MEETING SEISMIC PERFORMANCE REQUIREMENTS IN HOSPITALS THROUGH EFFICIENT DESIGN

RONDO®

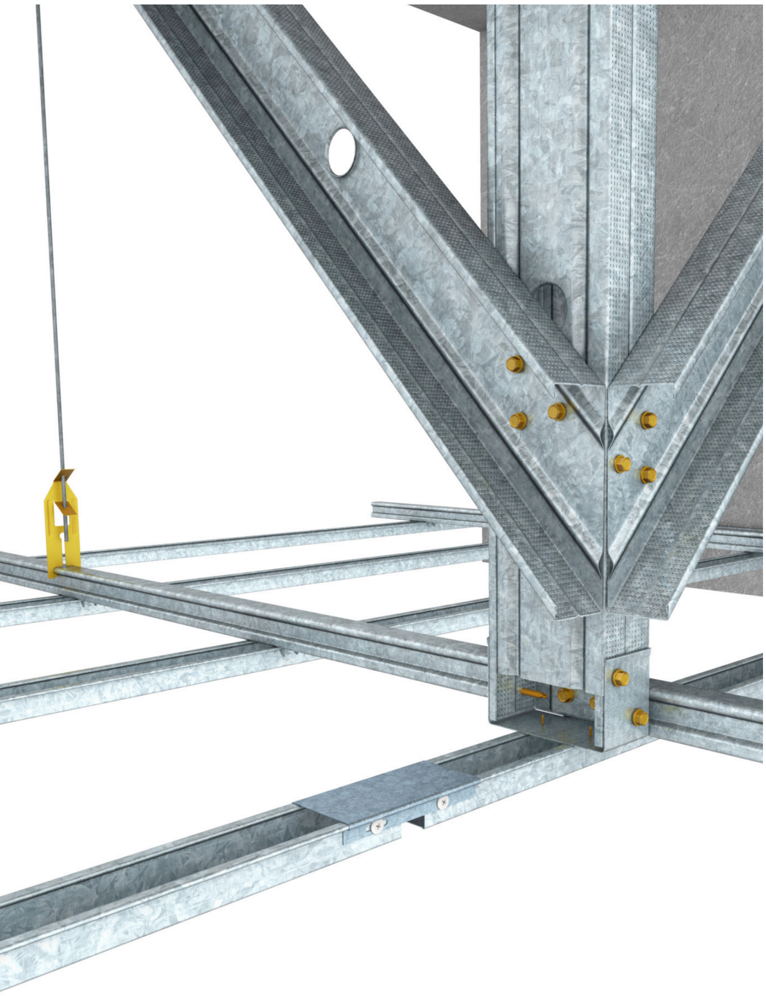
rondo.com.au

INTRODUCTION

It is a common misconception that earthquakes do not affect Australia because the continent is situated in the middle of a tectonic plate. However, the reality is that intraplate earthquakes can – and do – occur in Australia. When energy that has built up at the edge of the plate is displaced to any geological fault within the plate, this lesser known, but nonetheless serious, type of earthquake occurs.[1] Energy released from intraplate earthquakes causes ground shaking, which can be extremely damaging to structures. Depending on the nature of the ground conditions, the duration and intensity of the tremor, and distance from the epicentre, intraplate earthquakes can have impacts ranging from mild to severe. Their strength is significant and should not be underestimated by the design and construction sector.

Both the 1988 Tennant Creek earthquake in the Northern Territory and 1989 earthquake in Newcastle are recent examples of Australian intraplate earthquakes. With a magnitude of 6.6,[2] the former remains the strongest recorded earthquake event in Australia to date, while the latter claimed 13 lives.[3] It is clearly evident that earthquakes do pose a very real threat to Australian lives and structures. In light of this, it is essential that designers and specifiers take seismic performance into account when designing public buildings, in particular hospitals.

> Hospitals fall into Importance Level 4, meaning that they "are essential to post-disaster recovery or are associated with hazardous facilities."



