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HARD MATERIALS TECHNOLOGY	DESIGN	YEARS 11-13

LIVING ON THE EDGE: THE SMARTPOD HOUSE

Designed by an engineer, the Smartpod house is a modular, cantilevered house which can be built on a small foundation on sites where a conventional structure would require extensive excavation/reinforcement. The houses are built in prefabricated components which are erected on site at the same time as access and service provision work is carried out.

FOCUS POINTS INCLUDE:

Characteristics of Technology

- Interdisciplinary design

Technological Products

- Material properties and performance capability
- Designing to fit the environment; material properties and performance capability

Technological Systems

- Prefabricated components that allow for variation in housing design

SUPPORT MATERIAL:

- www.smartpods.co.nz

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Cantilevering is a well-known structural engineering technique used to construct bridges and some commercial buildings, but the concept has never taken off when it comes to residential buildings. That looks set to change thanks to an innovative new modular design, which is the brainchild of chartered civil and structural engineer, Warrick Weber.

The Queenstown-based engineer owns a structural engineering and architectural design business with offices in Queenstown, Auckland, and Dubai, where he indulges his passion for what he calls “structural-led architecture”. He designs buildings where people can look at the structure and understand how it works, putting structural elements on display and celebrating the crucial role they play in the final make-up of any building.

He contends it has become all too common to hide the structural elements of buildings – a situation he attributes to the trend of architects and engineers increasingly working in isolation, rather than co-operatively to find ways of combining aesthetics and structural design elements.

“Engineers nowadays take a lesser role in determining the final form of buildings. What I am doing is going back in time by letting engineering take a bit of a lead in determining the look of a building.”

The Smartpod House

The Smartpod house, as Weber has dubbed his innovative design, is a product of the environment Weber works in. In many cases, the sites are too steep or too expensive to modify to enable a conventional house to be built. Weber likes to view his Smartpods, which appear to protrude from rock faces as though almost geological entities themselves, as working with rather than against

nature. “I do like steep sites and structure shaped by the geology of the site they are on,” he says. “I like structure to appear to be an extension of nature.”

It was this challenge that prompted Weber to develop his modular cantilevered house which, thanks to its much smaller foundation footprint, can be built on sites where conventional homes could not be erected economically. “The Smartpod home can be built anchored to the site by excavating just a small divot in the hillside rather than having to create a much larger pad to support the entire structure of a conventional house,” he explains. Rather than building each house from the foundations up, Weber’s houses are built in prefabricated components or pods. These are then trucked to the site and lowered into place by crane. Pod construction occurs at the same time as access, service provision and excavation works are carried out at the site of the house, cutting construction time.

The Smartpod has been designed with two different floor areas – 47 square metres and 67 square metres. The smaller pods measure 4.5 metres by nine metres long, with 50% of the length cantilevered. The larger version, which weighs in at 16 tonnes, measures 4.5 metres by 13.5 metres, and has nine metres of the longer side suspended above the ground. The flexibility of the concept also means house shapes can vary, including stacking pods on top of each other.

Smart Design

The biggest engineering challenge with the pods was dampening the structure to prevent unwanted vibration or vertical movement, particularly when people are in the extreme end of the overhang. “The natural frequency of the nine-metre pod is eight Hertz,” says Weber. “At that level, you need to start thinking about the effect of vibration and how people will perceive that level of vibration. It is a case of trying to dampen the structure as much as possible.”

The key to solving the vibration problem or vertical acceleration is the steel truss frame which forms the core of each pod. The trusses are made up of fully welded 150 UC 37 members. These are of sufficient weight and strength to minimise the vibration levels the structure generates. For lateral loads, the two main trusses are braced with diagonal 16-millimetre rods beneath the ceiling and under the main floor. However, the ceiling cables are likely to be replaced with a plywood diaphragm.

The floor itself is a sandwich of three components – the main structural components are cold rolled steel joists, the underside material is fibre cement board, and the top surface is particle board, which is ready to accept the finished surface. Insulation is sandwiched between the top and bottom layers.

The walls are largely doubled-glazed glass with extensive use of bi-folding doors. To prevent falls, the cantilevered end uses waist-high safety diamante glass panels. The exterior cladding can be varied from all glass to a more solid look with wall panels. Internal rooms are created using non-structural internal walls made from steel or timber framing with plaster board, which can be located anywhere within each pod for maximum layout versatility.

The roof is known as “warm roof”, which is a flat roof design common in Europe. The roof comprises timber rafters then a plywood diaphragm and vapour barrier, which sits below tapered rigid installation sheets called Enertherm. Waterproofing is achieved using two layers of bituminous membrane. Weber says the roof has a very high insulation rating to compensate for the amount of glazing used in the pods.

Each pod is transported to the building site with the steel frame, floor and roof already installed. Installing each pod in situ takes between five and six hours, after which services are connected to the building. Due to the torsional rigidity of the pods they can be transported to site with the glass already installed. The other key to any successful cantilevered structure is the foundations, which depend on the material on the site. On a rock site, rock anchors are drilled horizontally between seven and 10 metres into the hillside to secure the back of each truss. On clay soils, 450-millimetre tension piles are secured to a depth of four to five metres. On a flatter site, which falls away to a steeper bank, a concrete foundation can be used as a counterweight. On most sites a retaining wall provides additional counterweight for the suspended pod.

The first Smartpod home has already been completed in Queenstown, and Weber is confident that with New Zealand’s hilly terrain there will be plenty of Smartpod homes appearing on hillsides in the coming years.