Promat

PROMATECT®-H
Concrete/Brick Upgraded Wall

Type of concrete upgrading	System code	Increase of fire resistance	Concrete/brick thickness	Board thickness	Tests and assessments standards/labs	Page no.
 Concrete/brick upgraded wall (2-sided direct fixing)	PH 112.24.1	From 108 to 240 minutes	100mm concrete [1]	1 x 15mm (each side)	BS476: Part 21, BS476: Part 22 and AS1530: Part 4 Report No. • BRANZ 96/876 Issue 2 • BRANZ 99/1355 • BRANZ FAR 2419 • BRANZ FP 2138 • BTL 97/1029	4
		From 60 to 120 minutes	75mm concrete [1]	1 x 12mm (each side)		
		From 120 to 240 minutes	100mm lightweight concrete [2]	1 x 9mm (each side)		
		*From 120 to 240 minutes	225mm brick or 100mm brick with 13mm gypsum plaster	1 x 9mm (each side)		
		From 60 to 240 minutes	100mm brick	1 x 20mm (each side)		
		*From 60 to 120 minutes	100mm brick	1 x 6mm (each side)		
 Concrete/brick upgraded wall (1-sided direct fixing)	PH 112.24.1	From 110 to 240 minutes	100mm concrete [1]	1 x 21mm [3] or 1 x 15mm [4]	BS476: Part 21, BS476: Part 22 and AS1530: Part 4 Report No. • BRANZ 96/876 Issue 2 • BRANZ 99/1355 • BRANZ FAR 2419 • BRANZ FP 2138 • BTL 97/1029	4
		From 60 to 120 minutes	75mm concrete [1]	1 x 15mm [3] or 1 x 12mm [4]		
		From 120 to 240 minutes	100mm lightweight concrete [2]	1 x 20mm [3] or 1 x 15mm [4]		
		*From 120 to 240 minutes	225mm brick or 100mm brick with 13mm gypsum plaster	1 x 21mm [3]		
		From 60 to 240 minutes	100mm brick	1 x 29mm [3] or 1 x 20mm [4]		
		*From 60 to 120 minutes	100mm brick	1 x 12mm [3]		
 Concrete/brick upgraded wall (Steel hat fixing)	PH 112.12.1	From 60 to 120 minutes	100mm concrete [1]	1 x 9mm (each side)	BS476: Part 21, BS476: Part 22 and AS1530: Part 4 Report No. • BRANZ 96/876 Issue 2 • BRANZ 99/1355 • BRANZ FP 2138	5
		*From 60 to 120 minutes	225mm brick or 75mm brick with 13mm gypsum plaster	1 x 9mm (each side)		

NOTES:

*For Hong Kong only

- [1] for concrete floors or walls with a nominal density of 2100kg/m³.
- [2] for lightweight concrete walls with a nominal density of 700kg/m³.
- [3] for fire risk from either side of the concrete or brick walls.
- [4] for fire risk from board side only of the concrete or brick walls.

Introduction

Strengthening and upgrading the structural system to improve fire performance of an existing building is a common building renovation activity. For upgrade projects, design engineers must deal with structures in which every element carries a share of the existing load. Contractors must also deal with critical issues related to access of the work area, constructability of the repair, noise and dust control, as well as the type of construction materials. The latter may not be quite as critical as for new construction projects. Upgrading concrete systems with matrix engineered mineral board not only improves fire performance but also ensures that high, increased loading is not added to the construction. Equally important, Promat concrete upgrading systems have been tested in a series of fire resistance tests of concrete floors and walls lined with PROMATECT®-H board. Results are presented in terms of the thickness of PROMATECT®-H linings required to give a specified improvement in performance over the performance of unprotected concrete. Base concrete thicknesses are readily available from the Promat Technical Department.

The fire resistance of a reinforced concrete structure depends, to a large extent, on:

a) The overall thickness of the section (in order to keep heat transfer through the member within acceptable limits),

b) The average concrete cover to the reinforcement (in order to keep the temperature of the reinforcement below critical values).

The tendency of concrete to spall, or break up, in a fire can lead to loss of the insulating cover to the steel and reduction in overall thickness of the member. In some constructions, supplementary reinforcement is necessary to reduce these effects. The overall thickness and cover is determined by the properties of the aggregate used. For example, lightweight aggregate formed from expanded pulverised fly ash has low thermal conductivity and expansion, and is, to some degree, more resistant to spalling, enabling thickness and cover reduction to be made without lowering the fire resistance.

