FIRETEX® Technical Bulletin

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Intumescent Coating Expansion Space Requirements

Intumescent coatings, also known as reactive coatings, are a type of passive fire protection. They can be applied to various substrates to provide protection against the effects of a fire, in the case of the FIRETEX® materials the substrate will normally be structural steel.

Intumescent coatings provide protection to the steel substrate when exposed to fire through a combination of processes, briefly described below:

As the temperature increases a number of endothermic reactions begin within the coating, these reactions absorb heat, helping to keep the substrate cool. The reactions typically begin after around 10 minutes exposure to a fully developed fire, as the substrate temperature reaches ~200°C by which time the temperature of a standard fire, i.e., the air temperature, is over 600°C.

The reactions cause the coating to expand by as much as 50x its original thickness, in this expansion the coating changes from a resin bound coating to a carbon-based foam or char. This char insulates the steel substrate from the heat of a fire.

Successful protection of the structural steel is dependent on both above processes and as such it is essential that intumescent coatings have space to swell into when exposed to a fire.

Construction projects using a structural steel frame will by necessity attach various items to this frame, such as external cladding, internal partitions, services etc. Parts of the frame will also typically be clad for aesthetic or practical reasons. These attachments to, and cladding of FIRETEX® protected steelwork must be done in a manner which does not adversely impact the fire protection afforded to the structural element.

FIRETEX® intumescent coatings do not exert any significant force when expanding as a result of heat/fire exposure. The chemical technology used is quite different to the intumescent materials used in fire stopping applications, e.g. pipe collars. To operate as designed an intumescent coating requires clear space into which it can expand.

General Guidance

An expansion gap (or zone) of 50mm has been found to be sufficient to allow correct function of the intumescent coating. For low thicknesses of intumescent coating a smaller gap may be acceptable, this can be calculated as below, based on the specified dry film thickness (dft) of the product:

Product	Expansion Zone
FIRETEX FX2000 Series	50x specified dft
FIRETEX FX5000 Series	50x specified dft

FIRETEX FX6000 Series	50x specified dft
FIRETEX Platinum Series	30x specified dft

Example:

FIRETEX® FX5090 specified at 250µm dft

The required expansion zone is 250 x 50 = 12500µm equivalent to 12.5mm

Services Passing Through Beam Web Openings – Cellular Beams

Services or other items passing through web openings in cellular beams do not need to have a specific clearance from the perimeter of the opening in order to allow correct function of the FIRETEX® fire protection. It is sensible however to ensure that there is sufficient clearance to allow installation of the item without risking damage to the coatings applied to the beam, any damage caused should be repaired.

Encasement Guidance

To enhance the above general guidance further work to investigate some common restrictions to intumescent expansion space was performed. The following encasement details were tested alongside control specimens in a fire test conducted by an independent, ISO17025 accredited laboratory. The results obtained were evaluated by a Chartered Engineer and Fellow of the Institution of Fire Engineers.

The following may be seen as exceptions to the general guidance provided in this and other FTB documents.

Reference	Structure Type	Protection	Description
1	I or H Beam	Up to 2 Hours	Non-fire rated gypsum/plaster board encasement using clip and channel fixing system
2	I or H Beam	Up to 2 Hours	Non-fire rated gypsum/plaster board encasement with mineral wool infill, using clip and channel fixing system
3	I or H Beam	Up to 2 Hours	Non-fire rated gypsum/plaster board encasement directly attached to the beam
4	I or H Beam	Up to 2 Hours	Timber/wooden noggins or batons directly attached to the beam (no encasement)

5	I or H Column	Up to 2 Hours	Non-fire rated gypsum/plaster board encasement using clip and channel fixing system
6	I or H Beam	Up to 2 Hours	Clip and channel fixing system, no plasterboard.
7	I or H Beam	Up to 2 Hours	Cable clips
8	Rectangular Hollow Beam	Up to 1.5 Hours	Non-fire rated gypsum/plaster board encasement directly attached to the beam
9	Rectangular Hollow Column	Up to 1 Hours	Non-fire rated gypsum/plaster board encasement attached to the column using timber/wooden noggins or batons

For clarification of the construction detail tested see the referenced section of this document.

