



# FISHWALL

**Fire and Seismic performances of Hybrid fire WALLs in case of single-storey industrial and commercial steel buildings**



UNIVERSITY OF TRENTO

## SESSION: Design guide of fire walls made of sandwich panels

- **Constructional details**
- Xavier DUPONCHEL / Christophe RENAUD
- EFECTIS France / CTICM

# Introduction

## ➤ Objectives of design guide :

- ❖ Ensure that the building and the fire walls behaves « correctly » under fire or earthquake situation.
- ❖ propose drawings in the design guide (to be adapted to each individual situation)

## ➤ Fire safety objectives in case of fire

- ❖ Progressive collapse of the compartment in fire (a local failure does not affect the overall stability of the building)
- ❖ Structure must collapse towards the inside of the building
- ❖ The collapse of the structure of the compartment in which the fire is located must not damage the firewall

# Concerned Items

## ➤ Fire walls

- ❖ Fire walls solidly attached to the building steel structure
- ❖ Fire walls associated with fusible links

## ➤ Fusible links

## ➤ Bracing systems

## ➤ Roof near the separation fire walls

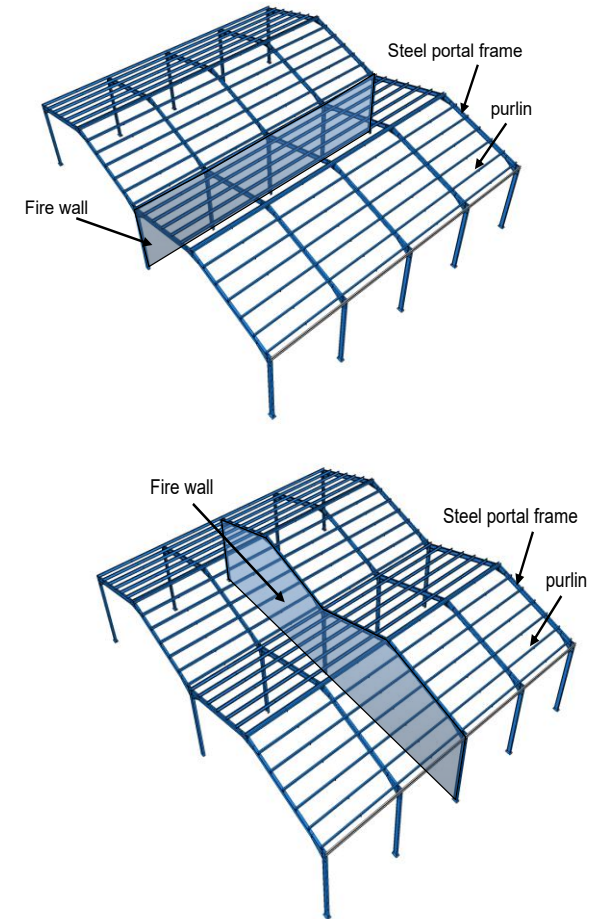
## ➤ Sliding fire doors



# Fire walls solidly attached to the building steel structure

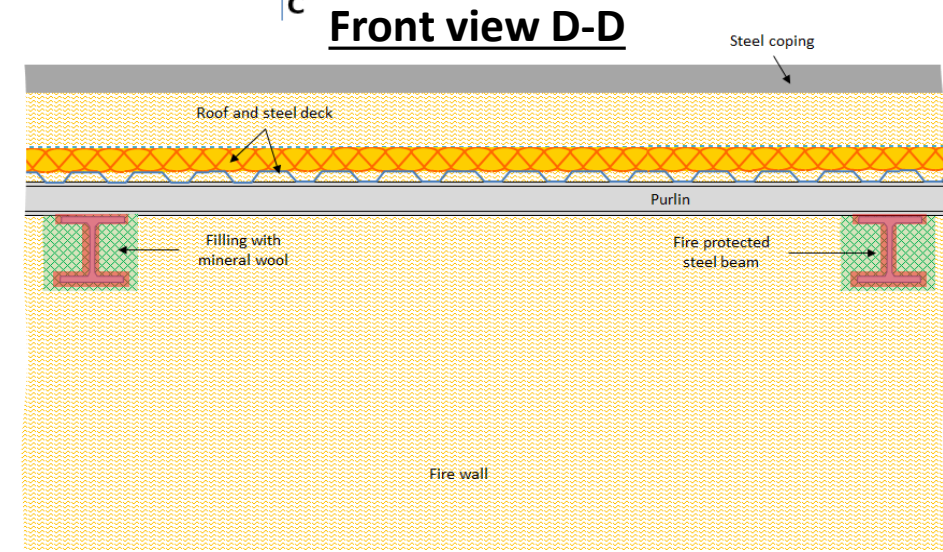
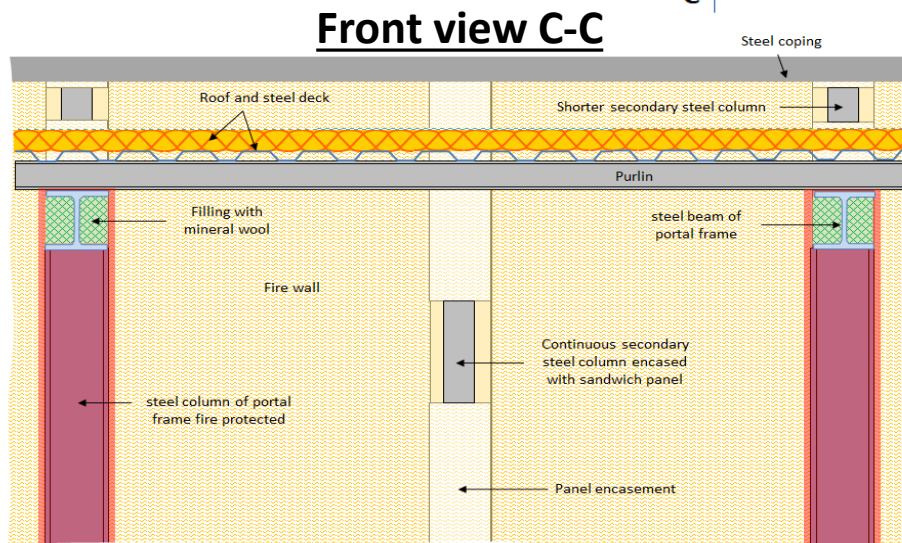
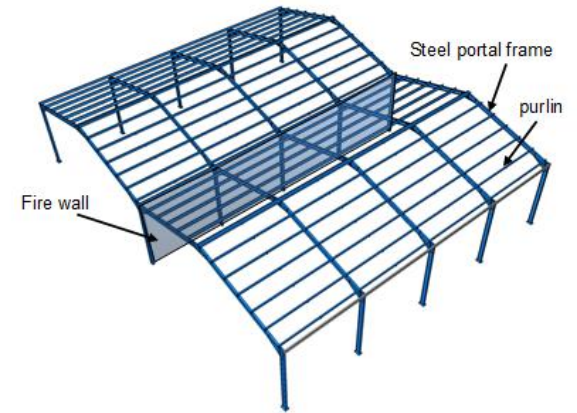
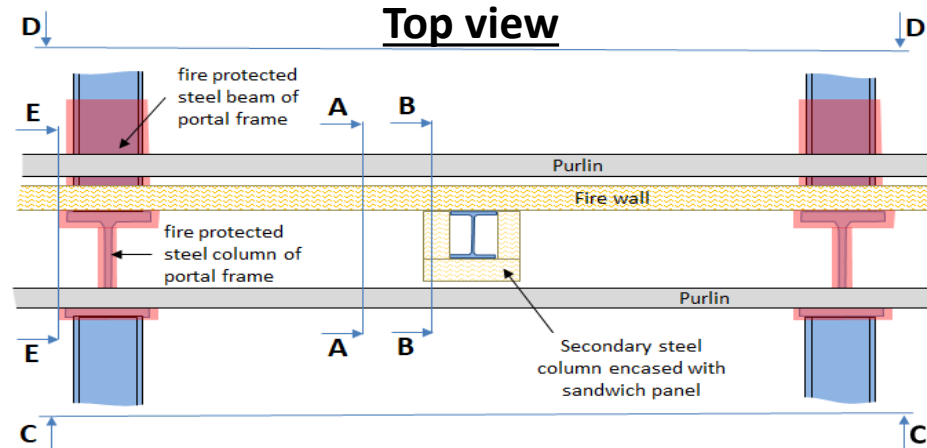
## ➤ Covered wall implementation

- ❖ Partition fire walls perpendicular to the steel portal frames
  - fire wall inserted into a row of columns
  - fire wall inserted between two rows of portal columns
- ❖ Partition fire walls parallel to the steel portal frames
  - fire wall in the plane of a portal frame
  - fire wall between two portal frames
- ❖ Walls extending or not beyond the roof



