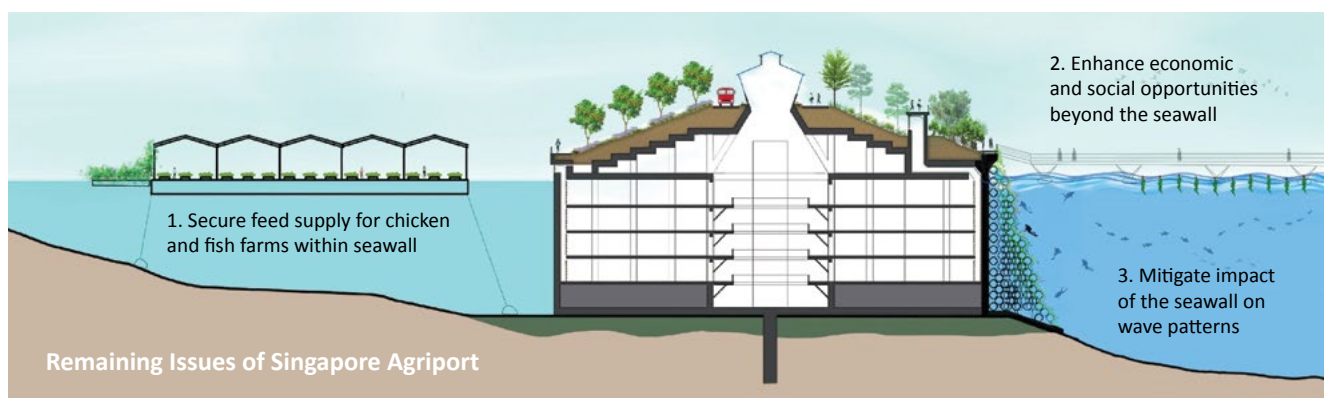
bauma 2025 recorded significant increases in visitor numbers, particularly those from Brazil, Portugal, Romania, the Netherlands, Turkey and Spain. The numbers from China also increased again, compared to the top result at bauma 2019.

The next edition of the event will be held in Munich from 3 to 9 April 2028.

A circular economy approach to combat sea level rise – ver 2.0

by Bjorn Low, Bobby Cheng, Christopher Leow, David Ng, Kuan Chee Yung, Leon Boey and Leong Tatt Man (Lead)

Restorative aquaculture and integrated multi trophic aquaculture farming strategy for the open sea off Singapore Agriport.



Future of the Open Seas

According to the World Oil Statistics data from the Worldometer website, the world has proven oil reserves equivalent to 46.6 times its annual consumption. This indicates we have approximately 47 years of oil left at current consumption levels, not accounting for unproven reserves. Hence, the Singapore Straits might face one of two scenarios in the future:

- A thriving seaport based on renewal clean-energy.
- A seaport with a much-reduced shipping volume.

In both cases, the Singapore Straits will likely be less polluted and more productive in natural capital due to the decline of petrochemical industries. However, due to global warming, sea temperatures might remain high for the foreseeable future.

This article aims to optimise Singapore's waterfront design, based on these future scenarios rather than the current oil-based environment which might not persist in the coming decades.

Remaining Issues of Singapore Agriport Version 1.0

An article on the Singapore Agriport was published in the July 2022 Issue of 'The Singapore Engineer' magazine.

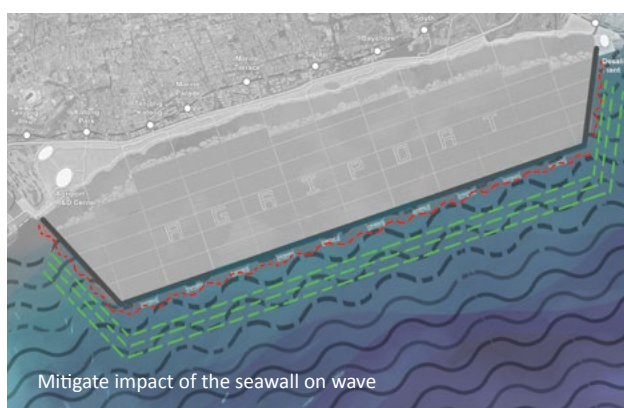
The design of the Agriport provides an alternative vision of Singapore's coastal protection strategy against rising sea levels, by adopting a circular economy approach that safeguards our national water, food and energy security, under one integrated solution.

However, some issues have not been resolved in the original design. These include:

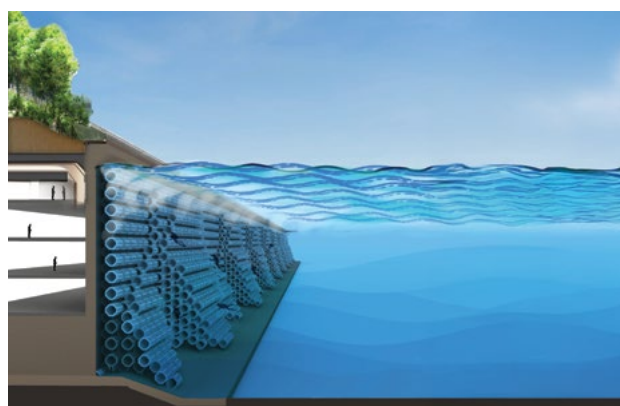
- Securing feed supplies for chicken and fish farms.
 - Enhancing economic and social opportunities beyond the seawall.
 - Mitigating the impact of the seawall on wave patterns, current speeds, seabed erosion and the marine ecosystem.
- This article aims to address these issues by using nature-based solutions to optimise design performance within planetary boundaries.



Wall Diving Along Seawall



Mitigate impact of the seawall on wave



Modular Coral Reef Design

As the undulating surfaces need to cover the 1.5 km long seawall surface, a modular, octagonal GFRP (Glass Fibre Reinforced Polymer) cage design is adopted to enhance constructability, buildability and durability. The module dimension is 3.6 m x 1.8 m x 1.8 m, which is small and light enough to be launched via a small crane from the boardwalk above the seawall. This process avoids the need to employ barges, significantly reducing the construction cost.

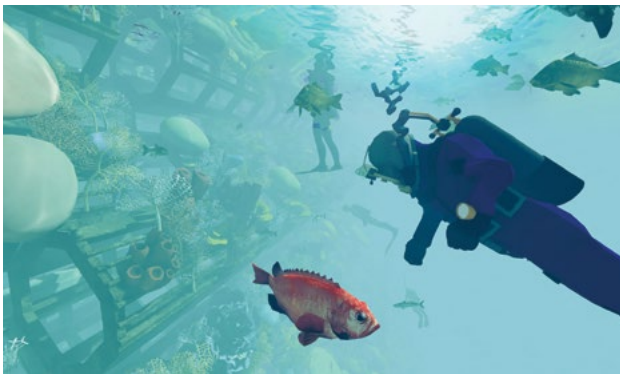
Based on a preliminary calculation, the total cost for this design is about Singapore Dollars (S\$) 6 million. These cages can interlock with each other in endless permutations and mimic the coastal cliff environment. Each cage has rods that allow coral fragments to be attached to it. Over time, the coral reef growing on the GFRP cages will further strengthen the structure and provide additional rough surfaces to further reduce wave impact.

Seawall Impact and Wave Attenuation

The 15 km long Singapore Agriport seawall will alter the wave patterns along East Coast Park, and the wave deflection from the seawall will transmit the wave energy to the surrounding coastlines, especially Marina Coastal Park to its west and Tanah Merah Terminal to its east.

The wave impact will cause coastal erosion and a scouring effect at the bottom of the seawalls. This will lead to costly long-term engineering maintenance. To avoid having a 15 km long, straight hard concrete surface, undulating surfaces are created both in the plan and in the section. Within this undulating three-dimensional geometry, crevices mimic the reef that dissipates the wave energy.

To mitigate any potential scouring at the bottom of the seawall, a Tensar Triton marine mattress with HDPE (High Density Poly Ethylene) geogrid will be wrapped around armour stones. Additionally, a 1 km wide flotilla of multi-tropical marine farms will fringe the seawalls, further reducing the waves' energy before they reach them.

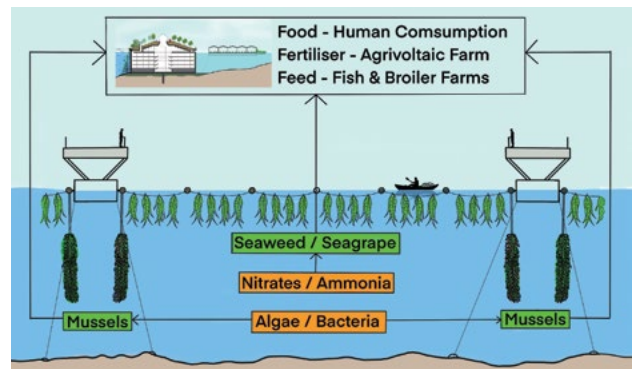


The Great Barrier Reef of Singapore

Seawater is expected to be gradually cleaner and clearer but warmer, based on future scenarios. Hard coral species that can endure warmer sea conditions are prioritised to address the risk of coral bleaching. The surfaces of the GFRP modules should facilitate a trophic cascade in the sequence of algae, hydroids and ascidians, if the sea conditions remain stable and conducive to growth. The natural process can be accelerated by adopting a coral propagation programme.

Based on the coral propagation density of 30 coral fragments/m², this project can facilitate coral transplanting of 5 million corals. According to Mr Leon Boey, the average fee for 1 m² of a coral propagation programme is about \$400/day.

Hence, the revenue that can be generated from coral propagation for a zone within a depth of 10 m from the water surface, along the 15 km seawall is \$60 million. A profit of \$6 million can be earned from this coral planting programme which basically cancels the initial construction cost. Furthermore, additional revenue can be generated by scuba wall diving and other waterfront activities along the coral reefs.



Natural Sea Purifiers

To expedite the improvement of seawater quality along the coral reef, the sea space surrounding the seawalls will have mussels, seaweed and sea grape farms. These farms purify seawater by acting as natural filters. Mussels filter out small organisms such as algae and bacteria from the water column. Through their feeding process, a single mussel can filter up to 60 l per day, while seaweed absorbs excess nutrients like nitrates and ammonia from the water, taking up any nitrates that are created from the chicken and fish farms.