Non-fire rated Gyproc 12.5mm wallboard plasterboard was used for the encasement. This plasterboard was selected as being representative of similar non-fire rated boards. It is anticipated that the results will be applicable to scenarios where alternative plasterboard is adopted unless on a case-by-case basis there is cause for consideration that the board's performance in fire could yield significantly different results from those presented in this report.

The insulation material was Rockwool RWA45 / ProRox SL920NA at a thickness of 50mm and an associated density of 40kg/m³. This material was chosen as being representative of common materials for this use. It is anticipated that the results will be applicable to scenarios where an insulation material has a density of 40kg/m³ or greater. Insulation material with a reduced density is likely to be less rigid which could lead to the potential for it to not remain in place following the plasterboard encasement burning and falling away. Alternatively, if the insulation manufacturer can provide evidence relating to an equivalent level of thermal performance and rigidity in fire to that tested, then a lower density material may be considered on case-by-case basis.

The clip and channel products used were British Gypsum's Gyplyner Encase system, but generically similar systems are available from other manufacturers.

The timber/wooden noggins or batons were all softwood, intended as the worst-case scenario.

Clearances/gaps around the fire protected steelwork, where identified in the drawings may be increased if desired but not decreased without potentially changing the fire protection performance.

Summary

This document and the supporting report provide insight for designers and specifiers into the performance of FIRETEX® intumescent coatings when encasement and associated

fixings details attached to protected structural steelwork give the potential for inhibiting or reducing the expansion of the intumescent or creating localised hotspots.

The results show that for all cases, the time to reach the average critical temperature of each specimen is at least 85%* of that of the relevant control specimen. As such, it may be considered that none of the specimens with fixings and encasement details tested would lead to a significant detrimental performance in the fire resistance of the member to which they are attached.

*The 85% value was selected as this is a common approach in the passive fire protection industry, being used in British Coatings Federation documents, EAD350402-00-1106, EN16623 and UL's fire protection durability test standard UL2431.

The results of the fire tests should provide a degree of comfort to design teams, approving authorities or other project stakeholders, that the use of such designs does not lead to a detrimental performance of the fire resistance of the protected member.

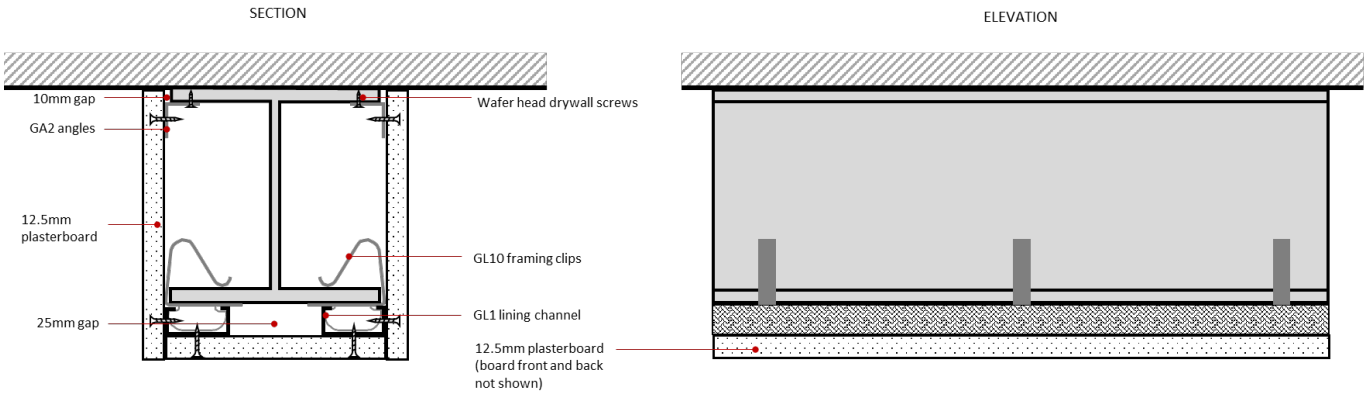
The designs adopted for these fire test investigations are based on common industry constructional details, however it is recognised that an almost infinite number of permutations of encasement and attachment design detail may occur in practice. Where the tested details are used on projects, they may provide a direct correlation to expected performance. Where alternative constructional details are proposed on a project, then the outcome of this report may be used by design teams to make an informed decision on the anticipated performance and therefore suitability of the design detail itself. This type of engineering judgement may be made by an appropriately qualified person which may be part of the project's design team or an appointed third-party.

