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Gypsum Plasterboard Lined Partitions in Commercial Construction Update

Gypsum plasterboard is a common internal sheet lining material for use in buildings. Taped and plaster-stopped gypsum plasterboard linings are very stiff and will be subjected to lateral forces when buildings are exposed to high winds and earthquakes.

Like glass in a frame, gypsum plasterboard wall and ceiling linings will sustain damage when 'racked' and if not properly detailed. There are two effective ways to limit damage to gypsum plasterboard linings;

- Design linings to accept imposed wind and earthquake forces
- Separate linings from the main structure and provide movement freedom

In New Zealand the stiffness and strength of gypsum plasterboard linings is recognised and long established procedures exist (NZS 3604:2011), enabling gypsum plasterboard to provide bracing resistance in low-rise light steel or timber-framed residential construction. During the recent Canterbury earthquakes gypsum plasterboard bracing systems in houses performed well when design and construction methods were in accordance with recommended practice.

In commercial buildings, wind and earthquake forces are often much higher. The main structure, commonly concrete or steel, is designed to provide resistance.

Gypsum plasterboard-lined partitions are non-structural and cannot resist forces associated with main structure deformations, such as expected 'inter-storey drifts' during design level earthquakes. To minimise the risk of damage, plasterboard-lined partitions must be separated from the main structure and be designed to accommodate anticipated structural movements.

SEISMIC RESPONSE CHARACTERISTICS AND COMMON DEFICIENCIES

Architectural preference, often guided by the building owner, is commonly for a flush monolithic interior finish and tight connections of partitions to the main structure. In the event of the building being subjected to ultimate limit state (ULS) or even serviceability limit state (SLS) design forces and movements, tight-fit plasterboard-lined partitions can interfere with the building's intended structural response and will be subjected to lateral forces they cannot resist.

The Canterbury earthquakes have resulted in significant damage to non-structural partitions in commercial buildings. Damage has been particularly pronounced where plasterboard-lined areas have been expansive and where linings have been continued past floor levels, such as in vertical shafts and stairwells in multi-level buildings. Common damage has included cracked sheet joints, crushed sheet edges, fastener 'pops' and in some cases substantial sheet fracture and sheets dislodging from frames.

Gypsum plasterboard non-structural elements often provide key building performance attributes such as noise control and fire resistance. Examples are fire separations between safe means of egress and other occupied spaces.

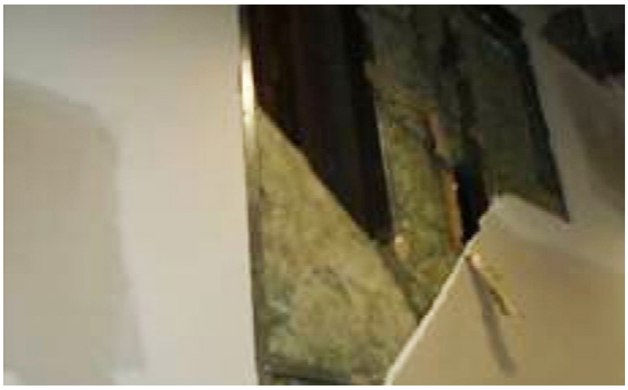
Damage to gypsum plasterboard linings can seriously degrade post-earthquake passive fire protection and occupant safety.

Merely re-fixing and conventionally plastering damaged gypsum plasterboard linings has resulted in repeat damage and the need for ongoing repairs following subsequent seismic events, as observed in a number of commercial buildings in and around Christchurch.

Damage to non-structural elements following earthquakes can often be more costly than damage to the structure itself and also causes significant business disruption either directly or during the repair process. The New Zealand Building Code aims to protect health and life safety of occupants but does not specifically set out to limit material losses.

However, the market is increasingly demanding low damage solutions as a result of tightening insurance policies and the increasing cost of premiums and excesses.

