Government of Western Australia
Department of Commerce

Building Commission

COMPLIANCE REPORT

Investigation into gypsum plasterboard ceiling collapses

May 2017

BUILDING COMMISSION COMPLIANCE INVESTIGATION

CEILING COLLAPSES

An investigation into the fixing of gypsum plasterboard ceiling sheeting to timber framing in residential homes in Western Australia

Cover image: Photograph by the Building Commission of a ceiling collapse assessed during this investigation.

Contents

Introduction

From December 2015 to June 2016 the Building Commission received 12 consumer complaints regarding the collapse or failure of a large section of gypsum plasterboard ceiling sheeting within Western Australian homes. In the majority of these cases home owners claimed that their home insurance policy did not cover the ceiling failure as the cause determined by their insurer was faulty workmanship.

Between 1 December 2014 and 30 November 2015, 129 queries were received by the Consumer Protection Division of the Department of Commerce (Consumer Protection) regarding a partial or complete collapse of a ceiling. The majority of enquiries made with Consumer Protection (95 instances) were enquiries relating to tenancies and delays in property owners attending to repairs and damage to the tenants household goods. Initially, these were not referred to the Building Commission as the callers were dealing with a tenancy dispute and in many instances the six year timeframe for lodging a building service complaint had expired and the caller was not the property owner. As a result of the awareness of incidents and possible causes of ceiling collapses all queries regarding ceiling failures are now referred to the Building Commission as a matter of course.

The Building Commission inspected seven of the 12 homes where ceiling failures had been reported to investigate the most likely cause of the failures. The investigation established that all affected homes were built between 2001 and 2009.

Inspections found various issues which may have contributed to the failure, although one common occurrence found at each home was the poor application of adhesive. Of the remaining five homes that were not inspected by the Building Commission, photographs were provided by the home owners and these also revealed that adhesive had not been correctly applied.

The amount and positioning of adhesive for fixing of gypsum plasterboard is well documented by manufacturers and forms a critical component of the ceiling sheeting fixing process. Any reduction in the amount or misplacement of the adhesive will affect the capacity of the sheeting to remain fixed to the ceiling framing.

This report sets out an account of the Building Commission's findings resulting from its investigation into ceiling failures. The Building Commission acknowledges the small number of ceilings inspected during this investigation cannot be regarded as a conclusive representation of all issues impacting ceiling collapses. However, the investigation found that sufficient evidence existed to be satisfied there is a public interest in publishing a guide for consumers warning of the dangers of incorrectly installed ceilings and to provide information on the early warning signs of failure.

What did we do?

Having become aware through media reports of a number of ceiling collapses the Building Commission undertook an investigation into why they occur. Contact was made with Consumer Protection, the Association of Wall and Ceiling Industries (AWCI) and building contractors who were actively installing ceilings during the times when failures had occurred, to gather information regarding the number of reported failures and likely causes.

What are our powers?

- Section 86(k) of *the Building Services (Complaint Resolution and Administration) Act 2011* (the Act) provides that it is a function of the Building Commissioner to review and identify the causes of complaints and to suggest ways of removing or minimising those causes.
- Section 60 of the Act allows the Building Commissioner to designate:
    (a) a public service officer; or
    (b) a person employed or engaged under the *Public Sector Management Act 1994* section 100 by the employing authority of the Department, as an authorised person for the purposes of this Act.
- Section 64 of the Act provides that an authorised person may carry out an inspection for compliance purposes which includes investigating a suspected contravention of the Act.
- Section 88 of the Act allows the Building Commissioner to publish (in any form) a statement identifying or giving warnings or information about any building services carried out in an unsatisfactory or dangerous manner.

Plasterboard product standards and manufacturers' recommendations

Part 3 of the *Building Act 2011* requires that building work must comply with applicable building standards. Relevant legislation in each Australian State and Territory prescribes the National Construction Code (NCC) to ensure any technical requirements for building work or plumbing and drainage installations are met. The NCC provides a uniform set of technical provisions for the design and construction of buildings and is published in three volumes. All three volumes are drafted in a performance format allowing a choice of *Deemed-to-Satisfy Provisions*[1] or flexibility to develop *Alternative Solutions*[2].

The technical requirements relating to the installation of plasterboard products are not prescribed in the NCC. However, there is a joint Australian/New Zealand Standard AS/NZS 2589 *Gypsum linings – Application and finishing*, which provides a reference for the building industry and specifiers, and a basic standard for adoption in contracts.

[1] A Deemed-to-Satisfy (DTS) solution uses the prescriptive approach detailed within each part of the Building Code of Australia.
[2] An Alternative Solution directly addresses the Performance Requirements by using one or more of the Assessment Methods available in the NCC.