Note: Fire Engineering

The use of a fire engineered approach to designing the fire protection for a structural steel frame is increasing in frequency. It should be noted that the act of fire engineering the structure could offer a reduction in the quantity of fire protection materials required to protect the steel elements.

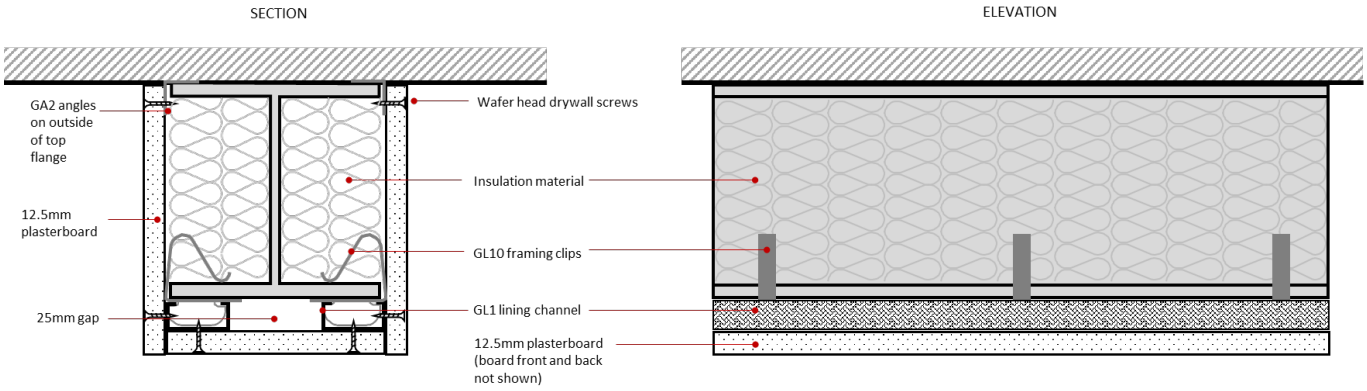
This process removes some of the conservatism inherent in the use of default limiting temperatures and those responsible for the fire safety of the building must satisfy themselves that the guidance provided by Dulux Protective Coatings in FIRETEX® Technical Bulletins or otherwise remains applicable when a project has been fire engineered.

1. Clip and Channel Beam (I or H shape) Encasement – Up to 2 Hours Protection



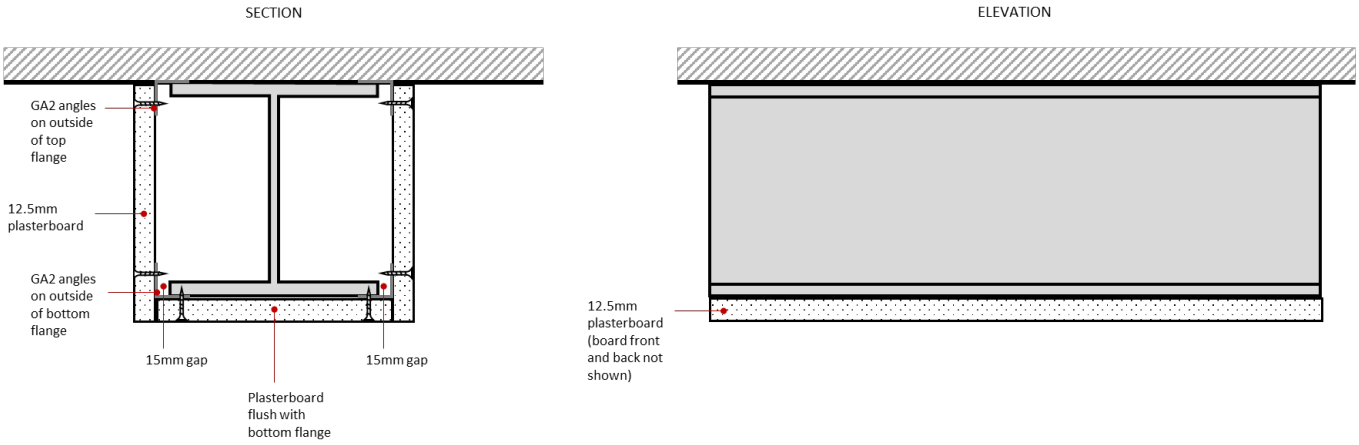
The encasement caused no significant detriment to the fire protection of the beam.

