Fire Resistance Levels for Walls and Ceiling Systems

A Specifier's Guide

RONDO®

GYPROCK® CSR

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INTRODUCTION

Building fires are a significant threat to human life, property and the economy. One only needs to look at the millions of dollars' worth of property damage caused by the 2014 Lacrosse and 2019 Neo200 tower fires to understand why fire-safe design requires careful consideration.

Passive fire protection is a technique for containing a fire at its source and stopping the spread of flames and smoke throughout a building for a predetermined amount of time so occupants can escape. Under the National Construction Code (NCC), wall and ceiling assemblies are among the key areas of focus for passive fire protection design strategies.

For the best possible fire protection, building regulations stipulate that these assemblies must undergo testing in accordance with industry standards to ascertain the levels of fire resistance they can be expected to provide. A solid understanding of fire-resistant construction, its regulation and how it applies to a building's walls and ceilings is essential in today's regulatory environment.

This whitepaper answers the essential questions of: how passive protection works in the context of building design, how Fire Resistance Levels are determined, what is required by the NCC for different building elements, and how these requirements impact the design and specification of wall and ceiling systems.

HOW PASSIVE FIRE PROTECTION WORKS

Passive fire protection (PFP) uses fire-resistant walls and floors to prevent the spread of the fire, heat, and smoke by containing the fire, heat, and smoke in one area at the point of origin. PFP systems are made to "resist" the spread of fire and smoke as well as the heating of structural members for a predetermined amount of time in accordance with building codes and regulations.

PFP serves a dual purpose—to protect escape routes and provide time for occupants to safely escape the building during a fire; and prevent the fire from ever turning into a life-threatening event. It achieves these goals by taking a proactive stance towards fire protection with measures to protect a building's critical structural members and addressing the tendency of fire to spread from room to room.

The four key principles of PFP are listed below:

- **Structural fire protection.** Structural fire protection safeguards vital structural elements (such as structural steel and joint systems) from the effects of fire.
- **Compartmentation.** Fire compartmentation divides up each level of a structure into smaller spaces in order to help contain or slow the spread of fire. Examples of fire barriers used in compartmentation include fire-rated walls, floors, and ceilings (typically made of concrete, steel and other materials, gypsum, or masonry).
- **Opening protection.** Fire doors and windows are installed in an opening of a fire barrier to maintain its fire resistance.
- **Firestopping materials.** These materials are used to limit fire spread through penetrations in a fire barrier.

The NCC adopts these principles in its requirements for wall and ceiling design. According to the NCC, a building will be divided into fire compartments. These fire compartments are separated from one another by walls, ceilings and floors made of a fire-resisting construction. For complete protection, walls extend from a fire-rated floor to the fire-rated ceiling above and continue into any concealed spaces.

WHAT ARE FIRE RESISTANCE LEVELS?

The NCC mandates that building components be fire resistant in order to prevent the building from facilitating the spread of fire and to delay the onset of structural collapse in the event of a fire. The NCC uses the term "Fire Resistance Level," or FRL, to describe this concept.

Understanding the three different components of a FRL, how they are determined, and how they contribute to PFP is crucial when discussing fire-resisting systems. The three components are as follows:

- **Structural adequacy.** A tested assembly's ability to support a load or carry a specific load under fire conditions.
- **Integrity.** A tested assembly's ability to restrict the passage of flame and hot gasses. Note that this criteria does not measure smoke leakage.
- **Insulation.** A tested assembly's ability to resist temperature rise on the non-exposed, or non-fire side, of a fire-resistant separating barrier.

AS 1530.4:2014 "Methods for fire tests on building materials, components and structures, Part 4: Fire-resistance tests for elements of construction" provides fire testing methods for determining the fire resistance of various elements of construction when subjected to standard fire exposure conditions. Fire testing is conducted by taking a completed wall or ceiling test specimen, the same assembly that would be used in the field, and loading it onto one face of a fire furnace. The specimen is then subjected to a standardised time-temperature curve to determine its performance under fire conditions.

