

BUILDING RESEARCH

Does the use of off-site manufactured building components make sense?

CRC FOR CONSTRUCTION INNOVATION

A CRC for Construction Innovation research project reviewed off-site manufacturing of building components and the opportunities for wide-spread adoption by the Australian construction industry. This article reviews one of several CRC case-studies.

Off-site manufacture (OSM) has long been recognised, in Australia and internationally, as offering numerous benefits to all parties in the construction process. More importantly, it is recognised as a key vehicle for driving improvement within the construction industry. The uptake of OSM in construction is, however, limited despite well-documented benefits. The purpose of this CRC for Construction Innovation project was to determine the state of OSM in Australia. It confirms the benefits and identifies the real and perceived barriers to widespread adoption of OSM, and identifies opportunities for future investment and research.

Although numerous reports have been produced in the UK on the state of OSM adoption, no prominent studies exist for the Australian context. This scoping study is an essential component on which to build any initiatives that can take advantage of the benefits of OSM in construction. The *Construction 2020: a vision for Australia's property and construction industry* report predicted that OSM would increase in use over the next five to fifteen years, further justifying the need for such a study. The long-term goal of this study is to contribute to the improvement of the Australian construction industry through a realisation of the potential benefits of OSM.

Mercure Apartments is a new development in Newcastle, New South Wales. It is a mixture of new build and the adaptation of an older structure. The finished building will have 14 floors and consist of a number of Mercure-branded hotel apartments.

Originally the client who owned the building looked to find a company which could develop the site into private apartments to a specific budget. Timwin Construction — a Chinese construction company with offices in Sydney — was selected to construct the building. In order to keep to budget, Timwin decided to develop the idea of using a number of different factory-made modules for the bathrooms, ensuites and kitchens in the development. Together with another company in China, Timwin established a factory in China to build these modules.

After construction of the building had commenced, the client decided to brand the building into the Mercure brand — and therefore its original use as private apartments changed to that of a hotel/serviced apartments. To ensure that the decor, and therefore

the design and construction of the kitchens and bathrooms, fitted in with the Mercure branding, the client contacted Duc Associates to assist in altering the design of the modules to fit with the new branding and use.

Duc Associates has a reputation for specialising in the design of large-scale hotel projects. Its work ensured that standards were met and the designs fit in with the Mercure brand.

During the construction of the building, Timwin was taken over by the company making the modules.

The product

The building uses the following modules, the bathroom, the kitchen, the laundry and the ensuite.

There are many variations in design, so they are by no means standard modules. There are approximately 100 modules of each type of room.

Construction

The modules consist of a 75 millimetre steel tubular chassis into which a concrete reinforced floor is poured. The finished floors are approximately 80 millimetres thick. The chassis provides the structural rigidity for the module, which allows them to be craned out of the containers, and also provides protection against damage while shipping.

Once the chassis is built, the frame is lined internally in a conventional way with plaster boarding and internal finishes. All services are plumbed-in using Australian standard water pipes which are supplied to China. All kitchen cupboards are pre-fitted. Wiring conduits are fitted and some wiring pre-done, but most lighting and sockets / switches are fitted once on site.

Transportation

The modules are manufactured in China and loaded into standard shipping containers. They are then shipped to Sydney. The containers are off-loaded at port, placed on a truck and driven to the site. Once on site, the modules are craned out of the containers directly to the floor in which they will be fitted. They are then shifted by hand using rollers to place them into the correct position. Once in place, they are levelled and plumbed.

Once on site, many of the modules have to have an in situ built 'extension' on them to bring them to the size necessary for the room.



On site

Because half the building is in a 50-year old structure, adapting it to its new use and incorporating the modules within has been challenging. In the existing building, the floor slabs have a very thick topping on them and this has had to be chiselled out in order to take the thickness of the module floors. Once the modules are in place, a new screed is poured. In the new parts of the building, the floor slabs have been designed with a set down to incorporate the thickness of the modules.

Once on site, the modules are craned to the desired floor using a static power crane, then manhandled off onto rollers and moved to the required position. At this stage they are integrated within the building systems. No (minimal) service ducts were constructed in the in situ floor slabs. Holes to accommodate vertical service pipes were drilled through the slabs at a later date. There was a sizeable space between the top external side of the modules and the underside of the concrete slabs of the ceiling above. This void was used to run horizontal service mains that the modules connected to.

Benefits

The completed modules are very cheap — a typical completed kitchen module installed on site cost less than a traditional kitchen replacement.

Materials which are perceived to be of a better quality in Australia actually cost less than conventional materials in China, so it is more cost effective to use 'higher quality' materials.

By making the modules off site, it allows the structure of the building to be completed while modules are being manufactured at the same time, which should theoretically reduce the total build time of the project.

Barriers

The main disadvantages of this project have seemingly stemmed from the history of the project and how things have changed during its build history.

The thickness of the module floors has caused considerable construction problems with the existing building and the new build.

The requirement for step changes in the floor slab to take the modules has resulted in an inefficient building process and restricted any future changes to the building's use.

One of the current problems is that modules have been supplied and fitted on the site before the building structure is complete.

At the time of the site visit, there were still a number of floors which were being built on the new build section. As a result of this, the structure has no windows and is not yet watertight. The modules are therefore exposed to rain ingress, damage by splashes of concrete and general workers being in the vicinity. This would have been minimised if the modules had been temporarily covered but no attempt had been made to do this. However this was not perceived to be a problem, as such items as cabinet doors can easily be replaced at little cost.

Lessons

The project has been earmarked as a learning curve for the various stakeholders, with the plan to use the system on future projects.

One of the key areas that needed improvement was document management. It is considered that any future projects will have a fully established documentation system for recording all aspects of the construction process stage by stage.

Because the modules are being manufactured in China, and because the main construction company on site is Chinese, there have been many cultural differences between the Chinese and Australian stakeholders, which have had to be overcome in order for the project to succeed. To help drive this process, an external consultant has been employed by the client to act as a facilitator on the project. However, as all parties involved wish to get to the same end point — and indeed use the experience as a platform to expand the availability of Chinese-made modules on other projects within Australia — a great deal of effort has resulted in many lessons being learnt.

As a result of a newspaper article about the project, Duc Associates has been contacted by another hotel group, and is currently working with the module manufacturer to refine the design / production / integration process for new projects.

Download the full report

The full research report entitled "Off-site manufacture in Australia" produced by the CRC for Construction Innovation is available free of charge online from the CRC's website.

Online — www.construction-innovation.info