2. Clip and Channel Beam (I or H shape) Encasement with Mineral Wool Infill – Up to 2 Hours Protection



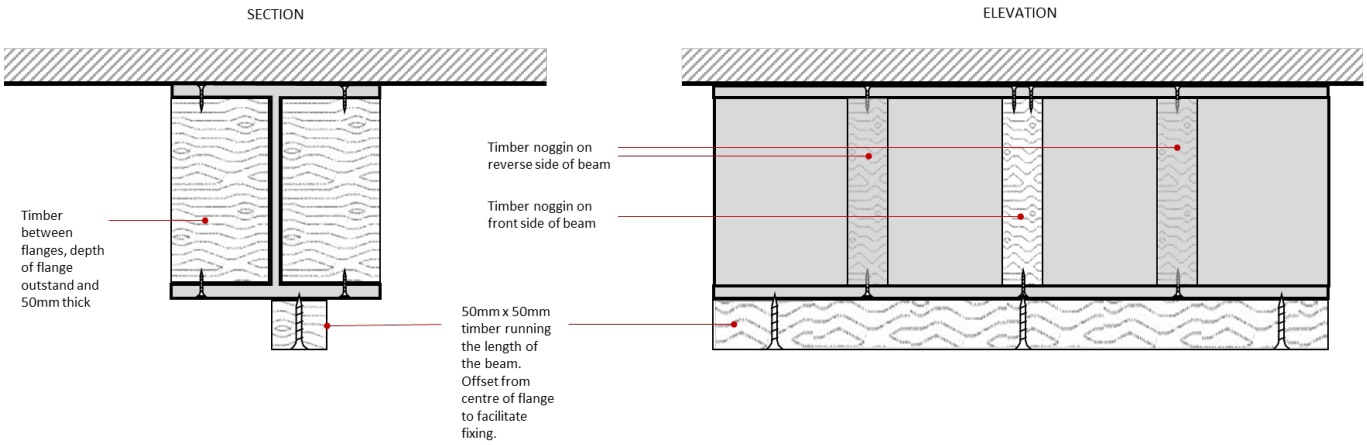
The encasement caused no significant detriment to the fire protection of the beam.

3. Encasement with Plasterboard Directly Attached to the Beam (I or H shape) Flange – Up to 2 Hours Protection



The encasement caused no significant detriment to the fire protection of the beam.