In accordance with AS 1530.4, the passing value is determined by the number of minutes in which there is no failure when tested in accordance with the three FRL test criteria. The failure criteria for structural adequacy is that the specimen collapses or deflects more than a certain amount or at a certain rate. The criteria for integrity includes the absence of any gaps or openings that could allow hot gases or flames to escape. The failure criteria for insulation is fulfilled when the thermocouples, or temperature measuring devices, on the test assembly's non-fire side go above the prescribed limits.

The duration of a test before it meets failure is used to measure all of these criteria. FRLs are expressed in the following format: X minutes/Y minutes/Z minutes, where X, Y and Z are numbers ranging from 0 to 240 minutes. For example, the FRL 60/60/60 means that the specimen passed the criteria for structural adequacy, integrity and insulation for 60 minutes respectively before failure.

REQUIREMENTS FOR WALL AND CEILING SYSTEMS

Note that the discussion below is intended to provide a summary only and not as a substitute for the NCC as it does not cover all building classes, requirements and exceptions. This paper refers to NCC 2022, which comes into effect on 1 May 2023 subject to transition periods for specific provisions.

General

The class, type of construction and type of building element is used to determine what FRL is required. Under the NCC 2022, the type of fire-resisting construction of a building is determined in accordance with Table C2D2 in Part C2 "Fire resistance and stability".

Rise in storeys	Class of building 2, 3, 9	Class of building 5, 6, 7 , 8
4 or more	A	A
3	A	B
2	B	C
1	C	C

Source: https://ncc.abcb.gov.au

Once the type of fire-resisting construction is determined, the FRL requirements for different building elements, including internal walls, floors and more, are set out by the NCC 2022 in Specification 5 "Fire-resisting construction".

Reference should also be made to Part C3 "Compartmentation and separation", which includes construction requirements for compartmentation to limit fire size and spread. Part C4 covers the protection of openings such as windows, doors, services and construction joints to reduce the risk of fire spread within or between buildings.

Generally, systems supporting other fire-rated elements laterally or vertically must have an equivalent or higher FRL.

Wall systems

Different FRLs are required depending on the building height, size, use and other relevant factors such as whether or not the wall is loadbearing.

For instance, in a four-storey apartment building (classified as Type A construction) a wall separating units will need an FRL of 90/90/90 if it is loadbearing or -/60/60 if it is not. The dash indicates there is no requirement for structural adequacy in the latter. In apartment buildings, each sole occupancy unit is designed to be its own fire compartment. A fire that starts inside a person's unit should be contained there for a sufficient amount of time to allow other building occupants to safely evacuate.

In another example, an internal loadbearing wall between or bounding a public corridor in a three-storey hospital (classified as Type A construction) must have an FRL of 120/–/–. The dash indicates there is no requirement for insulation or integrity in this instance. Compare this to the internal walls of a fire-resisting lift or stair shaft in the same building, which requires an FRL of 120/120/120. In the event of a fire, hospitals generally need to provide more protection and assistance to the many vulnerable patients housed therein.

The NCC also contains FRL requirements for common walls and "fire walls", which are a special type of fire separation assembly commonly constructed of non-combustible materials that subdivides a building or separates adjoining buildings. Fire walls have their own set of FRLs. See Table S5C11d below in relation to Type A construction.

Wall type	FRL (in minutes): Structural adequacy / Integrity / Insulation			
	Class 2, 3 or 4 part	Class 5, 7a or 9	Class 6	Class 7b or 8
Loadbearing or non-loadbearing	90/90/90	120/120/120	180/180/180	240/240/240

Source: https://ncc.abcb.gov.au

Ceiling systems

A ceiling's role in PFP is to support the horizontal compartmentation of a structure or a particular compartment. Horizontal compartmentation is crucial because it prevents the transfer of hot gases and fire from one floor to another.

An important consideration when specifying fire-resisting floors and ceilings is whether the system provides one-way or two-way FRL. One-way FRL specifications only provide fire protection from the side to which the protective linings are fastened, whereas two-way FRL specifications provide protection from fire from either direction.