FIGURE 1: Substantial damage to non-structural gypsum plasterboard partition



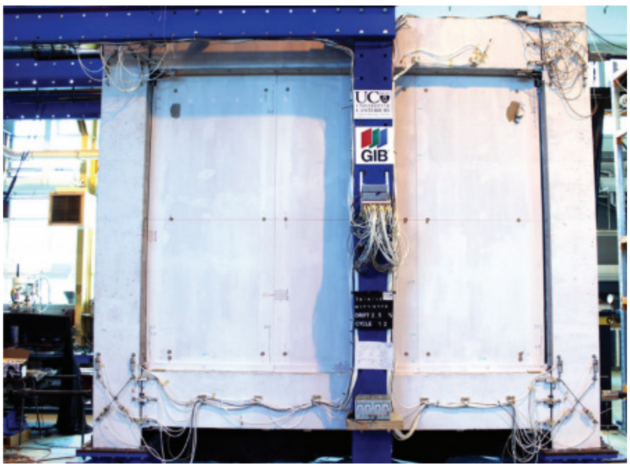
TESTING LOW DAMAGE SOLUTIONS

Testing at Canterbury University (Tasligedik et al, 2012) has shown that by simply incorporating regular relief joints, 'low' and even 'no damage' solutions for non-structural partitions can be designed successfully. 'Shadow lines' or 'negative details' at wall junctions and intersections with the main structure, and breaking up expansive areas with regular control joints, provides freedom for the non-structural elements to accommodate main structural movements.

Testing has shown that incorporating such details can result in 'no damage' at SLS and even ULS inter-storey drifts. Gaps can be arranged by simple calculation and can easily be made aesthetically pleasing or hidden with sealants or trim finishes.

A shift in owner and architectural expectation is required to make these details work. The challenge to the architectural profession is to incorporate and 'celebrate' visible details if 'low' or 'no damage' solutions for non-structural gypsum plasterboard elements in commercial buildings are to be successful.

FIGURE 2: Non-structural partition being tested at Canterbury University



NEW CONSTRUCTION

In order to protect plasterboard-lined partitions from damage, connections must be minimised and separation from the main structure must be provided so that seismic movements can be accommodated. Figure 3 shows the principle of constructing partition framing. Metal top and bottom tracks are used with friction-fit metal or timber studs. A standard nominally 90mm timber stud fits into a commonly available 92mm metal track. Plasterboard linings are fixed to studs but not to the top and bottom tracks.

Figure 4 shows a number of already available details (Winstone Wallboards, 2006) that can eliminate or will significantly reduce earthquake damage to gypsum plasterboard lined partitions in commercial construction.

All details involve 'disconnection' from the main structural elements and a regular pattern of intermediate control joints.

Gypsum plasterboard packing strips can be provided behind joints to ensure on-going integrity of fire or noise control separations. Proprietary trims and finishes exist to create clean shadow lines which can be left, covered, or sealant filled depending on architectural preference.

