Dancing building prevents collapse

Super strong lightweight composite can carry a ton

In future, anybody caught inside a building during an earthquake need no longer fear the roof collapsing on them. Thanks to the use of composite materials, all the building will do is dance along, riding the waves of the earthquake. At least, according to Professor Ir. Adriaan Beukers of the Aerospace Engineering department of Delft University of Technology or TU Delft. He is developing composite columns that will enable a building to be put up in a matter of seconds.

Robert Visscher

Giant lorries trundle onto a stretch of wasteland. Thick slabs of concrete are piled on top of one another. A button is pressed, and the floors begin to move. Between the concrete pieces composite columns suddenly appear where a few seconds ago there were only small packages a few centimetres thick. They expand to become two and a half metres tall, carrying floor upon floor of the immensely heavy building. Where only moments ago the sand was whirling, a few minutes later a brand new apartment building has risen as if from nothing. This is the vision that Adriaan Beukers, professor of composite materials and structures, has of the future. "The columns are as flat as a pancake, and will be packed between the concrete slabs. All you need is a little room for a hose to inject water under pressure into the columns, and hey presto a building has been erected. The water inside the columns can then be used as a heat exchanger, so you can pump hot water into them during the winter, and cold water to cool the building during the summer. It is a very smart building, cheap to put up, more robust, and with inexpensive cooling and heating facilities."

Barbapapa

But we haven't got as far as this yet. "At the moment you might think we're talking pure fantasy, but we're very close to being able to realise a building of this kind," Beukers predicts. And he knows what he's saying. For many years his department has been researching the possibilities offered by composite materials. Composites consist of fibre-reinforced synthetics, several layers of which are pressure-bonded to form a lightweight material that can carry a great load. It sounds simple, but the practical implementation is very complex. Nonetheless Beukers has managed to reach a new, major milestone. He proudly points out a black piece of composite about a metre high. It's not much to look at. It moves in all directions, looks like rubber and doesn't appear to be very strong. "But this composite is extremely tough," Beukers says. "Appearances can be deceptive. This one-metre piece of composite can carry a weight of fifty to sixty tonnes. That's a big load and it brings the vision of inflatable buildings a whole lot closer. You could make the piece several times this size and use it to support a concrete floor."

Barbapapa

The composite is a bit like the shape-shifting cartoon figure Barbapapa, who – 'Clickety Click, Barba Trick' – could transform his body into any shape required. And that is exactly what Beukers

Photos: Sam Rentmeester/FMAX

Satellite dish at Airborne Composites in Ypenburg

has tried. "We want to be able to produce a piece of composite in any shape we like, so we can make practically anything and not just columns."
The Taniq company, which is run by TU alumni and uses technology developed at TU Delft, is currently developing composite shock absorbers for cars. "We can also use composite to make flexible oil pipes to float in the ocean. The composite pipeline would ride along with the flow and protect the oil by being so strong."

