INTRODUCTION TO RONDO SEISMIC WALL & CEILING SYSTEMS

MAY 2014

RONDO®

We want you to know that we've rallied the best, most experienced experts at Rondo together in the making of this book so that we can offer professionals like yourself a detailed technical reference to use.

Despite our efforts however, products, systems and Building Codes do change over time, and interpretations may also vary, which means we cannot accept any liability for any of the information (or lack of information) in this brochure, or any consequences which happen as a result.

We also recommend you check that you are referring to the latest edition. You can do this by comparing it to the one currently available on our website at *www.rondo.com.au.*

Finally, and only because we've invested so much pride and resources into producing this information for you, we kindly ask that you help us protect the quality and exclusivity of this book by not reproducing any of our images or information for commercial purposes without our written agreement, as per the copyright laws which apply.

Thank you

RONDO®

RONDO SEISMIC WALL & CEILING SYSTEMS

INTRODUCTION

Rondo's Seismic Wall and Ceiling Systems have been designed and tested to ensure they:

- are strong enough to resist lateral forces during an earthquake
- limit the structural damage of the system
- accommodate differential movements resulting from inter-story movements
- prevent tiles and lining boards from dislodging and blocking evacuation paths
- support critical services after an earthquake

Rondo's market-leading seismic designs have been developed through use of the current Australian and New Zealand Standards, comprehensive in-house and third party testing, and extensive research into the latest seismic developments. This allows Rondo Engineers to offer superior seismic wall and ceiling designs that are tailored to a project's seismic requirements, with the upmost importance on the safety of all building occupants.

SEISMIC SYSTEMS

Seismic solutions are available for the following systems:

- Rondo KEY-LOCK® Concealed Suspended Ceiling System
- Rondo DUO® Exposed Grid Ceiling System
- Rondo Steel Stud and Track Drywall Framing System

IN PRACTICE

Projects requiring seismic wall and ceiling designs have increased over the last few years which, due to Rondo's engineering expertise, has seen our seismic designs provided to major projects across Australia and New Zealand.

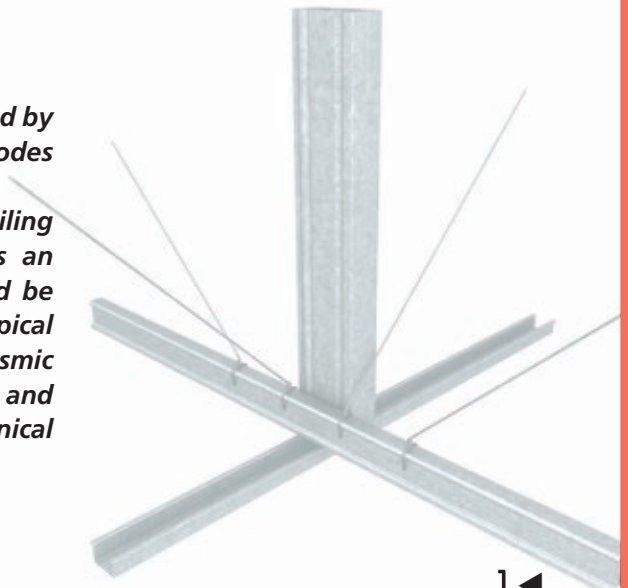
Recent examples include ***Taranaki Base Hospital in NZ*** where our Engineers designed an internal wall framing system that could stabilise seismic loads; ***Lambton Square in Wellington, NZ,*** which required bracing over numerous levels and varying planes; and ***Kilmore St Medical Centre in Christchurch*** which required seismic wall and ceiling designs that would allow it to remain operational after a 1 in 500-year earthquake.

IMPORTANT NOTE:

Rondo recommends its products and systems are installed by a qualified tradesperson and according to the relevant codes and standards outlined on page 2 of this manual.

This brochure is not suitable for all suspended ceiling and partition wall configurations and is designed as an introduction to our seismic solutions. Reference should be made to the Rondo Professional Design Manual for typical wall and ceiling system details; this brochure is for seismic guidance of those systems. For further information and design advice please contact your local Rondo Technical Representative.

CONTENTS:



GENERAL INFORMATION

STANDARDS & CODE REQUIREMENTS

Seismic designs for ceiling and wall systems have been prepared in accordance with the following standards:

- AS/NZS 2785:2000
  Suspended Ceilings – Design and Installation
- AS/NZS 1170.0:2002
  Structural Design Actions – Part 0: General Principles
- NZS 1170.5 Structural Design Actions –
  Part 5: Earthquake actions - New Zealand
- AS 1170.4:2007
  Structural Design Actions - Part 4: Earthquake Actions in Australia
  Section 8: Design of parts and components
- AS/NZS 4600:2005
  Cold-formed steel structures

The Rondo seismic systems will perform to the requirements of these standards when installed by an approved fixer in accordance with the recommendations contained in this and other relevant Rondo manuals.

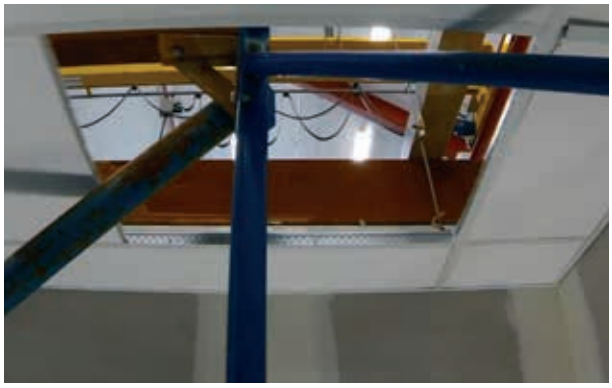
TESTING PROGRAM

Rondo has embarked on a seismic testing program which consists of component testing at Rondo's Head Office, followed by full scale testing at an independent laboratory in New Zealand.

We chose to conduct full scale testing at an independent laboratory due to their experience and dedicated team of Engineers. Our research team for the seismic program also consisted of KCL Consulting Engineers based in New Zealand and our own dedicated Rondo structural engineers. Together we were able to develop Wall & Ceiling Systems to be tested on the shake table to establish the seismic behaviour and were able to model interstorey movement to replicate seismic behaviour.

Our component testing was conducted to determine critical loads and behaviour of our systems to further develop the Rondo System's ability to withstand loads generated through seismic events up to the magnitude of a 1/1500 year event.

Further development was then followed by full scale testing where the interaction of the walls and ceilings was considered. Information received has allowed us to then develop, with the help of KCL Engineering, software to provide quick ceiling designs for Rondo's KEY-LOCK® Seismic Ceiling System and DUO® Seismic Ceiling System.



DESIGN CONSIDERATIONS

The objective of seismic design is to safeguard people from hazard or injury and to minimise damage by preventing failure of engineering systems when subject to earthquake actions. This design guide provides requirements for restraining Rondo engineering systems in buildings to resist such actions in a manner that meets the requirements of relevant codes and standards for Australia and New Zealand.

Some of the considerations that need to be taken into account for seismic design of ceilings and partition walls includes:

- likely magnitude of seismic design events for a given building location
- accelerations and movements of the primary building structure during an earthquake
- interaction with other building parts, including the support structure as well as other building attachments
- capacity of the system to transfer seismic inertia loads back to the support structure
- design of restraints to the system and resulting capacities of connections to transfer loads to the support structure
- accommodating appropriate differential support structure movements between points of attachments, including inter-storey drifts
- limiting damage through the careful selection of restraint type fixings (e.g. fixed, sliding or free)
- capability of systems to deform, including deformations of individual components, joints and connections
- relative stiffness of the system to the support structure
- minimum clearances maintained between hanger/plenum bracing for ceilings and services
- minimum clearances maintained between wall studs and services

ASSUMPTIONS & LIMITATIONS

The following assumptions and limitations have been adopted in the development of this design guide:

- Designs assume that the supporting structures have sufficient capacity to withstand all loads (and load combinations) applied from ceiling and partition wall framing, including those for seismic. Support structures must be both strong enough and stiff enough to resist lateral seismic loads without suffering significant damage. This should be checked by the project/structural engineer for the project.
- Ceiling and walls systems are not considered sensitive to vertical accelerations experienced during earthquake events, hence only horizontal accelerations have been considered.
- Rondo ceiling and wall systems have not been designed to act as primary building frames, hence they should not be included as part of a primary seismic load resisting system or to transfer loads between structural elements of the building.
- This guide only applies to Rondo suspended ceilings and partition wall systems. All components must be manufactured by Rondo. Substitutions are not permitted as system designs have been based on Rondo specific sections and testing.
- Design and installation of all systems must be in accordance with the details contained in this brochure, as well as all other Rondo brochures and design codes.
- Partition walls must not be braced by the ceiling grid unless specially designed to do so. All interior partition walls must be supported independently from ceilings; otherwise their weight must be included in the ceiling seismic mass calculations, including specific consideration of the seismic load on each individual ceiling member.
- Any items weighing more than 10kg must be independently supported with an appropriate isolation gap to ceilings. This should include all evacuation and life safety systems so that they remain operational in the case of a ceiling collapse.
- Ceilings are to be non-trafficable.