AS/NZS 2589 sets out requirements for the application and finishing of gypsum linings for both walls and ceilings in residential and commercial construction applications. Furthermore, each plasterboard manufacturer provides specific guidelines on how to install its particular products. Generally, the manufacturer's recommendations for installation for gypsum linings reflect the requirements set out in AS/NZS 2589. For the purposes of its investigation the Building Commission refers to AS/NZS 2589 along with the applicable manufacturer's recommendations when assessing installation compliance and performance of gypsum linings.

Fixing of plasterboard to interior timber ceiling joists

AS/NZS 2589 allows for gypsum plasterboard to be fixed to a substrate using three different fastening systems. The recommended systems are:

(a) a combination of adhesive and fasteners;
(b) screw fixed only; and
(c) nail fixed only (only suitable for level 3 finish when no decoration is expected, that is inside service shafts and the like).

Generally, interior gypsum plasterboard ceiling linings are being fixed using a combination of adhesive and fasteners. AS/NZS 2589 Clause 4.4.3.2 provides requirements for combination adhesive and fastener fixing with Table 4.4.3.2.5 providing layouts for screws and adhesive for wall and ceiling applications. The part of Table 4.4.3.2.5 which is applicable to the securing of 1200mm and 1350mm wide plasterboard ceiling sheets is replicated in part below.

Table 1. Extract from AS/NZS 2589:2007, Table 4.4.3.2.5

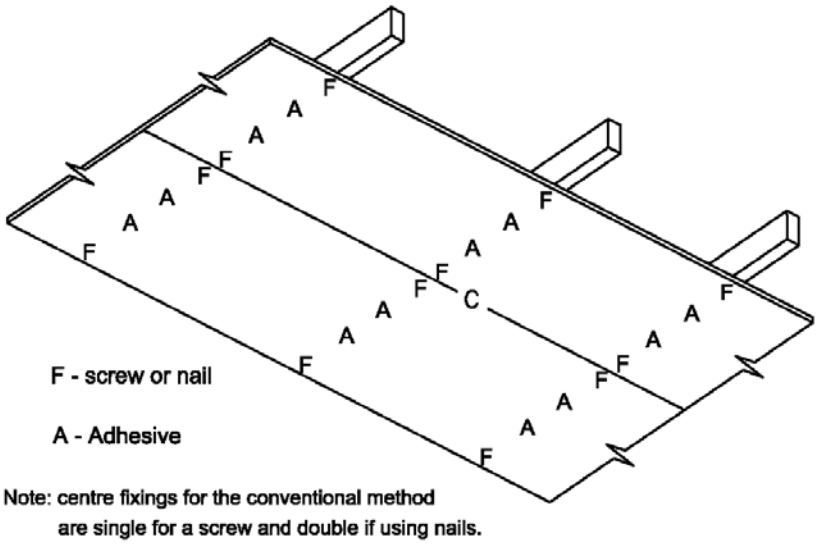
Gypsum plasterboard width (mm)	Conventional spacing	1/3 spacing
1200	F A A F/F A A F	F A F A F A F
1350	F A A F/F A A F	F A F A F A F

LEGEND: F = one nail or screw, F/F = two nails or one screw, A = one adhesive daub

Prior to 2007–2008 it appears that generally the conventional method of fixing was used to secure the plasterboard sheeting. This method relied heavily on adhesive to secure the sheeting in position and was considered by industry at the time to be vulnerable to failure if the adhesive was not applied correctly. The one third method of fixing was adopted by industry around 2007–2008 and is now considered to be the preferred method of fixing as time has shown it will improve the long term performance of plasterboard ceilings.

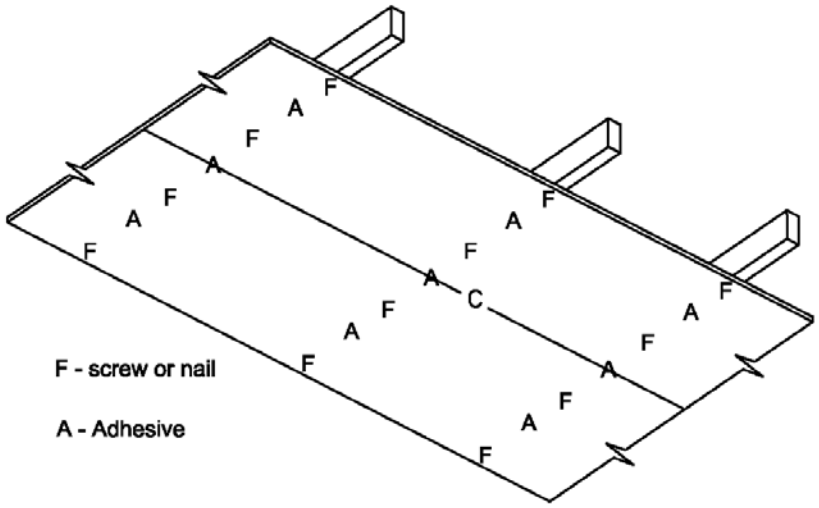
All the ceiling failures inspected by the Building Commission found that the conventional method of fixing had been used in all situations. These findings do not conclude that the conventional method of fixing is inadequate. The conventional method is an approved method under the current standard and approved for use by plasterboard manufacturers.