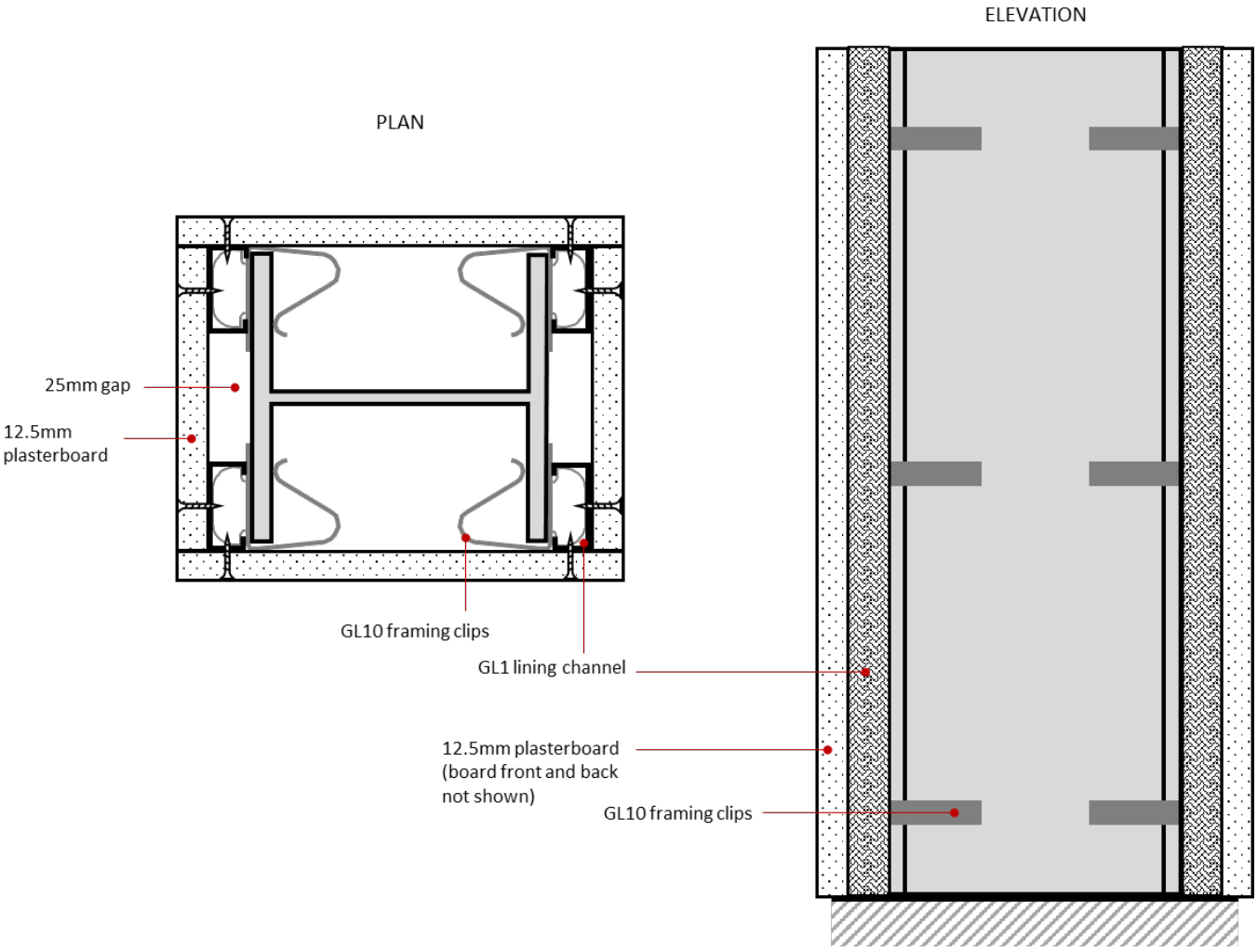
4. Beam (I or H shape) with Timber/Wooden Noggins or Batons – Up to 2 Hours Protection



This arrangement was tested to evaluate encasement attached via 2 inch (50mm) width timber/wooden noggins or batons, and other attachments to the fire protected beam using a similar attachment method.

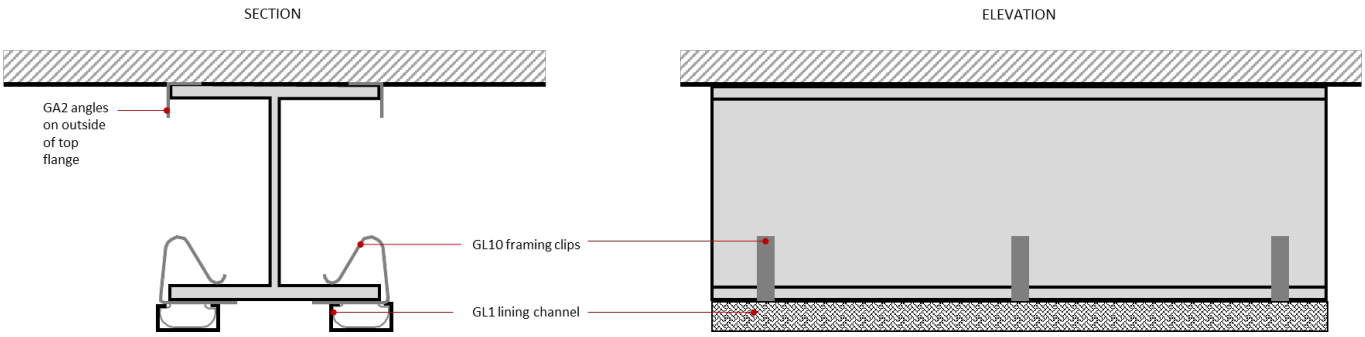
The attachments caused no significant detriment to the fire protection of the beam.