SEISMIC LOADS

Actions for which ceiling and partition wall systems are required to withstand are generated as a result of their inertial response to excitations of the building during an earthquake event. This includes secondary stresses induced by deformation imposed by the response of the primary building structure.

Design forces are typically determined from the seismic response of the floor(s) which support the system, in combination with the dynamic response of the ceiling and partition wall systems themselves.

Both NZS1170.5:2004 and AS1170.4:2007 specify methods for determining the forces generated, taking into account a number of factors including:

- Location of the building
- Building importance level
- Design working life
- Overall height of the building
- Soil type and conditions
- Height of the ceiling or wall seismic attachment from ground level
- Seismic mass (including weights of linings, insulation and service load provisions)
- Ductility of parts and systems
- Risk factors

SEISMIC CEILING BRACING OPTIONS

Two primary mechanisms are used to restrain ceilings for lateral seismic loads, being either:

OPTION 1: Fixing ceilings at the perimeter (i.e. to walls or bulkheads).

OPTION 2: Bracing in the plenum space to the structure above (i.e. from slab soffits or steel framing that supports the ceiling).

Option 1 is typically used for smaller ceilings and lower seismic loads, and Option 2 for larger ceilings and higher seismic loads.

From an economic and installation point of view Option 1 is typically preferred; however Option 2 is required in cases where the seismic loads exceed the perimeter ceiling fixing capacities or the capacity of perimeter wall/bulkhead structures. Seismic ceiling restraint relies on diaphragm action to transmit seismic ceiling loads to perimeter fixings or plenum braces.

Mixing of Options 1 and 2 is not recommended. Plenum bracing should be provided in both directions where perimeter fixing is not adequate.

For Option 1 perimeter fixing, if a ceiling is rigidly fixed to supporting structures at both ends, there is an increased risk of damage occurring as a result of differential movement between perimeter structures. Sliding connections at one end only are used to prevent differential forces from being induced into ceilings. As a result for Option 1 the perimeter wall / bulkhead structures must be designed to carry the seismic load for the full width of ceiling.

Option 2 plenum brace design is dependent on brace capacities, which can vary depending on the plenum height. The brace capacity is used to determine the maximum ceiling area allowed per brace, and to determine a suitable arrangement for setting out the braces in each orthogonal direction. Mixing different plenum brace types within the same ceiling is not recommended.

To simplify calculations and optimise design between both bracing options, Rondo has developed Seismic Design Wizards *(see next page)*. Depending on specific ceiling and partition wall configurations, other seismic bracing methods may be available. For further design advice please contact your local Rondo Technical Rep.

SEISMIC DESIGN WIZARDS

Rondo has released market-leading Seismic Wizards to help design Rondo KEY-LOCK® and DUO® Seismic Ceiling Systems.

Designs meet code requirements for both Australia and New Zealand and features include:

- Customised for project location (Australia or New Zealand)
- Building Data Input
- Building Geometry Input
- Lining Weights Input
- Service Loads Input
- KEY-LOCK® and DUO® Framing Input
- Automated Vertical Capacity Check
- Automated Seismic Weight and Seismic Force Calculations
- Automated Seismic Ceiling Designs

You can access the Rondo Seismic Design Wizard today at *www.rondo.com.au/seismic*

1

■ SEISMIC DESIGN WIZARDS ONLINE

KEY-LOCK® SEISMIC CEILING SYSTEM

COMPONENTS

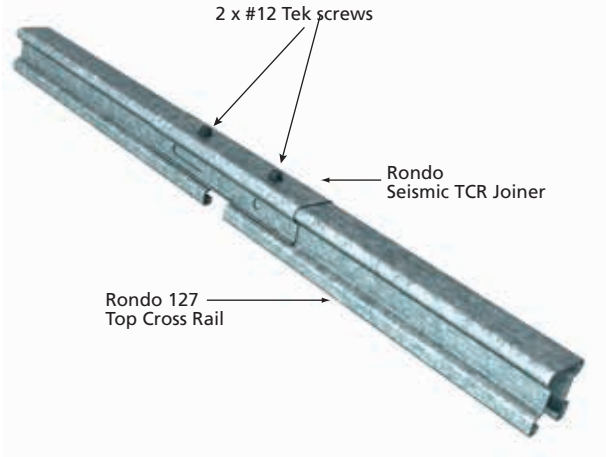
127	25mm Top Cross Rail
129	28mm Furring Channel
141	1.15bmt Wall Track to suit 129 Furring Channel
865	KEY-LOCK TCR Seismic Joiner
138	Furring Channel Joiner
120	2.5mm Soft Gal Tie Wire (Bracing)
Steel Stud	64mm or 92mm Steel Stud (Bracing)
DHT	Deflection Head Track

Typical splice details and bracing options for KEY-LOCK® Seismic Ceiling Systems are outlined in this section. Reference should be made to the Rondo Professional Design Manual for typical system details.

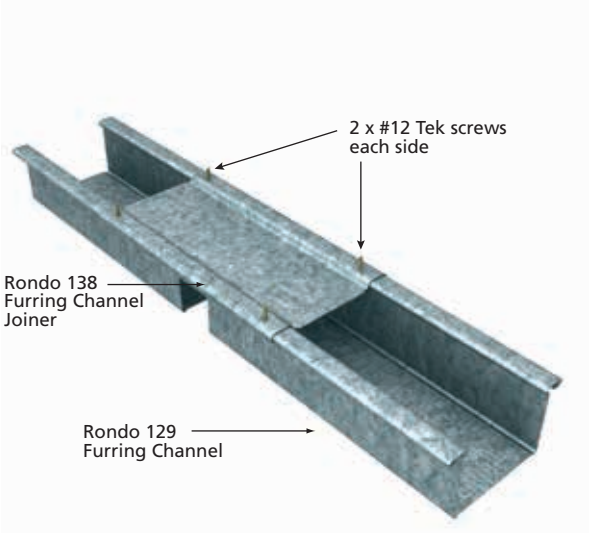
SPLICES

In order to transmit lateral seismic forces to perimeters and/or plenum braces, all Top Cross Rails and Furring Channels should be spliced together as shown below. This applies to both Option 1 and Option 2 braced systems.