# Fire walls solidly attached to the supporting steel structure of building

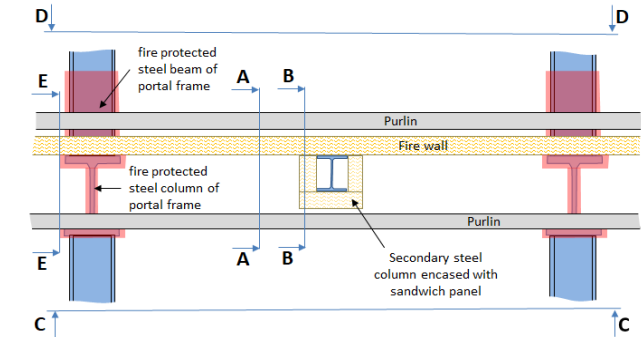
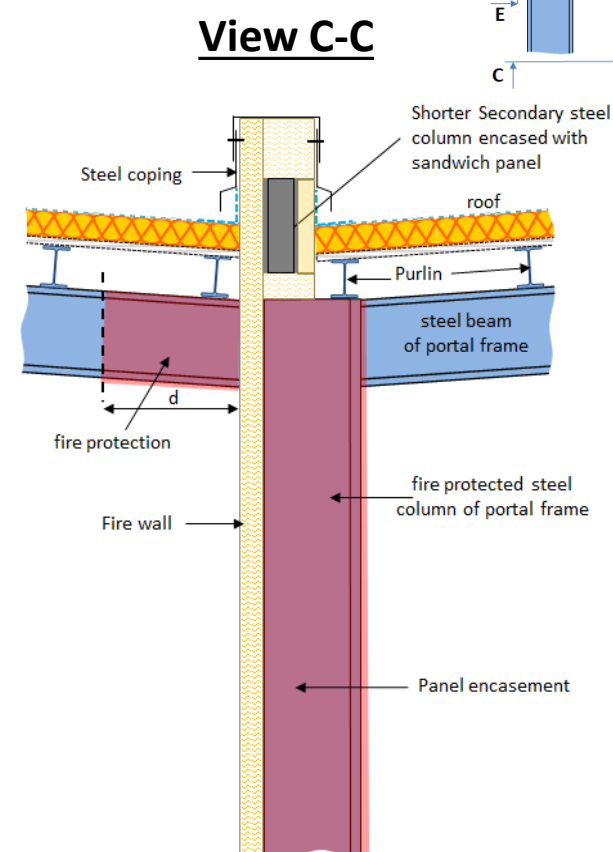
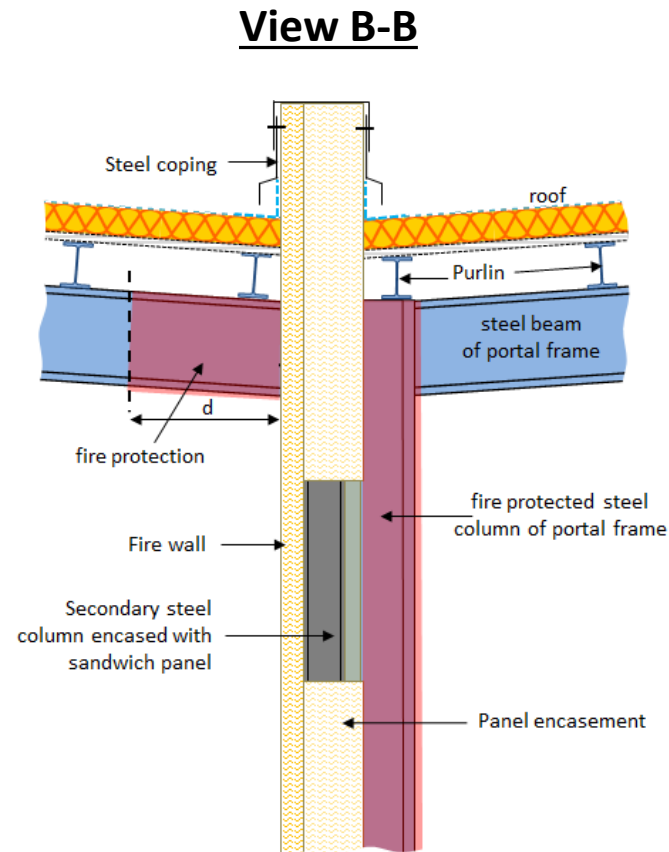
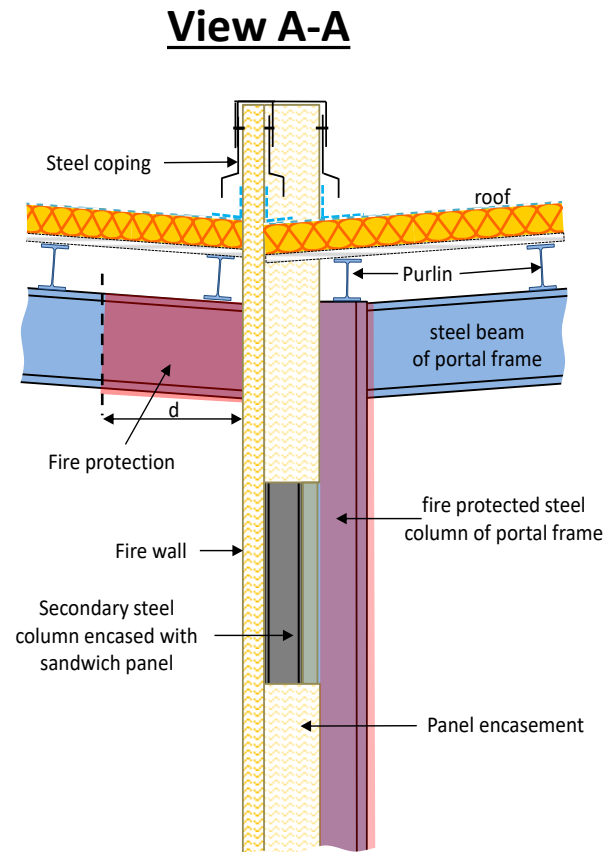
- Walls perpendicular to steel frame / inserted into a row of columns
  - ❖ Walls extending beyond the roof