Every 1 kg of seaweed biomass can sequester 370 g of nitrates during its 45-day growing cycle. The quality of the mussels and seaweed will improve over time, as toxins in the polluted seawater are gradually reduced. These mussels and seaweed can be used as fertiliser for the agrivoltaic farm within the reservoir of Singapore Agriport, or be used as feed for the fish and chicken farms within the caisson structure, and eventually for human consumption, when their food quality meets the standards of Singapore Food Agency.



Greater East Coast Park Promenade



Image: Mr Christopher Leow

Natural Carbon Sink

Besides purifying seawater, sea farms can act as a mega carbon sink. Based on Agriport's sea space of 15 km x 0.8 km = 9.6 km³, this project has the potential to sequester 9600 metric tons of CO₂ annually. According to Mr Bobby Cheng, if the whole sea farm is turned into a carbon credits project, the annual revenue generated will be approximately \$1 million. This revenue can offset the capital cost of setting up the sea farm.

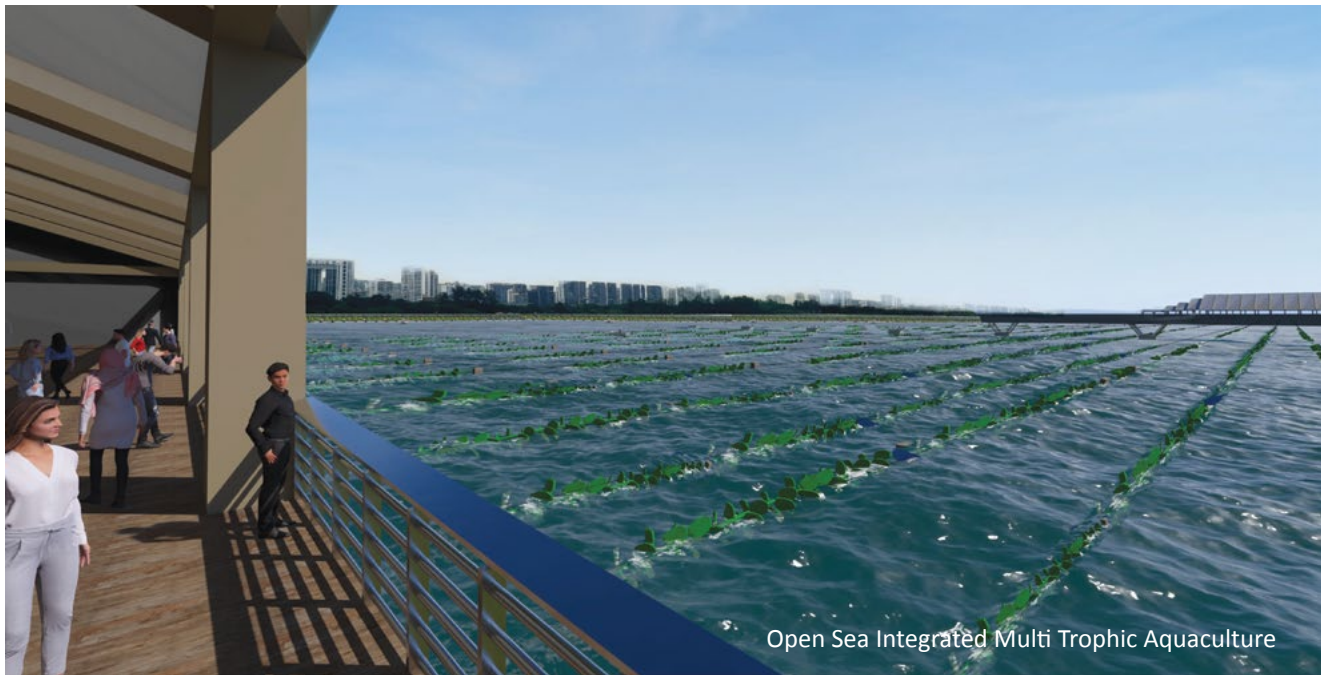
Furthermore, the carbon credits gained can also be used to support high-tech industries that need to purchase carbon credits. One option is to have floating data centres, where these centres can harness the electricity generated from the agrivoltaic farms within the reservoir and purchase the carbon credits from the sea farms. The iconic setting of Agriport will entice top-notch MNCs to relocate their eco-HQs here, and this eco-investment will help finance and profile Singapore Agriport.

Restorative Aquaculture

Singapore's Agriport agroecology approach to farming is extended through the adoption of restoration of the sea space. This showcases the principles of improving biodiversity and habitats, carbon storage and circularity. Specifically, a method called Integrated Multi Trophic Aquaculture (IMTA) is carried out.

IMTA is a type of farming in which multiple aquatic species from different trophic levels are farmed together. The by-products or wastes from one species become the food or nutrients for another species. IMTA can improve efficiency, reduce waste and provide ecosystem services, in the long run. Low trophic aquaculture is the cultivation of species lower in the trophic levels.

At the base of the trophic levels is phytoplankton which generates the biomass for others in the different trophic levels. By choosing to cultivate these species such as macro algae (e.g. seaweed), and bivalves (e.g. mussels), we are being efficient in terms of food-energy utilisation.



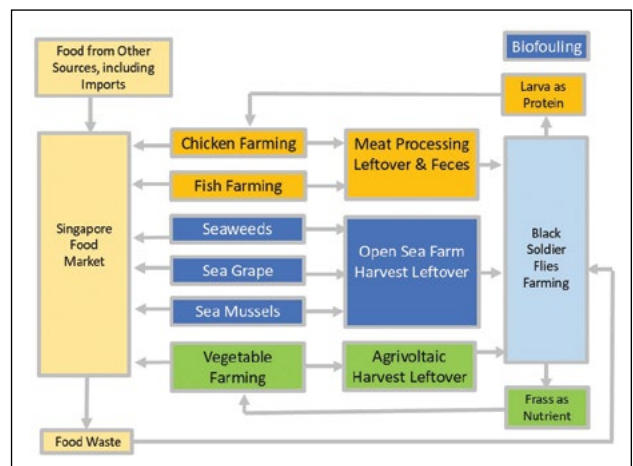
Open Sea Integrated Multi Trophic Aquaculture



Integrated Multi Trophic Aquaculture Farming

For seaweed farming, a floating line cultivation method will be adopted. Seaweed seedlings will be tethered to the line, with floats keeping the line on the surface. For sea grape cultivation, an adaptation that uses neutrally buoyant HDPE meshed structures that can be attached to the line, is deployed. This is to support optimised growth conditions for sea grapes that tend to sprawl. The lines will be attached to pontoon platforms that support the system at every 200 m. These platforms are fastened to mega pontoons at 1 km intervals.

The mega pontoons, on the other hand, are connected to the seawall via gangways. For mussels, they will be grown on ropes that are attached to the pontoons. According to Er. David Ng, the entire floating system and seawall network are integrated, making it an economical and robust marine engineering design. The estimated cost for the entire 15 km² infrastructure is about \$50 million.



Circular Economy and Ecology

The possible circular system enabled by the chosen species is the primary driver of this design. Seaweed can be utilised as human food in both fresh or processed forms, such as roasted snacks. Seaweed (Gracilaria variety) can also be processed into a dry or liquid organic fertiliser which can be utilised in floating vegetable farms as nutrients. Sea grapes, a type of seaweed that has particularly high economic value, in its dried form, can retail for up to \$100/kg.

The mussels cultivated are Asian Green-Lip mussels (*Perna viridis*). Their flesh can be utilised, fresh, as human food, and processed into value-added products like smoked-canned mussels, the retail price of which can reach \$150/kg. Calcium carbonate can be extracted from their shells, which become an important additive in chicken feed, to support healthy egg production. In addition, a result of farming operations is biofouling, which is caused by a mixture of marine organisms that attach to the mussels, lines etc. These can be processed into chicken feed.



IMTA Return of Investment

Based on Mr Christopher Leow's calculation, the projected initial annual profit is \$73.75 million, and the initial capital investment is \$87 million. Further processing of the marine produce into final food products would significantly increase this number. The only limitation at this point is the ability of the local market to absorb such a large quantity of products.

Over time, the sea space is set to improve in terms of the quality of the water and its biodiversity. Further down the line, there is the possibility of adding other types of marine species, such as sea urchins and sea cucumbers, to enhance the productivity of the IMTA system.

AGRIPORT ^{plus} : Construction Cost and Return of Investment				
	TRADES	Construction Cost	Annual Profit	Return of Investment
1	Coral Reef Propagation	\$2000 x 4166 = \$6 mil	\$400/sqm x 10m x 15km x 10% / 8 = \$0.75 mil	\$6 mil/ (\$400 x 5) = 8 YEARS
2	Integrated Multi-Trophic Aquaculture Framing	Infrastructre = \$50 mil Process Plant = \$31 mil	Seaweeds = \$20.0 mil Seagrapes = \$ 52.2 mil Sea Mussels = \$ 0.8 mil	\$81 mil/\$73 mil = Within 2 YEARS
3	Carbon Credit Scheme (Optional)	9.6km ² carbon sequestration farm = \$5 mil	9600 metric tons of carbon sequestration = \$1mil	\$5 mil/\$1 mil = 5 YEARS
	TOTAL (1 & 2)	\$87 mil	\$73.75 mil	\$87 mil/ \$73.75 mil = Within 2 YEARS

Designing Singapore's Future

Singapore is a small island state with a 6 million, largely ageing population, operating in an increasingly volatile geopolitical world, exacerbated by the depletion of global natural resources and climate change. While Singapore cannot afford to detach itself from the global GDP-driven economic system, we must consider a nation-centric, ecology-based strategy to safeguard our nation's water, food and energy security, so that we can create a space of wellbeing and resilience despite such predicaments. Singapore Agriport offers such a resilience strategy for the country.

Be Water. Be Bold.

Team members of Singapore Agriport^{plus}



Agroecology Design: Bjorn Low, Founder of Edible Garden City. **Carbon Credit Consultant:** Bobby Cheng, BDO of L-Energy. **IMTA Design:** Christopher Leow, Founder, The Freestyle Farmer. **Engineering:** Er. David Ng Chew Chiat, Founding Managing Director, One Smart Engineering. **Biophilic Design:** Ar Kuan Chee Yung, Managing Partner, Consulting at Consulus Pte Ltd. **Marine Restoration:** Leon Boey, Founder, Livingseas Foundation. **Team Lead & Planner:** Ar Leong Tatt Man, Founding Member, The Circle for Human Sustainability. **Computer Modelling and Rendering:** Yang Yuhao, Year-5 Student, Master of Architecture, NUS.

