

Fire Rated Joints in Walls and Floors

By John Rakic – Owner Trafalgar Group P/L

Introduction

Control, movement or expansion joints are an important part of good building practice. They are used to allow for movement and expansion and **stop unsightly cracking**.

We have all walked along the footpath as kids and jumped over, or tried not to step on the cracks as we called them; but they are movement joints, to stop the concrete cracking and allow it to age well.



I will use the term “control joint” in this article to refer to these movement or expansion joints.

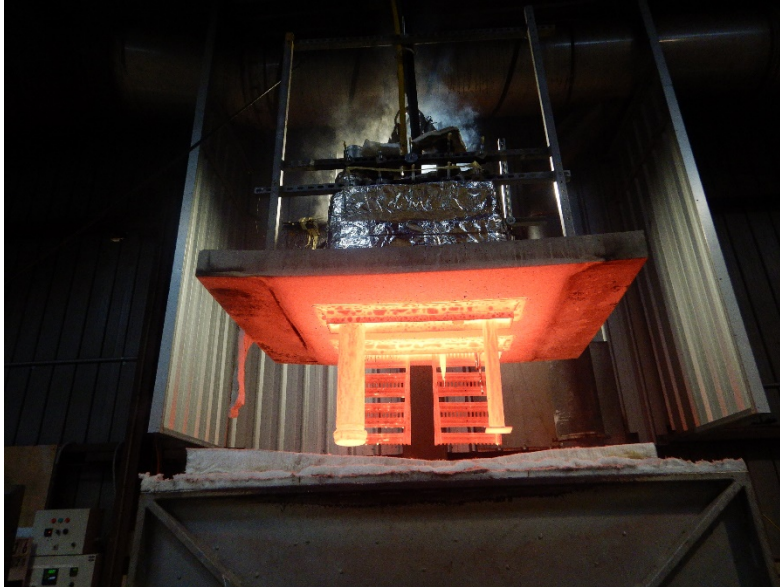
When we incorporate a control joint into fire rated walls or fire rated floor slabs, these control joints must incorporate fire rated materials to provide an as tested fire rated control joint SYSTEM. This article discussed the fire testing requirement here in Australia, the determination of an FRL and what fire testing is required for compliance with the National Construction Code (NCC), formerly the Building Code of Australia.

Sadly, there are many so called fire rated sealants or “FR sealants” on the Australian market, which are being sold, purchased and installed which do not have the correct fire testing and therefore do not comply with the strict requirements of the NCC. This is even more prevalent now that the NCC has outlined that from May 1, 2022, that all fire test approvals must be current and require full compliance with the latest version of AS1530 Part 4, 2014.

This article will hopefully help you understand what constitutes a compliant fire rated control joint.

Fire testing, fire ratings and the determination of an FRL

The NCC requires elements of construction required to have an FRL, to be fire tested and approved to the current version of AS1530.4 – 2014, Methods for fire tests on building materials, components and structures Fire-resistance tests for elements of construction

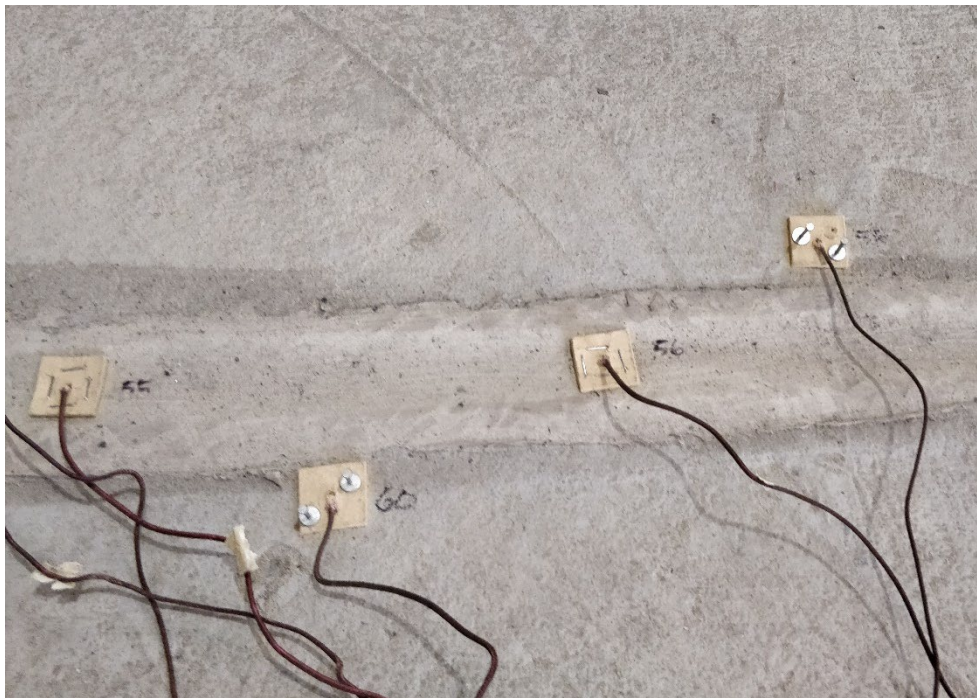


A photo of a horizontal fire test specimen immediately after completion, where the floor slab is being removed off the top of the AS1530 Part 4 fire resistance furnace

Fire testing to AS1530 Part 4, represents a full developed fire in a compartment, where flashover has occurred, and temperatures rise dramatically from the start of the fire test, reaching temperatures well in excess of 1000 deg C.