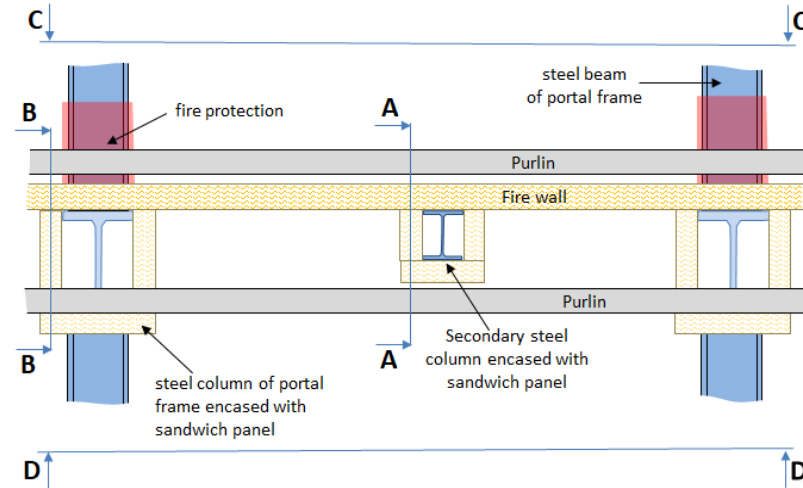
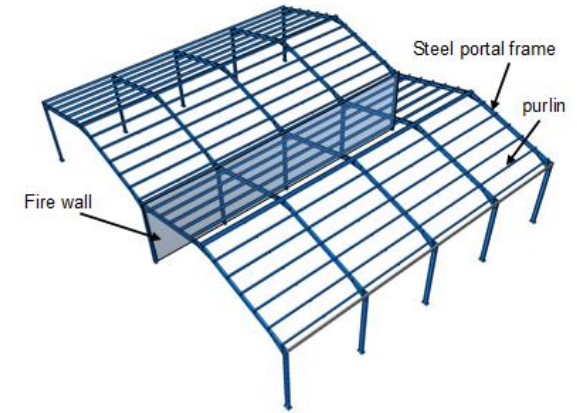
# Fire walls solidly attached to the supporting steel structure of building

- Walls perpendicular to steel frame / inserted into a row of columns
  - ❖ Walls extending beyond the roof