Figure 1 provides a pictorial depiction of the conventional and one third fixing methods.



CONVENTIONAL METHOD

ADHESIVE AND FASTENER FIXING POINTS



1/3 METHOD

ADHESIVE AND FASTENER FIXING POINTS

THE 1/3 FIXING METHOD IS CONSIDERED TO IMPROVE THE LONG TERM APPEARANCE AND PERFORMANCE OF PLASTERBOARD CEILINGS

Figure 1. Conventional method and one third method of fixing plasterboard sheeting

How did we do it?

Review of information

A review of media reports found a significant number of ceiling collapses occurring in Western Australia and across Australia. A number of reports indicated the ceilings had been in place for some time, and that the home owners' insurance companies did not cover the damage because the cause of the failure was assessed as faulty workmanship.

An assessment of matters reported to Consumer Protection revealed that in the 12 months from 1 December 2014 to 30 November 2015, partial or complete ceiling collapses were identified as the subject of 129 enquiries and seven complaints. The majority of the enquiries made with Consumer Protection (95 instances) related to residential tenancy disputes arising from delays in property owners attending to repairs and damage caused to the tenant's household goods. These tenancy matters were not referred to the Building Commission as the callers were dealing with a tenancy dispute and the caller was not the property owner. As a result of the awareness of incidents and possible causes of ceiling collapses all queries regarding ceiling failures are now referred to the Building Commission as a matter of course.

The seven complaints mostly concerned the quality of repair work following a ceiling collapse, with other cases referred to the Building Commission (see Figure 2). Typically, Consumer Protection does not refer a matter relating to building work that is older than six years, as this falls outside the scope for lodging a building service complaint.

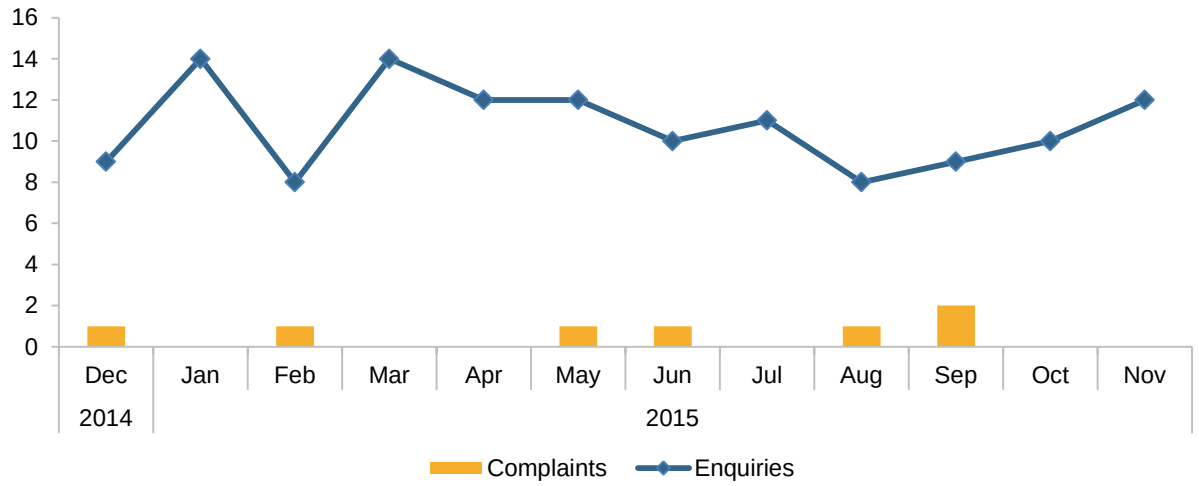


Figure 2. Consumer Protection monthly enquiry and complaint history

Further analysis of the 129 enquiries found that 23 concerned ceilings that were sagging or cracking, but had not fully collapsed. This report excludes all cases where, based on available data, collapses were caused by external factors such as storm damage, water leaks, termites etc.

The approximate age of the house was recorded for the 23 enquiries – averaging 8.9 years since construction (see Figure 3).