UNDERSTANDING EARTHQUAKES

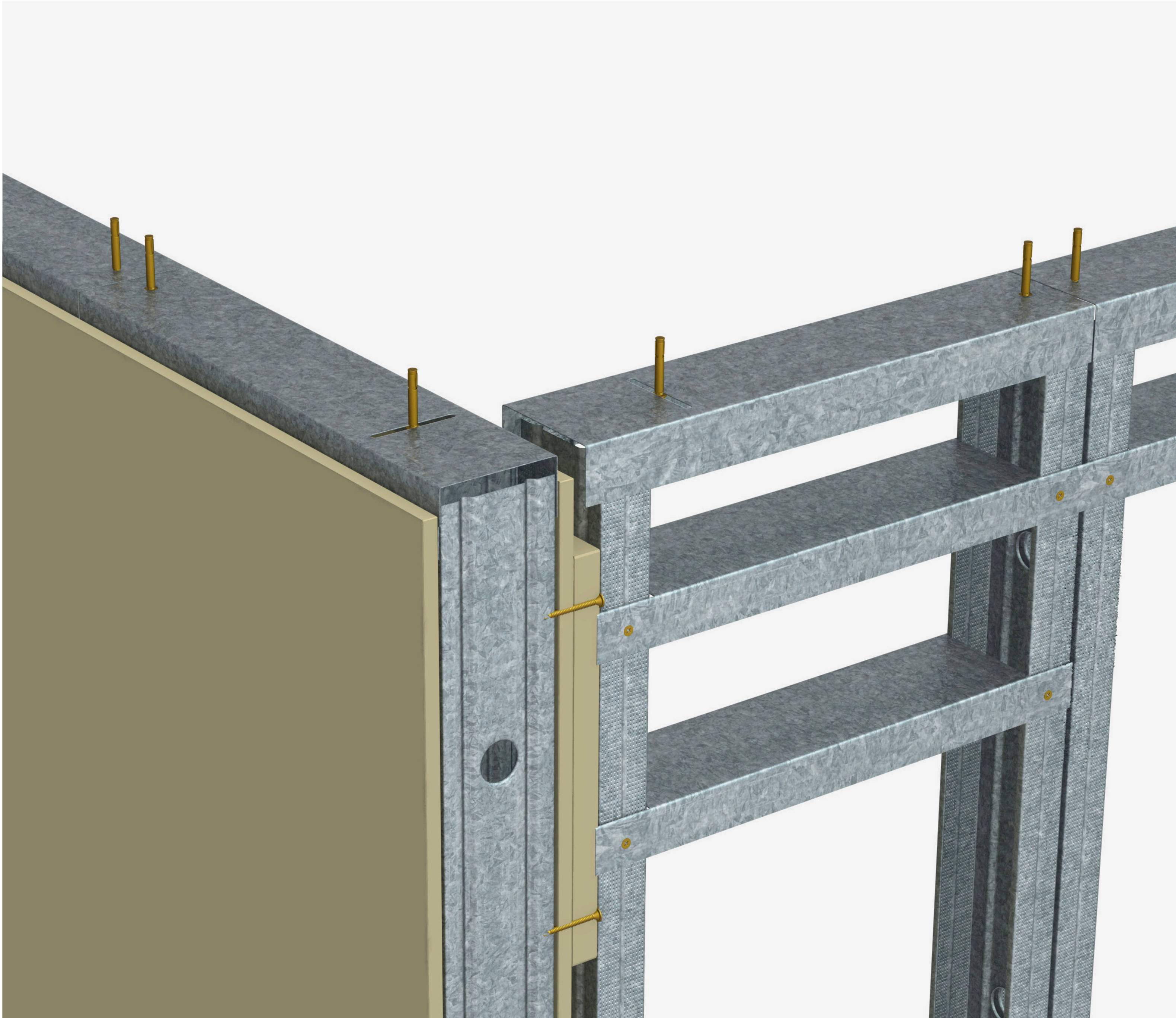
Earthquakes are a type of natural disaster that results from tectonic plates shifting and causing energy to disperse through the earth in a wave. As this wave spreads, energy is released outward from the epicentre of the earthquake. The strength or size of an earthquake is measured in various terms, including energy, observable responses or seismic movement, and is typically presented on an ascending scale of intensity. Geoscience Australia, the Government's technical advisor on all aspects of geoscience, explains that earthquakes with a magnitude of less than 3.5 "seldom cause damage", but that earthquakes with magnitudes of 4.0 or greater can cause shaking in populous areas and create tremors that can potentially trigger landslides and, in the worst instances, may cause casualties.[4]