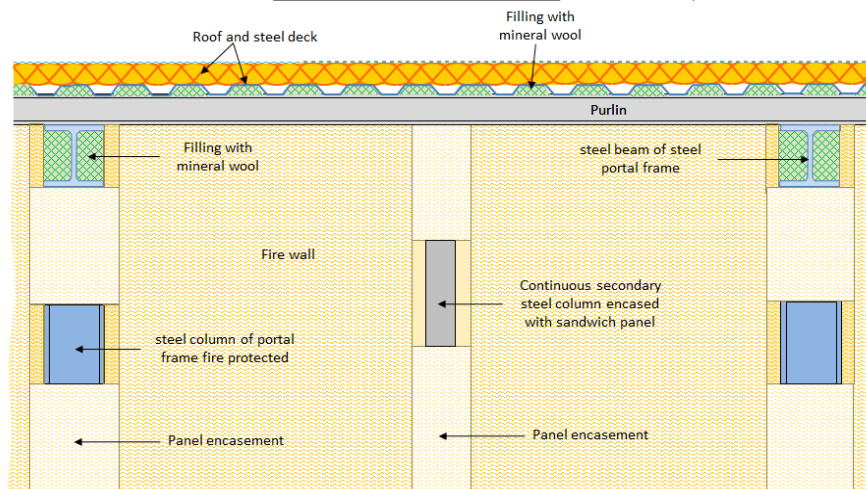


# Fire walls solidly attached to the supporting steel structure of building

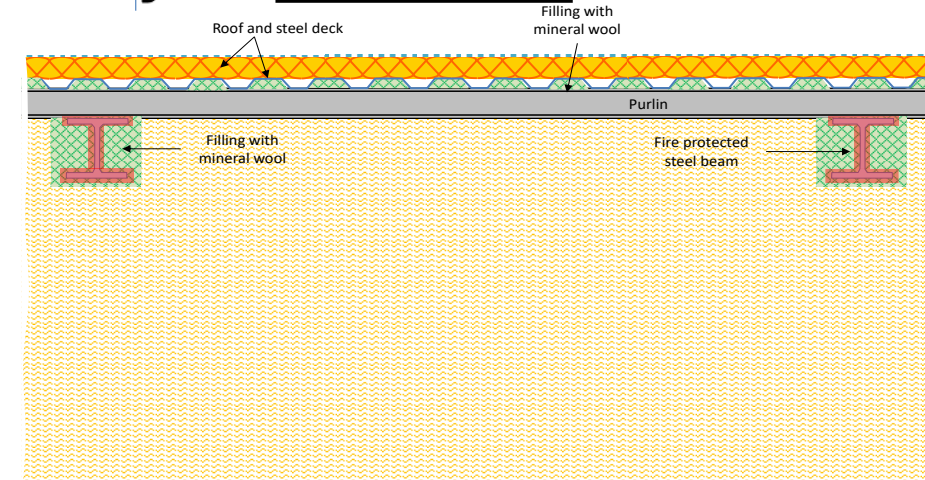
- Walls perpendicular to steel frame / inserted into a row of columns
  - ❖ Walls not extending beyond the roof