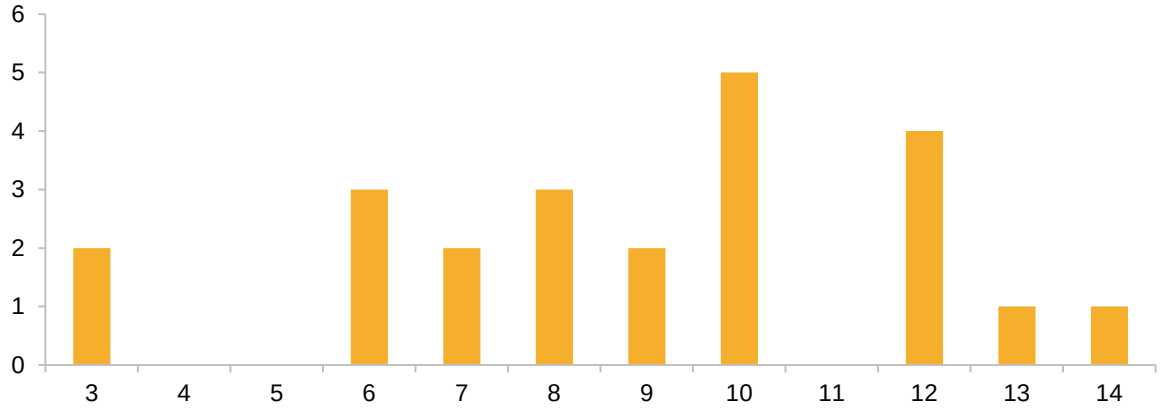


Figure 3. Years since house was constructed

Table 2 details three enquiries where specific reference was made to faulty glue being the cause of the ceiling collapse.

Table 2. Faulty glue identified as cause of ceiling failure

Log date	Description
24 Jul 2015	Complainant had a property built just over six years ago – the ceiling in the alfresco area has collapsed – insurance company won't pay out as a faulty glue/sealant was used.
31 Aug 2015	Complainant has had bad batch of glue applied to ceiling creating issues with ceiling and screw security – according to repairing trades, this has affected a number of complaints.
8 Sep 2015	Ceiling collapse – purchased 10 years – ongoing issues – assessed by trader, insurance inspection claims structural fault – failure of glue, insufficiently fixed.

Response to reported incidents

A number of media stories regarding unexplained ceiling collapses prompted the Building Commission to undertake an investigation into the cause of the ceiling failures. The investigation commenced in December 2015. In addition to investigating the cases reported in the media, any call received by the Building Commission's Customer Service Centre from a home owner advising that their ceiling had collapsed, or was sagging and in danger of collapse, was referred through to the Building Commission's Principal Technical Officer for consideration and inclusion in the investigation.

In every case investigated by the Building Commission, the date of completion of the building work exceeded six years. This meant home owners were unable to make a building service complaint to the Building Commissioner under the *Building Services (Complaint Resolution and Administration) Act 2011*.

Site investigations

Where possible, Building Commission inspectors attended the scene of ceiling collapses to ascertain the site conditions and plasterboard installation compliance. A visual inspection was conducted from within the roof space and below, using a preformatted check list to assess the installation of the ceiling sheeting against AS/NZS 2589 (both the 1997 and 2007 versions dependent upon the age of the home) and the manufacturer's installation recommendations. Site conditions were checked to detect any consistencies relating to the building materials used in the construction of the home, any plant and equipment installed within the ceiling/roof space and maintenance of the roof cladding.

Table 3 details which home sites were inspected by the Building Commission and the age of the ceilings at the time of collapse or significant failure.

Table 3. Matters reported to the Building Commission

Date of practical completion	Date of collapse/ failure	Age of ceiling (years)	Address	Inspected by Building Commission
2001	May 2016	15	Secret Harbour	Yes
2002	Dec 2015	13	Canning Vale	Yes
2003	Feb 2016	12	Yalyup	No
Mar 2005	Nov 2015	10	Aveley	Yes
2005	Feb 2016	10	Merriwa	No
2006	Feb 2016	10	Hocking	Yes
2006	Jan 2016	10	High Wycombe	Yes
Feb 2007	Jan 2016	9	Beeliar	Yes
2007	Apr 2016	9	Clarkson	Yes
2007	Mar 2016	9	Wattle Grove	No
2007	Nov 2015	8	Port Kennedy	No
2009	May 2016	7	Southern River	No

Approximately 60 per cent of ceiling failures reported to the Building Commission occurred around nine to 10 years after the home reached practical completion. Homes constructed during the years 2005–2007 appeared to be most affected.

Of the reported failures two builders were responsible for the construction of eight of the 12 affected homes. These were large volume builders and the number of failures is comparatively very small to the large number of homes each company constructed during this time. It is unlikely that the ceiling collapses represent a systemic failure on the part of these builders.

Enquiries were undertaken to establish whether the faulty workmanship could be attributed to a particular contractor or contractors. Neither builder was able to provide specific information regarding the ceiling fixers used on the affected constructions, and advised that there may have been up to five or six different sub-contractors used by both builders during this time.

The seasonal timing of the collapses (see second column in Table 3) does not appear to have any bearing on the cause although the ceilings failures inspected were carried out during the warmer months of December to June. Since June 2016, the Building Commission has received a further six reports of ceiling failures.