The photo above shows how severe the fire test is, as you can see the bowing in the 120mm thick concrete slab, and the underside of the slab is glowing “orange. In this particular fire test, there were copper pipes in between the two steel pipes, which have completely melted.

Fire rated control joints like one would expect need to be fire tested to show that they will not reduce the FRL of the wall or floor slab they are being used in. Fire testing incorporating control joints must be conducted for all different wall types and floor slab types and thicknesses, and of course, with different joint widths to provide the requisite fire test reports for NCC compliance. The fires test prove that the control joint will not crack or shrink, and will stick to the substrate during real fire conditions, and prevent the passage of flames and hot gases, and equally will not get too hot on the surface of the joint on the cold or non-fire side of each fire test.



A picture of a 40mm control joint in a 175mm concrete floor slab, with Trafalgar FyreFLEX fire rated sealant applied to the top of the joint in the concrete only immediately prior to fire testing to AS1530 Part 4 - 2014

The FRL, commonly incorrectly referred to as the fire rating, provide a measure of time for both the **integrity** of the control joint in fire conditions (ability to resist hot gases or ignition) and the high temperature **insulation** properties of the control joint; that is its ability to insulate the joint from the 1000 Deg plus temperature of the fire, and maintain temperatures on the non-fire or non-exposed surface below a temperature rise of 180 deg C

A so called one hour fire rating, which we often hear spoken of, is in fact for regulatory purposes and the NCC, an FRL of -/60/60; that is from an actual fire test to AS1530 Part 4, the joint in question, and the fire rated sealing material, for the given width of joint and depth of material used, and just as importantly the orientation it is installed, (one sided, or two sided application), successfully **provided both integrity and insulation during the fire test**, in the given wall or floor type being fire tested for at least 60 minutes duration.

Similarly, a two hour fire rating would be an FRL of -/120/120.

I am going to now talk about different types of fire rated control joints in turn, because they are treated differently in terms of FRL's and fire testing requirements.

Joints in fire rated walls & shafts – vertical fire barriers

There are many fire rated wall types, ranging from bricks, blockwork, tilt up concrete, fire rated plasterboard partitions and a whole plethora of proprietary wall types we have seen introduced into the Australian market over the last decade in particular, such as Hebel, Speed Panel and Pronto Panel just to name a few. These wall constructions are also often used to construct fire rated stair shafts, fire rated lift shafts, and fire rated service risers, and all of these also typically include control joints.

Most, if not all of these fire rated walls, fire rated partitions or fire rated shafts, if built correctly, will require fire rated control joints.

We don't know which side of a wall or shaft that a fire will happen on, hence in terms of the NCC, the FRL must apply in both directions of possible fire exposure.

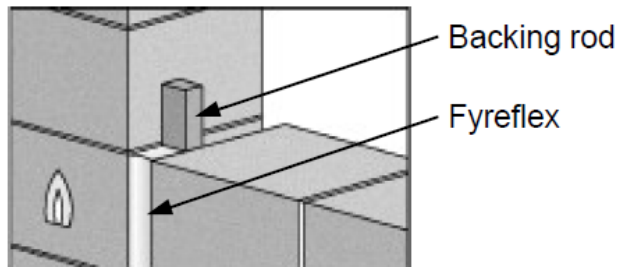
In practice, what happens on actual building sites, makes fire testing, even more, cumbersome and expensive, because quite often for reasons such as access, waterproofing, speed of construction and sadly mistakes, the application of fire rated control joints may only be practical from only one side, not both sides of the wall or shaft. [A fire test conducted with fire rated sealant on both sides of a wall, cannot be used for these applications where fire sealant is only applied to one side of the wall.](#)



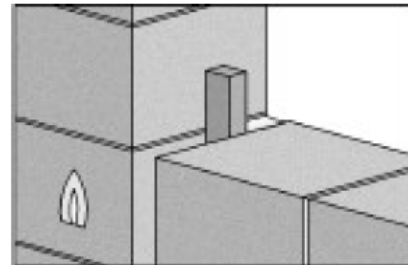
An example of a vertical control joint in some tilt up panels requiring an FRL

So let's take a look at some joint configurations and directions of fire exposure first to get your minds thinking fire and heat transfer.

A) JOINT PROTECTED FROM EXPOSED SIDE



B) JOINT PROTECTED FROM UNEXPOSED SIDE



There are two joints depicted here, joint A and joint B

You will notice the little flame, signifying which side the fire exposure is on. It's on the side of the wall closest to you as you look at both these diagrams.

Joint A has the FyreFLEX sealant exposed directly to the fire, whereas joint B, allows the fire to enter the joint and attack the back of the FyreFLEX sealant. I am sure you can see the difference in these two fire rated control joint systems.