5. Clip and Channel Column (I or H shape) Encasement – Up to 2 Hours Protection



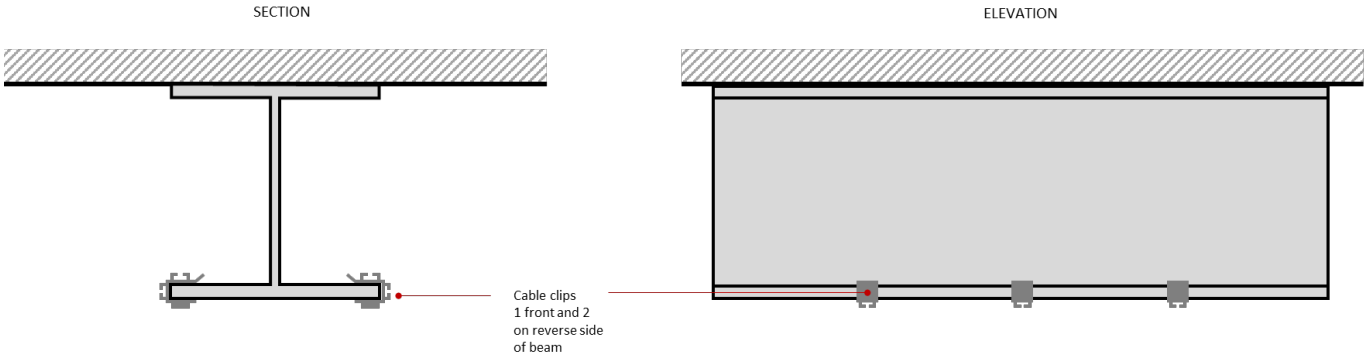
The encasement caused no significant detriment to the fire protection of the column.

6. Clip and Channel System Beam (I or H shape), No Plasterboard – Up to 2 Hours Protection



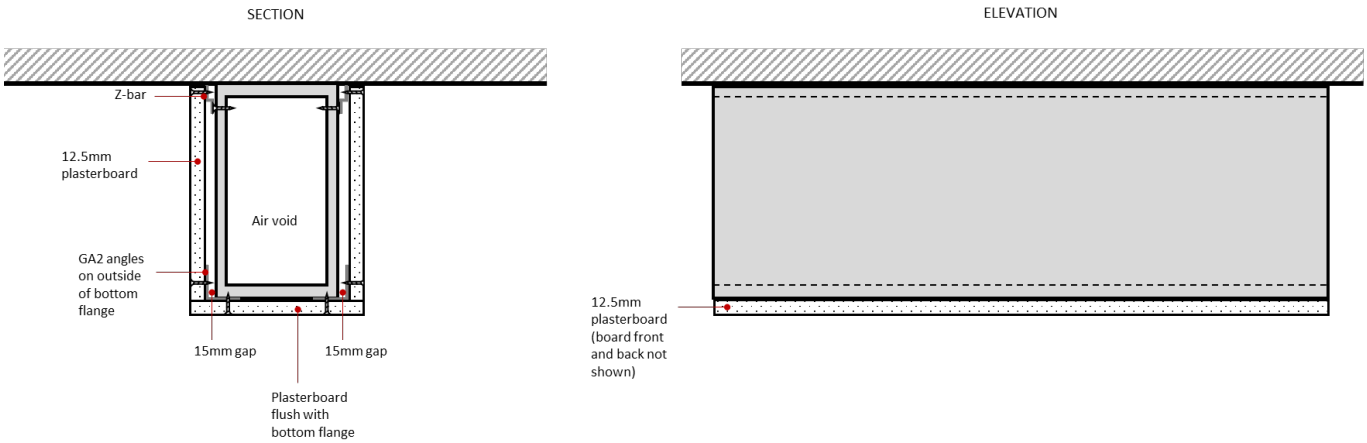
The attached items caused no significant detriment to the fire protection of the beam.