When inspecting the sites listed in Tables 4 to 8, the inspectors used a checklist to ensure the same components of the ceiling installation were checked at each site. The list of components that were checked provides baseline information about the circumstances that existed in each home at the time of the collapse or failure. This information was compared with compliance standards, manufacturers' recommendations and owners' maintenance responsibilities, to determine any common factors.

The construction of the ceilings in each home inspected was of the same design; however the manufacturer of the plasterboard sheeting differed. The ceiling framing for all homes was found to be constructed using softwood timber (generally MGP10 grade) with 600mm spacing between joists. All ceiling sheeting was found to be 10mm thick and 1200mm in width gypsum plasterboard, secured directly to the timber framing using a combination of both adhesive and mechanical fasteners. All ceilings, except for one with loose cellulose insulation, had batt type insulation installed directly onto the upper surface of the ceiling sheeting, with "Thermoseal Batts" present at five of the seven sites inspected.

At all sites inspected a single cause of the failure was not evident. In some homes the ceiling sheeting had been removed prior to inspection, so it was not possible to determine exactly the point of failure and whether the plasterboard sheeting had sustained any earlier damage. The main contributing causes and installation non-compliance issues are discussed later in this report.

Site inspections checked for evidence of poor care and maintenance of the ceilings due to owners' activities such as overloading the sheeting, moisture damage to sheeting and/or the removal or displacement of ceiling framing. However, apart from some slight moisture staining at two sites, no other contributing factors were noted.

The homes inspected by the Building Commission were selected for inspection following the receipt of information about the ceiling collapse or a complaint being lodged.

Table 4. Details of ceiling components of residential homes checked during Building Commission site inspections

Component inspected	Secret Harbour	Canning Vale	Aveley	Hocking	High Wycombe	Beeliar	Clarkson
Roof cladding type	Metal	Tiles	Tiles	Tiles	Tiles	Tiles	Tiles
Condition of ceiling	Dropped	Collapse	Collapse	Collapse	Collapse	Dropped	Collapse
Signs of moisture entry	No	No*	No	No	No**	No	No

* 1-2 years ago leak on family room ceiling. Not considered to contribute to failure.
** Slight staining on ceiling joist over dining area where A/C duct had come adrift.

Table 5. Details of ceiling loadings of residential homes checked during Building Commission site inspections

Component inspected	Secret Harbour	Canning Vale	Aveley	Hocking	High Wycombe	Beeliar	Clarkson
Weather conditions before collapse	Not known	Very windy	Not known	Hot day	Light winds	Not known	Mild
A/C in use at time of collapse	Not known	Not known	Not known	No	Not known	Not known	Not known
A/C ducting supported on ceiling framing	Yes	Nil A/C split wall system	Yes	Nil A/C split wall system	Yes	Yes	Nil Ducting over failed area of ceiling
Exhaust ducting in place	OK	N/A	N/A	N/A	N/A	N/A	N/A
Insulation type	Thermo-Seal Batts (bags)	Loose cellulose	Thermo-Seal Batts (bags)	Thermo-Seal Batts (bags)	Thermo-Seal Batts (bags)	Thermo-Seal Batts (bags)	100mm thick pink batts
Ceiling fitments (light fittings, mouldings etc)	Light weight	Light weight	Light weight	Light weight	Light weight	Light weight	Medium weight
Any inappropriate weight (household items) on affected ceiling	Nil	Nil	Nil	Nil	Nil	Nil	Nil

Table 6. Details of plasterboard of residential homes checked during Building Commission site inspections

Component inspected	Secret Harbour	Canning Vale	Aveley	Hocking	High Wycombe	Beeliar	Clarkson
Manufacturer	Knauf	Boral	AGL	CSR	Boral	Boral	CSR
Sheet thickness	10mm	10mm	10mm	10mm	10mm	10mm	10mm
Sheet width	1200mm	1200mm	1200mm	1200mm	1200mm	1200mm	1200mm
Location of failure	Family, kitchen, bedrooms and lounge	Family and kitchen	Theatre room	Lounge and games room	Family, dining and games room.	Family, activity bedroom	Upper floor bedroom
Approximate area of failure	100m^2	60m^2	35m^2	54m^2	90m^2	70m^2	25m^2
Back blocking present to affected areas	Yes	No	Unable to identify	Yes	Unable to identify	Yes	N/A
Cornice size and type	90mm coved	90mm coved	Not known	90mm coved	90mm coved	90mm coved	90mm coved

Table 7. Details of ceiling framing of residential homes checked during Building Commission site inspections