All images by Ar Leong Tatt Man, unless otherwise stated

Why we are counting on more sustainability leaders

The future needs you.

The world stands at a tipping point. As some governments roll back progressive environmental policies, businesses and organisations are stepping up, recognising that sustainability is not just about ticking boxes – it is about survival. Climate risks are disrupting supply chains, investors are prioritising Environmental, Social, and Governance (ESG) criteria, and consumers are demanding greater accountability.

Since returning to office in 2025, American President Donald Trump has signed many Executive Orders that reverse critical sustainability policies. The response has been swift and severe, with world leaders and environmental experts condemning the rollbacks.

But with the US retreating from sustainability initiatives, other nations may follow suit – risking years of progress in the fight against climate change. In this uncertain landscape, businesses are refusing to wait for political action. Companies understand that consumers are willing to vote with their wallets, supporting brands that align with their values. In today's climate, sustainability is not only a moral obligation but also a business imperative.

Despite policy reversals at the governmental level, many businesses continue to champion sustainability. For instance, under the lead of Chief Sustainability Officer, Karen Pflug, IKEA has publicly declared its commitment to becoming climate-positive by 2030. The company has since reinvested its profits in renewable energy, sustainable materials and circular economy solutions, to shrink its climate footprint from scope 1, 2, and 3 emissions.

Evidently, the forethought



In order to be able to limit the global temperature rise to 1.5 °C, it is necessary to bring global energy-related CO₂ emissions to net zero by 2050.

demonstrated by these actions are shaped not only by corporate missions but also by key players within the organisations.

From sustainability officers to environmental strategists and policy experts, these changemakers are playing a vital role in spearheading sustainability.

The skills needed to lead

Being a changemaker does not come easy. It requires a unique blend of expertise, strategic vision and an unshakeable commitment to driving change. Sustainability leaders must navigate complex environmental policies, integrate sustainability into business strategy and drive systemic change in industries that are often resistant to transformation.

One of the most crucial skills is understanding environmental governance and policy. Sustainability professionals need to interpret and implement regulations that shape corporate and governmental sustainability efforts. With shifting policies and international agreements like the Paris Agreement at stake, leaders who can advocate for stronger

environmental protections will be instrumental in ensuring long-term ecological and economic stability.

A deep knowledge of sustainability and ecosystem health is also essential. Effective leaders must be able to assess environmental risks, design sustainable resource management strategies and integrate ecological principles into decision-making.

To lead effectively in this space, one requires knowledge, resilience and a proactive approach to solving global challenges. Passion, dedication and a willingness to leave a lasting impact are vital.

The world needs changemakers and leaders to put sustainability back on track.

The Master of Environmental Management and Sustainability program at Newcastle Australia Institute of Higher Education, in Singapore, equips one with the critical skills to navigate complex environmental policies, drive sustainable business strategies and create real impact.

If you are ready to be at the forefront of change, take the next step in your journey today.



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THE ART of BUILDING SUSTAINABILITY



Ensure a strong level of interoperability by using open protocols which have third-party listing laboratories to verify adherence to your protocol's form and function.



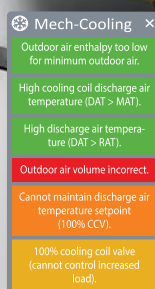
Employ a single sign on (SSO) architecture with compliance to scalable credentialing architectures and secure tunneling methodologies such as BACnet virtual private networks (B/SC).



B/SC



Specify integrated FDD (IFDD) that delivers real-time fault detection, step-by-step root-cause diagnostics while using all your existing cabling structures, including twisted-pair networks.



Insist on timely analytics for all stakeholders with complete control of formatting and scheduling while retaining full ownership of your data and the reports generated.



Sustainability requires a high level of integration between HVAC, lighting, and security systems. The art of building sustainability skillfully combines this integration with other technological and supporting elements that must endure over the long term. When these additional elements are maintained over the life of your building, true building sustainability emerges. To learn more about the ART of Building Sustainability please visit reliablecontrols.com/TABS.



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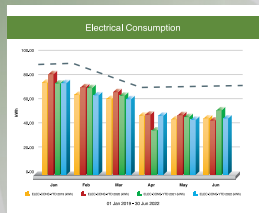
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An industry leader in 'greenifying' tyres and mobility

Making sustainability dreams a reality.

A growing brand in the global tyre industry, Giti Tire is proudly Singaporean and even more proudly, increasingly sustainable. Leading the charge towards greenifying tyres and mobility, Giti's efforts have not gone unnoticed by accreditation boards and evaluation organisations around the world.

Giti efforts to grow sustainably have gained the recognition of international accreditation bodies, with the company receiving the Platinum award in the 2025 EcoVadis Sustainability Rating and a B-Rating from the CDP (formerly Carbon Disclosure Project), the independent environmental disclosure system.

Besides these two recent awards, Giti has been recognised by Brand Finance as the 7th highest sustainability value company in the tyre industry, in 2024.

To-date, these are but a handful of the many awards and accreditations that Giti has received, recognising the company's progress in enacting positive, trackable change in its processes, in order to make a cleaner, greener future for future generations.

THE METHOD

Giti adopts a 3P approach to making its sustainability dreams a reality:

- Profit: Building a sustainable business sustainably
- Planet: Establishing sustainable production practices
- People: Building up the community

Profit: Building a sustainable business sustainably

Similar to the popular saying "Rome was not built in a day", a sustainable business cannot be easily carved out of an established business entity, nor is a truly sustainable business built overnight. Giti's journey to reaching this current stage of sustainability was facilitated by the continued and strong dedication of all stakeholders in the company's value chain.

Addressing all levels of the organisation, Chief Sustainability Office at Giti Tire, Dr Pang Chong Hau, has implemented a series of sustainability training programmes, investing in equipping all staff with the knowledge on how to integrate sustainable practices into their daily lives and improve production and logistical processes. With each individual taking personal responsibility and ownership, Giti sees fresh sustainability efforts championed by the staff on a day-to-day basis.

On a more corporate level, Giti also invests in, and prioritises building partnerships towards, sustainability.



Giti Tire received the Platinum award in the 2025 EcoVadis Sustainability Rating.

With a shared commitment towards protecting the environment and the community, Giti is able to ensure that business decisions and collaborations would align and contribute to the general direction that will ensure a positive impact on all who are within the company's sphere of influence.

Giti works with local farmers around its factories, to reduce deforestation and increase the intentional planting of plant varieties that will improve biodiversity. Giti also participates in various global platforms, like P4G (Parties for Good) and GPSNR (Global Platform for Sustainable Natural Rubber), and comes to the table to have effective discussions with various key stakeholders in the tyre value chain, in order to ensure an equitable and sustainable way forward for mobility and transport.

Keeping a close eye on the pulse of sustainability around the globe, Giti stays at the forefront of policies and regulations, preparing internal staff and suppliers for changes in the business climate, in order to remain sustainably viable into the future. Ahead of the full implementation of the European Union Deforestation Regulation (EUDR), Giti has already begun working with suppliers to ensure compliance and has secured EUDR-compliant suppliers to meet its EUDR-production needs.

Using Singapore as a testbed for global implementation, Giti has piloted a Reverse Logistics Program. In this programme, waste tyres are collected from customers along the delivery route and brought back to the Giti warehouse. Through this, Giti intends to reduce logistical wastage by utilising the otherwise 'wasted' return trips to consolidate waste tyres from customers, at a central location.

Next-step recyclers are then able to collect waste tyres

from this central location, rather than making their own milk run route, reducing fuel consumed for the transport of tyre waste for recycling.

Planet: Establishing sustainable production practices

As an established tyre manufacturer, Giti regularly revisits its processes, continually making improvements to its production lines. When opportunities present themselves to break ground for new factories and facilities, Giti would also place sustainability high on the priority list.

As with its latest factory in Anhui, China, Giti has plans to incorporate green energy, low-energy technology and practices, and state-of-the-art equipment. Among other benefits realised, these actions serve to increase automation and efficiency, save energy, optimise and grow human capital, and improve inventory management through the use of robots.

On a product level, Giti engineers are working on increasing the amount of recycled materials that can be incorporated into new tyres, without affecting performance or safety. This initiative helps to reduce tyre waste from both defective and scrap tyres, contributing towards a reduction in waste from the company's manufacturing processes.

"While we placed high priority on the speedy implementation of our system to segregate our EUDR-Rubber, achieving these accolades was not done single-handedly, nor was it achieved overnight," shared Mr François Petiot, Director at Giti's International QA Centre, regarding what he believes contributed to this momentous achievement.

"We recognise three main factors that have contributed to our achievement. Firstly, a deep understanding and strong commitment to sustainability by all our plant managers, thanks to our proactive sustainability training. Secondly, established policies and structures that build a robust due diligence system, and lastly, having all levels of production and management walk the talk, designing and implementing action plans that enable sustainability to become a reality within Giti," he added.

"Through the commitment of our staff, Giti has been able to also obtain Letters of Compliance for ISO20400 – Sustainable Procurement, for our Chinese and Indonesian plants, with our USA plant close by on the flank, to adopt similar practices to achieve the same level of sustainability across our organisation," Mr Petiot continued.

At non-production facilities, sustainability concepts are also integrated into business processes. Sustainability concepts, including reducing, reusing and recycling, are taught and lived out, on a daily basis. In the company's R&D facilities, ongoing research takes into account technological developments to increase energy efficiency and optimise tyre lifespan, in order to reduce waste generation. Other developments include making tyres from recycled materials and projects to increase the recycling rate of waste tyres and tyre waste.

People: Building up the community

Giti also champions various sustainability-related topics, collaboratively with municipalities, to bring about positive change within the community. Working with established Non-Governmental Organisations, like Conservation International, Giti contributes to positive action for the conservation and restoration of the natural environment.

Going beyond its immediate sphere of influence, Giti looks to support various humanitarian causes, like enabling education. Giti was proud to have the opportunity to support the building of a learning centre in Talatast, a rural town at the foot of the Atlas Mountains in North Africa.

This learning centre has, in the past, seen young students through their early education, equipping them to leave the town and gain further education. For the uneducated women of the town, skills like weaving are shared to create exquisite pieces that help the town generate revenue. The new centre will also include a medical clinic, where nurses, who were once students of the school, have returned to provide much needed medical services to the community.