2



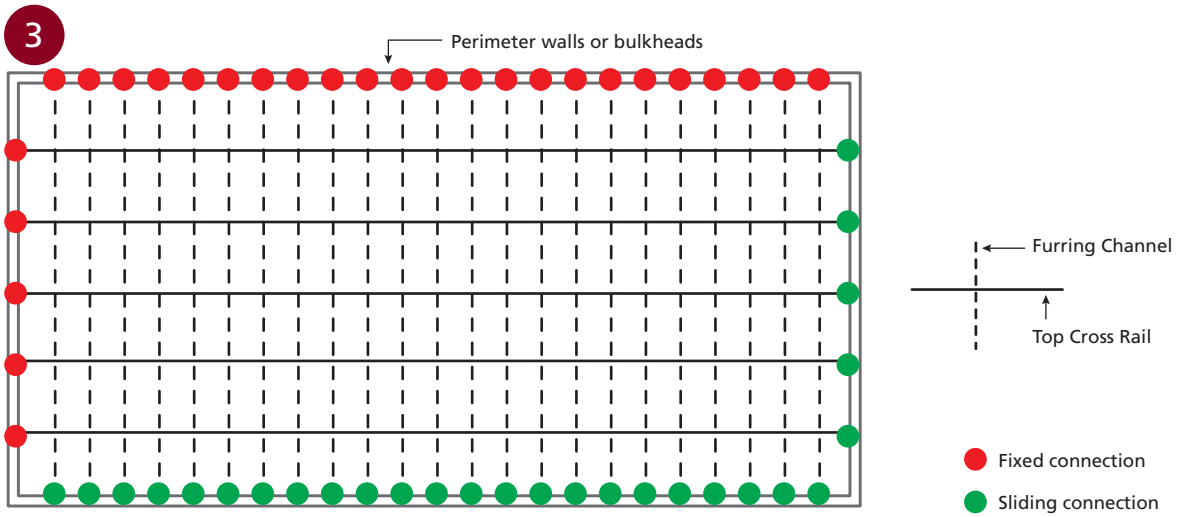
■ TOP CROSS RAIL SPLICE



■ FURRING CHANNEL SPLICE

OPTION 1: PERIMETER FIXING

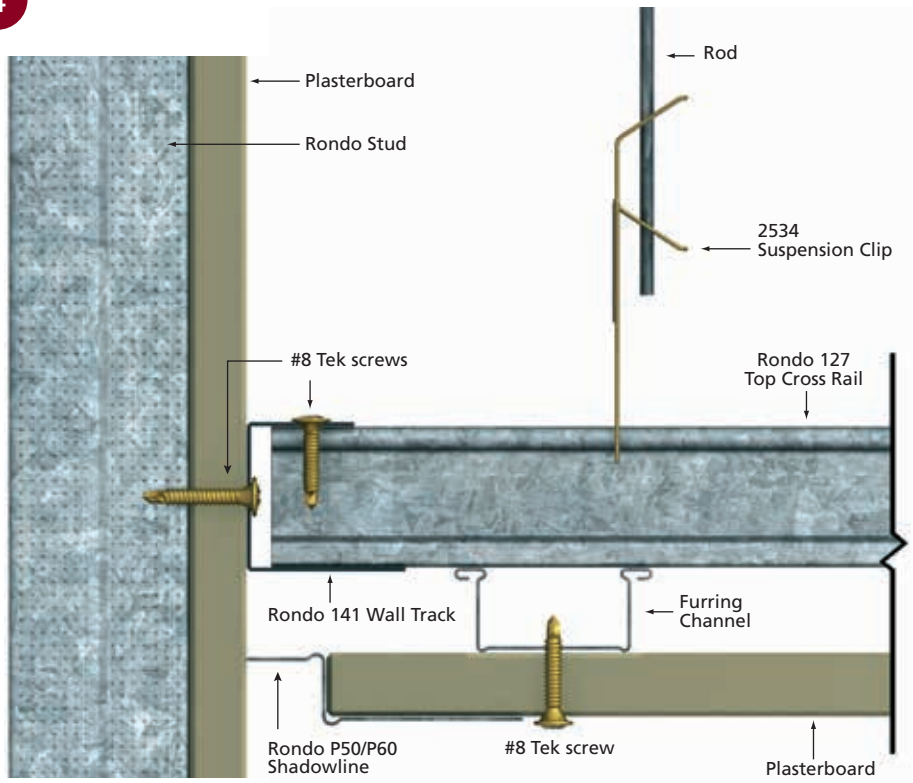
In Option 1, the suspended ceiling system is screw-fixed to the perimeter on two adjacent sides, with sliding connections on the opposite sides. Lateral earthquake loads are transferred from the ceiling to the perimeter through the fixed sides.



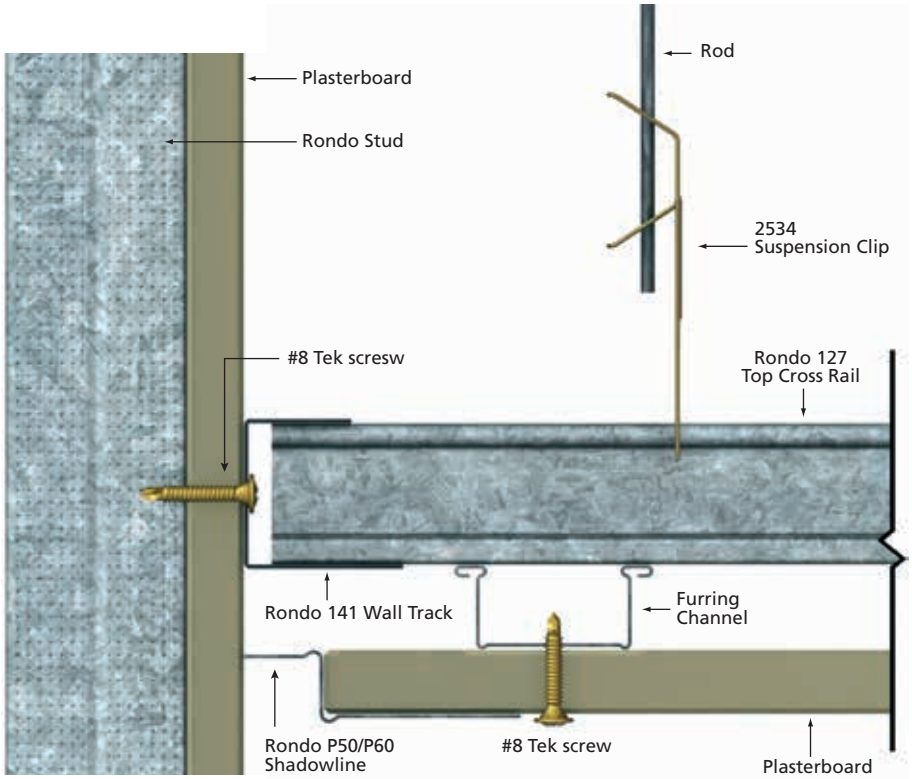
■ KEY-LOCK® CEILING PLAN – TYPICAL PERIMETER FIXING ARRANGEMENT

KEY-LOCK® SEISMIC CEILING SYSTEM (continued)