Assuming each joint is 20mm wide, and the depth of the FyreFLEX sealant shown here is also 20mm, **which joint do you think will keep the bricks on the non-fire side the coolest and why?**

Think about it for a minute and take another look at both diagrams above more carefully.

I'll give you a few clues to help you

1, the backing rod, does nothing except help the applicator when installing the sealant get the correct depth of sealant and provide little or no significant contribution to the FRL. It melts and shrivels up with direct heat very quickly.

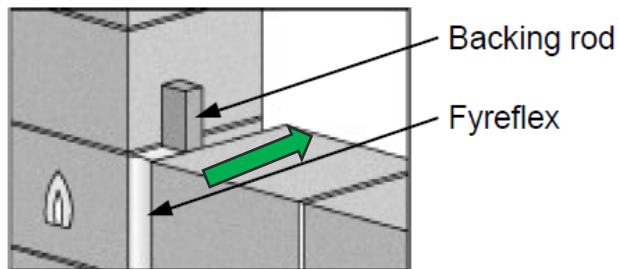
2, FyreFLEX sealant is a much better thermal insulator than the bricks.

If you guessed that joint A would keep the temperature of bricks the coolest you are correct.

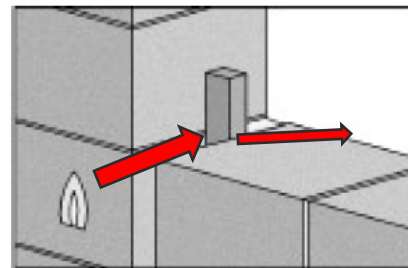
If you can't see why.....

Then let's explore why?

A) JOINT PROTECTED FROM EXPOSED SIDE



B) JOINT PROTECTED FROM UNEXPOSED SIDE

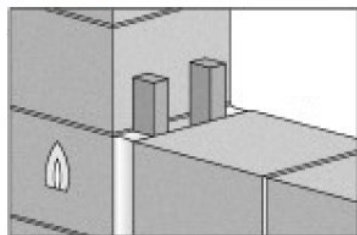


In joint A, the heat has to transfer through the **entire thickness of the bricks** to get hot, because the FyreFLEX sealant stops most of the heat transfer through the joint itself. The hottest heat transfer mechanism in the scenario is shown by the green arrow.

In joint B, the heat is allowed to travel into the unprotected portion of the joint where it hits the backing rod and the back of the FyreFLEX sealant. The backing rod will quickly melt. The FyreFLEX sealant will protect the rest of the joint, but the heat only has to heat up a much thinner portion of the thickness of the remainder of the brick, and the temperature directly adjacent to the joint, gets much hotter than Joint A for the same fire exposure conditions. The two red arrows show this heat transfer mechanism.

OK, what about joint C, below, how would the temperatures on the bricks on the non-fire side be compared to joint A? Hotter or colder?

C) JOINT PROTECTED FROM BOTH SIDES



The answer is, in fact, the temperature will effectively be the same.

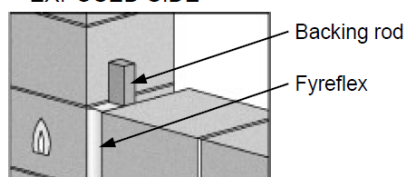
I am sure I will get some people who think differently, but I know these answer to be true from both my thermodynamics studies and real fire testing of FyreFLEX sealant in joints also!

Anyway, if you did think about this, I achieved my goal to start making you understand FRL ratings and directions of fire exposure for scenarios where for whatever reason people want to do single sided fire protection. It can be done, but the thickness of sealant required is deeper, and this is where good intumescent sealants which swell up and backfill into the unprotected joint cavity do their magic.

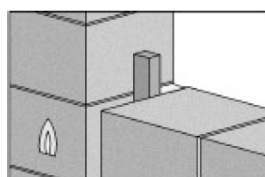
The discussion earlier might help you understand why Tables like the one show below are included in technical literature to provide different thicknesses of fire rated sealant, required for different joint widths, one or two sides of sealant and of course the FRL required.

Concrete, Brick and Block Walls

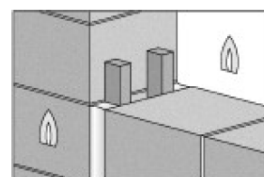
A) JOINT PROTECTED FROM EXPOSED SIDE



B) JOINT PROTECTED FROM UNEXPOSED SIDE



C) JOINT PROTECTED FROM BOTH SIDES



Fill Depths of Fyreflex (mm)

JOINT WIDTH (mm)	10			20			25		30		40		50	
JOINT FILL TYPE	A	B	C	A	B	C	A	C	A	C	A	C	A	C
RATING (hrs)														
-/120/120	10	15	10	10	30	10	12	12	15	15	20	20	25	20
-/180/180	10	15	10	10	30	10	12	12	15	15	20	20	25	20
-/240/240	15	15	10	30	35	15	30	20	30	20	40	20	40	20

NOTE: Joint may be filled on one side if direction of fire is known. If direction of fire is not known, sealant must be applied from both sides.