There are a variety of ceilings used for PFP. For example, "horizontal protective membranes" are suspended ceilings that are designed to increase a horizontal structural building members' capacity to withstand fire. These systems are primarily employed to protect the steel beams that support the load-bearing concrete floor slabs, concrete slabs, and, in certain circumstances, timber floors.

Two-way FRL ceilings provide fire protection in both directions, both upwards and downwards. The ceilings may be self supporting, directly fixed to a frame or building, or supported by fire protected hangers. Integrity and insulation performance must be provided by the system independent of the supporting floor construction.

For ceilings, two-way fire rated suspended ceilings are not that common due to wall design. Walls are designed to go full height and connect to the concrete slab above, meaning that if there is a fire in the adjoining room, the fire will be contained by the wall.

DESIGNING A FIRE-RESISTANT WALL OR CEILING SYSTEM

There is no single product that delivers total passive fire protection—it takes a combination of several distinct fire-resistant materials and components working in concert to prevent the passage of flames, smoke, and toxic gases. Many interior commercial wall assemblies utilise light-gauge steel studs, fibreglass insulation in the wall cavity, and plasterboard, all of which are naturally fire-resistant.[1]

To increase the system's fire performance, multiple layers and increased thicknesses of the above materials may be used. Less spacing between studs and fasteners, as well as the inclusion of noggings, can increase the structural performance of the assembly.

The connection from a wall to the superstructure is through the bottom and top track. These connections hold the studs in place to support the plasterboard but also stop the fire getting between the wall and superstructure.

The wall studs hold the plasterboard. In a fire wall, a reduction factor is applied to the stud to allow for the reduction of strength of the stud that the heat of a fire will produce. The studs' role in the fire is to support the plasterboard. The stud centres and noggings will be at centres to ensure that the plasterboard is supported and the studs are able to take the loads, knowing the reduction of strength for fire.

Rondo wall framing systems give builders the scope to design internal wall framing systems that comply with building codes and regulations. With the appropriate plasterboard lining, Rondo Steel Studs and Tracks framing systems can comply with a range of fire resistance ratings.

The plasterboard being the face of the wall means it is the contact to the heat and fire. Gyprock offers several fire rated plasterboard products that are manufactured with special additives to enhance their fire resistance properties. Gyprock Fyrchek's glass fibre-reinforced core enables it to maintain structural integrity when subjected to direct flame, making it an ideal board for use as part of a fire rated wall or ceiling system. Specially designed with a focus on superior impact resistance, Gyprock EC08 Extreme is an Australian made, GECA certified, multi-function plasterboard that can also be used as part of a fire-rated system. Both products are commonly specified for commercial installations in areas where there is a higher level of fire resistance required.

One-way ceilings are protected from below and the role of the furring channels is like the role of the studs in the walls. The hanger's role is to hold the ceiling against gravity force, with the top cross rail then the primary structure, and there to support the furring channel, which supports the plasterboard.

Proper installation, closely following the manufacturers' instructions and the tested fire-rated assembly's specifications, is also important. The wall or ceiling must be installed in accordance with the specifications stated in the classification report or the fire test report (including junctions, joints, and jointing materials).

