

# UNIVERSAL CONNECTORS FOR MODULAR BUILDINGS

## PROJECT FACTSHEET



LOW CARBON LIVING  
CRC



## KEY POINTS

- Innovations in modular building systems are limited by the low availability of well-designed module connectors.
- We have developed a universal, bolt-less connector for modular buildings of all shapes and sizes of up to 40 storeys (including public housing, condominiums, hospitals, hotels, offices, shopping centres etc.).
- Unlike other modular connectors, which are limited structurally and functionally, our design safely transfers lateral loads whilst remaining independent from the modules.
- Our universal connectors are remotely operable and enhance construction automation (Construction 4.0) and the uptake of low carbon modular buildings.

## THE OPPORTUNITY / CHALLENGE

Construction using modular buildings (factory manufactured 'black-box' modules) have a number of advantages including 20-50% less build times, 80% less accidents, 90% less waste, 10% construction cost reduction, superior quality and less environmental disruption. Their evolution into fully-modular systems is hampered by a range of limitations:

- **Technical**
  - Inefficient lateral load resistance
  - Inadequate robustness
  - Limitation on the size of open plan
- **Logistical** - handling, transport and construction of modular buildings can be challenging, and damage may occur

### CRC for Low Carbon Living

We are a national research and innovation hub supported by the Commonwealth Government's Cooperative Research Centres programme that seeks to enable a globally competitive low carbon built environment sector.

With a focus on collaborative innovation, we bring together practitioners from industry and government with leading Australian researchers to develop new social, technological and policy tools for facilitating the development of low carbon products and services to reduce greenhouse gas emissions in the built environment. For more information visit [www.lowcarbonlivingcrc.com.au/](http://www.lowcarbonlivingcrc.com.au/)

- **Regulatory** - there is a lack of guidelines for design, procurement and management.

To address these limitation, we have developed a universal connector that efficiently connects generic modules to meet demanding structural performance requirements (Fig. 1). They can be mass produced using automotive industry technologies and exported to international markets.

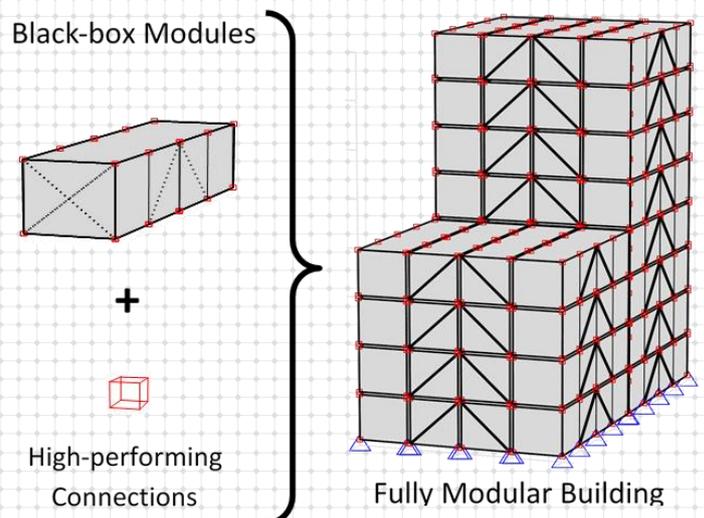


Figure 1: The versatility of fully-modular systems

## OUR RESEARCH

To develop our universal connector, we documented best practice in modular building construction and critically reviewed all relevant structural and functional performance requirements.

We then developed a computer generated multi-story modular building formed by modules with the peripheral modules forming the required lateral force resistance system. The structural integrity (under normal and extreme conditions such as earthquakes) was then tested and validated through numerical models.

We then designed, trialled, tested and iterated prototype connectors that were remotely operable, demountable, easily scalable, cost effective, simple to mass manufacture and capable of handling various construction tolerances.

We are currently investigating the technical issues associated with handling and transporting modules, road vibration hazard, fatigue failure and shock and impact hazards.