The Table of above shows the thicknesses of FyreFLEX required previously under fire testing to AS1530 Part 4 – 2005; under the new requirement of AS1530 Part 4 -2014, these thicknesses will most probably increase. The reasons why are discussed later in this article

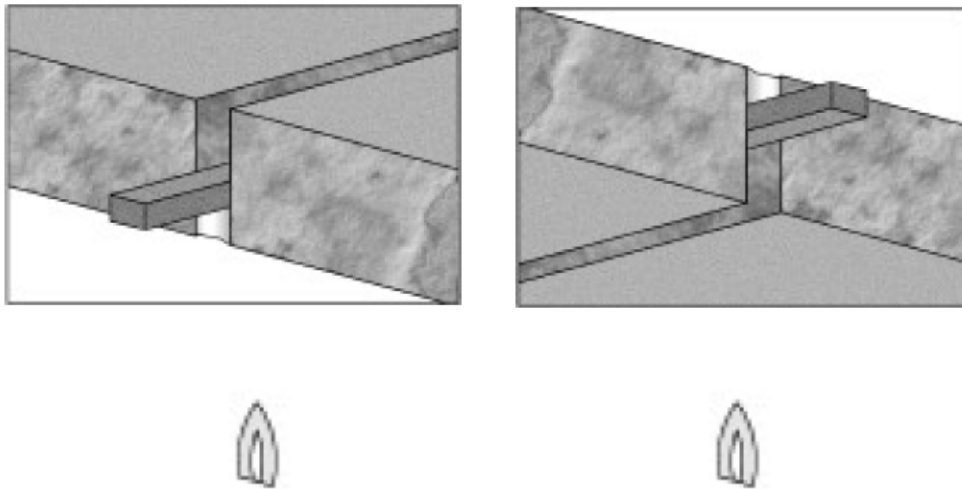
FyreFLEX



In terms of fire testing requirements, sadly, **manufacturers need to fire test in all the different wall types**, so many fire tests are required to cover all the different walls types.

Joins in fire rated floor slabs – horizontal fire barriers

The NCC recognises that heat rises, and unlike walls where the FRL must apply equally to both sides of a wall; that is **2 WAY fire protection** is required, **for floor slabs, fire exposure from below only is required.**



Let's play our little game again.....

Which joint will provide the best performance, the one on the left or the one on the right, with the fire exposure from below as required by both the NCC and AS1530 Part 4 fire testing?

The answer is the one on the left

However, we know applicators like to do the one on the right, so they don't need to scaffold and get access to the underside of the slab.

To get the same FRL with only fire rated sealant on the top, you need much deeper sealant.

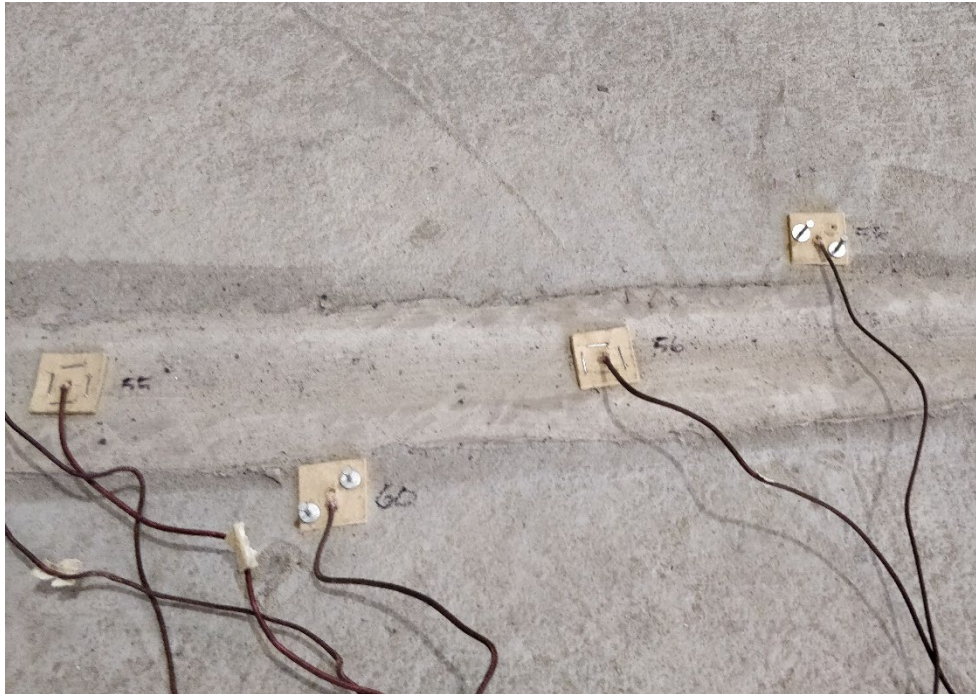
The reason I am going through these little quizzes is to help you understand what fire testing is required, and to be able to look a bit more carefully at the manufacturer's technical datasheets, and **ensure the correct fire testing is in place**, and you are installing the correct thickness, especially when doing fire sealant on only one side of the joint only.

