SWISS RESEARCHERS HAVE DEVELOPED A NEW WOOD-CEMENT COMPOUND THAT MAY PROVE A GAME-CHANGING MATERIAL FOR USE IN CONSTRUCTION.

With end-of-life tyres, glass, plastic waste and even coffee grounds being explored as new, sustainable alternatives to conventional materials in infrastructure and construction in Australia alone, what is being investigated on a global scale is proving just as adventurous.

Switzerland’s National Research Program “Resource Wood” – a collaboration with industry, forest owners and authorities – aims to generate scientific insights and practical solutions to optimise the use of wood in Switzerland and is one of many global initiatives leading the charge for sustainability in construction. One of the program’s most recent projects is the research into and development of a new type of concrete that largely consists of wood.

Daia Zwicky, head of the project and of the Institute of Building and Environmental Technologies at the School of Engineering and Architecture of Fribourg, says cement-bonded wood products or wood-cement compounds (WCCs) have been used in construction for more than 100 years for non-load-bearing applications, such as noise or fire protection panels.

However, Prof. Zwicky and his team opted for a more radical approach when exploring the potential of concrete/wood hybrid material for construction.

“We thought that cement-bonded wood may also be used as load-bearing material, thereby further profiting of their non-structural properties. In addition to their structural functions, these elements also contribute to acoustic and thermal insulation, therefore having economic and ecological advantages over pure timber elements,” he says.

The project is part of Resource Wood’s ‘Advancements in timber construction’ module, which covers a variety of projects aimed at developing better adhesive bonding and wood-based construction materials. The aim, Prof. Zwicky says, is to encourage more widespread use of soft and hardwood and improve building acoustics, earthquake protection and product manufacturing.

To rise to the challenge of creating a wood-based concrete that exceeds convention, Prof. Zwicky and his team had to overcome a number of technical obstacles.

“The main challenge with existing WCC products is the fact that they are mainly available as prefabricated panels. This limits their applicability in structural elements as they have to be connected among each other for achieving greater dimensions,” Prof. Zwicky states.

The fabrication of these panels, he explains, is often quite elaborate, making the product relatively expensive compared with basic wood material.

“As a result, our major challenge was to develop pourable wood-based lightweight concrete mixtures, allowing considerably larger structural application fields. We further wanted to work with real wood ‘waste’ (i.e. saw dust) and to develop mixes where the wooden components do not require any pre-conditioning, which would mean ‘gold-plating’ waste.”
The team dubbed the pourable wood-based concrete mix they would eventually produce WooCon.

With this direction in mind, the project team would need to develop a number of different recipes — testing fresh and hardened state properties such as workability, mechanical properties, building-physical properties — including thermal insulation and storage — and fire protection.

"Based on these properties, we further developed and tested different conceptual designs for building slabs and wall elements made of timber and WooCon," Prof. Zwicky says.

Using regular Portland Cement and softwood components, the strength of the WooCon was mainly influenced by the amount of wood contained. Initial 1:1 stress tests showed that the WooCon could provide a load-bearing function in construction and was suitable for slab and wall elements.

"We also considered end-of-life issues of WooCon from the project start, stipulating that these materials can be thermally recycled — i.e. combusted — which also had to be proved experimentally," Prof. Zwicky says.

The main difference between conventional concrete and the wood-based concrete the team produced is that the gravel and sand is replaced with finely ground wood — or sawdust. As a result, the material has shown to be a good flame retardant, acts as thermal insulation and even weighs significantly less than normal concrete — the lightest mix even floats, according to Prof. Zwicky.

While the material is applicable in a construction setting, Prof. Zwicky says its use for infrastructure should only be consider for the interior of buildings for the time being.

"Infrastructure is usually highly stressed structures with very long life span. Considering the relatively low strength and the prior unknown durability of WooCon in an outside environment, I’d refrain from applying it there — but, in my view, this is not where the big construction material volumes are — that’s in buildings. If infrastructures and major buildings — like skyscrapers — are still built from concrete but all other buildings are constructed in timber and WooCon, we will have a very sustainable future."

Due to the amount of wood that comprises it, Prof. Zwicky says WooCon also provides a sustainable alternative to conventional construction materials.

"Using WooCon eliminates the exploitation of rivers and pits for gravel and sand, even though cement is still needed. Our research showed, however, that alternative binders could be used, as well, and that the cement part of WooCon can also be recycled, thereby considerably reducing landfill waste and cement consumption," he says.

"Overall, it is a clearly more ecological way of construction."

While the project team has tested full-scale specimens of slab and wall elements comprising WooCon, Prof. Zwicky says the next step is to prove the material’s practical applicability beyond a proof-of-concept level.

"The next steps would be to further develop WooCon as a construction material to industrial scale and promote complete construction elements. Real-life test may be made in the framework of pilot projects — unfortunately, the construction business is very conservative, so it will only start in niches," he says.

While there are still hurdles to overcome and challenges ahead for WooCon, Prof. Zwicky says finding new ways to utilise renewable resources in construction in general is of utmost importance to achieving a sustainable future.

"The construction business is responsible for approximately 50 per cent of non-renewable resource exploitation, 40 per cent of landfill waste, 40 per cent of energy consumption and 35 per cent of global warming potential. Therefore, such ideas for developing more sustainable construction materials and systems is essential for the future of us all," Prof. Zwicky says. "It does not move very fast in this business, unfortunately, but if you never try, you’ll never know."