7. Cable Clips (RS Pro, Girder Cable Clip 15-20mm) Beam (I or H shape)– Up to 2 Hours Protection



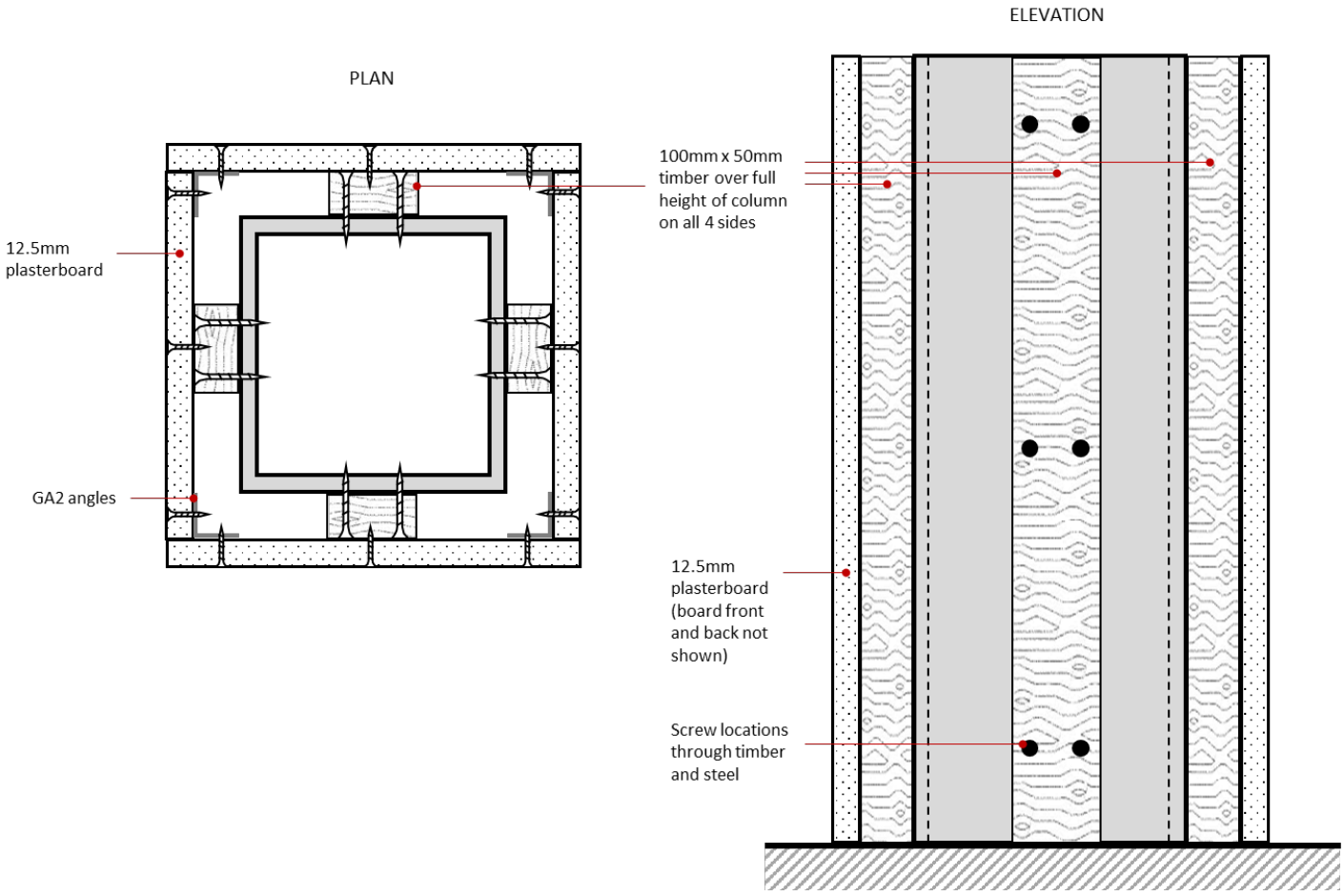
The attachments caused no significant detriment to the fire protection of the beam.