4



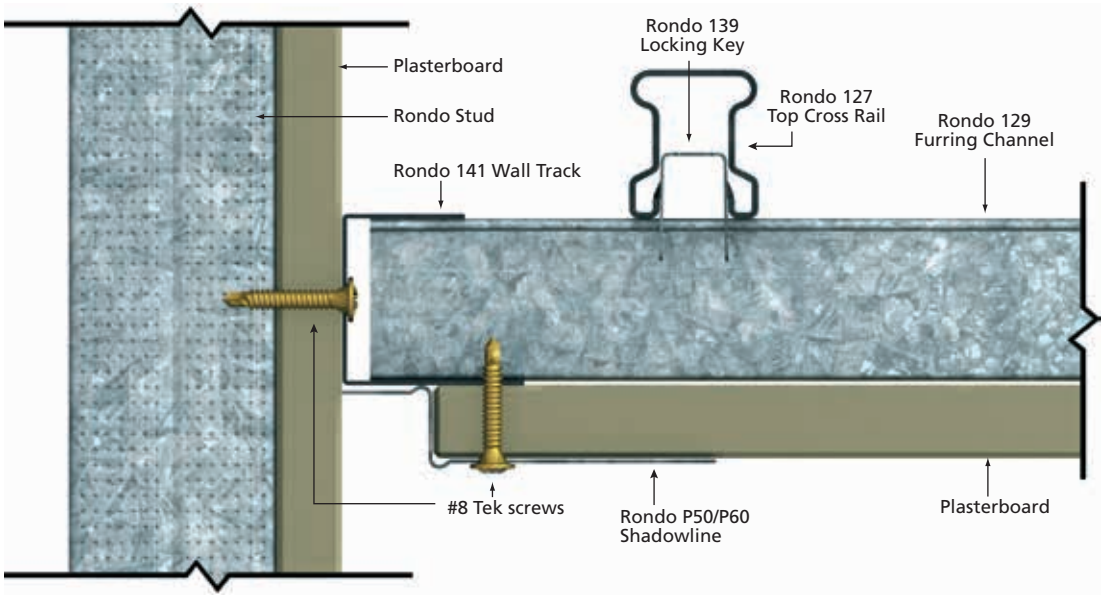
● TCR FIXED CONNECTION



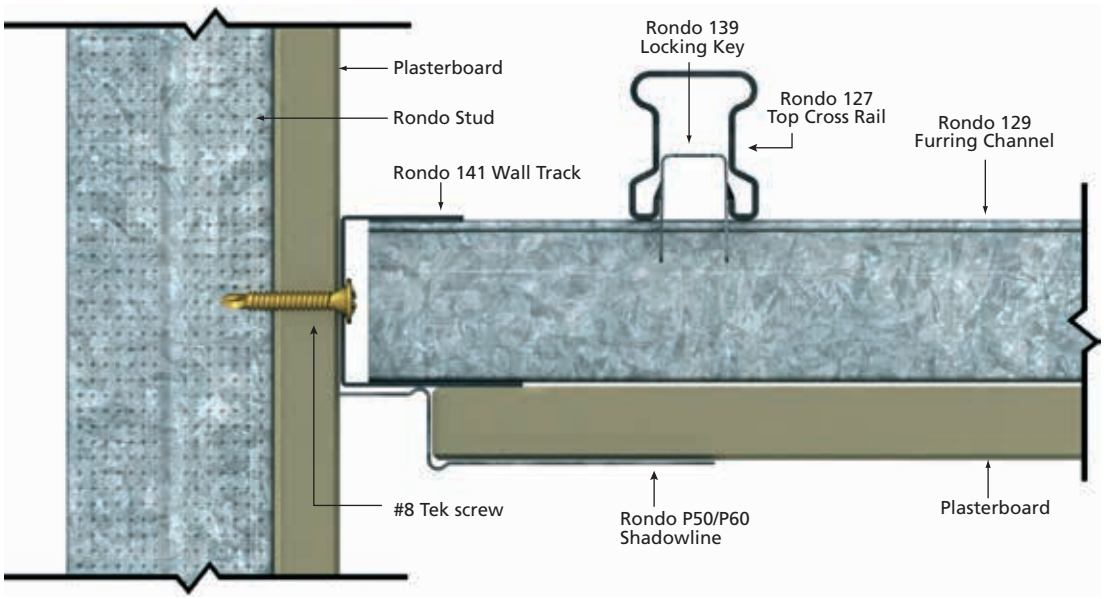
● TCR SLIDING CONNECTION

■ KEY-LOCK® TOP CROSS RAIL FIXED AND SLIDING PERIMETER CONNECTION DETAILS

5



● FC FIXED CONNECTION



● FC SLIDING CONNECTION

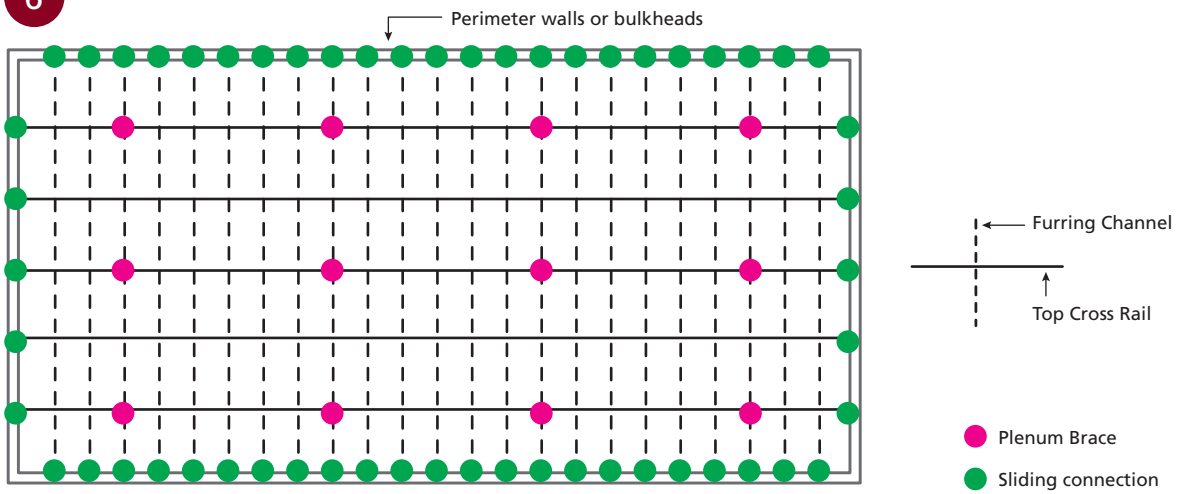
■ KEY-LOCK® FURRING CHANNEL FIXED AND SLIDING PERIMETER CONNECTION DETAILS

KEY-LOCK® SEISMIC CEILING SYSTEM (continued)

OPTION 2: PLENUM BRACING

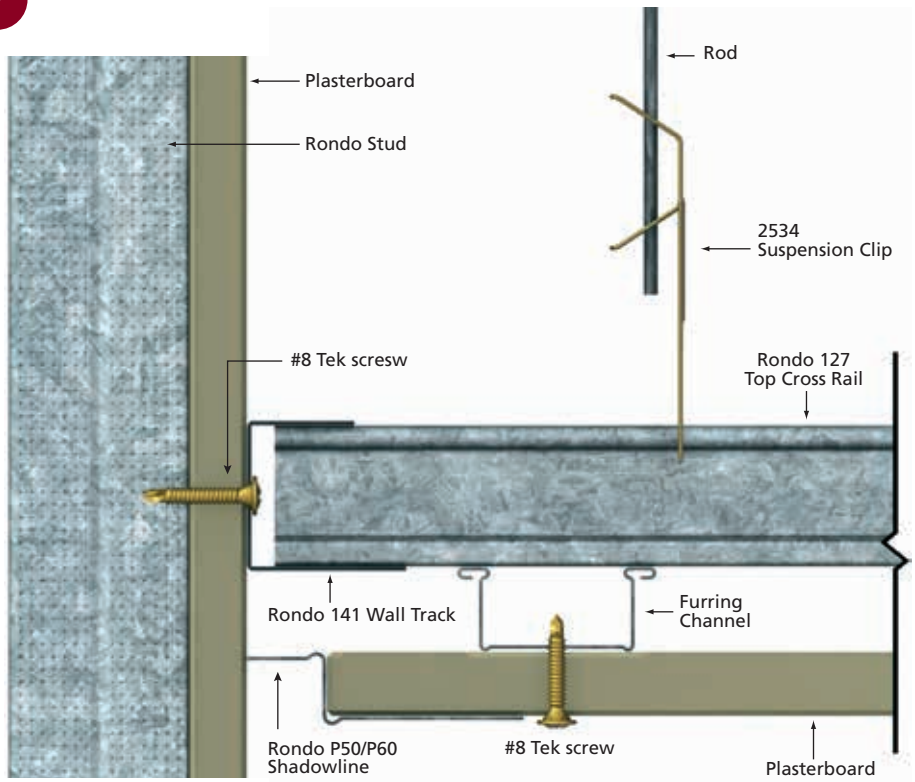
In Option 2, the suspended ceiling system is restrained by providing evenly distributed braces in the plenum space, with sliding connections to all perimeters. Lateral earthquake loads are transferred from the ceiling through the plenum braces to the support structure.

6

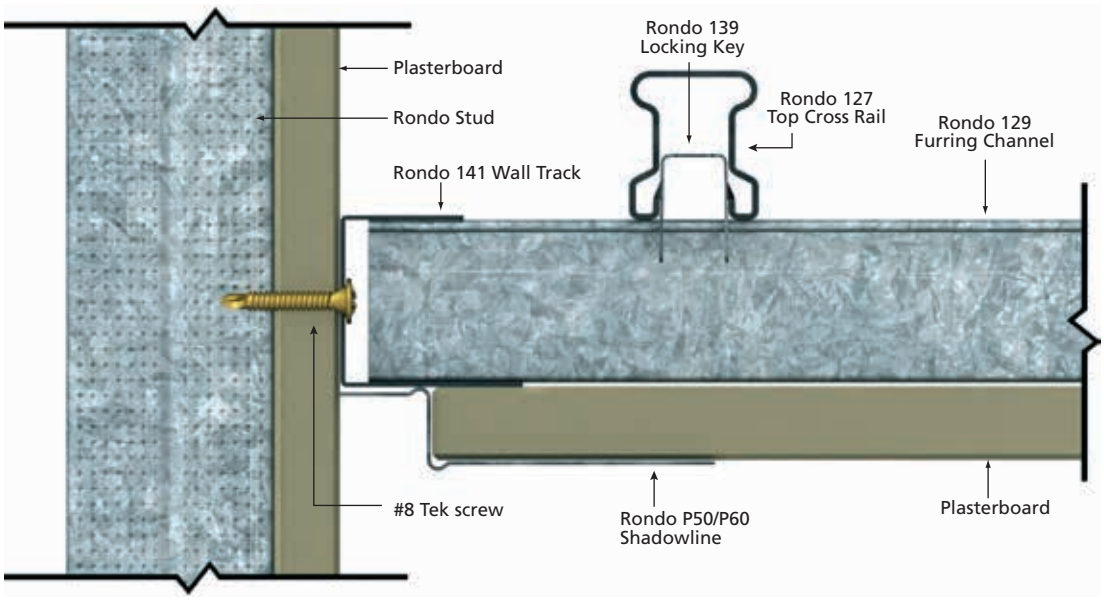


■ KEY-LOCK® CEILING PLAN – TYPICAL PLENUM BRACING ARRANGEMENT

7



TCR SLIDING CONNECTION

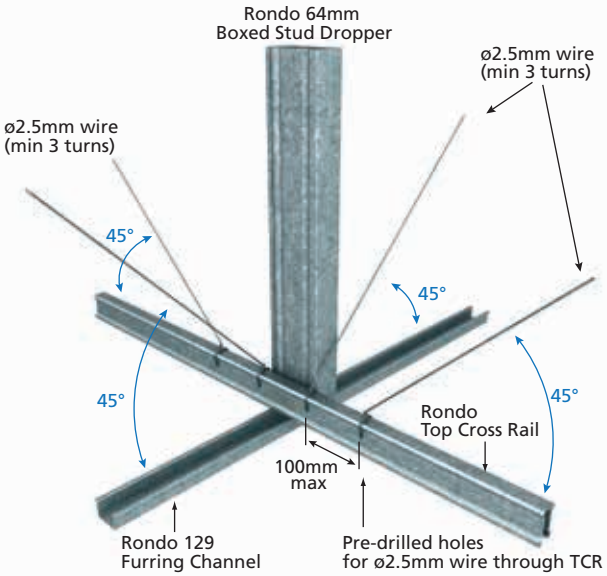


FC SLIDING CONNECTION

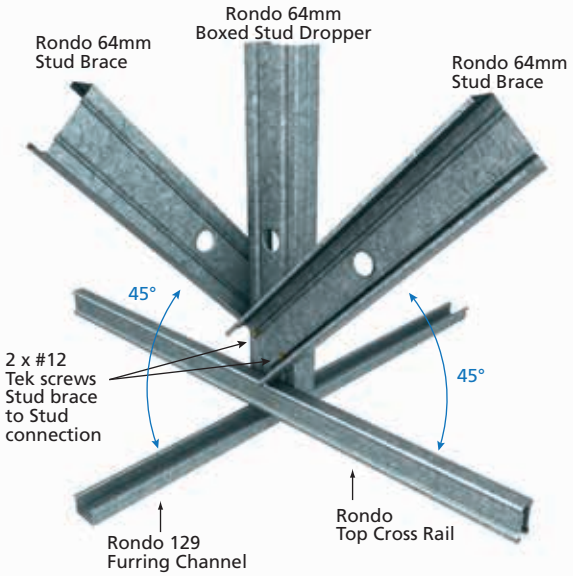
KEY-LOCK® SLIDING PERIMETER CONNECTION DETAIL

KEY-LOCK® SEISMIC CEILING SYSTEM (continued)