Fire Testing Methods

Concrete floors should normally be tested or assessed in accordance with AS1530: Part 4 or BS476: Part 21 and are required to satisfy the three failure criteria of loadbearing capacity, integrity and insulation when exposed to fire from below. Floors protected with a suspended ceiling should be tested or assessed to BS476: Part 23. The systems detailed in this section satisfy the above requirements. However, some concrete structures can be exposed to more onerous heating conditions, e.g. in tunnels. Please refer to Promat for details.

Design Considerations

The following points are some of the factors that should be considered when determining the correct specification to ensure a concrete floor will provide the required fire performance:

1. Concrete Density

Density not only affects the strength of concrete but also its insulation properties and susceptibility to spalling when exposed to fire.

2. Concrete Moisture Content

Depending on the concrete type, concrete will spall severely when exposed to fire if its moisture content is greater than 2~3%.

3. Concrete Thickness & Cover To Reinforcing Bars

The overall slab thickness will contribute to the strength and insulation of the structure but the concrete cover to the lowest reinforcing bars is also critical. The concrete slab may need upgrading if inadequate cover has been provided.

4. Supporting Steelwork

Care should be taken that any structural steel supporting the concrete slab is adequately protected against fire.

5. Other Factors

The reference made to suspended ceilings, light fittings, service penetrations, cavity barriers and loading in the timber floor section of this handbook apply equally to concrete floors.

6. Type of Fire Exposure

The rate of increase in temperature is critical to the susceptibility of concrete to spall or collapse when exposed to fire. The more rapid the rise in temperature, the greater the likelihood of damage to concrete occurring. For more details concerning the effects of fire on concrete, please refer to *Promat Tunnel Fire Protection Manual*.

Guidance Notes

Cover

Cover may be taken in all situations as the distance between the nearest heated face of the concrete and the surface of the main reinforcement or an average value, determined as follows:

For floor slabs, cover is the average distance from the soffit or the heated face. With one-way spanning single layer reinforcement the actual distance is used, i.e. C_1. With two-way spanning floor slabs the average distance is calculated taking into account reinforcement in both directions as multi layer reinforcement. With one-way spanning floor slabs, only multi layer reinforcement in the same direction should be used to determine the average distance. The average distance C_{over} is calculated:

$$\text{Cover} = \frac{A_1C_1 + A_2C_2 + A_3C_3 + \ldots A_nC_n}{A_1 + A_2 + A_3 + \ldots A_n} = \frac{\Sigma AC}{\Sigma A}$$

Where A = Area of tensile reinforcement/tendons

C = Distance between the nearest exposed surface and the main reinforcement

Floor Thickness

In the case of solid slabs and ribbed slabs, the thickness to consider is the actual thickness of the slab (including any non combustible finish screed on top).

For hollow slabs (or beams with filler blocks) the effective thickness 't_e' should be obtained by considering the total solid per unit width, as follows:

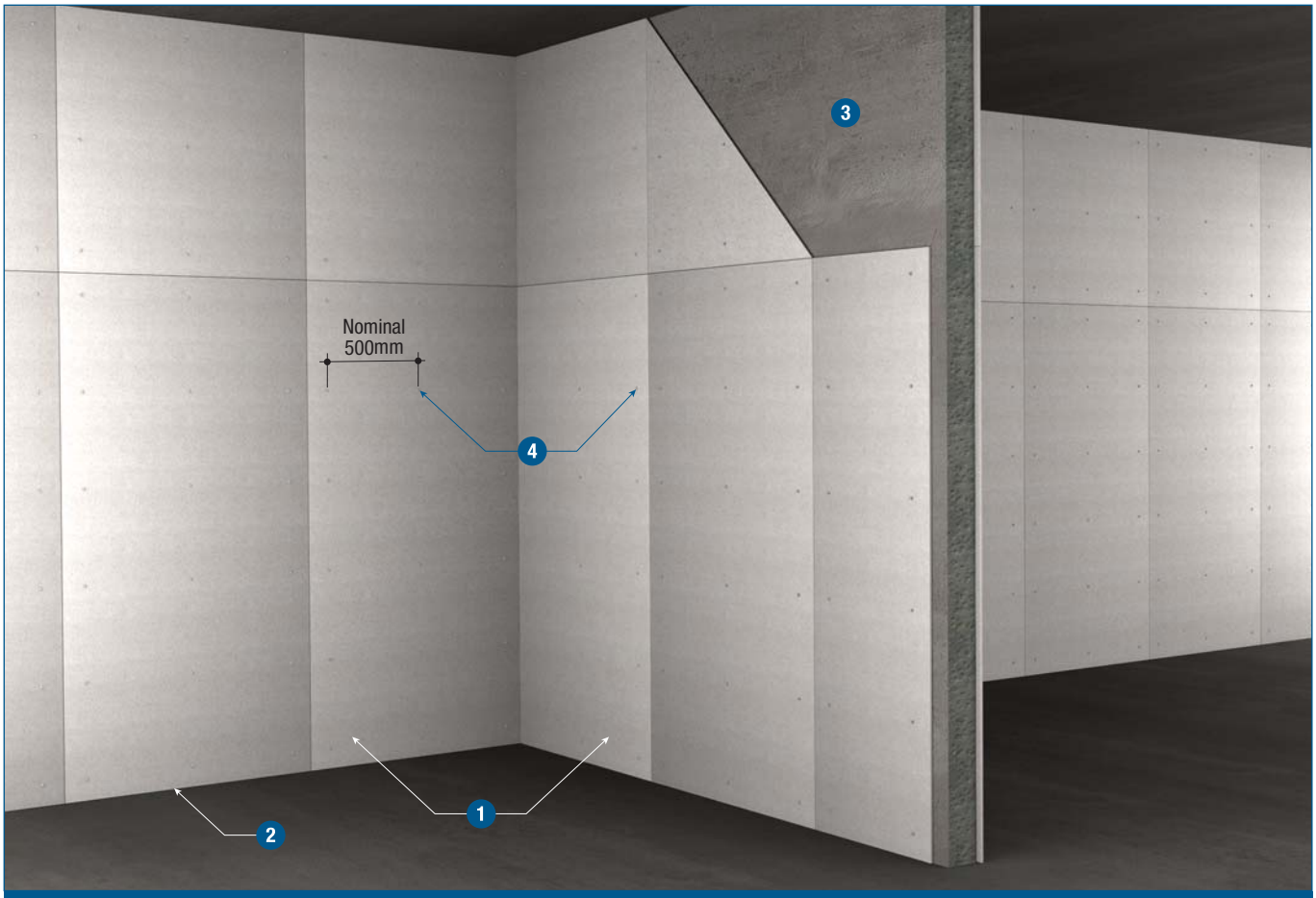
$$t_e = h \times \sqrt{S} + t_f$$

Where h = Actual thickness of slab

S = Proportion of solid material per unit width of slab

t_f = Thickness of non combustible finish

Direct fixing – Fire attack from one or both sides / Non loadbearing and loadbearing

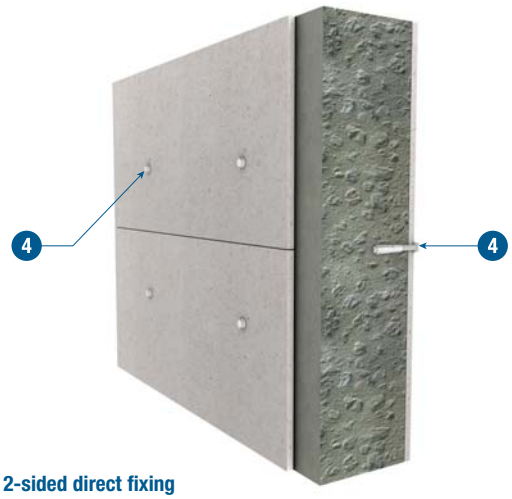


TECHNICAL DATA

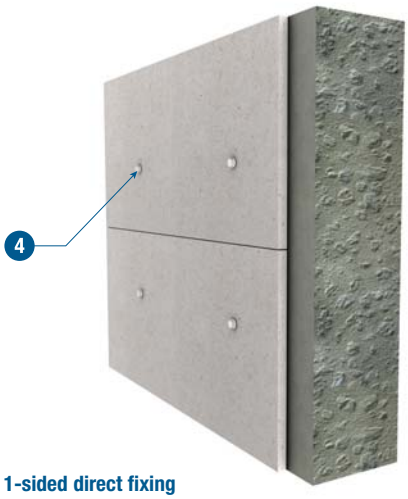
1. For increasing the fire resistance from 60 to 240 minutes
   1 layer of PROMATECT®-H board fixed directly to each or one side of concrete or brick wall. See page 2 for the ranges of fire resistance, and the required thicknesses of wall, board and gypsum plaster where applicable.
2. Caulk all perimeter gaps with PROMASEAL® AN Acrylic Sealant to achieve stated fire and/or acoustic performance
3. Concrete or brick wall
4. M6 masonry anchors at 500mm centres with steel washer 16mm diameter, should allow for a minimum 30mm penetration into the concrete.