Component inspected	Secret Harbour	Canning Vale	Aveley	Hocking	High Wycombe	Beeliar	Clarkson
Framing type (metal or timber)	MGP10 pine	MGP10 pine	Timber	MGP10 pine	MGP10 pine	MGP10 pine	MGP10 pine
Flatness of framing over affected area	1 twisted joists visible	3 twisted joists visible	OK	12mm difference	OK	OK	Twisted joists
Span between joists	600mm	600mm	600mm	600mm	600mm	600mm	600mm
Sheet end trimmers to enable 300mm spacing's	Nil	Nil	Unable to check	Yes	Nil	Unable to check	Nil
Openings framed	Yes	Yes	N/A	Yes	Yes	Yes	N/A
Cross trimmers where appropriate	Yes	Yes	Unable to check	Yes	Appeared OK	Unable to check	Appeared OK
Framing contact surfaces are dry and clean	OK	OK	Unable to check	OK	OK	Unable to check	OK
Joist width (minimum 35mm for timber 32mm for steel)	Meets require-ment	Meets require-ment	Meets require-ment	Meets require-ment	Meets require-ment	Meets require-ment	Meets require-ment

Table 8. Details of plasterboard fixings of residential homes checked during Building Commission site inspections

Component inspected	Secret Harbour	Canning Vale	Aveley	Hocking	High Wycombe	Beeliar	Clarkson
Fastener spacing method (conventional or 1/3)	Convent-ional	Convent-ional	Unable to identify (ceiling had been replaced)	Convent-ional	Convent-ional	Convent-ional	Convent-ional
Screw types and size	Correct	Correct	Unable to identify	Correct	Correct	Unable to identify	Incorrect*
Screw position on sheet**	OK	OK	Unable to identify	Unable to identify	OK	OK	OK
Temporary fasteners	Not required***	No evidence	Not required***	Not required***	No evidence	No evidence	Not required***
Adhesive colour	Purple	Yellow	Orange	Blue	Yellow	Orange	Purple
Adhesive position	Incorrect	Correct	Incorrect	Incorrect	Incorrect	Incorrect	Incorrect
Adhesive size (25mmx15mm)	Insufficient	Insufficient	Correct	Insufficient	Insufficient	Insufficient	Insufficient
Adhesive to screw distance (min 200mm)	Incorrect	Correct	Unable to identify	Incorrect	Incorrect	Incorrect	Incorrect

* "S" class 25mm long screws used which are not suitable for timber. Minimum length should be 30mm.
** Generally 1 screw on each edge and 1 in middle of sheet (3 total).
*** Only Boral require temp fasteners for 1200mm wide sheets.

Note: At the time of inspection by the Building Commission the ceiling sheeting had been removed at the Canning Vale, Hocking, High Wycombe and Clarkson sites and couldn't be inspected.

Contact with Association of Wall and Ceiling Industries (AWCI)

The Building Commission's Principal Technical Officer met with the AWCI and sought its opinion about past ceiling installation practices, the adequacy of plasterboard materials and how plasterboard materials may or may not influence ceiling failures.

The AWCI advised that in the absence of any obvious cause such as water damage or overloading of ceiling sheeting, it would consider workmanship to be the main cause for plasterboard ceiling collapses. In the AWCI's opinion of the cases examined by the Building Commission, insufficient adhesive was applied and over time this caused the ceiling sheets to detach from the ceiling framing. The AWCI also reported that early disturbance of glue (within 24 hours) can be a major cause for defective bonding between the timber framing and the plasterboard. It also noted that activity in the roof space should be restricted until the adhesive is fully cured. Temporary fixings between adhesive daubs also assist with controlling any minor movement whilst the adhesive cures.

The AWCI advised that the fixing specification for ceiling sheeting has changed since 2007 with most installers preferring the one third method over the conventional method. The conventional method of fixing relies upon a single centre screw/double nail fixing and edge fixings (a total of three screws per joist). The one third method of fixing relies upon four screws per joist and is considered to be a better system as it relies less on adhesive. The AWCI advised that the one third system of fixing ceiling sheeting was adopted in Western

Australia around 2005–2006 as the preferred method of fixing. The AWCI recommends the one third method of fixing to all its members.

Contact with ceiling fixers

Contact was made with four ceiling-fix companies who are installing and repairing plasterboard ceilings to seek their opinion about the main causes for failure. Generally, they advised that there have been problems with the conventional method of fixing and that changing to the one third method in 2005–2007 had seen a reduction in ceiling failures.

The ceiling fixers were of the opinion that ceiling sheets failed due to a number of issues and it was difficult to determine exactly the cause. There was acknowledgement that adhesive was not always being placed in sufficient quantities and in the correct location. The opportunity for home owners to access their roof space and cause damage to a small area of ceiling sheeting was seen as significant. This could lead to added stress placed on the surrounding ceiling fasteners and cause the ceiling to fail over the longer term.

A Building Commission inspector conducted a site visit with a ceiling-fix company to verify current plasterboard installation practices and found their practices to be in accordance with the manufacturer's directions; apart from using the specified type of screw fastener (screw length was under size).