You might get some nasty surprises sadly when you do go looking for this fire test data..... **"but, we have never fire tested that way, and it has always been OK???"**

The one thing I will say is that as a potential warning sign is if suppliers can only make loose claims such as "fire rating up to 4 hours" or just state that their product is an "FR sealant". You MUST ask for the technical manuals and copies of the fire test reports to be sure and makes sure the fire testing is current.

I will also say that fire rated sealant and the complexity with FRL's and certification do not lend themselves to selling them through Bunnings and places like that.

So back to this photo I showed earlier:



This you will remember is a 4 hour (175mm thick) floor slab with a 40mm wide joint protected by Trafalgar FyreFLEX sealant with some backing rod used during installation that you cannot see. In this case, the sealant is applied only to the top of the slab, and the heat comes from below.

Those square pads you see in the picture above, the ones with wires connected to them, are thermocouples, which measure temperature and allow the fire test laboratory to record and graph the temperature rise during the full duration of each fire test.

This picture is the top of the floor slab prior to fire testing, and you will see that thermocouples are positioned both on the FyreFLEX sealant itself and 25mm away from the sealant on the concrete floor slab itself.

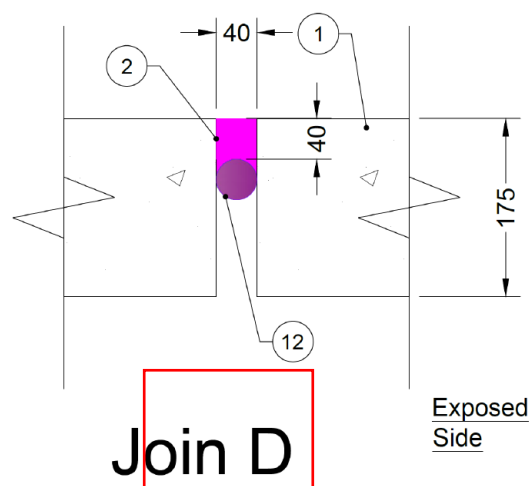


Figure 9 Cross-section G-G

This is a cross section drawing of the FyreFLEX control joint from the fire test report

Control joint D		
D	Service	Control joint
	Aperture size	40 mm wide × 1000 mm long
	Local fire-stopping protection	
	Protection	Backing rod (item 12) was first inserted into the aperture to a depth of 40 mm from the unexposed side. Sealant (item 2) was then applied into the aperture up to the backing rod. See Figure 1, Figure 2 and Figure 9 in Appendix A for more details.

This is a description of the fire tested specimen D, which is the FyreFLEX sealant control joint