For loadbearing upgrading, the concrete cover to the reinforcing at the non-board side must be of minimum 30mm thick for 120 minutes wall or minimum 50mm thick for 240 minutes wall.

The board thickness of the protection material is relevant to the strength of the concrete and the cover to the reinforcement. In some instances, e.g. high strength (Grade B70), PROMATECT®-H 50mm is needed for a 120 minutes performance to RWS. This situation applies to all exposure curves.

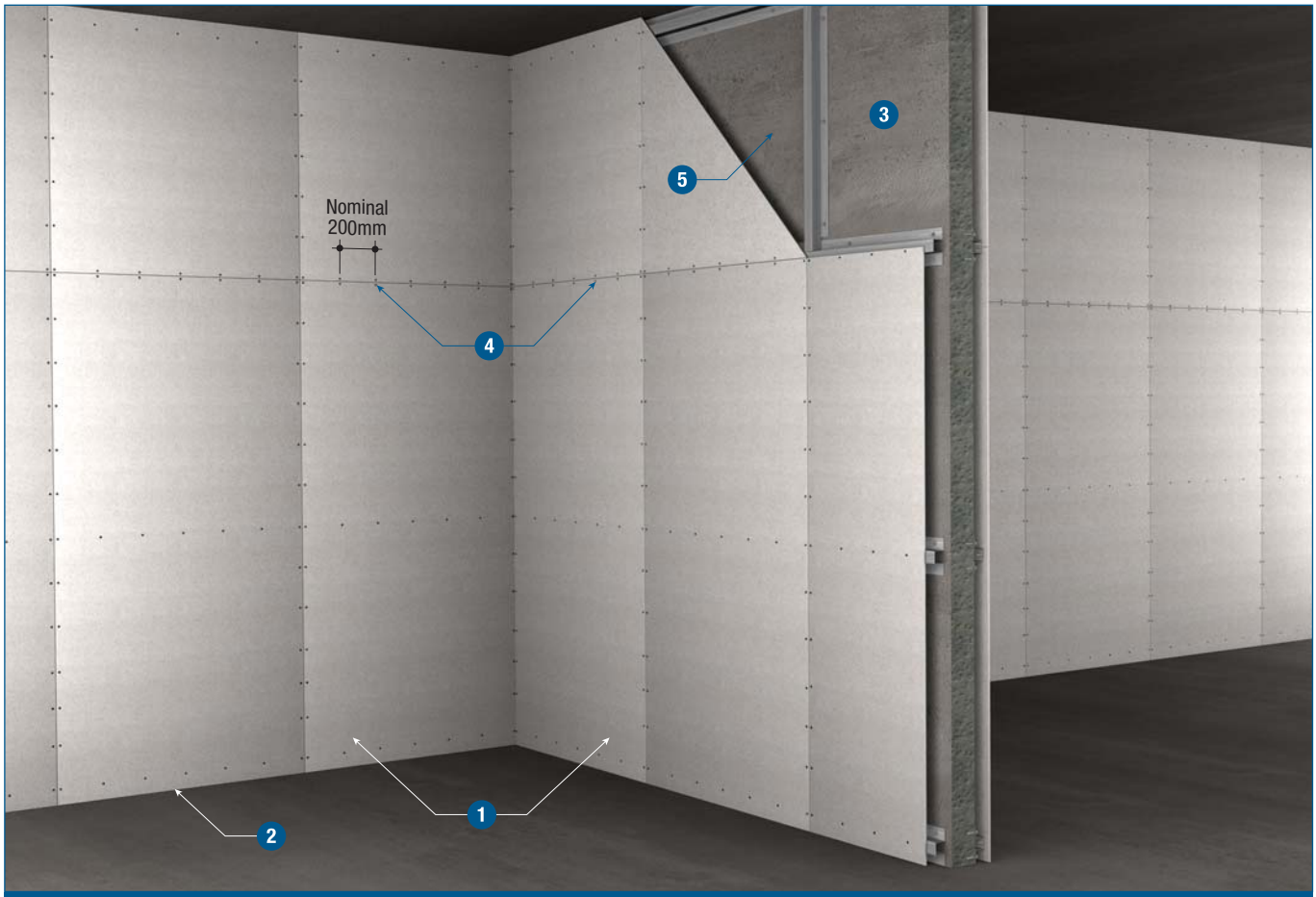


Details of 2-sided direct fixing



Details of 1-sided direct fixing

Steel hat fixing – Fire attack from both sides / Non loadbearing and loadbearing

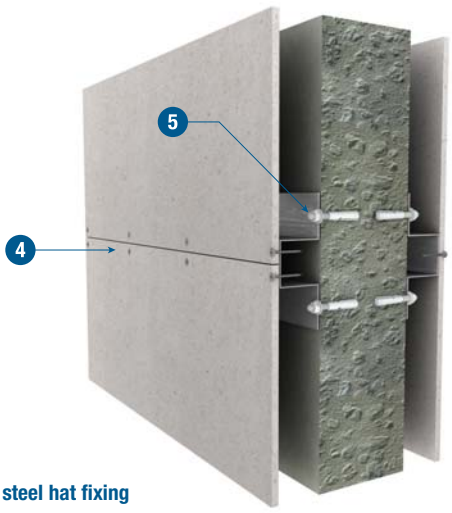


TECHNICAL DATA

1. For increasing the fire resistance from 60 to 120 minutes
   1 layer of PROMATECT®-H board 9mm thick, fixed with steel hats to each side of concrete or brick wall. See page 2 for the required thicknesses of wall and gypsum plaster where applicable.
2. Caulk all perimeter gaps with PROMASEAL® AN Acrylic Sealant to achieve stated fire and/or acoustic performance
3. Concrete or brick wall
4. 25mm x No.8 self-tapping screws at nominal 200mm centres
5. Steel top hats 50mm x 50mm x 50mm x 1.2mm thick at 1220mm x 610mm grid spacing, fixed with M6 masonry anchors with a minimum 25mm penetration into the concrete

For loadbearing upgrading, the concrete cover to the reinforcing at the non-board side must be of minimum 30mm thick for 120 minutes wall or minimum 50mm thick for 240 minutes wall.

The board thickness of the protection material is relevant to the strength of the concrete and the cover to the reinforcement. In some instances, e.g. high strength (Grade B70), PROMATECT®-H 50mm is needed for a 120 minutes performance to RWS. This situation applies to all exposure curves.



Details of steel hat fixing

Architectural Specification

Following is the standard Architectural Specification for concrete/brick floor slab or wall upgrading using PROMATECT®-H. The designer must determine the suitability of the design to the application and requirements before undertaking or constructing any works relating to the specifications and where in doubt should obtain the advice of a qualified engineer.