Back home in Singapore, Giti worked with the Singapore Road Safety Council and other local non-profit organisations, supporting road safety education, dementia care and cancer support.

Working with partners throughout its value chain, Giti collaboratively reduces the environmental impact of its tyre verticals, optimising logistics and creating sustainable alternatives to current high-consumption practices. Progressively, Giti champions EUDR-readiness among the tyre community and leads the charge towards the 'Sustainable Tyre'.

The 'Good' rating that Giti has received on the key topics of Environment, Ethics, Labour and Sustainable Procurement indicate a deep understanding and commitment to enacting sustainability from the ground up, making sustainability in Giti a reality. The established due diligence system gained the attention of partners and manufacturers, obtaining positive feedback, and establishing Giti as one of the 'most ready suppliers' when it comes to creating original equipment for some of the largest vehicle manufacturers in the world.

"These accolades are not something that we could have achieved on our own and we express our heartfelt appreciation to our staff, shareholders, suppliers, partners and customers, who have made this achievement possible. It is only with a concerted effort between all parties that we have been able to, and will continue to, achieve great results sustainably," shared Mr Chris Bloor, Executive Director, Sales and Marketing, Giti Tire Group.

"These awards are but a welcome milestone, as we have not reached the end of our sustainability journey. We will continue to remain dedicated to the future, creating a reality where people 'Enjoy Driving Sustainably and Enjoy Sustainable Driving'," he added.

Formwork sheet with recycled plastic core

High durability and multiple reuse cycles help to reduce greenhouse gas emissions.

Doka is actively working across diverse product segments to develop a growing portfolio of more climate-friendly solutions for its customers, contributing to the reduction of greenhouse gas emissions (GHG) on construction sites.

A significant transformation enabler is product design, focusing on material selection, modularity and refurbishment.

Doka is already demonstrating its commitment to these principles in its formwork rental model, with formwork being refurbished, on demand, in dedicated service centres worldwide, to significantly extend their lifespan.

With the introduction of the Xlife top sheet, Doka has taken this commitment to the next level.

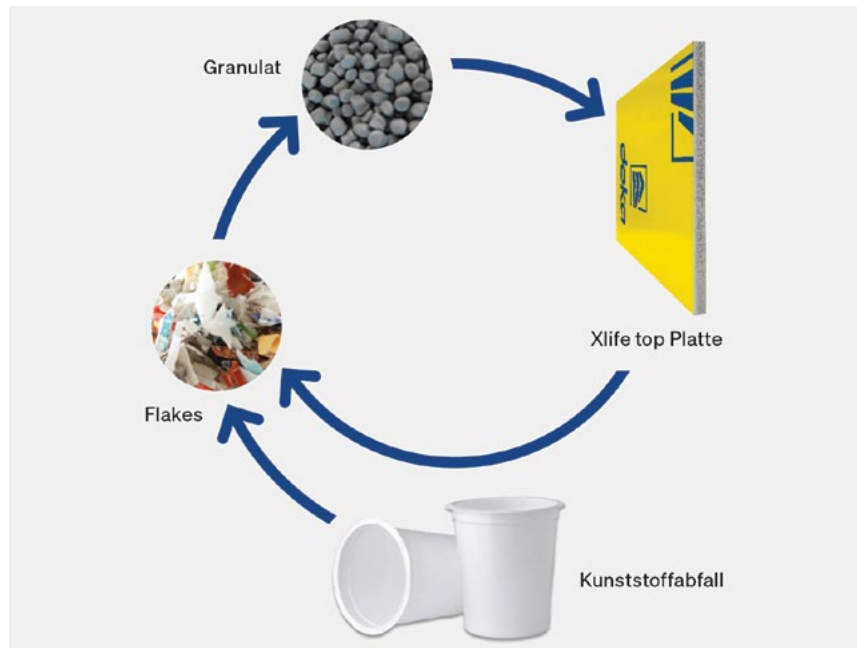
“Until now, sustainable solutions are often premium or niche products that struggle to reach the mainstream construction market. With Doka Xlife top, we are breaking that pattern and proving that sustainability and economic viability can go hand in hand, making climate-friendly concrete construction feasible, accessible and practical, at scale,” said Robert Hauser, CEO of Doka.

Sustainability in action

With Xlife top, Doka has successfully integrated closed-loop recycling into an industrial-scale solution. The core of the sheets is made of 100% recycled plastic. At the end of their lifecycle, the used Xlife top sheets are taken back by Doka and fully reintroduced into the cycle – that is, at the beginning of production of a new sheet core.

“This represents the full realisation of a circular economy,” said Mr Hauser.

When it comes to product carbon footprint (PCF) data, the Xlife top sheet has a significantly smaller PCF in comparison to conventional wood-composite sheets, due to the



With Xlife top, Doka has successfully translated the concept of a closed recycling loop into an industrial scale solution. Image: Doka.

usage of recycled plastic and long lifespan.

Advanced features for superior concrete quality and efficiency

Beyond its sustainability benefits, Xlife top offers tangible performance and economic advantages.

A standout feature is its silk-matte surface which is highly scratch-resistant, ensuring consistent concrete quality across multiple uses. Unlike phenolic resin sheets, it does not stain the concrete, and its flush installation in the panel, delivers a high-end finish.

The Xlife top surface and advanced composite technology make the sheet more resistant to damage, extending its lifespan significantly beyond conventional formwork sheets. Its robust structure allows fast and easy cleaning, even with high-pressure washers, which reduces on-site labour time. The new sheet lowers refurbishment costs due to

enhanced refurbishment methods including partial sheet replacement.

All Xlife top sheets are designed for seamless integration with the well-established Doka framed formwork systems. Fewer replacements, lower maintenance and reduced concrete refurbishment translate into significant cost savings for construction companies.

Xlife top premieres at bauma 2025

With Xlife top, Doka is leading the transition into a new era of cost-efficient and sustainable concrete construction. This innovation represents a fundamental rethinking of how formwork materials are designed, utilised and reintegrated into the material cycle, aligning with Doka's ambitious climate goal of achieving net zero by 2040.

The Xlife top sheet made its world premiere at bauma 2025, giving visitors an exclusive opportunity to experience its performance, sustainability benefits and economic advantages firsthand.

Towards achieving zero local emission compaction

Introducing new battery-powered electric tandem rollers.

At bauma 2025, compaction specialists, Hamm, introduced a new model in the series of pivot-steered tandem rollers – The HX 70e VV-S. The model with two vibration drums is fully electric, helping the construction industry to hit emissions targets with a view to making road construction sustainable.

The HX 70e VV-S was also joined by the HX 70e VO-S, a sales variant with an oscillation drum. As an ongoing technology project, both tandem rollers are initially being put into operation on inner-city construction sites in Europe.

Fast charging and quiet operation

Hamm's HX 70e makes use of tried-and-tested components, such as the 400 volt Li-ion battery from Kreisel with a capacity of 63 kWh. The machine is charged via a Type 2 connector, with other charging options such as Type 1, J1772 and CCS also to be added. With the fast charge option, the battery can be charged from 20% to 80% in under an hour.

Owing to the electrical components, the battery-powered electric tandem rollers are not only quieter but also more efficient in operation than their diesel-driven counterparts. This is especially true of the models with the oscillation drum.

Here, the already low noise of oscillation is combined with the quiet electric drive, making the machines an ideal choice for use in vibration-sensitive and noise-sensitive environments, such as within the vicinity of hospitals or historical buildings.

Comparable with diesel-powered rollers

The new HX 70e tandem rollers



The HX 70e pivot-steered tandem rollers deliver the same compaction power as the diesel-powered models of the HX series.



The first construction sites to use the HX 70e VV-S provided the opportunity for the demonstration of its high compaction power and simple operation, in addition to the usual strengths of the HX series.

deliver the same compaction power as the diesel-engined machines and, in fact, produce a higher output at their peak. The battery-powered electric rollers are operated in virtually the exact same way as their conventional diesel counterparts, with the only difference being the display which now features new symbols to give operators an intuitive user experience.

Easy maintenance and low operating costs

Another added benefit of the new battery-powered electric tandem rollers is their lower maintenance

requirement. With the electrical components of the high-voltage system having long maintenance intervals and not being subject to the same maintenance requirements specific to diesel engines, operators benefit from low operating costs.

When it comes to matters of servicing and maintenance, customers and users can rely on the same service quality they have come to expect of the Wirtgen Group. Another plus point is that just like the diesel-powered machines, the new models can also be connected to the John Deere Operations Center.

Electric articulated haulers launched at bauma 2025

Assisting customers to move towards zero-emission operation.

Volvo Construction Equipment (Volvo CE) has introduced the new A30 Electric and A40 Electric, the world's first serial-produced battery-electric articulated haulers of their size class.

Boasting the same unrivalled off-road performance as conventional models, the two new machines are matching zero emissions with world-class hauling for a range of segments, including quarrying, mining and construction. With a payload of 29 t and 39 t, respectively, these machines are now among the largest in Volvo CE's electric portfolio.

The launch is the latest milestone in a series of hauler innovations. It comes not only 60 years after Volvo CE pioneered the world's first articulated hauler, but also shortly after the company's recent unveiling of a new generation of conventional articulated haulers.

As part of the company's largest product portfolio renewal in decades, within which 35% of the company's total portfolio has been updated, this new generation makeover enjoys improved productivity, safety and fuel efficiency.

Together, both the new electric and conventional ranges offer customers a pioneering and productive solution.

Electric operation made easy

Thanks to their powerful lithium-ion batteries, the A30 Electric hauler and A40 Electric hauler are designed to offer a runtime of 4 to 4.5 hours, across most applications, though high-energy jobs may require more frequent recharging. They can even enjoy a runtime of up to 7 hours, depending on driving conditions. Ideal applications include downhill load carrying and uphill empty runs, tunnel work and quarries, and underground



The A30 Electric articulated hauler from Volvo CE.

operations, where emission reduction is critical.

Fast charging, from 20% to 80% in around 1 hour, is made possible when using a DC charging solution with a maximum charging capacity of 350 kW.

What is more, when powered by renewable energy, these two machines offer a CO₂ saving of 84% (for the A30 Electric) and 90% (for the A40 Electric), across their entire lifecycle, when compared to their diesel equivalents.