FIGURE 3: Framing details to minimise risk of post-earthquake damage

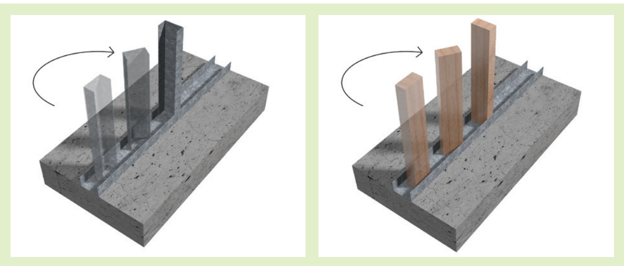
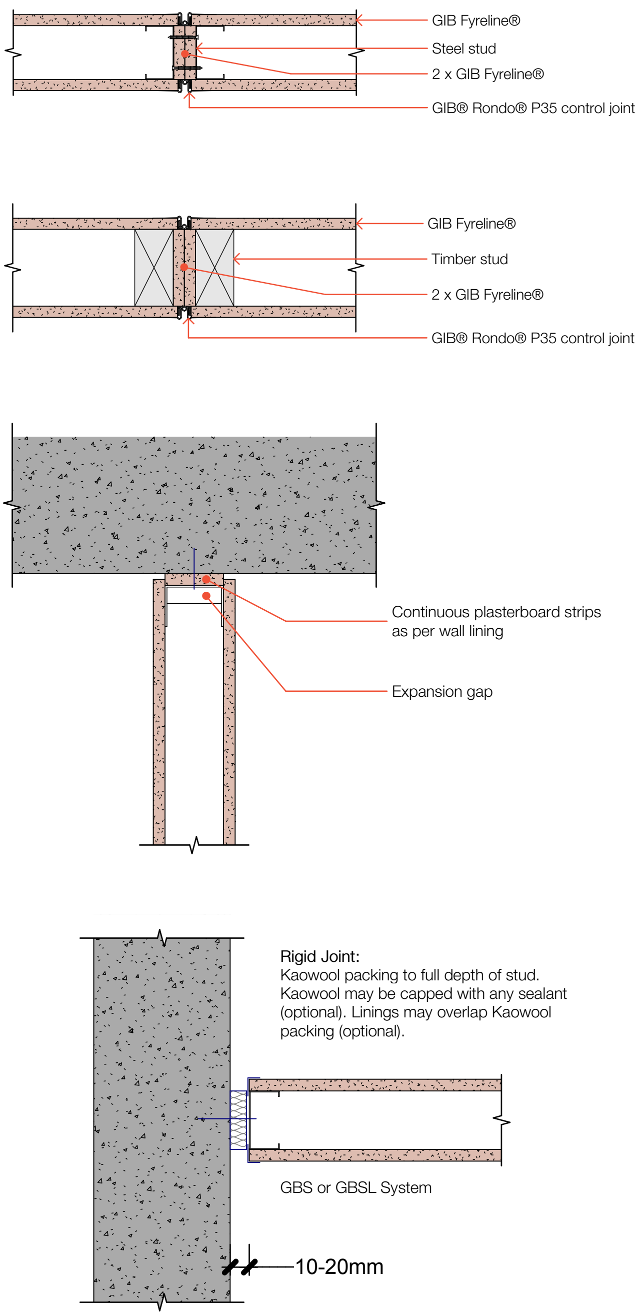


FIGURE 4: Simple plasterboard jointing details to minimise risk of post-earthquake damage



REPAIR STRATEGIES

Repair techniques for gypsum plasterboard linings can be found by visiting gib.co.nz with specific reference to the current version of the GIB® Site Guide and the website section dedicated to the Canterbury earthquakes. Recommendations include printed documentation and application software.

Some of the more common repair methods for non-residential structures are discussed in the table 1, on next page with comments regarding their limitations.

Table1: Floor/Ceiling Systems

Repair Type	Advantages	Disadvantages	SLS Performance	ULS Performance
Re-fix and where necessary replace damaged gypsum plasterboard sheets, restop to monolithic finish and paint as previous	Relatively simple to implement and relatively un-intrusive. May be carried out with conventional skill base and permits limited occupation.	Prone to repeat damage following further seismic activity with possible loss of other performance aspects such as fire resistance.	Likely re-occurrence of damage and need for on-going repairs.	Re-occurrence of damage.
Re-fix and where necessary replace damaged gypsum plasterboard sheets, remove stopping from joints and create perimeter relief, fill with suitable sealant. Overlay with minimum 10mm standard grade gypsum plasterboard. Offset joints from layer below. Leave perimeter gaps and regular relief joints in overlay layer.	Provides relief and freedom for the main structure to 'drift' relative to the nonstructural element. Full reinstatement of original finish is not required and overlay repair is often less time consuming, resulting in a better finish.	More material intensive. Final aesthetic appearance includes regular control joints and perimeter relief.	No damage expected	Low or no damage depending on relief provided by both the original infill and the overlay.
Remove partition and reconstruct. Ensure friction fit timber or steel studs in metal C-section top and bottom tracks. Do not fix linings to top and bottom tracks. Incorporate relief at connections to the main structure and incorporate regular control joints (depending on expected drifts).	Provides relief and freedom for the main structure to 'drift' relative to the nonstructural element. Future proofing.	Material and labour intensive. Final aesthetic appearance includes regular control joints and perimeter relief.		Low or no damage

For further information, contact the GIB® Helpline on 0800 100 442 or visit gib.co.nz.

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