Ceiling fixers are predominantly using the 25mm long "S" class screw when fixing 10mm plasterboard sheeting to timber ceiling framing, which is contrary to the manufacturers' recommendations and the recommendations of AS/NZS 2589. Ceiling fixers along with the AWCI all appear to be of the opinion that the additional screw length is not required and no loss of performance has been noted. Whilst conducting its investigation, the Building Commission did not observe screw pull-out from the timber joists due to the shorter screw length and this is not considered to be the cause of any ceiling failures.

The Western Australian Branch of the AWCI is recommending a change to AS/NZS 2589 to enable 25mm "S" class screws to be used when securing 10mm plasterboard to timber framing.

What did we find?

The positioning and amount of adhesive applied to the timber ceiling joists is critical to ensuring the stability of the ceiling sheeting and this element was found to be the most problematic.

At five of the seven sites inspected the following adhesive components failed to meet minimum Australian Standards and manufacturers' requirements:

- adhesive daubs were spaced too far apart;
- adhesive daubs were insufficient in size; and
- adhesive daubs were placed too close to a mechanical fastener.

The poor application of adhesive can be seen in Image 1. This example of deficient and misplaced adhesive was common at all sites visited and also observed in photographs provided from home owners of homes not inspected by the Building Commission.

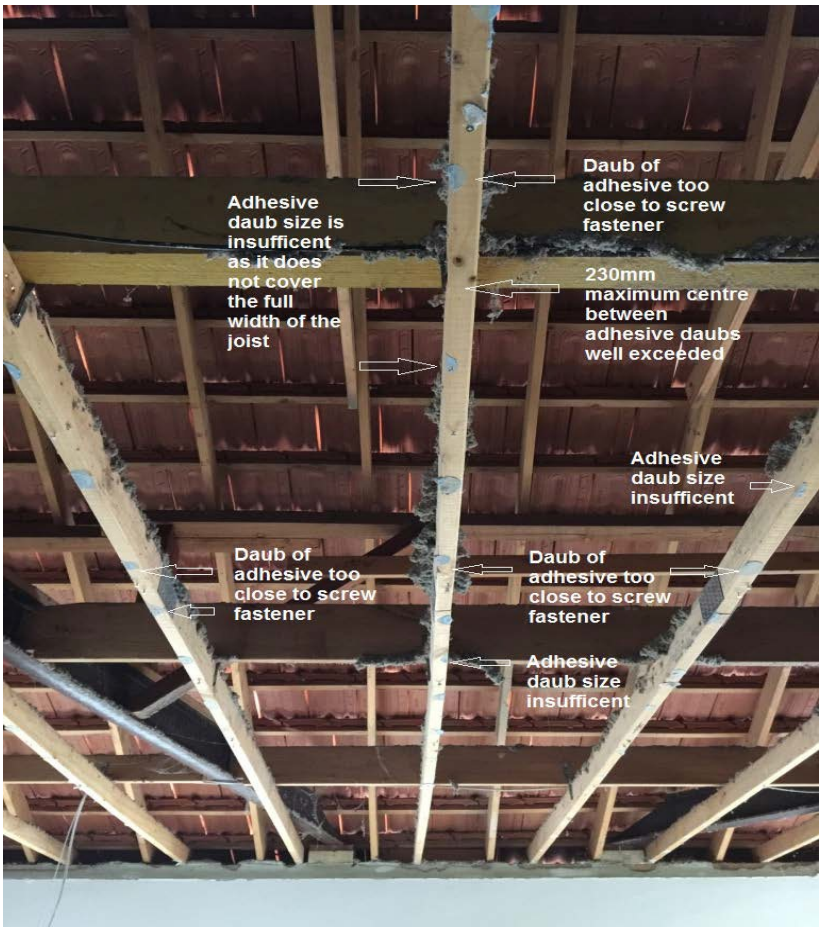


Image 1. Example of incorrect positioning and insufficient quantity of adhesive from a failed ceiling installation

Building technical compliance audits

Ceilings are inspected as part of the Building Commission's technical compliance audit program. In 2015–2016 building inspectors assessed 102 points of ceiling compliance including an assessment of ceiling fixings – screws and adhesive application. Fixings were found to be satisfactory in 87 per cent (20 of 23 homes) of ceiling fixing points inspected. Unsatisfactory fixings were attributed to the poor application of adhesive.

Early warning signs of collapse

The residents of the homes inspected had all noticed warning signs of the ceiling being under stress prior to the collapse. Unfortunately, these warning signs seemed minor to the residents and on their own they did not lead the residents to believe that there would be an imminent collapse.

The warning signs generally consisted of cracking noises in the roof space, screw pops on the face of the ceiling sheets and deflection of the cornice against the wall. In conversation with the owners they advised that in some cases residents had just left the room prior to the collapse. In one case a small child was in a lounge room playing when the child's mother, who was in the kitchen, heard a loud noise in the roof, she called the child to her and the ceiling of the lounge room collapsed directly after the child left the room. If the mother had not called the child after hearing the noise, the ceiling would have fallen on the child.