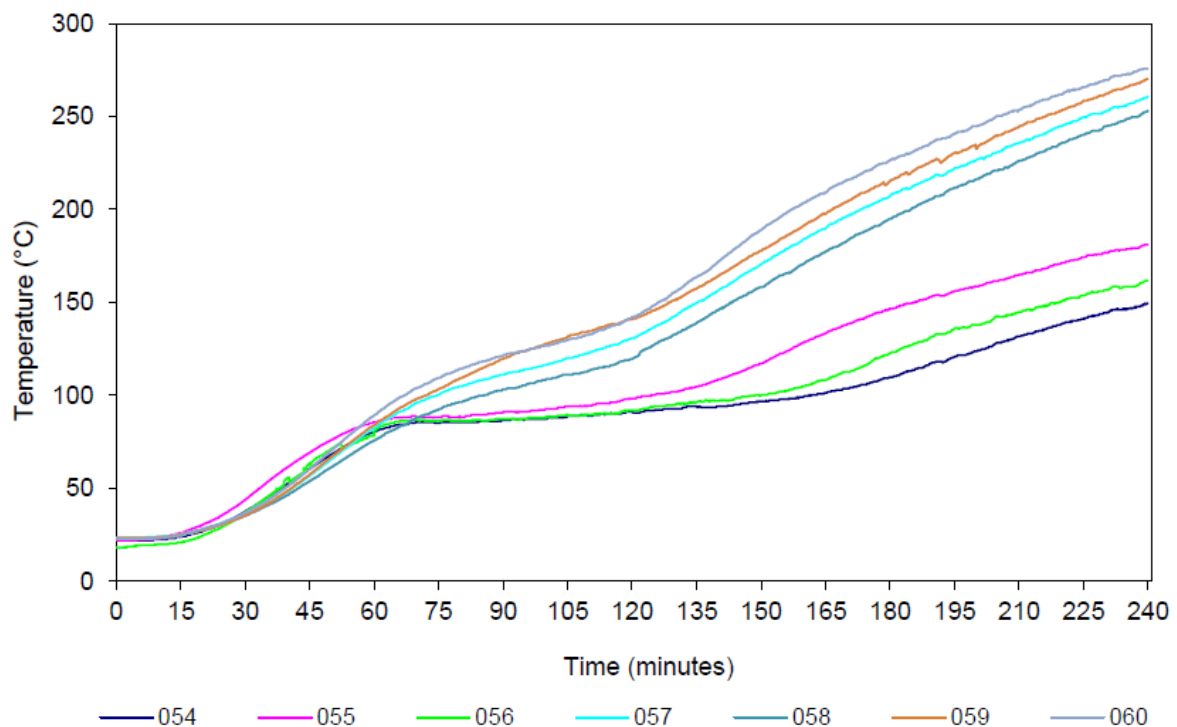


Figure 66 Penetration system D – temperature vs time

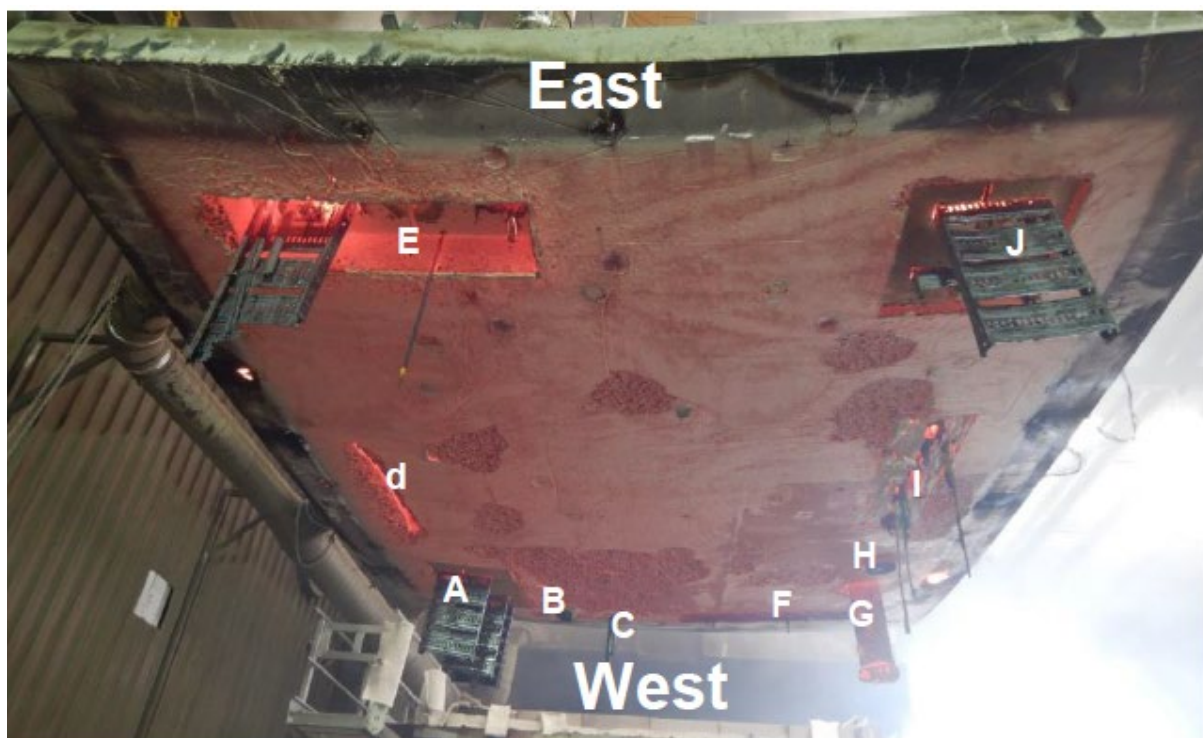


This graph shown above shows the temperature rise on the floor slab adjacent to the FyreFLEX sealant (57, 58, 59, 60) and on the FyreFLEX sealant itself (54,55,56); it shows how good an insulator FyreFLEX sealant is, 40mm of sealant, stayed cooler than 175mm of concrete for the entire 4 hours of fire exposure.

You might remember from earlier, that the failure criteria for insulation is a temperature rise exceeding 180 deg C; which if you have a good eye, you will see in the graph was 158 minutes!

D	Structural adequacy	Not applicable	-/240/120
	Integrity	No failure at 241 minutes	
	Insulation	Failure at 158 minutes	

I cheated, I looked at the report to get the 158 minutes, shown in the abstract from the actual fire test report.



Exposed face of the specimen at the end of the test, eastern view

I thought I would include a photo of immediately after the 4 hours when the 4000mm x 3000mm concrete slab was lifted off the fire resistance furnace. You will see the concrete spalling in many places; this is a serious exposure level and a damn long duration, You will also notice the control joint, designated "d" with the FyreFLEX sealant still in place after the 4 hours of exposure.

Head of wall control joints or deflection heads

This article is already getting a bit lengthy, but for completeness, I thought I better mention the interface where a non-load bearing partition meets a floor slab.

This needs a fire rated control joint.

This area is often referred to as a head detail, head of wall detail, top of wall or a deflection head amongst other things.