Zero emissions

These electric models not only mark a significant step forward in sustainable innovation but also benefit from the new generation upgrade with pioneering advancements in safety, uptime and efficiency. Built on the new generation platform, they feature the same innovative, modern design and enhanced fleet management capabilities.

Advantages that come with this platform include advanced operator support systems to reduce accident risk, improved visibility for safer operation, and simplified servicing for quicker and easier maintenance.

Maximum productivity and comfort

The integrated Volvo Co-Pilot display offers easy control over media, cameras, climate and machine status, while the dynamic



Operators will benefit from a comfortable and customisable cab.

instrument cluster provides key data at a glance.

A repositioned door, guided entry lighting and new handrails facilitate safe entry and exit, while the comfortable and customisable cab will ensure operators enjoy an in-cab experience with more connectivity and convenience.

A more comfortable work environment is also assured with an electric operation, thanks to near silence and reduced vibrations. Furthermore, the lack of tailpipe emissions also results in the removal of harmful pollutants such as nitrogen oxides (NOx) and particulate matter (PM), improving air quality for those nearby.

Operators can also stay in the know, by checking charging status, machine hours and energy consumption, using Volvo CE's My Equipment app, whether on site or remotely.

The addition of the Haul Assist set of tools improves productivity and reduces energy consumption and machine wear.

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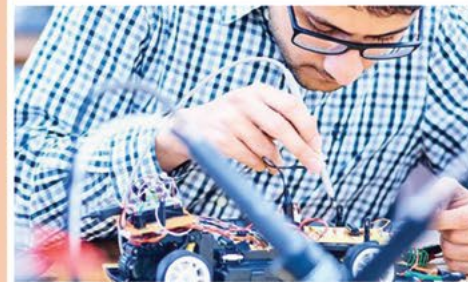


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Self-healing materials market to build on success in the construction industry

by Dr Conor O'Brien, Senior Technology Analyst at IDTechEx

Biological approaches lead the way.

Every year, industrialised nations lose approximately 3% of GDP due to issues associated with material corrosion and degradation. In particular, damage to concrete structures and infrastructure, ranging from small cracks to complete failure, can lead to severe disruptions, and repairs can incur significant expense. But what if damaged concrete had the ability to self-heal microcracks before they could propagate into larger-scale issues?

In IDTechEx's report, 'Self-Healing Materials 2025-2035: Technologies, Applications, and Players', a detailed overview of the market is given, including insights into technical challenges and progress, key sectors for market growth, and commercial readiness levels. A third-party, independent assessment of the market is provided throughout, including an unbiased outlook for the covered materials and industry sectors.

Concrete typically fails due to the development of microcracks, which gradually expand into larger cracks. Freeze-thaw action can be a major issue, where water fills cracks before freezing and expanding, causing further damage in a repetitive cycle.

Self-healing concrete is designed to repair these microcracks efficiently. Many technologies exist, but IDTechEx research finds that biological approaches lead the way for the successful commercialisation of self-healing concrete.

An ancient approach

Rome wasn't built in a day, but many of its most beautiful buildings and structures have stood the

test of time, remaining standing over two millennia after their construction. Roman concrete is composed of quicklime (calcium oxide), volcanic ash and water, and was produced at high temperatures using a technique called 'hot mixing'.

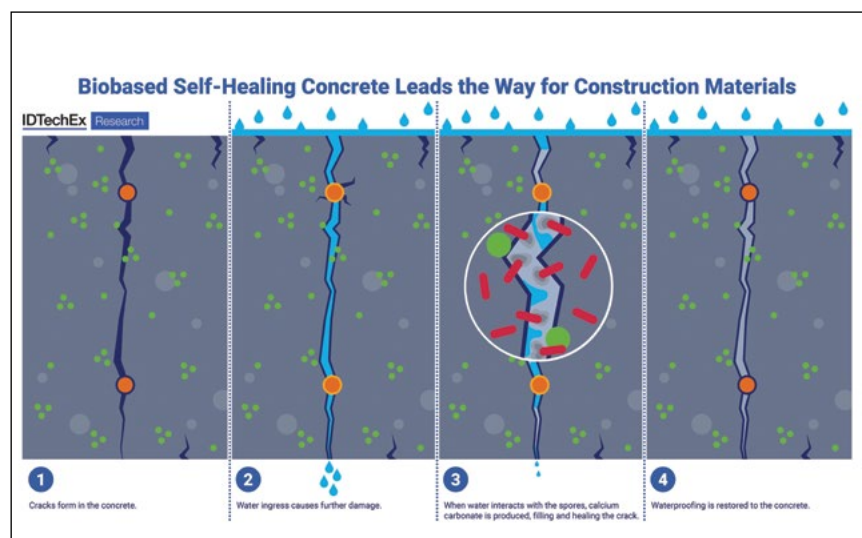
Studies have revealed the presence of lime clasts (calcium-rich mineral deposits) visible in Roman architecture as small, distinct white features measuring a few millimetres in size.

When a crack forms, water infiltrates, and a calcium-enriched solution is created. Despite detailed research, two proposed healing mechanisms exist. In the most straightforward scenario, the solution heals the crack itself. The second and more complex mechanism is known as the Pozzolanic reaction and involves the formation of several intermediates at the interface between the volcanic aggregate and the surrounding matrix.

Modern methods

A promising approach, from players such as Basilisk, involves embedding mineral-producing bacteria into concrete for self-healing purposes. These acid-producing bacteria can remain dormant for over 200 years and serve as catalysts in the crack-repair process. When cracks develop, the bacteria become active, consuming calcium lactate and generating limestone to seal the damage. Bacterial strains used in construction include *Bacillus pasteurii*, *B. sphaericus*, *B. subtilis*, *B. cohnii*, *B. halodurans* and *B. pseudofirmus*.

The healing process occurs through a biological reaction between unreacted limestone and a calcium-based nutrient. When bacterial spores encounter water, they begin to feed on the calcium lactate, a process that consumes oxygen and helps reduce the risk of steel corrosion. The soluble calcium lactate is converted into insoluble limestone which hardens



The activity of bacterial spores can help to fill the cracks in concrete. Image: IDTechEx.

and fills the crack.

Alternative approaches to self-healing construction materials are also discussed in the report.

Geopolymer concrete, produced from waste materials such as fly ash and self-healing mechanisms, has been proposed.

There is also a compelling method utilising bacteria-coated fibres. The major benefit is that the core of the fibre acts like a stitch and holds the crack closed, restricting the propagation of the crack and minimising the extent of self-healing that is required.

Concrete offers a high-volume

route to market for self-healing materials, allowing confidence and trust to be built in the novel approach to increasing the lifespan of structures. Initial risks can be lowered by considering only slabs, with vertical pours for walls delayed until phase two of adoption.

From an economic perspective, IDTechEx's assessment of the market reports a 30% increase in material costs when adding self-healing properties. However, these can be accounted for in a number of ways. Saving on the aforementioned costs, reduced need for replacements, minimised

maintenance and limited downtime, can all be summed up in the life-cycle costs that are reduced in total when considering self-healing concrete.

The 'Self-Healing Materials 2025-2035: Technologies, Applications, and Players' report provides an in-depth analysis of this emerging market. Leveraging its expertise in advanced materials, IDTechEx delivers an independent evaluation, covering technology comparisons, industry trends and key player assessments, and offering valuable insights into this promising but still developing sector.

Deciphering how concrete can heal itself

Addressing one of the most persistent and expensive problems in construction, Dr Congrui Grace Jin, an Assistant Professor in the Department of Engineering Technology and Industrial Distribution, Texas A&M University College of Engineering, USA, has taken inspiration from nature to develop a synthetic lichen system to enable concrete to self-repair.

Concrete is the most widely used building material, yet it suffers from the dangerous flaw of cracking easily. These cracks, big or small, can lead to catastrophic structural failure, as witnessed in the collapse of a building, bridge or highway.

The key to overcoming this critical challenge lies in understanding how concrete forms and how to exploit that process. Concrete is made by mixing crushed stone and sand with powdered clay and limestone. When water is added, the combination hardens through a chemical reaction called hydration.

Once set, it becomes strong. However, natural forces like freeze-thaw cycles, drying shrinkage and heavy loads cause cracks. Even those barely

visible to the naked eye can allow liquids and gases to reach embedded steel reinforcements, causing corrosion and weakening structures.

Discovering cracks before they endanger lives is a high-stakes and costly challenge, with the US annually spending tens of billions of dollars repairing concrete infrastructure. Locating cracks in bridges and highways, that are constantly in use, is especially difficult.

"Microbe-mediated self-healing concrete has been extensively investigated for more than three decades, but it still suffers from one important limitation – none of the current self-healing approaches are fully autonomous since they require an external supply of nutrients for the healing agents to continuously produce repair materials," said Dr Jin.

For example, after inspectors go through the laborious process of locating a crack, they may then have to inject or spray nutrients into the crack, which is not practical.

The solution suggested by Dr Jin is to harness the power of lichen systems to allow concrete to heal itself without outside

intervention.

Lichen is often found clinging to trees and rocks. Its true beauty lies in its unique symbiotic system of fungi and algae, or cyanobacteria, that form a self-sustaining partnership, allowing it to thrive in even the harshest conditions.

With that inspiration, Dr Jin and her fellow researchers created a synthetic lichen system that collaborates like natural lichens.

Their system uses cyanobacteria, which turns air and sunlight into food, and filamentous fungi, which produces minerals that seal the cracks. Working together, these microbes survive on nothing more than air, light and water. The autonomy of this system sets it apart from previous self-healing concrete endeavours.

In lab tests, these microbe pairs were able to grow and produce crack-filling minerals even in challenging environments such as concrete.

This groundbreaking research has far-reaching potential and applications. Concrete that can heal itself could reduce maintenance costs, extend its longevity and even protect lives through increased safety.

Ensuring the durability of roofs

Mr Dino Vasquez, Product Manager for Waterproofing Products Line, Mapei SpA, Italy, provides answers to various questions on the topic.

Question: What is a roof and what is its function?

Answer: In the building industry, a roof is the part of a building that covers and protects the construction underneath it and, in turn, protects the rooms, from atmospheric conditions such as rain, snow and cold weather. At the same time, a roof also has to withstand the design stresses and loads acting on it, which depend on what the roof is actually designed for.

