



ENGINEERING A FIRST WORLD

50 FEATS THAT TRANSFORMED SINGAPORE



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FOREWORD BY PRIME MINISTER LEE HSIEN LOONG



SAMWOH ECO-GREEN BUILDING

TURNING TRASH *into* CONSTRUCTION MATERIAL

above:

Crushing and sieving of construction and demolition waste into the shape and size suitable for concrete production

right, from top:

Recycled concrete aggregate is added to cement to make new concrete

Recycled concrete aggregate is derived from the processing of construction and demolition waste

Singapore is a city that never stops building – at a breakneck pace – 365 days a year, constructing new homes, and office and industrial buildings. But access to raw materials to make concrete, particularly aggregates, is increasingly difficult as traditional sources of supply have, for various reasons, restricted or banned exports to Singapore.

Aggregates, such as sand and crushed stones, are added to cement to make concrete. In its quest to address the dwindling supply line, Samwoh Corporation Pte Ltd activated its engineers to develop alternatives for the construction industry. Its research and development team turned its attention to the two million tonnes of construction and demolition, or C&D, waste that is generated in Singapore each year.

The plan was to convert it into recycled concrete aggregate that the industry calls RCA. This is not something new as RCA has been used for road kerbs, drains and other road construction. But its integrity has never been deemed good enough for the construction of buildings and structures.

National urgency

Determined Samwoh engineers teamed up with Building & Construction Authority and Nanyang Technological University, and pushed the envelope to develop RCA into high-grade aggregate. Their success along the way drastically slowed down the pace of C&D waste that was rapidly taking up space at Singapore's only landfill at Pulau Semakau.

To prove the RCA they developed was as good as natural aggregates, the engineering team used 100 per cent of RCA to construct a three-storey Eco-Green Building in 2010 to house its new office and research lab. The research findings have since been reviewed and published by prestigious international journals in engineering and construction, including the American Society of Civil Engineers and the United Kingdom's Magazine of Concrete Research.

The journey there had been a national urgency for the construction industry and the Samwoh R&D team, led by chief operating

officer Ho Nyok Yong, who was then group technical director and principal investigator. They were determined to close the gap between Singapore's lack of natural resource and the demand from the construction industry for raw materials.

"The challenge lay in reformulating concrete containing RCA so as to preserve its integrity under sustained loads in complex structures, such as buildings, while making it cost-effective," says Nyok Yong.

"The idea is to preserve the quality of the original material in the waste. Rocks like granite, which is mainly used in Singapore, are strong, as it took few million years for its formation to take place. RCA, comprising mainly granite, is therefore still useful. The question is how do we recycle it? The cement paste, which is a mix of sand and cement, is present on the surface of RCA and has some adverse impacts on the integrity of new concrete mix."





above, from left:
Creep testing equipment developed by Samwoh
Flexural strength testing

Nyok Yong explains that it is costly and tedious to remove the cement paste. Others have previously tried using different techniques such as heat treatment, but it's about five to six times more expensive than natural aggregate, and makes no economic sense.

Breaking new ground

“So, we redesigned the processing of C&D waste by removing the amount of foreign materials to less than 5 per cent and employing a crushing system to minimise the amount of cement paste on the RCA,” he points out. “We find that the old cement paste in our RCA concrete does not compromise on the integrity of the mix and is strong enough to sustain the load.”

His team also conducted extensive R&D to evaluate the performance of RCA concrete, and designed it to be comparable to normal concrete containing natural aggregates.

Samwoh used this to build the Eco-Green Building to convince the industry that this will help Singapore reduce its reliance on external sources for materials. Because of its success, BCA now allows up to 20 per cent of RCA in the construction of new buildings in Singapore. “We put Singapore on the world map,” says Nyok Yong. “This is something we are proud of, because this is the first building in the region, and very likely even in the world, to be fully made up of RCA.”

Samwoh also uses the Eco-Green Building as a live research prototype. Fibre optic sensors are embedded in columns of the building to provide real time data to study its behaviour under the influence of RCA concrete.

Since the building was completed in 2010, more than 8,000 visitors from all over the world have visited it. The team's efforts towards sustainability development have also

won numerous awards and gained recognition not only in Singapore, but also within Asean.

“Innovation is one way Singapore can stay ahead of the competition against other countries that are bigger or have their own resources,” Nyok Yong emphasises. “And with engineering gaining more prominence, our Little Red Dot can make up for its lack of space for colossal structures with life-changing innovations. Other countries may have their massive buildings but Singapore, with our pool of engineers, can level the playing field with innovations.”

Inspiring a new generation

Nyok Yong believes that such impressive accomplishments should inspire students to pursue an engineering course and strive to

innovate. The veteran engineer with more than 30 years of experience believes parents are now more supportive of their children choosing the field over long-time favourites such as finance, law and medicine.

Kelvin Lee, Samwoh's senior technical manager and the project coordinator for the engineering breakthrough, relishes his work as a civil engineer in solving problems. “There's never a dull moment. There are no two same customers or projects, as each has its own unique set of requirements and solutions.”

Emphasising the point, Nyok Yong adds: “Engineering trains the mind to be more analytical. We know the numbers, we know how to calculate, we compare and we use our engineering judgment.”

below:
Members of the project team, L-R: Kelvin Lee Yang Pin, Ho Nyok Yong and Lim Wee Fong



right:
Specimen preparation process:
Stage 1: Batching
Stage 2: Compaction
Stage 3: Slump test