Fire Attack From Underside / Fire Attack From One and/or Both Sides / Non Loadbering & Loadbearing

Integrity and insulation for up to 240 minutes in accordance with the relevant criteria of **AS1530: Part 4: 2005** and **BS476: Part 21 and/or Part 22: 1987**. For loadbearing and non loadbearing concrete floors/walls and bricks respectively.

Supporting Structure

Care should be taken to ensure that the concrete upgrading system, when applied to any structural element, is adequately supported. Minimum penetration of fixings into substrate is 25mm.

Lining Boards

Single layer each side _____mm(1) PROMATECT®-H matrix engineered mineral boards as manufactured by Promat International (Asia Pacific) Ltd. Standard board dimensions 1220mm x 2440mm x _____mm(1) to provide _____ minutes(2) of FRL.

Fixing

Option of fixing the PROMATECT®-H concrete upgrading construction:

1) Lining fixed directly to concrete wall/floor with M6 anchor bolts at 500mm centres allowing sufficient length to ensure minimum 25mm penetration into concrete.
2) Lining fixed to top hat section steel battens with M4 self-tapping screws at nominal 200mm centres. Steel battens fixed to concrete wall or floor with M6 anchor bolts at nominal 500mm centres, allowing a minimum 25mm penetration into the substrate.

Similar details apply for brick wall constructions.

Tests & Standards

The complete system along with all materials and the framing should be tested and assessed in accordance with the criteria of BS476: Part 22 for non-loadbearing walls and slabs, BS476: Part 21 and AS1530: Part 4 for loadbearing walls and slabs.

Jointing

Plain butt joints between machined edges of boards. (3)
Joints filled in preparation for painting. (4)
Joints filled and taped in preparation for decoration. (5)

Follow-on Trades

Surface of boards to be prepared for painting/plastering/tiling(6) in accordance with manufacturer's recommendations.

NOTES:

- (1) see Systems Index on page 2 to ascertain the required thickness.
- (2) insert the required FRL not exceeding 240 minutes.
- (3), (4), (5), (6) delete as appropriate.
- Perimeter gaps will be filled with fire resistant PROMASEAL® AN Acrylic Sealant.

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