A roof may be exploited to serve a number of different purposes. It can serve as a simple terrace or balcony, for example, or it can have more technical applications. It can be a place that houses a building's plant and service equipment; or it can serve as a roof-top carpark on a shopping centre, that allows the passage of vehicles; or it can be a roof-top garden (such as the one on the Vertical Forest building in Piazza Garibaldi in Milan), to greenify densely populated metropolitan areas etc.

Whatever the specific function and purpose of a roof, it is important to study its stratigraphic layout very carefully, in order to define the most suitable waterproofing system, to ensure the roof is able to protect the building and maintain its resistance over the years, thereby ensuring the durability of the entire structure.

Q: Why do we call them 'waterproofing systems'?

A: In order for it to carry out its primary function of protecting a building, we need to employ not only the best waterproofing products but also the best accessory items and related products required. This is why we refer to them as 'waterproofing systems'.

The Mapei range of waterproofing solutions includes various waterproofing systems. For balconies and terraces, for example, there is the MAPELASTIC line and related accessory items such as special sealing tapes (MAPEBAND EASY, MAPEBAND SA and MAPEBAND TPE) and drainage items from the DRAIN line.

For roofs, on the other hand, the products available can vary, from the AQUAFLEX ROOF range of liquid acrylic membranes to the PURTOP EASY line of polyurethane membranes and to the PURTOP range of polyurea membranes.

Choosing the most appropriate product range depends on the function of a roof.

Q: Is it more effective to apply a waterproofing solution over or underneath the layer that forms a slope?

A: In order for a waterproofing solution to last over the years and, as a result, enable a roof to also last over the years, it is important that it is applied on a sloping substrate.

With a balcony or terrace, for example, applying the waterproofing layer on a sloping substrate protects the screed and the other underlying layers from water which, in turn, prevents water seeping into joints and affecting the functionality of the entire structure. This also allows the water to run off correctly towards drainage points so that it does not remain under the ceramic tiles and lead to the onset of various problems.

In the case of a flat roof with a bituminous membrane, for example, water may collect in any depressions or hollows that have formed in the membrane and provoke the so-called 'lens-effect'. In such conditions, heat from the



Mr Dino Vasquez

sun causes a dark roof to warm up, which leads to premature deterioration of the waterproof membrane and, as a result, a reduction of the roof's service life. If a waterproof membrane is installed on a sloping surface, on the other hand, this phenomenon does not occur.

In both cases, and in all similar situations, it is very important to carry out the correct, routine maintenance on guttering, downpipes and runoff channels.

Q: What is the minimum thickness required, in order to waterproof a surface correctly?

A: The minimum thickness for a waterproofing system varies and it depends on the type of material applied, the characteristics of the material such as its thixotropy and the area of use of the structure.

As far as cementitious waterproofing systems are concerned, such as products from the MAPELASTIC line, the total recommended thickness of the layer to be applied is 2 mm. This thickness is easy to achieve by using a notched trowel to apply the product, thanks also to the reinforcement which is sometimes used to improve the product's performance properties.

In the case of polyurea systems, we suggest applying a 2 mm thick layer. In such cases, the correct thickness can be achieved by using specific tools as thickness guides, especially if skilled, specialised workmen are employed to apply the product.

In the case of polyurethane systems, we suggest applying a single layer (1.2 mm to 1.5 mm thick), in order to form a waterproof membrane with excellent mechanical properties, which is achieved also due to the use of specific additives.

And lastly, the final thickness for water-based liquid membranes (such as those belonging the AQUAFLEX ROOF line) is 1 mm, which may be increased according to the area of use of the roof.

Q: Can ceramic tiles be installed directly over a waterproofing system?

A: They certainly can. If a client wants a terrace, balcony or roof covered with material suitable for external applications, Mapei can offer an extensive range of adhesives available for bonding it to waterproofing systems.

For example, for a cementitious waterproofing system from the MAPELASTIC line, we suggest a class C2 cementitious adhesive according to EN 12004, while for a polyurea waterproofing system, we suggest using an epoxy or epoxy-polyurethane adhesive.

Also, we must not forget that liquid membranes for external applications, such as balconies, terraces and roofs, are covered by EN 14891. This European standard is used to evaluate the conformity, classification and area of use of liquid waterproofing products applied underneath external covering materials. The standard specifies the test methods to be used and the performance levels

required for liquid waterproofing products applied underneath a covering material such as ceramic tiles bonded with adhesives.

Q: Is it possible to intervene on an existing bituminous membrane? And if so, how?

A: Absolutely. In this case, too, it is important to clarify various aspects before starting, such as the area of use or the final finish required by the client. So, we should ask ourselves, “Is the flat roof with the bituminous waterproofing system used to house plant or service equipment? Will vehicles need to pass over the roof? Or is it for a terrace that needs to be renovated?”

Whatever the situation, Mapei has just the right solution to give any roof a new waterproofing system, without having to remove the old bituminous membrane. Mapei can offer liquid acrylic membranes from the AQUAFLEX ROOF line, polyurethane membranes from the PURTOP EASY line, or polyurea membranes from the PURTOP line. In such cases, once the substrate has been prepared correctly with special primers, the waterproofing product may be applied. These solutions should be adopted in the case of exposed roofs used for technical purposes.

If, on the other hand, we need to work on a roof with a bituminous membrane and turn it into a terrace with ceramic flooring, we suggest creating a sloping screed with just the right amount of slope, applying a cementitious waterproofing system from the

MAPELASTIC line over the screed and then installing the ceramic tiles over the membrane.

The indications above are just a general guide because, with building work, there are a multitude of variables and variations that need to be carefully considered, before determining the right solution.

Q: What does routine maintenance consist of, and how important is it?

A: Maintaining and maintenance are synonyms for ‘conserving a good level of efficiency’. Maintenance work on a roof is essential for the durability of the structure itself.

Mapei products, which are certified according to European standard EN 1504-2, already play an important part in protecting structures and, as a result, they maintain their durability over the years. If, however, these products are not used correctly, or if they are not stored in the right conditions, it will be the roof that suffers by gradually losing its overall efficiency.

Website for further information

www.mapei.com
www.mapei.com/sg

(Please contact customer service at Mapei Far East for the available products.)

This editorial feature is based on an article from **Realtà MAPEI INTERNATIONAL** ISSUE 84.

Global waterproofing market to grow

The global waterproofing market is projected to witness a growth rate of 5% annually from 2023 to 2028, with an anticipated size of USD 56 billion by 2028, according to an analysis by Stratview Research, a global market research firm.

The analysis is part of a report on the global waterproofing market, that provides a

comprehensive outlook of the industry, current and emerging trends, segment analysis, competitive landscape, and other information.

It suggests that Asia Pacific could remain the largest regional market, with key countries like China, India, South Korea, Japan and Thailand, playing a vital role.

The region is also likely to witness the highest growth in the coming years.

Major factors, such as increasing construction activities owing to rapid urbanisation and industrialisation, promising growth in the economies, as well as mandatory codes, are driving the growth, according to the report.

Singapore remains among the top performing countries in 2024

The country has, however, the potential to do better.

Singapore's Workplace Safety and Health (WSH) performance continues to rank among the top performing countries globally, with a five-year average workplace fatality rate of 1.1 per 100,000 workers.

In 2024, Singapore recorded its lowest workplace major injury rate of 15.9 per 100,000 workers (587 major injuries), improving from 16.1 per 100,000 workers in 2023 (590 major injuries). However, the 2024 workplace fatal injury rate increased to 1.2 per 100,000 workers (43 fatalities), from 0.99 per 100,000 workers in 2023 (36 fatalities). This underscores the need for all stakeholders to consistently remain vigilant and prioritise WSH.

Performance of key sectors

The Construction and Manufacturing sectors saw continued improvements in their fatal and major injury rates, but remained the top contributors to workplace fatal and major injuries in 2024, with 166 and 125 injuries, respectively. While relatively smaller in workforce size, the Marine industry saw its highest workplace fatal and major injury rate since 2018, at 35.8 per 100,000 workers (22 injuries) in 2024.

The Manufacturing sector saw substantial improvements in its fatal and major injury rate, per 100,000 workers, from 36.3 (total 155 fatal and major injuries) in 2023 to 29.3 (125 fatal and major injuries) in 2024.

In particular, the Metalworking industry saw a 20.1% reduction in its fatal and major injury rate, decreasing, per 100,000 workers, from 58.1 (61 fatal and major injuries) in 2023 to 46.4 (48 fatal and major injuries) in 2024. This was

Workplace Safety and Health Performance For 2024 Remains Among Top Performing Countries

- ◆ **Increase in fatal injury rate puts Singapore just behind top OECD countries**
1.2 per 100,000 workers (2024), an increase from 2023's 0.99
- ◆ **All-time low major injury rate**
15.9 per 100,000 workers (2024), improving from 2023's 16.1

Sectoral Fatal and Major Injury Performance (per 100,000 workers)



Overview of sectoral and major injury performance.

driven by targeted inspections to address machinery and noise-related issues, and extension of the Demerit Point System for WSH breaches to the Manufacturing sector in October 2023.

The Food & Beverages industry also saw a 16.7% reduction, reducing, per 100,000 workers, from 62.3 (38 fatal and major injuries) in 2023 to 51.9 (33 fatal and major injuries) in 2024. This could be attributed to proactive engagement efforts by the Ministry of Manpower (MOM) and the Singapore Food Agency in educating stakeholders on good WSH practices.

The Construction sector's overall workplace fatal and major injury

rate also decreased, per 100,000 workers, from 31.9 (167 fatal and major injuries) in 2023 to 31.0 (166 fatal and major injuries) in 2024. However, the sector's fatal injury rate increased, per 100,000 workers, from 3.4 (18 fatalities) to 3.7 (20 fatalities).

In November 2024, the Multi-Agency Workplace Safety and Health Taskforce (MAST) initiated a voluntary safety time-out for construction companies to reinforce safety procedures and raise safety awareness among workers. MOM also stepped up its enforcement at construction worksites.

MOM urges the industry to remain vigilant and uphold

stringent safety standards to prevent further incidents. MOM and MAST will continue to focus efforts on higher-risk sectors, enhancing WSH capabilities for smaller firms and trialling new safety technologies to improve hazard detection.

The increase in the fatal and major injury rate in the Marine industry was driven by an increase in fatalities (0 fatalities in 2023 to five fatalities in 2024). Four of the five fatalities involved works on vessels at anchorage and two of the five fatalities involved diving operations where systemic safety lapses were observed.