» FIRE-RATED STEEL STUD WALLS (NON-LOAD BEARING)

HEAD DETAILS

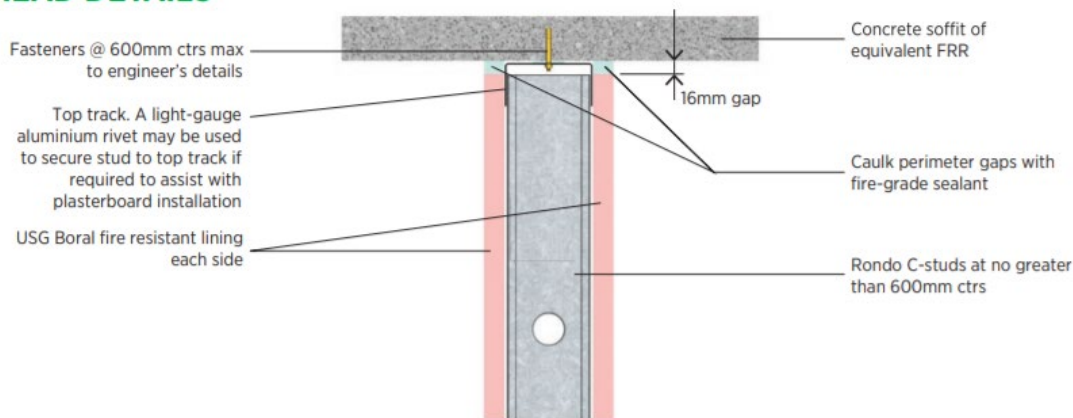


Figure 47: Partition Head Detail

This is an example of a detail from one of the Australian manufacturers of fire rated plasterboard

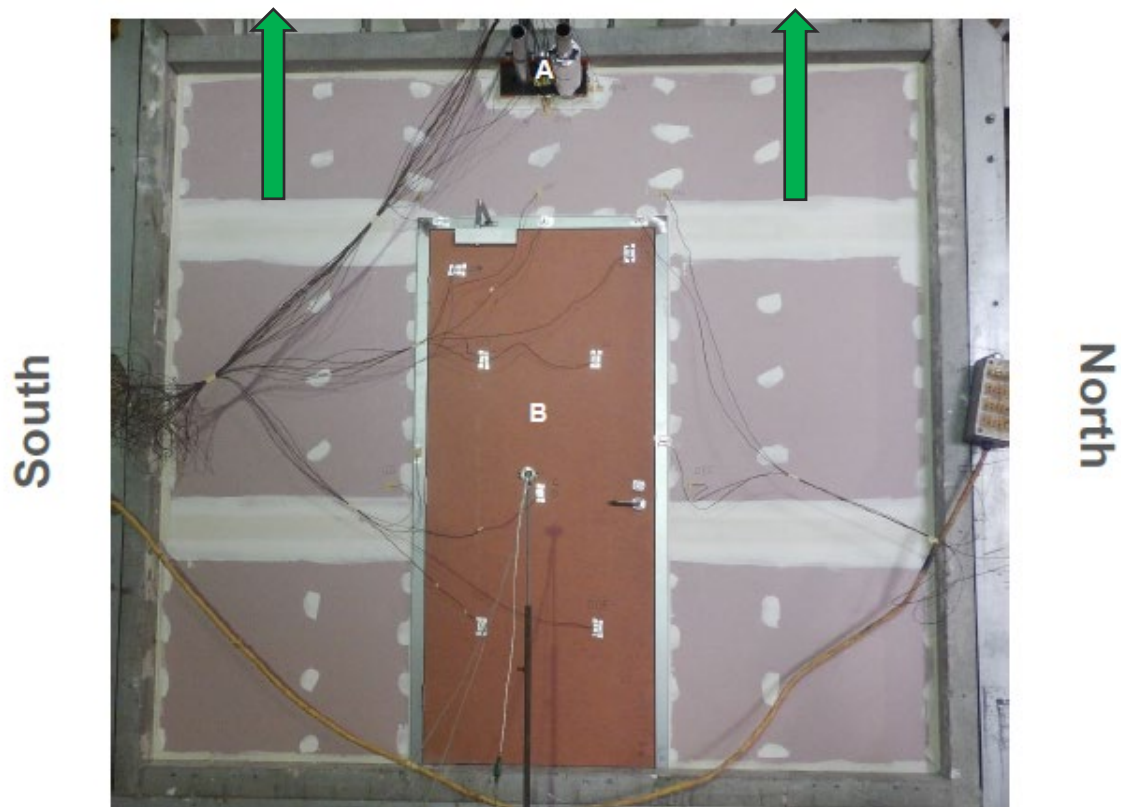


Figure 33 Unexposed face of specimen before the start of test

*Shown above is a full-scale fire test incorporating a fire door assembly and one of our Trafalgar patented Fyrex slab mounts in a plasterboard wall, no prizes for identifying the head of wall detail and the FyreFLEX sealant, it is shown in green.
Can you see any other fire rated control joints?????*

Service penetrations

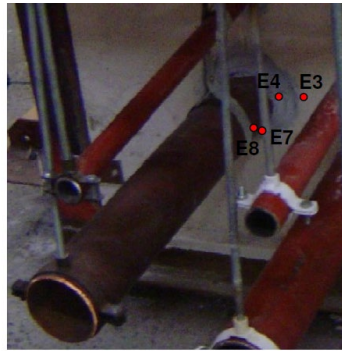
Fire testing of opening for services passing through fire barriers, although fire tested to AS1530 Part 4 – 2014, also, have very different fire testing requirements, but also have the added complication of having to comply with the additional requirements covered in AS4072 Part 1.