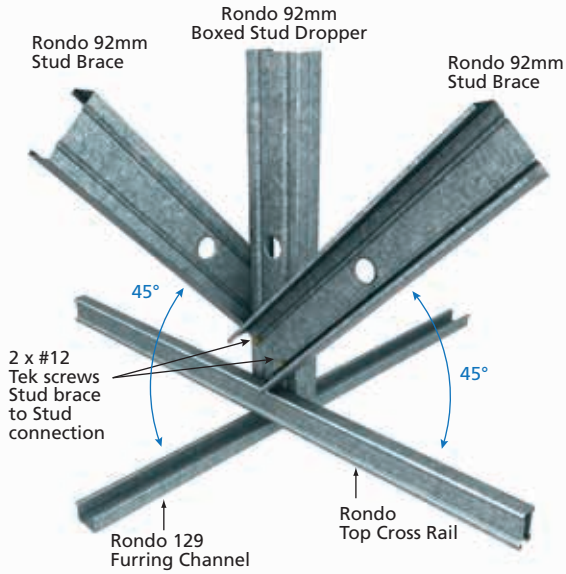
8



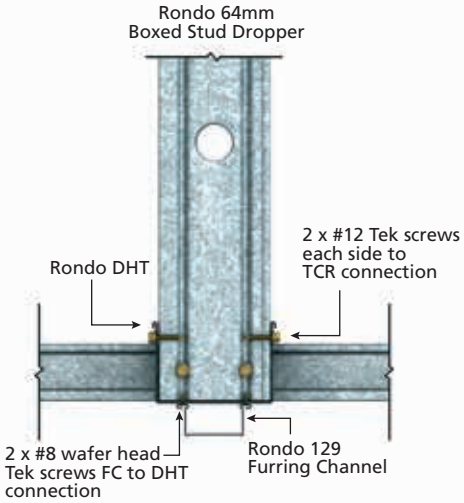
TYPE A



TYPE B



TYPE C



KEY-LOCK BOXED STUD DROPPER CONNECTION DETAIL

■ **KEY-LOCK® PLENUM BRACING – TYPICAL DETAILS**

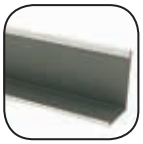
DUO® SEISMIC CEILING SYSTEM

COMPONENTS

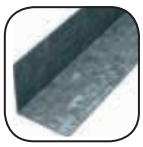
DUO1	Main Tee: 24 x 38mm
DUO2	Cross Tee: 24 x 34mm
DUO5	Rolled Edge Steel Wall Angle: 25mm x 19mm
850	DUO Seismic Perimeter Trim Sliding Clip
530	50 x 30 x 1.15bmt Heavy Duty Angle
120	2.5mm Soft Gal Tie Wire (Bracing)
Steel Stud	64mm or 92mm Steel Stud (Bracing)
DHT	Deflection Head Track


DUO1

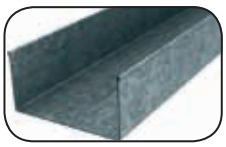

DUO2


DUO5


850


530


STEEL STUD

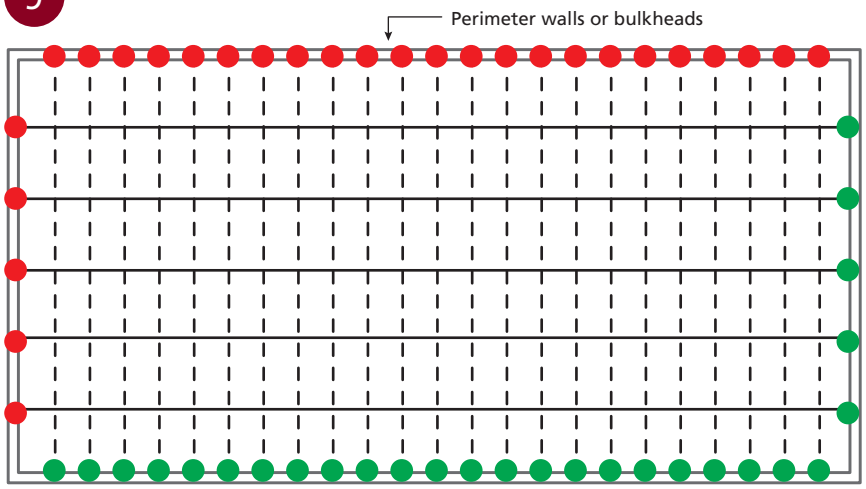

DHT

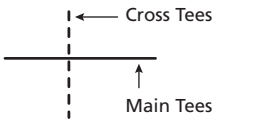
Typical bracing options for DUO® Seismic Ceiling Systems are outlined in this section. Reference should be made to the Rondo Professional Design Manual for typical system details.

OPTION 1: PERIMETER FIXING

In Option 1 the suspended ceiling system is fixed to the perimeter on two adjacent sides, with sliding connections on the opposite sides. Lateral earthquake loads are transferred from the ceiling to the perimeter through the fixed sides.