Pancakes

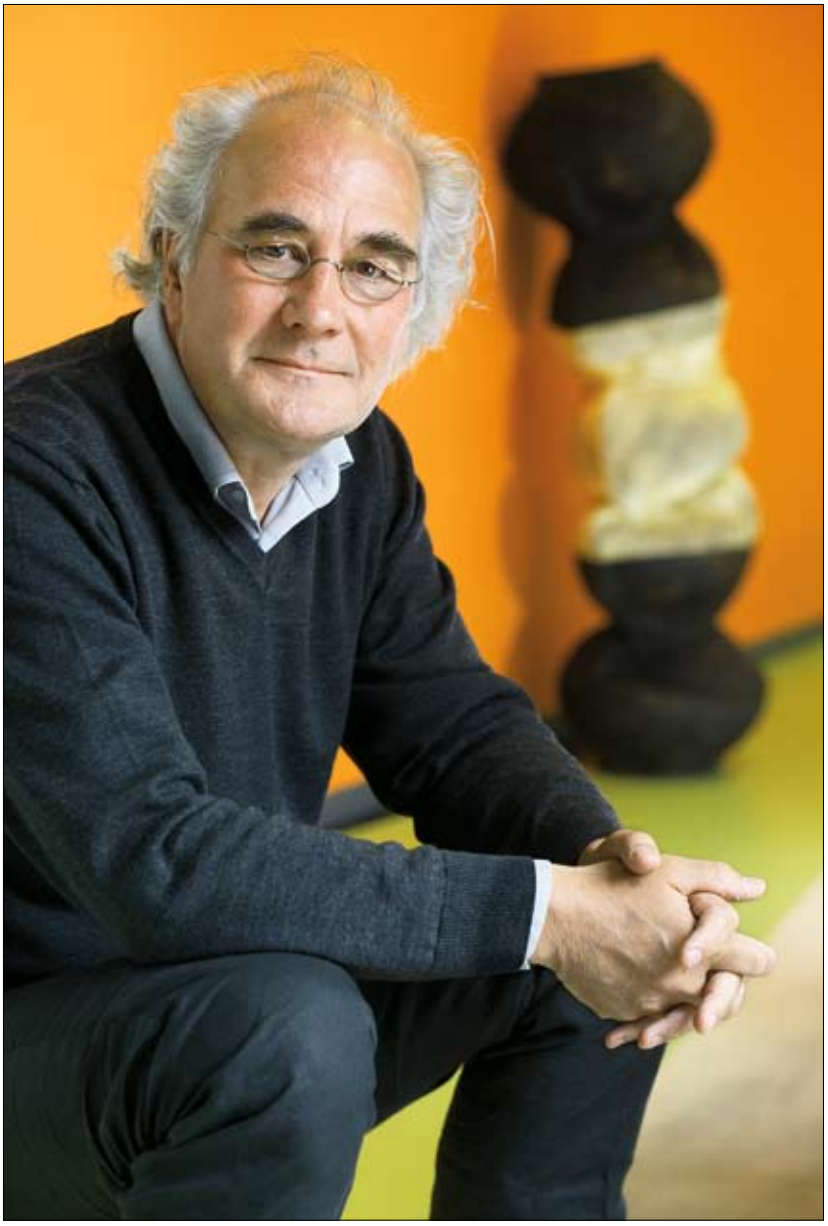
To some extent, Beukers owes his current progress with the composite research to a patent granted twelve years ago, when TU Delft developed a piece of composite about fifty centimetres in diameter that looked like a flattened car tyre. Beukers likes to refer to it as the pancake. "If you take this small pancake, only a few centimetres thick, and apply eight bars of pressure, the pancake will expand to lift a weight of up to forty tonnes. A very handy standby when a lorry has overturned. All you have to do is slip the pancake under the lorry and pump it up to push the vehicle back onto its wheels."
The pancake came in very useful on 11 September 2001. "The firemen used it to push the floors of the collapsed Twin Towers apart to free people trapped inside. In Los Angeles and Italy, composite materials are being used on a regular basis when disaster strikes. Israel has a special version that can actually lift a Hercules transport aircraft in the event of a crash. You used to need a crane for a job like that."

'We want to be able to create anything from composites'

"The new columns we are currently developing," Beukers continues, "are in fact a series of these pancakes stacked together to make the assembly more rigid and capable of lifting even greater weights."

Dancing columns

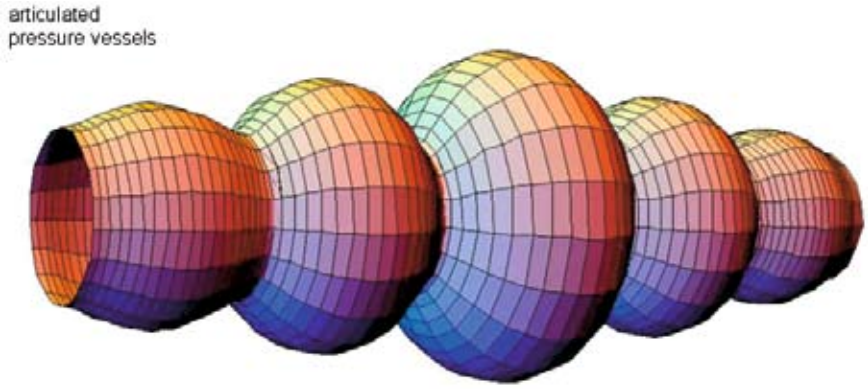
In the future buildings held up by composite columns would be immune to earthquakes. Instead of coming crashing down under these extreme forces of nature, as is the case with the ▸▸