MOM and the Maritime and Port Authority of Singapore stepped up on enforcement efforts in the industry and will continue to take strict actions against companies and individuals who flout the rules.

Maintaining vigilance

In 2024, MOM conducted more than 17,000 inspections, with a focus on higher-risk industries such as Construction, Manufacturing and Marine. Aside from general workplace safety, there were also targeted inspections in priority areas – slips, trips & falls, machinery safety, vehicular safety and falls from height.

MOM took enforcement actions for more than 16,000 breaches under the WSH Act and Regulations, which included 1,500 composition fines amounting to more than SGD 3.1 million, and the issuing of 58 Stop Work Orders. These actions were meted out to errant companies found to have flouted the rules.

Strengthening WSH Excellence

Singapore has the potential to do better, as seen by the country's record-low injury figures in 2023.

Developers, contractors, employers and workers must remain vigilant, uphold safety standards and strive for WSH excellence. Implementing and adhering to the right safety practices can ensure that workers and workplaces can continue to thrive.

“ Developers, contractors, employers and workers must remain vigilant, uphold safety standards and strive for WSH excellence. Implementing and adhering to the right safety practices can ensure that workers and workplaces can continue to thrive. ”

Fatal falls from height decline

Falls from height have consistently been the second leading cause of workplace deaths over the past decade, until 2024. Last year, the four fall from height fatalities marked a 10-year low, resulting in falls from height being ranked fifth, after fatality causes such as vehicular incidents and drowning/suffocation.

Injuries sustained from falls from height are typically more severe than most other types of accidents, and generally of greater consequence. Over the years, the Workplace Safety and Health (WSH) Council has been increasing collaboration with the industry to drive significant improvements in work at height (WAH) safety and safeguard the lives of workers.

The WSH Council has taken a step further to assist the industry in improving WAH safety. The WSH Council has signed Memoranda of Understanding with two Institutes of Higher Learning (IHLs) to build capabilities and co-create solutions to safeguard workers who work at height.

The partnership with Singapore University of Technology and Design (SUTD) is aimed at driving innovation in WSH, particularly in WAH safety. It will seek the following outcomes:

- Research, testing and implementation of robotic safety solutions within the industry, to enable students to assess the

real-world performance of their innovations, collect valuable data, and refine designs, thus bridging the gap between research and application.

- Knowledge sharing and public engagement to highlight the importance of WAH safety.

The partnership with Singapore University of Social Sciences (SUSS) is aimed at driving behavioural and cultural advancements in WSH, particularly in WAH safety. It will seek the following outcomes:

- Research and co-creation of innovative solutions for influencing behavioural shifts in high-risk work environments. This may involve developing new safety tools or frameworks to address human elements in safety.
- Co-developing training programmes focused on improving safety behaviours for supervisors, managers and workers in environments involving WAH.

- Knowledge sharing and public engagement to highlight the role that human factors play in WAH.

Strengthening WSH requires industry commitment, collaboration and building up capabilities through training and technological innovation.

The WSH Council urges all companies to take ownership of WSH and leverage technology to safeguard workers.

The world's largest telescope being built in Chile

Providing appropriate formwork and scaffolding solutions.

The cool, dry and cloud-free Atacama Desert in Chile offers ideal conditions for astronomical observations and is already home to several telescopes. It is therefore not surprising that the world's largest telescope is also being built there, on the 3,046 m high Cerro Armazones mountain, and is expected to go into operation in 2028.

With the help of the Extremely Large Telescope (ELT), scientists hope to gain new insights into the early history and future of the universe or even discover new, earth-like planets.

PERI supplied the formwork and scaffolding systems required for the construction of the foundation as well as for the wall structures and the central base of the telescope.

The ELT surpasses the performance of existing telescopes many times over. With a primary mirror 39 m in diameter, the telescope can collect 15 times the amount of light compared to previous telescopes, making it possible to see much smaller details in space than previously possible.

This requires several technical masterpieces. For example, the main mirror consists of 798 individual, moveable hexagonal mirrors which ensure that the mirror shape corresponds to an optically ideal shape at every temperature and inclination of the telescope. Before the light reaches the cameras, it is directed via a further mirror which can be deformed using almost 6,000 adjusting elements and thus compensates for air turbulence.

This is supported by six 'artificial stars' which are projected by laser into the atmosphere at a height of around 90 km. The complete



An Extremely Large Telescope (ELT) is being built on the Cerro Armazones mountain in the Chilean Atacama Desert.



Shoring construction consisting of ST 100 Stacking Towers for load transfer of the cantilevered platform at the top.



By combining the ST 100 Stacking Towers with components from the PERI UP Scaffolding Kit, access to the platform above could be created.

structure will weigh 3,700 t after completion.

The large-scale project is being financed by the 15 member states of the ESO (European Organization for Astronomical Research). As the largest member, Germany is contributing around EUR 230 million towards the total construction costs of EUR 1,104 million. In 2016, the construction contract was awarded to an Italian consortium led by the company, Cimolai SpA.

Responsive and effective support

PERI not only supplied the appropriate formwork and scaffolding solutions, but also contributed to a fast construction process, in terms of engineering, by searching for and finding the simplest possible assembly solutions which could also be realised thanks to the versatile material.

The fact that the PERI Engineers reacted quickly and effectively to special, ad-hoc project requirements, and aligned the construction site planning accordingly, was also essential for the few time losses. PERI also provided support from a commercial and logistical point of view, and thus made a further contribution to efficient construction site execution.

High pressure and load absorption

The foundations for the telescopic structure were laid in 2018, using the lightweight Handset Alpha panel formwork. TRIO Panel Formwork was used for the massive wall superstructures that now carry the steel structure of the enormous telescopic dome. The 2.40 m x 2.70 m TRIO Panels were designed for the large volume of concrete and the associated high concrete pressure.

Almost in parallel, a complex shoring structure grew upwards with the help of ST 100 Stacking Towers to support the loads of the cantilevered platform above. The shoring was erected and dismantled using the stacking principle, whereby the individual frames were quickly and easily



MULTIFLEX Girder Slab Formwork for fast and flexible covering of the base of the ELT.



A bird's-eye view of the base of the ELT, which was formed with the MULTIFLEX Girder Slab Formwork.

assembled without bolts or screws. By combining the Stacking Towers with components from the PERI UP Scaffolding Kit, the accesses to the platform above could then be created.

Flexible solution for a geometrically demanding area

MULTIFLEX Girder Slab Formwork was used for the so-called base in the middle of the ELT, allowing all areas of the circular surface to be covered as quickly and flexibly as possible. The MULTIFLEX Girder Slab Formwork is designed for challenging geometries, such as the round slab area of the base, as both the spacing of the girders and props, and the alignment of the girders, can be individually adjusted.

First light is still a while away

After around half of the construction work on the ELT was completed in the summer of 2023, ESO estimates that the remaining work will probably continue until 2028, before the so-called first light is expected. At first light, the ELT will see real starlight for the first time and will then be able to provide mankind with new insights into the universe.

PROJECT CREDITS

Contractor

Cimolai SpA, Antofagasta, Chile

Field Service

PERI Chile, Antofagasta, Santiago

All images by PERI SE

Construction of Scandinavia's second tallest tower

Two cranes from Liebherr are a key part of this project.

An impressive structure has emerged at remarkable speed in Karlskrona, Sweden. Standing at a height of 200 m, the NKT Tower 3 is the second tallest tower in Scandinavia.

Two Liebherr cranes, a 542 HC-L 12/24 Litronic and a 258 HC-L 10/18 Fibre, are a key part of this ambitious construction project. The tower, which is built by Skanska, will be an integral part of the world's largest high-voltage submarine cable factory which will supply wind turbines and solar parks with essential components. Weighing 28,000 t in total, the NKT Tower 3 is a feat of engineering.

Providing implementation support

A high-performance crane solution was needed to meet the exceptionally tight construction deadline of just 90 days. The Liebherr Tower Crane Center (TCC) provided the Liebherr 542 HC-L and 258 HC-L cranes from its rental fleet to facilitate rapid construction progress.

"To secure 24/7 operation, we moved key spare parts such as a new fibre rope and various modules directly onto site in advance, so that time is not lost if these are needed," said Stefan Gröber, Head of TCC Used & Rental.

In addition, Tower Crane Solutions (TCS), Liebherr's project department for large and special projects, provided detailed calculations for optimal tie-in geometry and made the required tie bars available through the TCC. The climbing steps were also carefully planned beforehand to ensure an efficient construction process.

An optimal crane configuration, including hoist rope lengths, power supply and tower bracing, was put together specifically for the project.

TCS also provided the structural data for foundation loading and tensioning forces and worked closely with the TCC to coordinate tie-in geometries. This custom solution successfully met the project's challenging requirements.

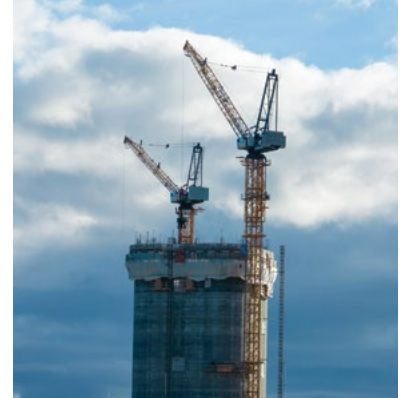
The project was successfully completed within the timeline because of the collaboration between TCC, TCS and the corresponding side in Sweden, Head Of Tower Cranes Skanska South District, Fredrik Funke and Project Specialist Anders Ekström from Ekström Lyftkonsult AB.

Fast construction progress

The 258 HC-L 10/18 Fibre and 542 HC-L 12/24 Litronic luffing jib cranes, used on site, climbed to a final tower height of 213 m and 210 m, respectively. The tower was constructed at high speed. In just three months, the structure grew by an average of 2.6 m per day, thanks to a four-shift system and round-the-clock operation. The entire structure covers an area of 23 x 23 and will boast a total volume of 112,445 m³, roughly the equivalent of 45 Olympic-sized swimming pools.



The Liebherr 542 HC-L and 258 HC-L cranes.



The Liebherr cranes climbed to a height of over 200 m.



Thanks to an innovative crane solution, the tower was erected in just 90 days.

Tunnelling on the Italian side of the Brenner Base Tunnel completed

Milestone reached for one of Europe's most important transportation projects.