9





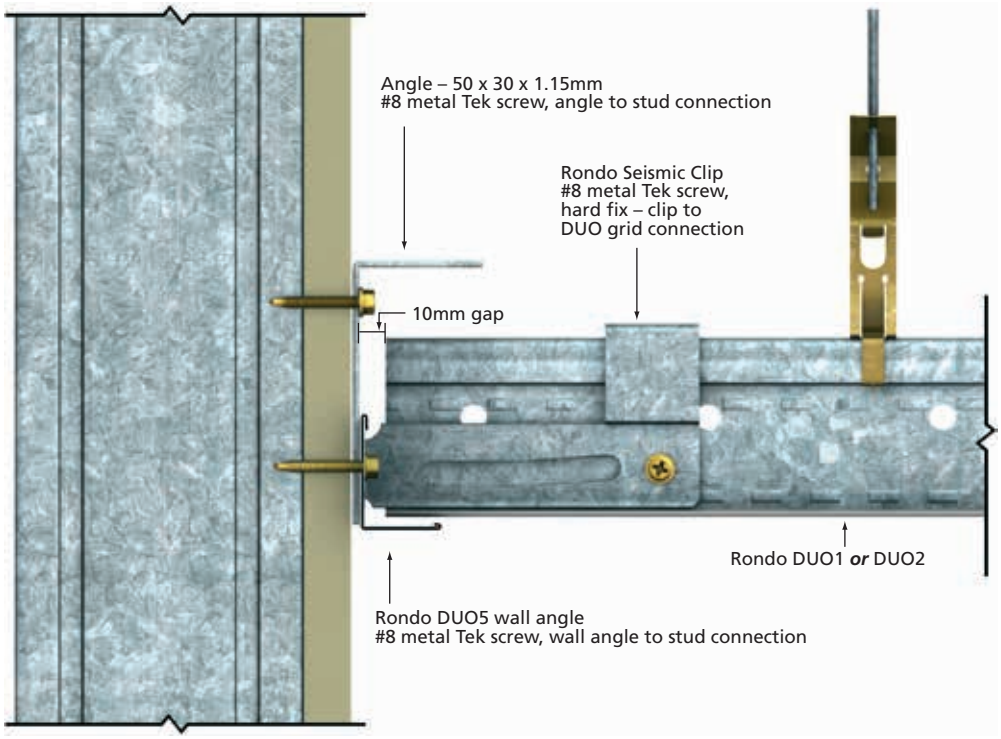
Fixed connection

Sliding connection

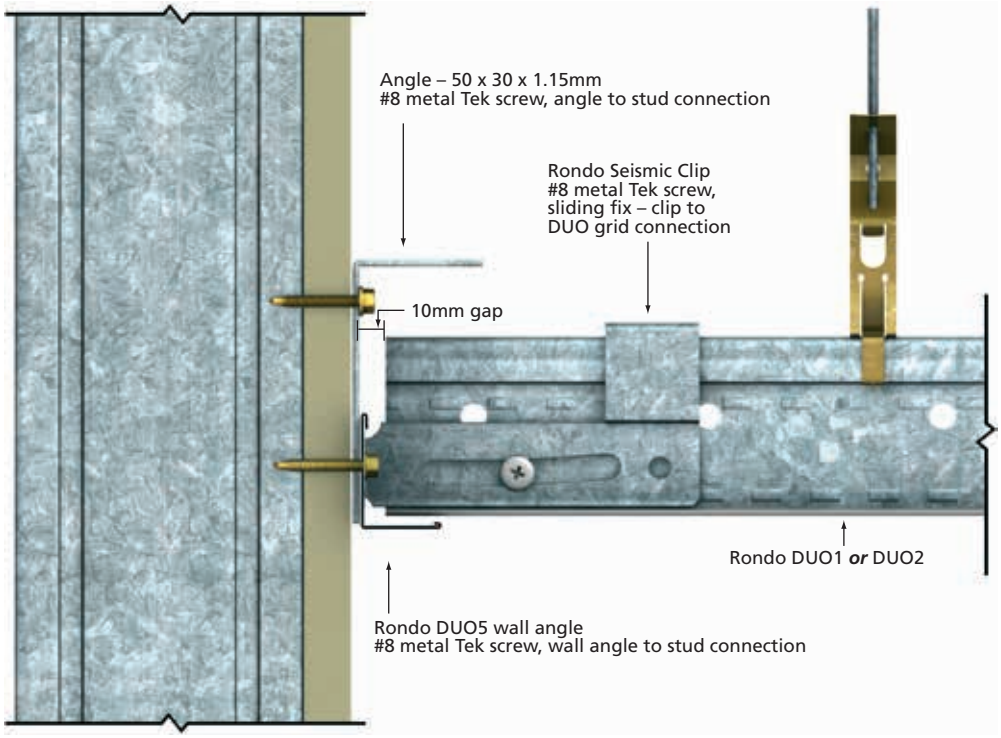
■ DUO® CEILING PLAN – TYPICAL PERIMETER FIXING ARRANGEMENT

DUO® SEISMIC CEILING SYSTEM (continued)

10



DUO GRID FIXING TO STUDWALL — FIXED CONNECTION



DUO GRID FIXING TO STUDWALL — SLIDING CONNECTION

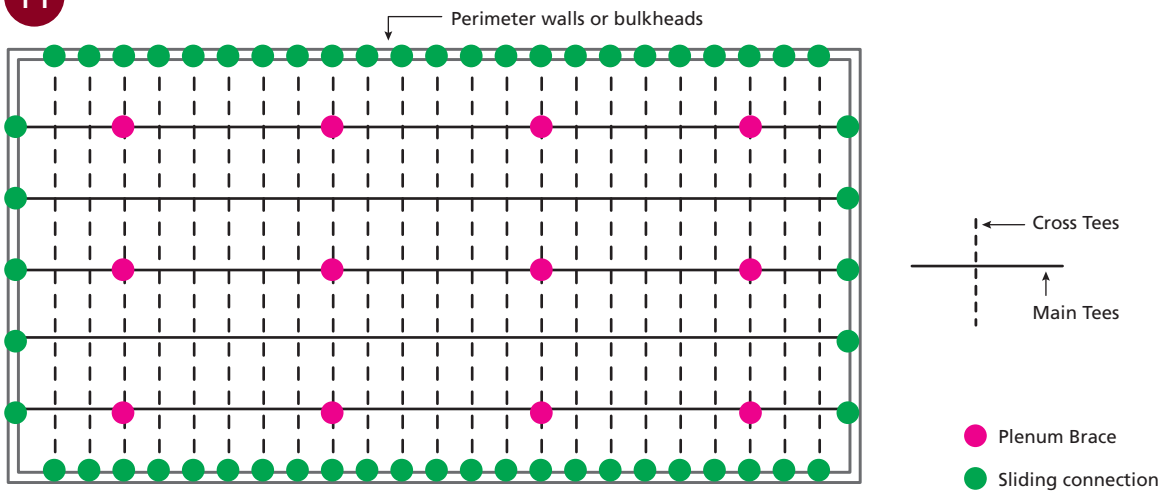
DUO® FIXED AND SLIDING PERIMETER CONNECTION DETAILS

DUO® SEISMIC CEILING SYSTEM (continued)

OPTION 2: PLENUM BRACING

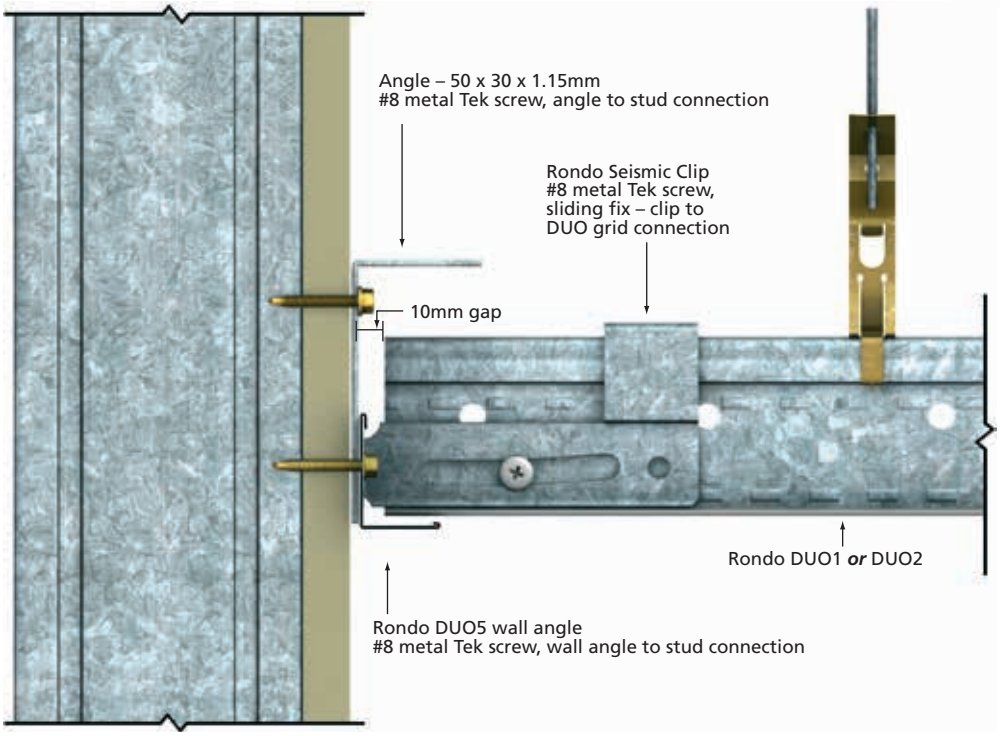
In Option 2, the suspended ceiling system is restrained by providing evenly distributed braces in the plenum space, with sliding connections to all perimeters. Lateral earthquake loads are transferred from the ceiling though the plenum braces to the support structure.

11



■ DUO® CEILING PLAN – TYPICAL PLENUM BRACING ARRANGEMENT

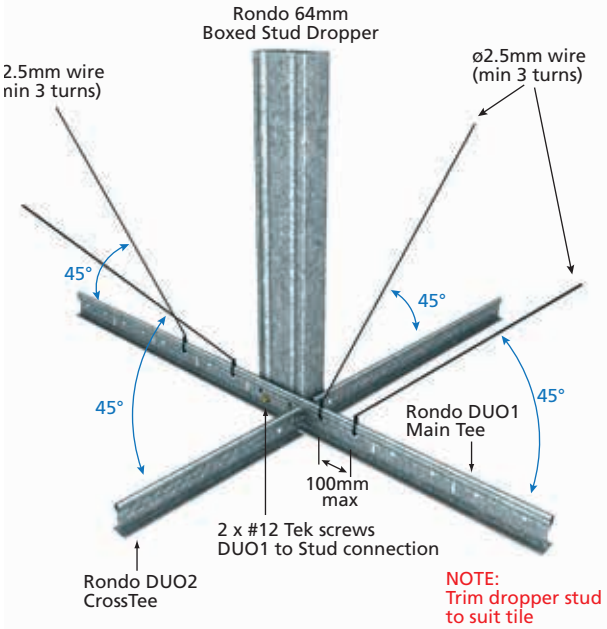
12



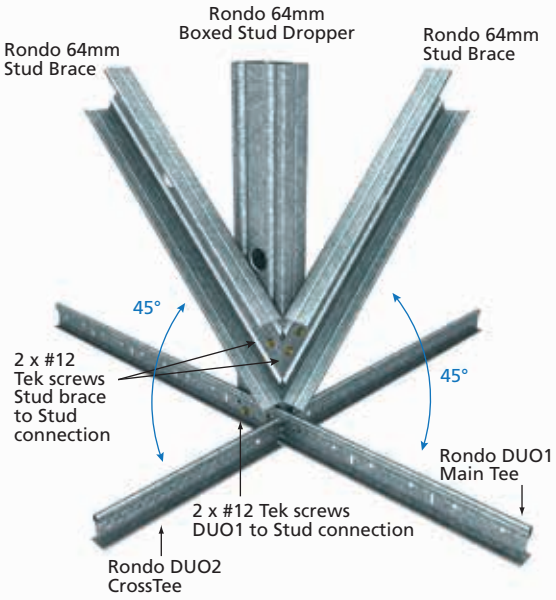
■ DUO® SLIDING PERIMETER CONNECTION DETAIL

DUO® SEISMIC CEILING SYSTEM (continued)