current generation of concrete and steel structures, composites would ride along with the waves of the earthquake. A building would be dancing rather than collapsing. “A lot of lives could be saved,” Beukers says. “The pressure inside each composite columns could be controlled individually. If a building starts to lean over, you can add pressure to the bending columns to give them extra strength and bring the building back to its normal shape. The same could be done with viaducts. Concrete is a very brittle material that does not stand up well to natural disasters. Concrete columns cannot take anything in the way of deformation, but composites can. Composites don’t break, they bend with the strain. And so a viaduct will also move with the shock waves of an earthquake. By removing the pressure from some of the columns and adding pressure at other points, the object can be kept stable.”

We could have composite bridges that can be raised and lowered. “If the water level rises, you could raise the bridge so cars and trains can still cross. You could also raise the bridge to allow tall ships to pass underneath. You would never again have to wait for an open bridge to close. We could have smart viaducts, bridges, and buildings.” To Beukers the question is not how it is going to be done, but when. To a large extent the future of composite materials depends on the level of acceptance of people at large. And that is exactly where most of the problem lies, for no matter how much new technology Beukers develops, people will eventually have to want to use it. The trouble is that many people do not regard

Beukers supplies lightweight composites to sports car manufacturer Spyker and for the new bike of champion cyclist Theo Bos



Carbon element that can be put under pressure

compressed plastic as a reliable material. "Plastic has long been considered a disposable product – a weak material. I can understand that people find it hard to believe me when I say that steel and concrete will no longer be necessary. After all, it sounds absurd, doesn't it? I like to compare the richness of composite materials with that of potato crisps. Crisps are not much to look at. They are full of air, but even so you're sold on them the moment you taste one. They are salty, they crackle, and they taste lovely. All in all, a fantastic product. Just like composites they have more to offer than you would think at first sight."

People do not regard compressed plastic as a reliable material

Small businesses

The future of composites depends on small businesses, according to Beukers. They are the ones that are going to have to accelerate the development of the material. Ever the businessman, the professor likes to stimulate his former students as much as possible to start businesses of their own, and hands out TU composite patents. Jan Peeters and his Composites Team, for example, are developing small composite bridges for use in newly developed residential areas. In a workshop in The Hague that used to be part of the Fokker works, Marco Brinkman of Airborne Composites built a giant dish aerial that is now being used to scan the heavens. "It just goes to show how much can be done. TU Delft is also developing composite wind turbines," Beukers says. "Using a mould we can produce a vane for a 70-metre diameter wind turbine in one go, and within an hour. After that you just leave it to polymerise for another hour, and you're done. All you then have to do is to send it on its way. Using current processes, production would take days." To ensure that composite products will no longer be viewed as disposable plastics, Beukers has started to actively cultivate interest among third parties. He now supplies lightweight composite material to Spyker, manufacturer of bespoke sports cars, and for the extremely expensive new bike to be used by top cyclist, Theo Bos. "It helps us to demonstrate the high-tech nature of composite materials. They are lightweight, which makes them extremely suitable for use in sports cars and bikes. Composites are a godsend to Formula 1 racing, where they can help in building lighter cars. The only drawback at this point is that everything we make still is very expensive. By helping with the development of Formula 1 racing cars and world-class bikes, we can improve the status of the product, making it more than just a bit of plastic. Once the jet set starts to buy composites, because they want a Spyker car or a bike like the one Theo Bos rides, the rest will follow. Before you know it, there will be buildings that can be erected simply by pressing a button."