The Brenner Base Tunnel (BBT) is a key project for the sustainable expansion of European rail infrastructure. Under the direction of the Austrian-Italian company, BBT SE, the world's longest underground railway connection, spanning 64 km, is being built between Innsbruck, Austria and Franzensfeste, Italy, on the trans-European north-south corridor from Finland to Malta.

It is being designed as a particularly high-performance flat railway line, i.e. with very low gradients.

Herrenknecht has won orders for a total of eight tunnel boring machines for the construction of the BBT.

On the Italian side, the last of three Herrenknecht machines has successfully completed tunnelling in the western main tube for construction lot H61 Mauls. Using two Double Shield Tunnel Boring Machines (TBMs) with a diameter of 10.65 m, the miners of the joint venture between Webuild, Ghella, P.A.C. and Cogeis excavated 14.3 km of the two main tubes.

They mastered both high-strength rock and challenging geological fault zones. They used another Double Shield TBM with a diameter of 6.8 m to construct a service and rescue tunnel beneath the main tubes.

On the northern, Austrian, side of the Brenner, four machines, manufactured in Schwanau, are currently driving the main tubes forward. The tunnel builders had already completed the Austrian section of the service and rescue tunnel with a Herrenknecht TBM, in 2020.

Herrenknecht AG

Herrenknecht AG delivers tunnel boring machines for all geologies



One of the Double Shield TBMs from Herrenknecht, used for excavation of the western tube of the Brenner Base Tunnel on the Italian side.

and in all diameters – ranging from 0.10 m to 19 m. The product range comprises tailor-made machines for traffic, supply and disposal tunnels, technologies for pipeline installation as well as additional equipment and service packages. Herrenknecht also manufactures drilling equipment for vertical and inclined shafts as well as deep drilling rigs.



Announcing the completion of the western main tube for the Brenner Base Tunnel.
Image: BBT SE / Bianchi.

PROJECT DATA

Project

Brenner Base Tunnel Lot H61 Mauls

Client

Galleria di Base del Brennero – Brenner Basistunnel BBT SE

Contractor

ARGE H61 Mauls 2-3, BTC S.c.a.r.l. (Webuild, Ghella, P.A.C., Cogeis)

Application

Railway

Tunnelling length

3 x 14.3 km

Geology

Granite gneiss, granodiorite, mica schist, phyllite

MACHINE DATA

Machine type

2 x Double Shield TBM

Diameter

10.65 m

Cutterhead drive power

4,200 kW

Torque

23,934 kNm

Machine type

1 x Double Shield TBM

Diameter

6,800 mm

Cutterhead drive power

2,800 kW

Torque

8,597 kNm

The new Cat 775 off-highway truck

Caterpillar Inc showcased the new Cat 775 off-highway truck at bauma 2025, spotlighting the company's ongoing leadership in technology and autonomous capabilities. The machine is the first next generation design of off-highway trucks for the company. Distinguishing it from the previous 775 models, this 65-tonne (71-ton) payload hauler is engineered to enable fully autonomous capabilities in the future.

Caterpillar is leveraging its current Autonomous Hauling Systems (AHS), Cat MineStar Command for hauling, already at work at mine sites throughout the world, and scaling the system's processes and technology, to meet the specific needs for quarry operations.

The Cat 775 next generation truck has a planned introduction in 2026. Autonomous capabilities with MineStar Command for hauling are currently under development.

Productivity

The 775 features an innovative new frame design that helps to optimise payload weight, a refined suspension for improved ride and handling, and advanced safety features like the 360° surround cameras and Cat Detect radar system to deliver superior performance, and safer and more comfortable operation.

Performance

With more body volume, the truck's new frame is optimised for weight distribution and structural efficiency. Compared to the 775G series truck, there is nearly 30% less welding, to minimise the risk of cracks and improve frame life. Less internal welding and ease of frame repairability help lower costs to maintain the new 775 over an estimated 40,000-hour truck life.

Its redesigned suspension boasts a lower centre of gravity. The 775 has shown to deliver better



The Cat 775 off-highway truck delivers superior performance and safer and more comfortable operation.

handling than previous designs, and an updated turning radius enhances on-site manoeuvrability. Improving service life, the truck experiences less bouncing on the tyres and driveline, and the operator feels less vibration and energy feedback into the truck.

The truck is powered by the 615-kW (825-HP) Cat C27 engine and comes in different emissions configurations to meet different global regulations. The US EPA Tier 4 Final/Stage V version displayed at bauma offers better fuel efficiency than previous models, with advanced electronic powertrain controls that deliver faster cycles and reduced road maintenance. The truck's enhanced ride and handling allow for higher speeds on curves and driving in higher gears, which directly reduces fuel consumption during the cycle.

Safety

The new cab is designed for efficiency and equipped with features to automate functions. The large windows give the operator visibility to the work area and surroundings. Automatic cab temperature controls and the Cat next generation deluxe seat is designed to help improve operator comfort.

Its 360° surround cameras with object detection alert operators

to hazards within the immediate vicinity, making it easier to safely operate the new 775. Cat Detect combines radar and camera systems to automatically detect hazards within critical areas around the truck – primarily the front, rear and turning radius on each side.

Serviceability

Multiple key maintenance and service contributors have been reduced with the new truck design. The next generation of enhanced serviceability incorporates extended-interval filters with ground-level access, ground-level lockout features and a serviceable suspension. Its design is fire suppression ready to simplify system installation.

The ability to access and analyse accurate real-time data enables faster diagnostics and enhances the ability to predict and prevent machine failure.

New for the 775, remote flash and troubleshooting capabilities help to boost truck availability. Remote flash instantly provides access to the latest software updates and enables the updates to be scheduled and executed at a time that does not interrupt the production schedule. Remote Troubleshoot enables the dealer to perform diagnostics remotely while the truck is still in operation.

The SP 33 enables concrete paving in offset and Crosspave modes



The Wirtgen SP 33 can pave a wide range of different monolithic concrete profiles, e.g. kerbs, kerb gutter profiles, rectangular profiles, concrete barriers up to 1.3 m in height or sewers and drainage channel profiles.

At bauma 2025, Wirtgen presented the compact SP 33, its latest slipform paver for the construction of monolithic concrete profiles. The machine can be used for concrete paving in offset and Crosspave modes. This enables the realisation of a variety of different paving applications with just one machine.

Versatile and manoeuvrable

Thanks to its modular construction concept and a wide range of setting options, the machine can be configured for use in almost all situations encountered on construction sites. Two track units, with parallelogram swing legs at the front and a laterally adjustable single track unit at the rear, enable zero-clearance paving and maximum flexibility.

In the offset mode, it can pave kerb and gutter profiles, rectangular profiles and concrete barriers up to 1.3 m in height,

as well as sewer and drainage channel profiles. Concrete slabs with a paving width of up to 2.2 m can also be realised without any problems, or up to a width of 2.4 m, in combination with a Trimmer.

In Crosspave mode, the track units are turned by 90° and the machine then paves transverse to the direction of travel. The slipform mould is centrally mounted under the machine, which enables the paving of concrete slabs with widths of up to 3.0 m.

The quick and easy conversion from one paving mode to the other makes the machine particularly versatile. In addition to delivering precise paving results, the capabilities offered by the machine also make it a particularly cost-efficient paving solution.

Guided operations

The new operating concept, with event-driven graphic visualisation,

assists operators in their work with both paving modes. The machine control panel provides separate zones for clear and simple visualisation of the currently relevant machine information for each of the three main working phases – Transport, Set-Up and Concrete Paving.

Load-dependent engine management

The load-dependent engine management system identifies every working situation and the power it requires and automatically adjusts the speed of the diesel engine accordingly.

This ensures that the diesel engine runs with optimal efficiency.

Stringless paving with AutoPilot 2.0

Wirtgen offers its field-proven AutoPilot 2.0 stringless paving system for all offset pavers and placers/spreaders.

New duty cycle crane with 220 tons load capacity

At bauma 2025, SENNEBOGEN presented the SENNEBOGEN 6220 E duty cycle crane – a new model with a load capacity of 220 t and a maximum boom length of 74.7 m in the lifting mode.

The new crane is characterised by its high performance, flexibility and safety, and is designed for a wide range of applications. With the new 220 tonner 6220 E, SENNEBOGEN is now expanding its series in the upper size class, closing the gap between the 140 tonner 6140 E and the 300 tonner 6300 E.

High versatility

The new 220 t duty cycle crane is versatile and can be customised for different applications. Depending on requirements, customers can choose between a 563 kW or the larger 708 kW engine with emissions stage V.

Various attachments and ballast variations are also available, depending on whether the machine is to be used as a crane or excavator. The duty cycle crane demonstrates its strengths particularly in the offshore sector and in dredging, for example by working particularly stably and reliably under the toughest conditions and even at inclinations of up to 4° with the higher engine power and more ballast.

In addition, the machine can be equipped with additional hydraulics for various attachments and there are several winch options, ranging from 30 t or 35 t free-fall winches, an equipment with 2 x 20 t double winches, through to other



The new, 220 ton SENNEBOGEN 6220 E duty cycle crane is suitable for various applications.

additional winches for different applications.

The duty cycle crane can also be equipped with an extra-powerful 6 t tagline winch with 60 kN tractive force for the necessary precision during grab work. With a fairlead and dragline bucket, on the other hand, the machine is used for extraction work.

In civil engineering, the robust boom design and the high load capacities make it easy to operate a hydraulic breaker, leader, vibrator or even a diaphragm wall grab. A pipework connection can also be configured. It can also be used in steelworks, with a drop ball, or for demolition work, with a wrecking ball.

High load capacities and tensile forces

The 6220 E demonstrates its load capacity in the grab and hoist mode and offers high values across the entire working range. Thanks to the increased rope capacity on the 1st

layer, the duty cycle crane can also work particularly deep with the maximum tensile force of its free-fall winches, i.e. 350 kN. This also greatly reduces rope wear.

The use of aramid guy ropes instead of steel ropes on the main boom has resulted in considerable weight savings. The machine also has two slewing gears as standard, which guarantee a high slewing torque of 585 kN.

Safety and comfort for the driver

Like all SENNEBOGEN duty cycle crawler cranes, the 6220 E is also equipped with the ergonomically optimised, large Maxcab, which offers the proven all-round comfort and can be tilted by 20° as standard, so that the operator always has an optimum view of the working area.

As an option, the duty cycle crane can also be equipped with a 2.0 m hydraulically elevating cab – a feature that is particularly useful in dredging applications.

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