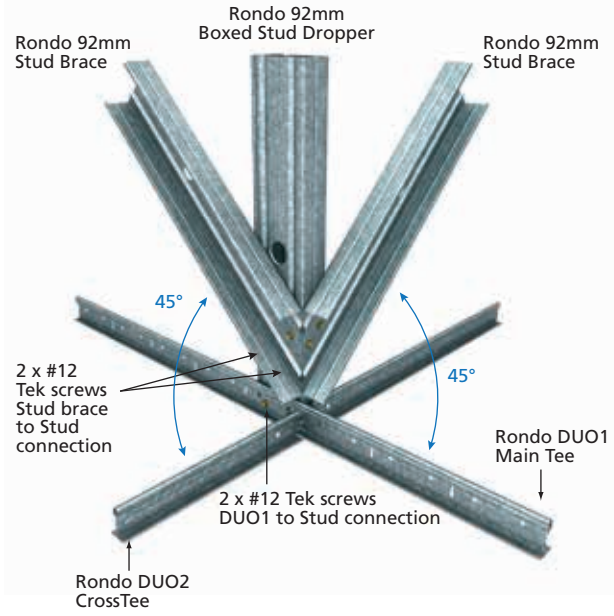
13



TYPE A



TYPE B



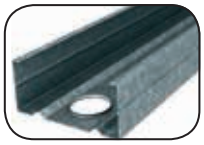
TYPE C

■ **DUO® PLENUM BRACING – TYPICAL DETAILS**

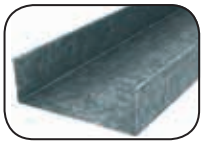
STEEL STUD SEISMIC WALL SYSTEM

COMPONENTS

Wall Stud
Wall Track
Seismic Slotted Deflection Head Track
Deflection Head Track
Nogging Track

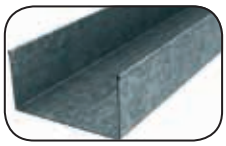


WALL STUD

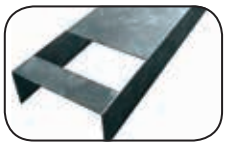


WALL TRACK

SEISMIC SLOTTED DEFLECTION HEAD TRACK



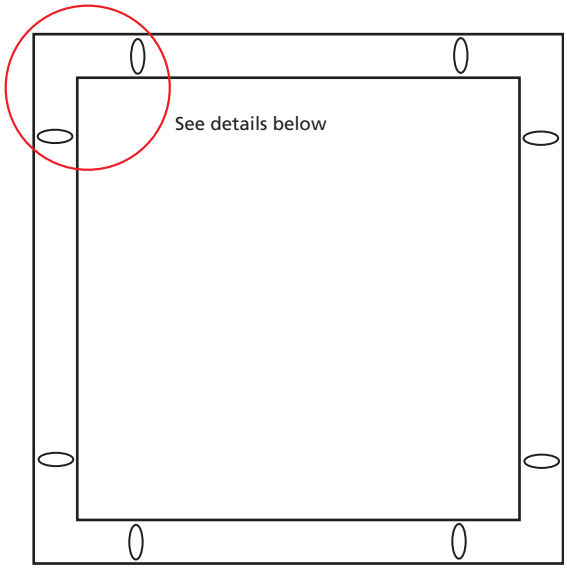
DHT



NT

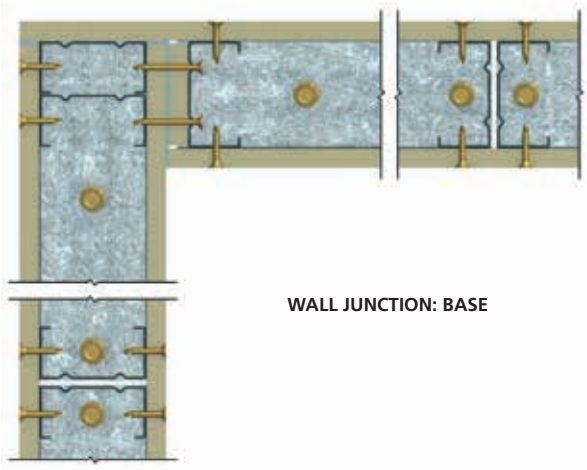
Wall details for Rondo's Steel Stud and Track Seismic Wall Framing System are outlined in this section. Reference should be made to the Rondo Professional Design Manual for typical system details.

The Rondo Steel Stud and Track Seismic Wall Framing System is designed to allow movement along the wall and provide flexibility at wall junctions due to deflection occurring from a seismic event. Where walls are not able to withstand the seismic loads it is recommended that bracing be introduced in the ceiling plenum to minimise the load transfer from the ceilings to the walls.

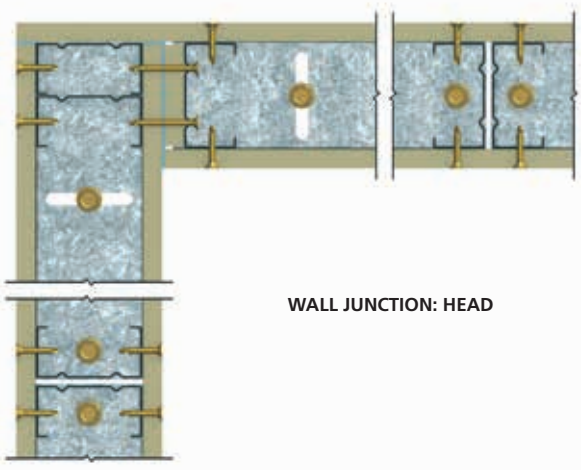


■ PLAN VIEW OF TYPICAL ROOM

14



WALL JUNCTION: BASE

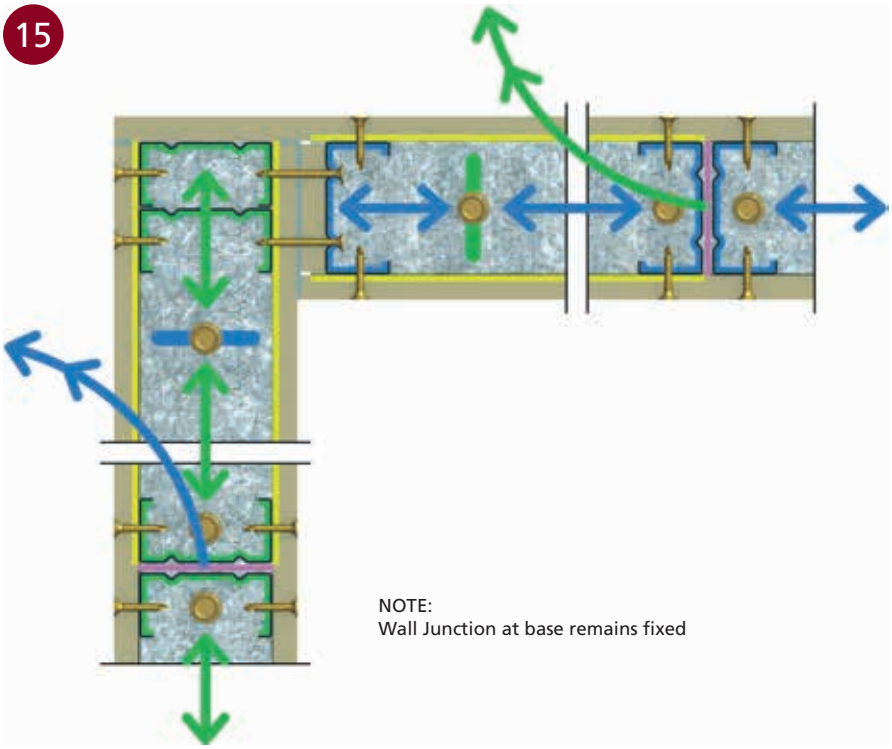


WALL JUNCTION: HEAD

■ SEISMIC STUD WALL ARRANGEMENTS (STANDARD CORNER DETAILS AT THE HEAD & BASE TRACK)

STEEL STUD SEISMIC WALL SYSTEM (continued)