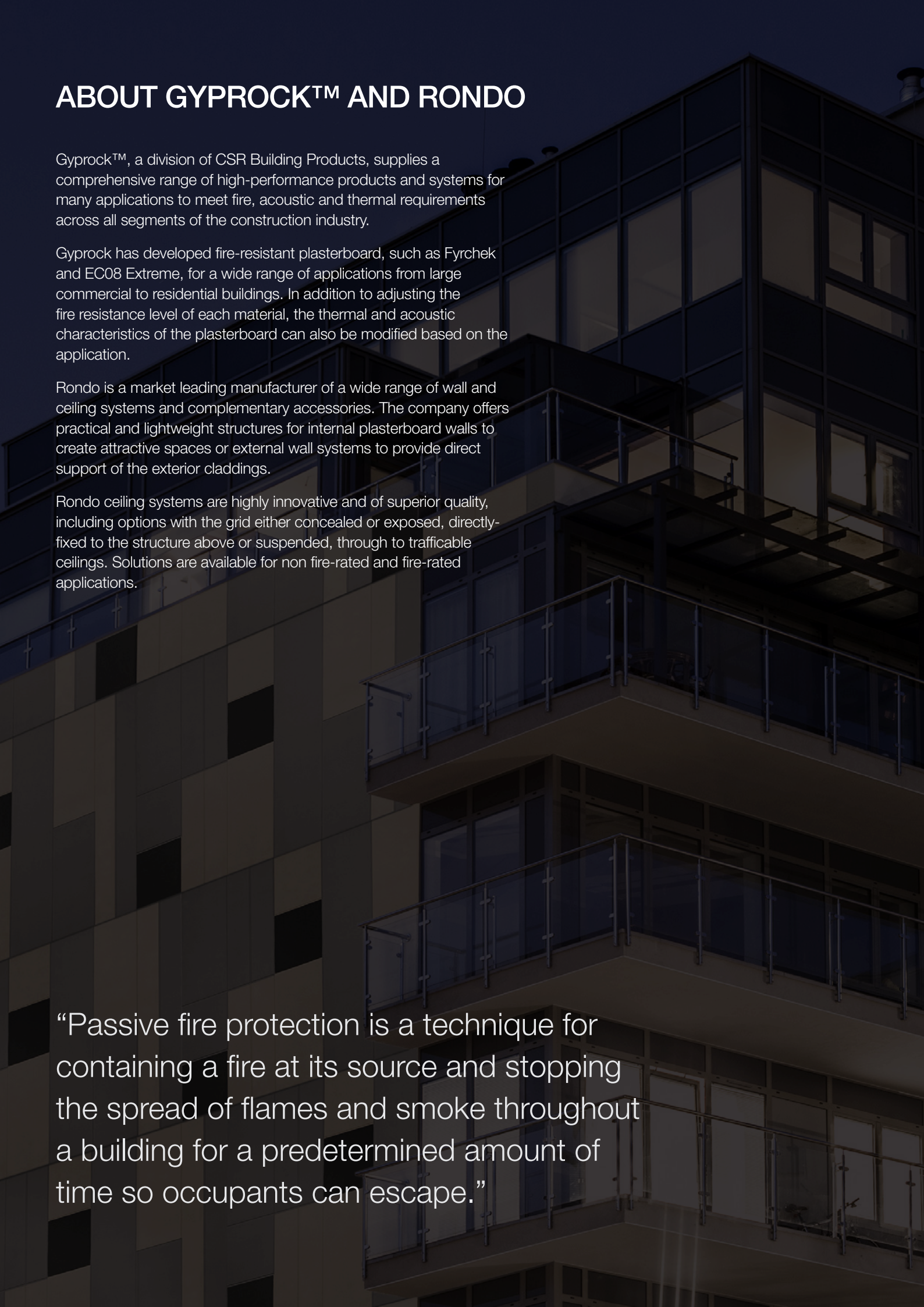
ABOUT GYPROCK™ AND RONDO

Gyprock™, a division of CSR Building Products, supplies a comprehensive range of high-performance products and systems for many applications to meet fire, acoustic and thermal requirements across all segments of the construction industry.

Gyprock has developed fire-resistant plasterboard, such as Fyrchek and EC08 Extreme, for a wide range of applications from large commercial to residential buildings. In addition to adjusting the fire resistance level of each material, the thermal and acoustic characteristics of the plasterboard can also be modified based on the application.

Rondo is a market leading manufacturer of a wide range of wall and ceiling systems and complementary accessories. The company offers practical and lightweight structures for internal plasterboard walls to create attractive spaces or external wall systems to provide direct support of the exterior claddings.

Rondo ceiling systems are highly innovative and of superior quality, including options with the grid either concealed or exposed, directly-fixed to the structure above or suspended, through to trafficable ceilings. Solutions are available for non fire-rated and fire-rated applications.



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References

[1] Stahl, Greg. “Passive fire protection and interior wall assemblies.” The Construction Specifier. https://www.constructionspecifier.com/passive-fire-protection-and-interior-wall-assemblies (accessed 3 April 2023)

All information provided correct as of May 2023