**Front view C-C**



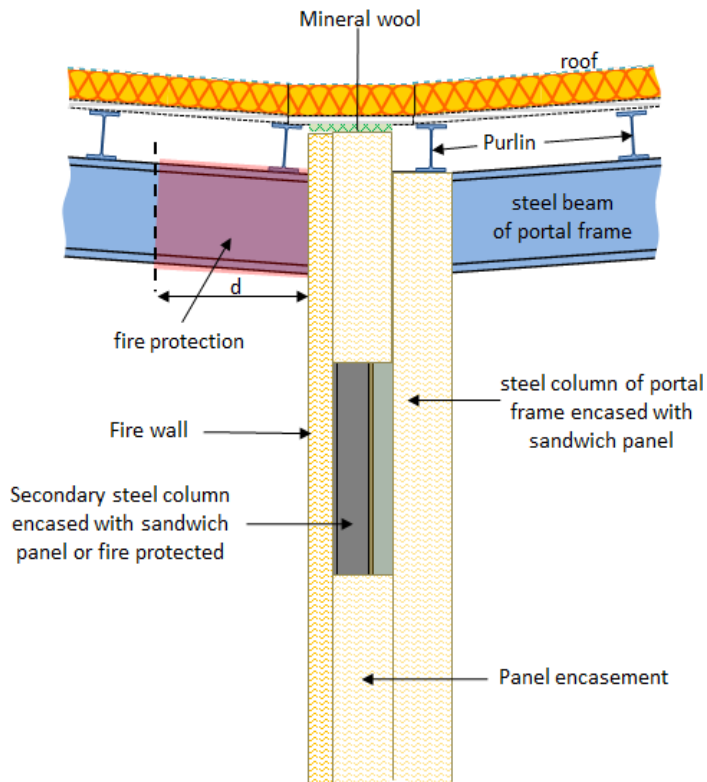
**Front view D-D**



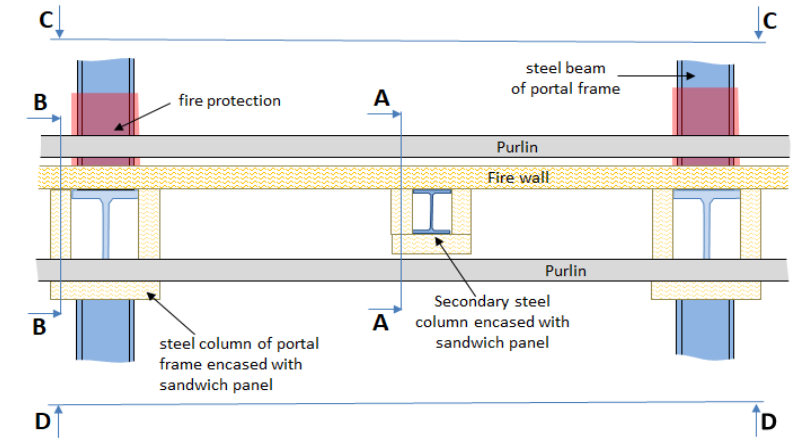
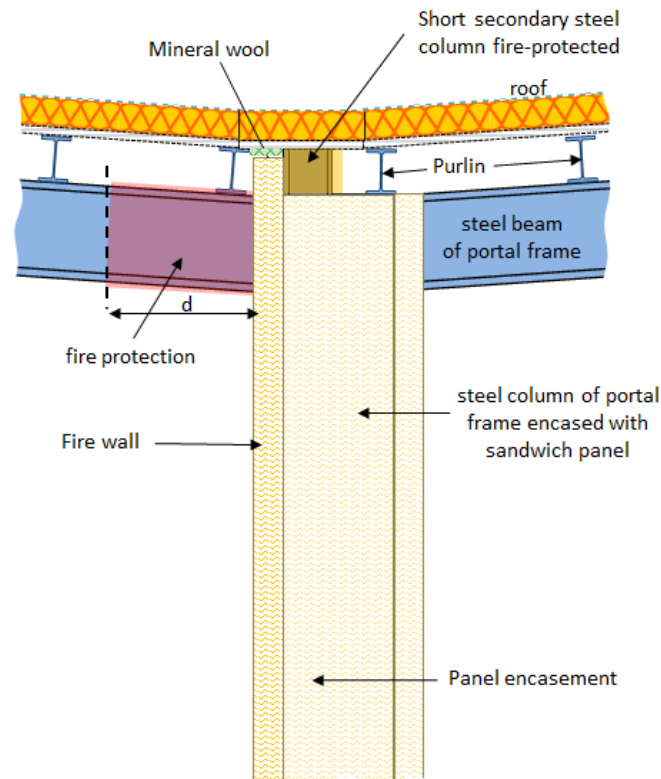
# Fire walls solidly attached to the supporting steel structure of building

- Walls perpendicular to steel frame / inserted into a row of columns
  - ❖ Walls not extending beyond the roof

**View A-A**



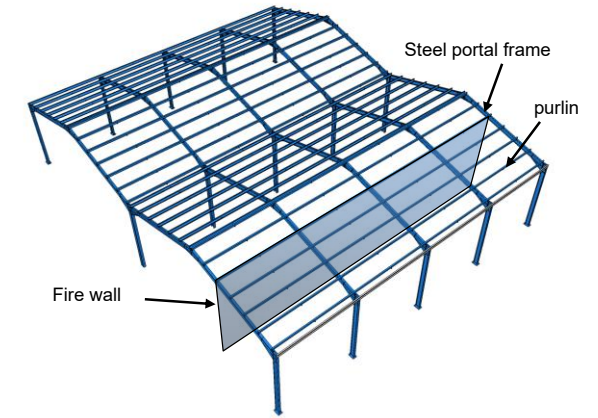
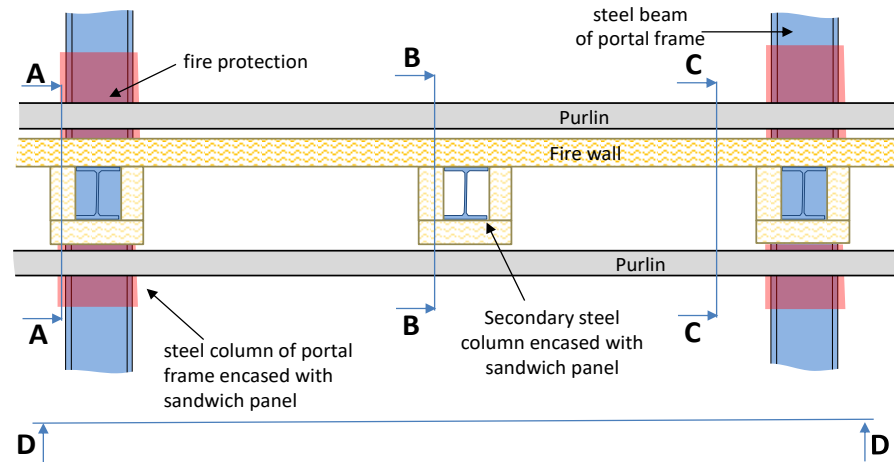
**View B-B**