## OUTCOMES

Our outcomes include:

- A method to accurately model multi-story modular buildings for connection and structural response
- A high-performing prototype bolt-less connector
- Design methods and guidelines for the use of bolt-less connectors
- Understanding of the behaviour of modular buildings and how they can be promoted as affordable low carbon alternatives
- Advanced computer simulations and modelling of modular fixtures during transportation

## HOW YOU CAN BENEFIT

- Modules can be manufactured from a variety of structural materials offering modular designers and manufacturers numerous options and flexibility
- Connectors can be manufactured separately
- The universal mechanism can be used in modular buildings of any shape or size, encouraging further uptake of modular buildings
- Onsite construction is simplified thereby lowering GHG emissions, embodied energy and carbon
- Guidelines for the design and transport of modules will reduce damage and failure of sensitive and costly components

## NEXT STEPS

We are now investigating opportunities for the utilisation of our technology by taking the prototype to industries focused on automated building construction.

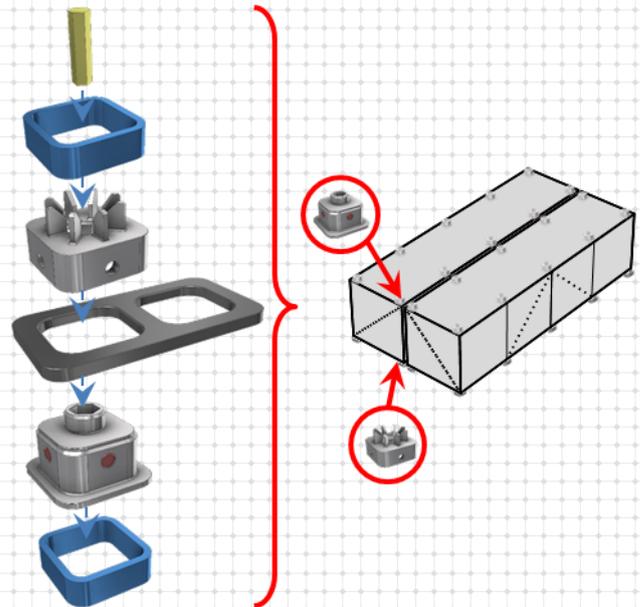


Figure 2 The ease in assembling a proposed bolt-less mechanical connection is shown

## PROJECT TEAM

Swinburne University of Technology: Prof. Saman Fernando [Project leader], Dr. Javad Hashemi, Prof. Emad Gad, Dr. Pathmanathan Rajeev and Mr. Srisangeerthan Srisikanthan.

University of Melbourne: Prof. Nelson Lam, Mr. Siddhesh Godbole and Mr. Mohamed Mafas.

Industry partners: BlueScope Steel, AECOM, HASSELL, Brookfield Multiplex and Victorian Building Authority.

## PROJECT REPORT(S)/ PUBLICATIONS

1. Srisangeerthan, S., Hashemi, M.J., Rajeev, P., Gad, E., & Fernando, S. (2017). Influence of diaphragm flexibility on the seismic performance of multi-story modular buildings. In: Australian Earthquake Engineering Society Conference. Canberra, Australia; 2017. <http://www.aees.org.au/wp-content/uploads/2018/02/465-Srisikanthan-Srisangeerthan.pdf>
2. Srisangeerthan, S., Hashemi, M. J., Rajeev, P., Gad, E., & Fernando, S. (2018). Numerical study on the effects of diaphragm stiffness and strength on the seismic response of multi-story modular buildings. *Engineering Structures*, 163, 25–37. <https://doi.org/10.1016/j.engstruct.2018.02.048>
3. Siddhesh Godbole, Nelson Lam, Mohamed Mafas, et al *Dynamic loading on a prefabricated modular unit of a building during road transportation*, *Journal of Building Engineering* 2018-19.

## FURTHER INFORMATION

**For more information about this project, please contact:**

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