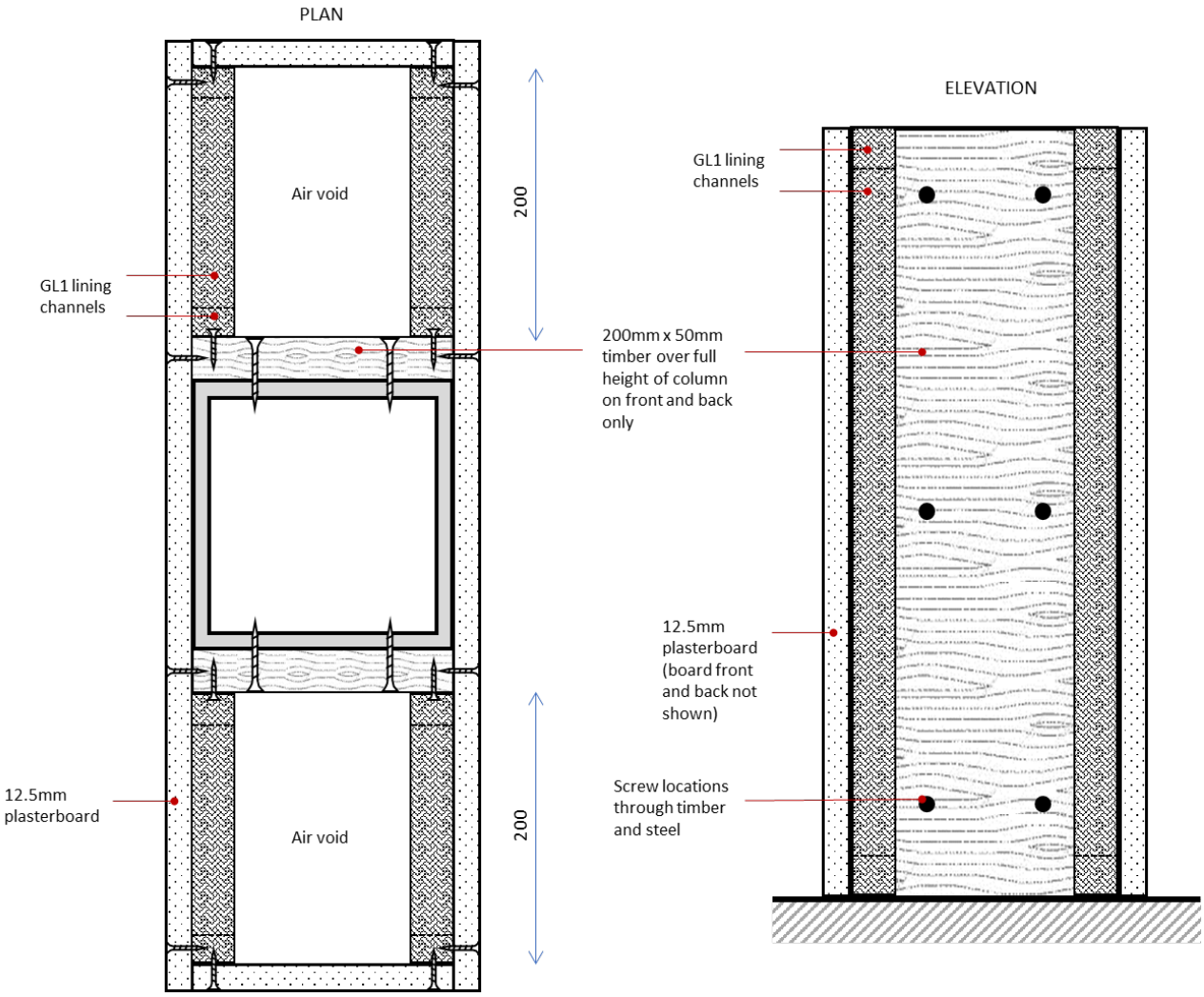
8. Encasement with Plasterboard Directly Attached to the Beam (Rectangular Hollow Section) Bottom Face – Up to 1½ Hours Protection



The encasement caused no significant detriment to the fire protection of the beam.

9. Column (Rectangular Hollow Section) Encasement Using Timber/Wooden Noggins or Batons – Up to 1 Hour Protection





The encasement caused no significant detriment to the fire protection of the column in both cases.

The information herein is subject to revision as a result of additional information or test evidence becoming available, please consult Dulux Protective Coatings to ensure you have the latest version.

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