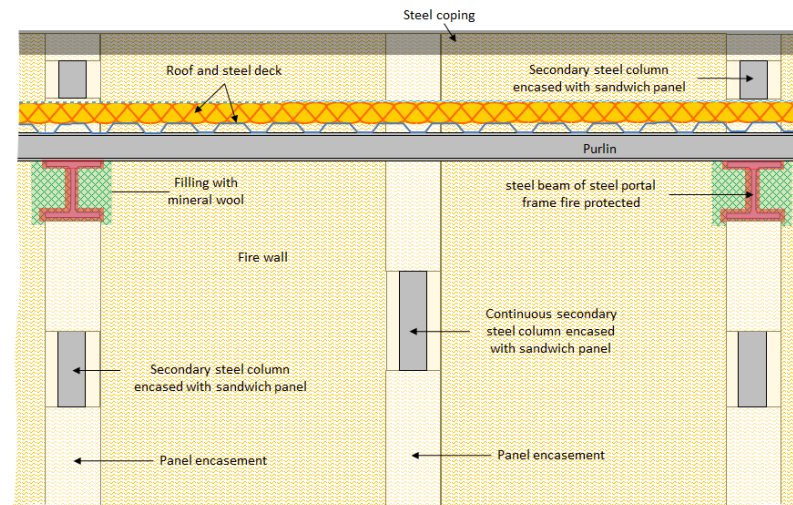


# Fire walls solidly attached to the supporting steel structure of building

- Walls perpendicular to steel frame / inserted between two rows of portal columns
  - ❖ Walls extending beyond the roof