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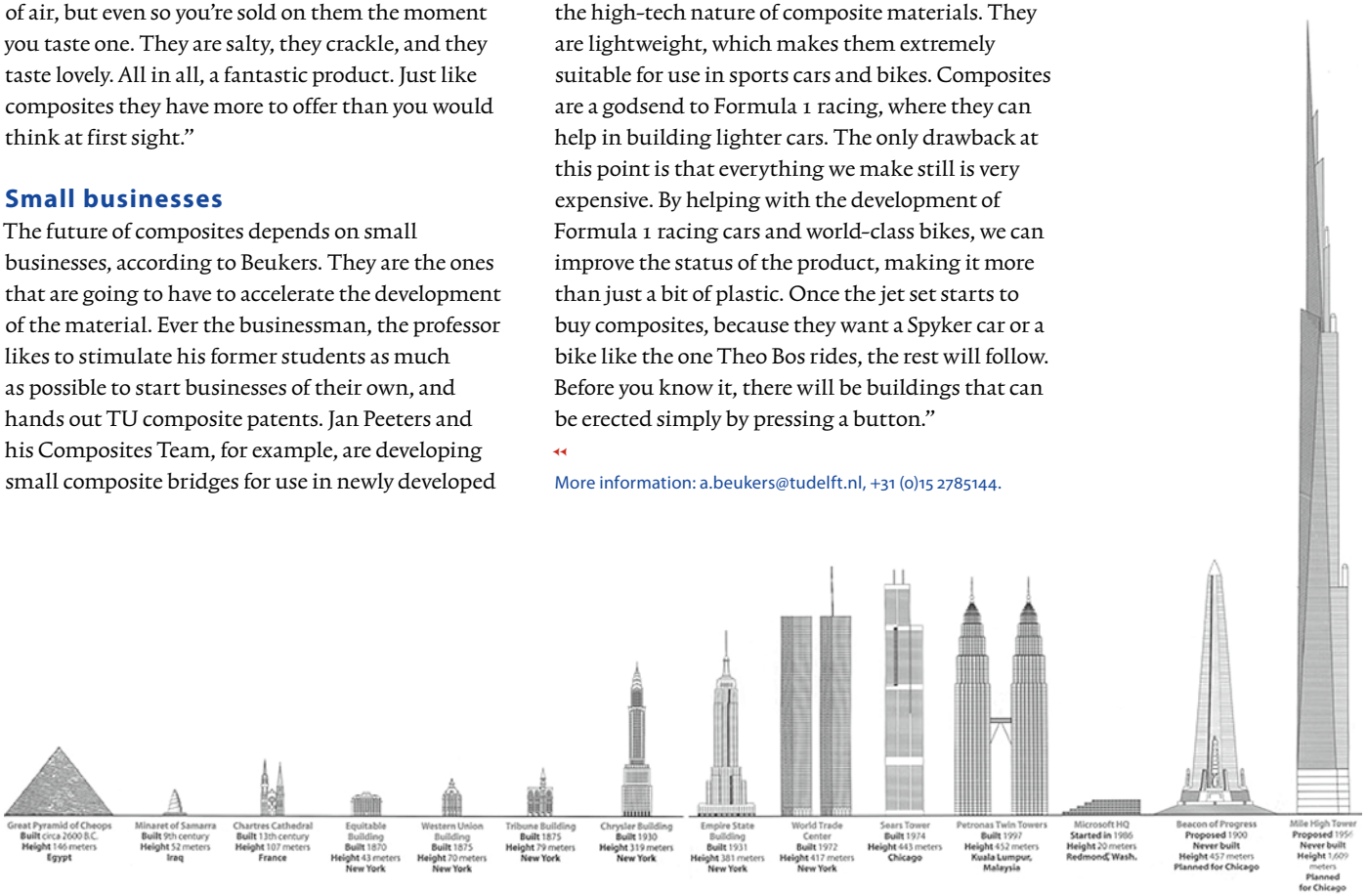

Illustration: Adriaan Beukers

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