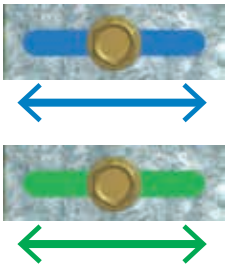
15



■ STUD WALL ARTICULATION/MOVEMENT AT CORNER JUNCTION AT HEAD

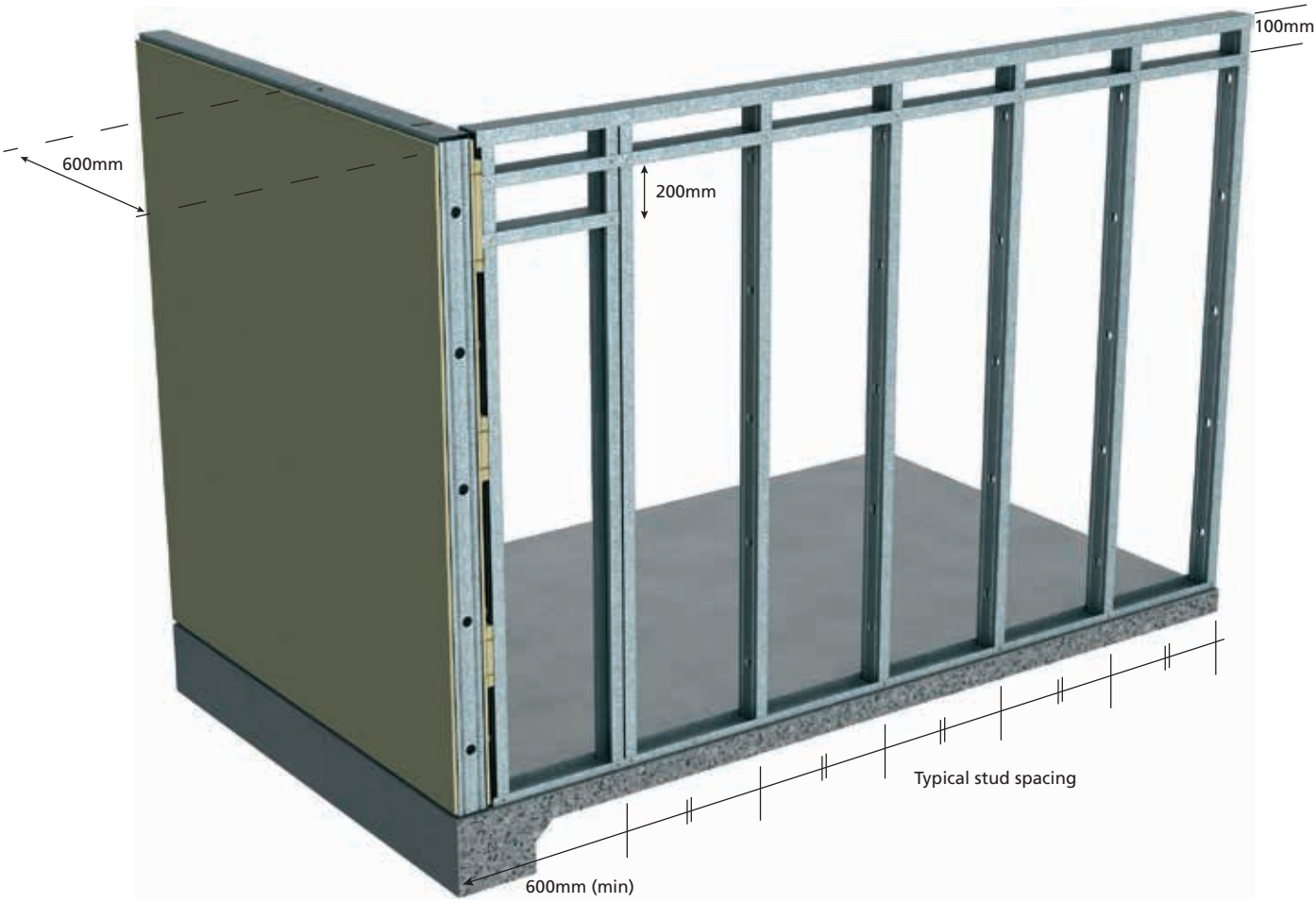
Indicates Rondo Seismic Slotted Deflection Head Track – length determined to suit seismic displacement limits

Indicates 'hinge' points in adjacent walls – location of 'hinge' is determined by the length of the Rondo Seismic Slotted Deflection Head Track.
Hinge points act upon displacement of Studs as indicated by the arrows



Indicates the fixing slot in the Rondo Seismic Slotted Deflection Head Track. The slot allows displacement of adjacent Wall Studs, letting them slide within the Tracks in the direction shown by the arrows. The movement occurs at the head whilst the wall framing is stabilised at the base.

16



NOTE: This is a pictorial only, a midspan nogging may be required depending on wall height and lining conditions, refer to the Rondo Professional Design Manual for nogging requirements.

TYPICAL SEISMIC WALL SYSTEM

GENERAL INSTALLATION & WORKMANSHIP

- All screws and anchors must be installed with a minimum edge distance and spacing of 3 x nominal fixing diameters.
- Where services are not braced, a 150mm clear space shall be maintained between hangers/ plenum braces and other services (i.e. pipes, ducting, etc). Where services are braced, a 50mm clear space shall be nominated.
- Angled wire and stud braces must be fixed at 40-45° to the plane of the ceiling system.
- Splices for KEY-LOCK® Top Cross Rails and DUO® Main Tees shall be located away from plenum bracing fixing points.
- Plenum braced ceilings must not be fixed to perimeter structures.
- The project engineer shall confirm that support structures have sufficient capacity to resist earthquake loads resulting from ceiling and wall framing.
- Plenum braces shall be evenly distributed across the entire ceiling.
- Ø2.5mm soft galvanised diagonal wires shall be secured through webs of KEY-LOCK® components and through the pre-punched holes in the upstand of DUO® Main Tees and secured with a minimum of 3 turns.
- All ceiling tiles shall be installed with hold-down clips as per tile manufacturer specifications.

REFERENCES

REFERENCE/AUTHOR	TITLE
NZS 4219:2009	Seismic Performance of Engineering Systems in Buildings
NZS 1170.5 Supp 1:2004	Structural Design Actions Part 5: Earthquake actions – New Zealand – Commentary (Supplement to NZ 1170.5:2004)
AS 1170.4 Supp 1:1993	Minimum design loads on structures Part 4: Earthquake loads – Commentary (Supplement to AS 1170.4:1993)
AS/NZS 2785:2000	Suspended Ceilings - Design and Installation
AS/NZS 1170.0:2002	Structural Design Actions - Part 5: Earthquake actions - New Zealand Section 8: Requirements for parts and components
AS 1170.4:2007	Structural Design Actions - Part 4: Earthquake Actions in Australia Section 8: Design of parts and components
AS/NZS 4600:2005	Cold-formed steel structures
ASTM International Paper E 580/E 580M -09a	Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions
BRANZ Study Report No. 124 (2004)	Seismic Response of Building Parts and Non-Structural Components
NZSEE 2002 Conference Paper	Earthquake response of building parts
Rajesh P Dhakel Gregory MacRae	Review of Design and Installation Practices for Ceiling and Interacting Components

The following trademarks of Rondo Building Services Pty Ltd are under license:
Rondo, Duo, Key-Lock, Exangle, Rondo Quiet Stud, Panther, Rondo U Clip, Rondo Extreme, Rondo MAXItrack, Rondo MAXIstud, Rondo MAXIjamb, Rondo MAXIframe, Betafil, BetaGrip.

RONDO OFFICES

AUSTRALIA

RONDO BUILDING SERVICES PTY LTD
CUSTOMER SERVICE HOTLINE: 1300–36–RONDO (1300–36–7663)

NEW SOUTH WALES
57–87 Lockwood Road Erskine Park NSW 2759
(PO Box 324 St Marys NSW 1790)
phone: 61–2–9912 7300 fax: 61–2–9912 7310 email: nsw@rondo.com.au

VICTORIA
12–14 Dunlop Road Mulgrave VIC 3170
(Private Bag 23 Mulgrave VIC 3170)
phone: 61–3–8561 2222 fax: 61–3–8561 2266 email: vic@rondo.com.au

QUEENSLAND
113 Binary Street Yatala QLD 4207
(PO Box 6006 Yatala QLD 4207)
phone: 61–7–3442 6400 fax: 61–7–3442 6427 email: qld@rondo.com.au

SOUTH AUSTRALIA
39 George Street Green Fields SA 5107
phone: 61–8–8256 5900 fax: 61–8–8256 5922 email: sa@rondo.com.au

WESTERN AUSTRALIA
5 Hazelhurst Street Kewdale WA 6105
(PO Box 168 Cloverdale WA 6985)
phone: 61–8–9251 9400 fax: 61–8–9251 9414 email: wa@rondo.com.au

HEAD OFFICE
57–87 Lockwood Road Erskine Park NSW 2759
(PO Box 324 St Marys NSW 1790)
phone: 61–2–9912 7303 fax: 61–2–9912 7313 email: rondo@rondo.com.au

EXPORT
phone: 61–438–427–479 fax: 61–7–3287–1881 email: export@rondo.com.au

NEW ZEALAND

RONDO BUILDING SERVICES PTY LTD
117A Captain Springs Road Onehunga Auckland 1061 New Zealand
(PO Box 12464 Penrose Auckland 1642 New Zealand)
phone: 64–9–636 5110 fax: 64–9–636 5111 email: newzealand@rondo.com.au
FREE CALL: 0800–0800–RONDO (0800–0800–76)

MALAYSIA

RONDO METAL PRODUCTS SDN BHD
Lot 606, Off Jalan SS13/1K
47500 Subang Jaya Selangor
phone: 60–3–5636 0710 fax: 60–3–5636 0711

INDIA

RONDO METAL SYSTEMS PVT LTD
Plot No. J-21, MIDC Taloja, Tal. Panvel
Dist. Raigad - 410-208 Mumbai India
phone: 91-22-2740 2831

RONDO®

www.rondo.com.au

Rondo Building Services Pty Ltd. ABN 69 000 289 207.
Version 1: First printed May 2014