LEFT: Rondo KEY-LOCK® Seismic Ceiling Bracing
RIGHT: Seismic Wall System

THE RELEVANT REQUIREMENTS

The National Construction Code (NCC) of Australia divides buildings into four categories of importance in accordance with the level of risk that their failure would present to life and property and also their function within the community or beyond. Table B1.2a of the NCC represents these divisions and provides an indication of how crucial they are to post-disaster recovery on an ascending scale of importance from 1 to 4.[5] Table B1.2b provides the minimum design requirements the building must meet for various events, including wind and seismic. For example, a building of Importance 4 needs to resist a 1-in-1500-year seismic event.

Australian Standard 1170.4:2007 provides the methodology for assessing the earthquake action for both the primary structure and parts within the building, in accordance with the Importance Level and design event established in NCC Table B1.2a and B1.2b respectively. Hospitals fall into Importance Level 4, meaning that they "are essential to post-disaster recovery or are associated with hazardous facilities." It should be noted that all buildings require an assessment of their seismic requirements; however, some buildings of Importance Level 1 are "deemed-to-comply" and therefore do not require a specific seismic design. The design requirements for parts of a building, including, but not limited to, walls, partitions and ceiling systems are covered by Section 8 of AS1170.4.



DESIGN-BASED SOLUTIONS FOR SEISMIC PERFORMANCE

Designers must develop a solution that takes into account the seismic requirements of a hospital by examining its environment, particular needs, and features and the interaction of these elements during a seismic event. This whitepaper outlines three general seismic solutions that can be used to provide resistance to the seismic loads caused by an earthquake – intraplate or otherwise – and reduce the risk of the building part's failure, injury, and loss of life. The solutions presented below can accommodate not only the design actions from an earthquake, but also the differential movements in the structure resulting from interstory drift. These solutions are intended to prevent tiles from becoming dislodged, plasterboard from falling, and the failure of the ceiling.

Perimeter Restraint

In this solution, the seismic forces developed within the ceiling during a seismic event are transferred through the ceiling grid to the perimeter walls, and ultimately back to the primary structure. This solution depends on three elements:

1. the capacity of the ceiling grid to carry the seismic load to the perimeter wall;
2. the connection of the ceiling grid members to the perimeter wall; and
3. the ability of the perimeter wall to transfer the seismic force back to the structure.

This solution can typically be employed for small rooms with lightweight ceiling systems and full height walls on all sides of the ceiling. It requires a rigid connection between the ceiling grid members and the perimeter wall along two adjacent sides of the ceiling, coupled with a "free or slotted" connection along the two opposing sides. The benefits of this method of installation are that it requires only limited coordination between the ceiling suspension and services within the plenum space, a particularly beneficial feature in hospitals where there are large amounts of services in the plenum.

Seismic Jointed Ceilings

This is an extension of the perimeter restraint method discussed above. By introducing seismic joints within the ceiling grid, the maximum room size may be significantly increased before plenum bracing is required.

As detailed above for the perimeter restrained solution, two adjacent sides of the ceiling have a free end at the perimeter wall wherein there is no axial seismic load transfer through these connections. The seismic jointed method simply creates a "free end" within the ceiling grid, using proprietary connectors, and the ceiling grid is restrained on all four sides of the room to take out the axial seismic loads.

Braced Two-Way Exposed Suspended Ceiling System

In this seismic solution, the ceiling is braced to the soffit in two directions, along the two orthogonal axes of the ceiling grid. This bracing method means that the ceiling can move independently of the perimeter walls while resisting lateral seismic forces by securing the ceiling grid to the structural soffit. The inherently modular nature of this solution means that it can be easily customised to different designs and can be efficiently installed; additionally, parts of this grid system can be individually replaced, allowing for a rapid and effective post-seismic event solution. There are no limitations on room sizes for this method of installation, and it is best suited to large open plan areas within the building.

Although this solution does require coordination between the ceiling bracing system and any services located in the ceiling plenum, the bracing set out can be adjusted to accommodate these services. Additionally, this system does not rely on load transfer to the perimeter walls, so it can be employed where the perimeter walls do not have sufficient capacity to transfer the seismic loads back to the structure.