Fire test from joints cannot be used for service penetration and vice versa.

The use of fire rated sealants have very limited application, without the additional use of additional wrap materials employed on the services in close vicinity to the fire barrier.



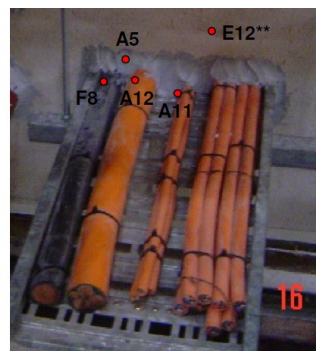
The picture above shows some service penetration undergoing AS1530 Part 4 - 2014 fire testing applying the requirements of AS4072 Part 1. FyreFLEX sealant is used to fill the void around the pipes, but there is also a requirement for the TWrap material you see here. Remember the FRL is required to be -/60/60, -90/90 and -/120/120, -/180/180 for 60, 90, 120 & 180 minute walls respectively, not, -/60/30, -90/30, -120/30 or -180/- for example.



Service F



Service G



Service H

F	Structural Adequacy	Not applicable
	Integrity	No failure at 181 minutes
	Insulation	14 minutes
	FRL	~/180/-
G	Structural Adequacy	Not applicable
	Integrity	No failure at 181 minutes
	Insulation	41 minutes
	FRL	~/180/30
H	Structural Adequacy	Not applicable
	Integrity	No failure at 181 minutes
	Insulation	100 minutes
	FRL	~/180/90

Here is an example of some very nice fire tested penetrations with fire rated sealant, but as you can see the insulation rating is 0, 30 and only 90 minutes, for services F, G & H respectively. These all should be 180 minutes. It should be noted that the enforcement of the insulation rating was poor historically but has certainly changed in the last 10 years.

Another really important point regarding the applicability of fire test data, can be gleaned from the example above. If you test in a big thick 4 hour concrete wall for example, the data cannot be used in thinner 60 or 90 minute plasterboard walls, or any other wall types for that matter. Fire testing is required in the specific wall type in question, whether it is a control joint or a service penetration alike.

Changes to NCC and changes to AS1530 Part 4

May 1, 2022 will see the requirement for all fire testing and FRL's to be required to be to the latest version of AS1530 Part 4 -2014.

This is what we are all calling "D day"

Previously fire tests to older versions of AS1530 Part 4 will be redundant and cannot be used anymore.

Did anything change pertaining to the fire testing of control joints?

Yes, we had a significant change, that of the temperature rise being measures on the joint itself. In previous versions of AS1530 Part 4, the failure criteria was only on the fire barrier 25mm away from the joint itself. This makes the new requirements more onerous.

At the time of writing, Trafalgar are in the process of re-testing its fire rated range of sealants to the more onerous and current fire testing requirements. We have completed services penetrations and we are halfway through control joints.

It's a time consuming and expensive exercise, but to want to stay as a market leader, we need to spend and validate our products in all the requisite system configurations we want to sell into. This means many wall types and of course floor slab types also.

Conclusions

- The NCC has strict requirements for FRL's
- FRL's are determined from fire testing to AS1530 Part 4 -2014
- Fire ratings are poor term to describe an FRL
- There really isn't any fire rated products per se, there is only fire tested SYSTEMS that incorporate products which together achieve an overall FRL
- Be wary of products that "say up to 4 hour rating" on the labelling
- Fire rated control joints require specific fire testing
- FRL applies to the wall or floor type, joint size, fire product used and depth of fill
- Fire testing on both sides of all wall does not allow the product to be used on one side of a wall
- Fire testing on the bottom of a floor slab means the product can only be used on the bottom of a floor slab
- To use a product on one side of a wall or on the top of the floor slab requires specific fire testing for these applications and will typically require a thicker fill depth
- May 1st, 2002 is "D Day"; fire tests to older version of AS1530 Part 4 can no longer be used
- AS1530 Part 4 – 2014 requires temperature measurement on the material in the joint whereas previous versions of AS1530 Part 4 do not
- Check now for AS1530 Part 4 fire testing
- **Don't be fooled by the big companies, I am not sure they even know they may be selling products that are strictly non-conforming building products; to say they don't know when and how they are being used by their customers, sadly does not wash with me, nor would it in a coronial enquiry.**
- Hebel wall means Hebel fire testing required
- Ditto for one hour, 90 minute and 120 minute plasterboard
- Ditto for blockwork
- Ditto for tilt up concrete slabs
- Ditto for other wall types, eg Speed Panel, Pronto
- **Fire kills and manufacturing and selling into these application is not for the feint hearted or for those without sufficiently trained and qualified technical support engineers**
- **Fire testing for control joints cannot be used for service penetrations and vice versa**
- A fire test in a 2 hour wall is not suitable for use in a one hour wall as the one hour wall is thinner and will yield very different fire test results to the two hour wall