Key findings

1. In all ceiling failures viewed by the Building Commission it was evident that insufficient adhesive had been applied. AS/NZS 2589 specifies a daub size of 25mm by 15mm high be applied to the framing member. The adhesive daub should fully spread across the framing member and be easily seen on both sides of the joist member after installation of the plasterboard sheeting.

2. Adhesive daubs were positioned inside the minimum 200mm separation spacing from fasteners and board edges. The distance between adhesive daubs exceeded the 230mm maximum centres. Fasteners also coincided with an adhesive daub which is contrary to manufacturers' recommendations.

3. Screw spacing at sheet ends were noted to exceed the manufacturers' recommendations of no more than 300mm spacing. Typically, cross trimmers are placed at 600mm centres and therefore there is no supporting framework to enable fixings to be installed at the 300mm maximum spacing.

4. Where Boral sheeting was installed, there was no evidence that temporary fasteners had been installed between adhesive daubs as per the manufacturers' recommendations. The purpose of temporary fasteners is to ensure sufficient pressure is applied between the plasterboard sheeting and the ceiling framing during the curing process. A failure to use temporary fasteners can lead to a lack of bond between the adhesive and the sheeting. AS/NZS 2589 does not specifically require the installation of temporary fasteners; however it notes that "when temporary fasteners are used to hold the gypsum plasterboard firmly against the framing members, they shall remain in place for a minimum of 24 hours under normal drying conditions".

5. The one third method of fixing was recognised as a more reliable system for the installation of plasterboard ceilings between 2005 and 2007, as it is less vulnerable to failure due to the poor or insufficient application of adhesive.

6. Twenty five millimetre long screws were found to have been used to secure plasterboard sheeting to softwood framing members, whereas AS/NZS 2589 specifies a screw length of 30mm. No issues have been attributed to the use of 25mm screws and the AWCI is recommending a change to AS/NZS 2589 to enable the use of the shorter length "S" class screws when used to secure 10mm plasterboard to timber framing.

7. Recent audits of ceilings have detected some evidence of a continuing problem with poor or insufficient application of adhesive in a small number of installations of plasterboard ceilings.

Conclusion

Between December 2015 and June 2016 the Building Commission reviewed 12 cases where a ceiling failure was reported. Building inspectors were able to inspect seven of those ceilings, with the remaining ceilings having been cleared prior to the Building Commission being notified or before an inspector could attend. In these cases home owners were able to supply photographs for review by the Principal Technical Officer.

Homes ranged in age from seven to 15 years with most homes being completed between 2005 and 2007. The Building Commission is only able to accept a complaint about faulty workmanship if the relevant building work was completed within a six year period.

The application and installation of the plasterboard adhesive and mechanical fixings observed during this investigation had been carried out contrary to manufacturer and Australian Standard recommendations. While adhesive deficiency has not been confirmed to be the sole cause of the ceiling failure, this investigation found that a number of plasterboard ceilings were not installed in accordance with the relevant standards, which significantly contributed towards the long term adequacy of plasterboard linings.

The one third system of fixing ceiling linings appears to have become the preferred method of fixing over the conventional method in Western Australia around 2005–2006. Recent audits of the application of plasterboard ceiling linings found some evidence that the conventional method of fixing is still in use although it appears the ceiling fixing industry predominantly adapted its practices to the one third method about the same time as the 2007 version of the standard was published.

The Building Commission will continue to monitor and record ceiling failures and work with ceiling industry participants and the building industry broadly to ensure the correct installation procedures for plasterboard ceiling linings are maintained.

The collapse of a ceiling has the potential to cause injury to anyone caught in the way and indicators of an imminent failure are hard to detect or respond to. It is imperative that installers implement and review control measures to ensure gypsum plasterboard linings are being installed to meet the minimum relevant standards to minimise risks to home owners so far as is reasonably practicable. The Building Commission has prepared an industry bulletin and a guide for home owners to raise awareness of this issue.

Recommendations

1. The Building Commission publish a guide for consumers. The guide will highlight warning signs alerting the occupant of a potential ceiling collapse, along with checks home owners can do to identify a ceiling failure and advice on how to care for their ceiling.

2. The Building Commission publish an industry bulletin for builders and ceiling fixers. The industry bulletin is intended to provide an alert to builders and ceiling fixers as to the importance of ensuring that gypsum plasterboard linings are installed in accordance with the manufacturer's specifications and the requirements of AS/NZS 2589 *Gypsum linings – Application and finishing*.

3. The Building Commission's audit program continue to stringently inspect the installation of gypsum plasterboard ceilings to check that critical installation processes are being carried out in accordance with the manufacturer's specifications and the recommendations in AS/NZS 2589.

4. The Building Commission continue to monitor consumer complaints and media reports regarding ceiling collapses to determine whether the current failures are confined to past installation practices or they relate to a new issue and whether any further action is required.