Designers must develop a solution that takes into account the seismic requirements of a hospital by examining its environment, particular needs, and features and the interaction of these elements during a seismic event.

Proudly Australian owned and manufactured, Rondo has been at the forefront of the global market for high performance innovative steel products and systems since 1959. The company is known for supplying light gauge rolled formed steel products and systems that meet the complex demands of contemporary construction, including the requirement for seismic performance. The wide-ranging and adaptable selection of engineer certified products includes solutions that are ideal for use in hospitals and other buildings of all Importance Levels. Rondo's design-based seismic solutions for ceilings and walls have been successfully implemented in a number of hospitals including Taranaki Hospital, Gosford Hospital, and the New Royal Adelaide Hospital (NRAH), to name a few.

BELOW LEFT: Seismic Perimeter Trim Sliding Clip
RIGHT: TRACKLOK®

RONDO SEISMIC CEILINGS AND WALLS

Rondo manufactures and supplies a selection of industry-leading wall and ceiling systems, which are specifically designed to resist seismic loads. As an Australia-based company with a strong presence in New Zealand it is particularly in tune with the nature of intraplate earthquakes and the characteristics of their specific seismic energy. Every component of each system has been stringently tested by Rondo and an independent New Zealand-based research laboratory and, when designed accordingly, will be fit for purpose and compliant with the relevant standards and requirements. Rondo provides complete wall and ceiling solutions, thus reducing the likelihood of conflicting tremor reactions at the crucial joint between walls and ceilings. Holistic systems also limit structural damage and resist lateral forces during an earthquake, with the additional benefit of preventing tiles from becoming dislodged, plasterboard from falling, and the failure of the ceiling and blocking of evacuation paths.

Responding to research that repeatedly shows that lightweight buildings attract less seismic loads, Rondo Seismic Ceilings and Walls are fabricated from lightweight steel, which is 80% lighter than equivalent masonry construction. The Rondo Steel Stud Seismic Wall System allows the wall to move, permitting an articulation of the wall panel and prevents cracking at its junction. The DUO Seismic Ceiling System was developed by Rondo to provide a suspended ceiling solution that can be perimeter restrained, braced in one direction or braced in two directions for both a one-way or two-way exposed grid ceiling.

TRACKLOK® and GRIDLOK® allows for independent movement of wall and ceiling systems under seismic load, this is achieved by the pre-engineered solutions and available in a range of easy to install clips for back bracing.
This simple solution meets the AU/NZ standards for seismic actions and wind loads for bracing wall and ceiling systems while at the same time reducing installation time. TRACKLOK® bracing for partition walls allows the seismic separation of walls and ceiling systems and GRIDLOK® ceiling bracing provides a consistent and speedy seismic back bracing for large, heavy or high ceiling systems.

These complete systems supply all the required components and fittings to ensure effective resistance to seismic loads during an earthquake. For the benefit of designers and specifiers, Rondo offers an online Seismic Wizard design tool that enables a quick and easy view of the Rondo Seismic Ceiling Systems and nominated seismic loads applicable to their project.

A combination of the Rondo Seismic Ceiling and Wall systems and solutions was engineered and installed at New RAH, where the Rondo Technical Services Team worked closely with the site contractor of the Hospital. They provided extensive design support to meet 'specific project' requirements, which include not only seismic specifications but also fire and acoustic requirements. The partnership between Rondo and NRAH yielded ground breaking results in terms of customised designs for seismic solutions, which are transferable to other buildings with post disaster functionality. Specific seismic solutions supplied by Rondo to the new RAH include 92mm studs at 0.55BMT and 0.75BMT, 0.50BMT Track, Seismic Deflection Head Track, QUIET STUD and Nogging Track.

REFERENCES

[1] https://www.usgs.gov/faqs/how-are-earthquakes-recorded-how-are-earthquakes-measured-how-magnitude-earthquake-determined?qt-news_science_products=0#qt-news_science_products

[2] http://www.ga.gov.au/scientific-topics/hazards/earthquake

[3] http://www.newcastle.nsw.gov.au/Library/Heritage-History/Search-the-Collection/Earthquake-Collecton

[4] http://www.ga.gov.au/scientific-topics/hazards/earthquake

[5] https://www.abcb.gov.au/-/media/Files/Resources/Education-Training/Ha

RONDO®

rondo.com.au