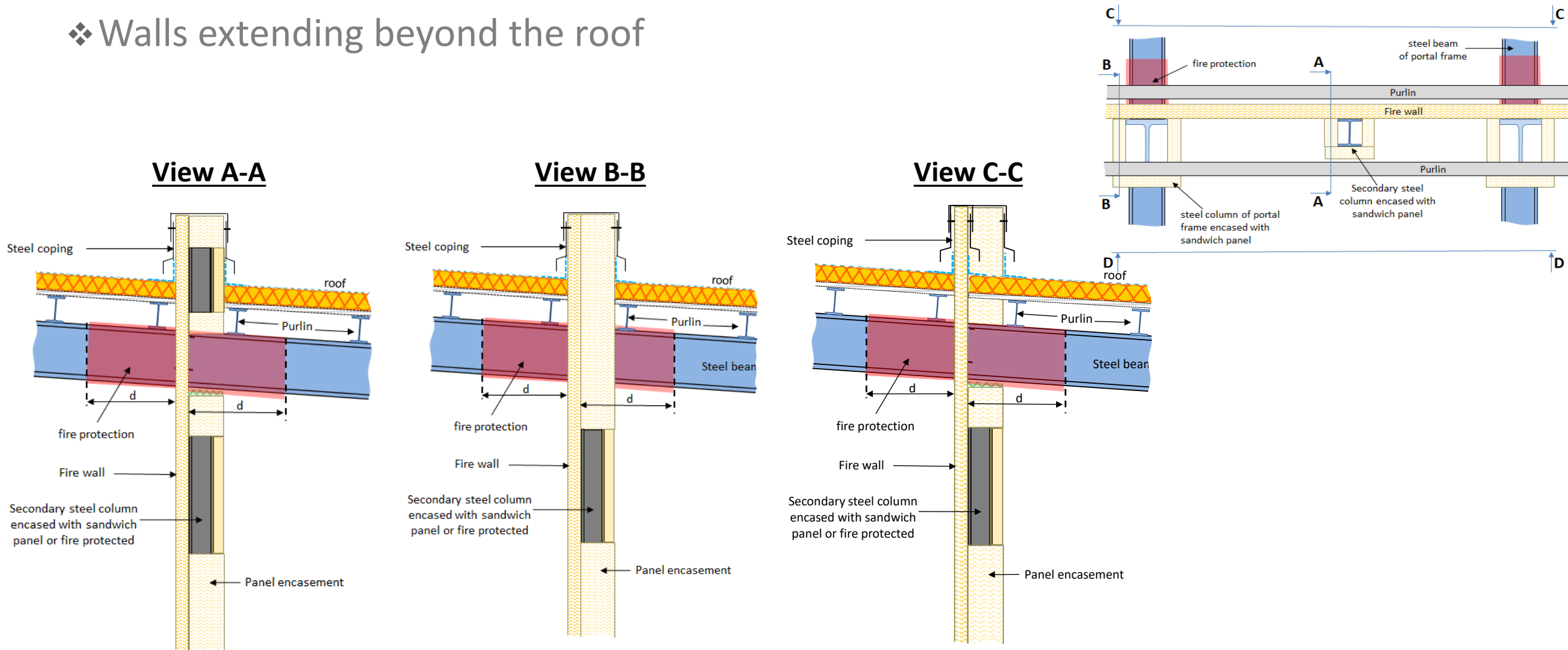


**Front view D-D**



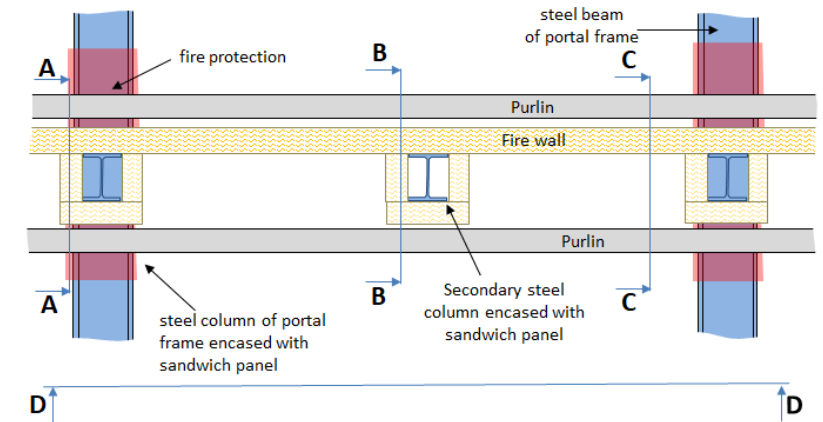
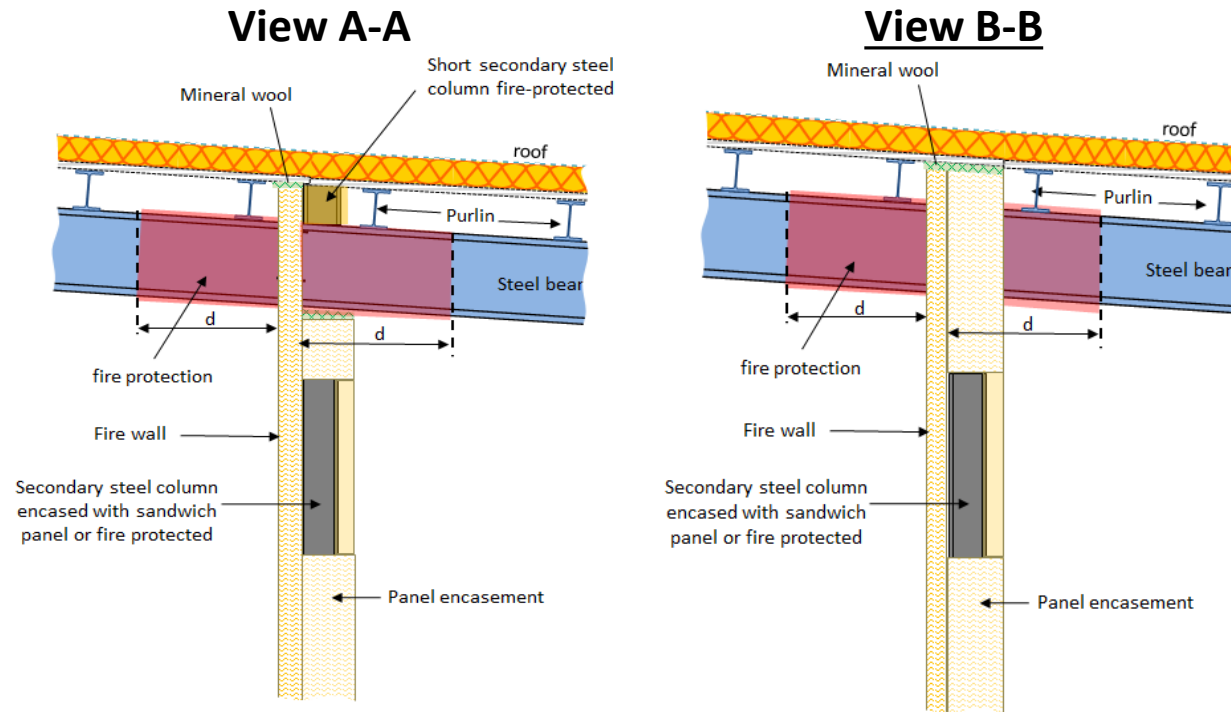
# Fire walls solidly attached to the supporting steel structure of building

- Walls perpendicular to steel frame / inserted between two rows of portal columns
  - ❖ Walls extending beyond the roof



# Fire walls solidly attached to the supporting steel structure of building

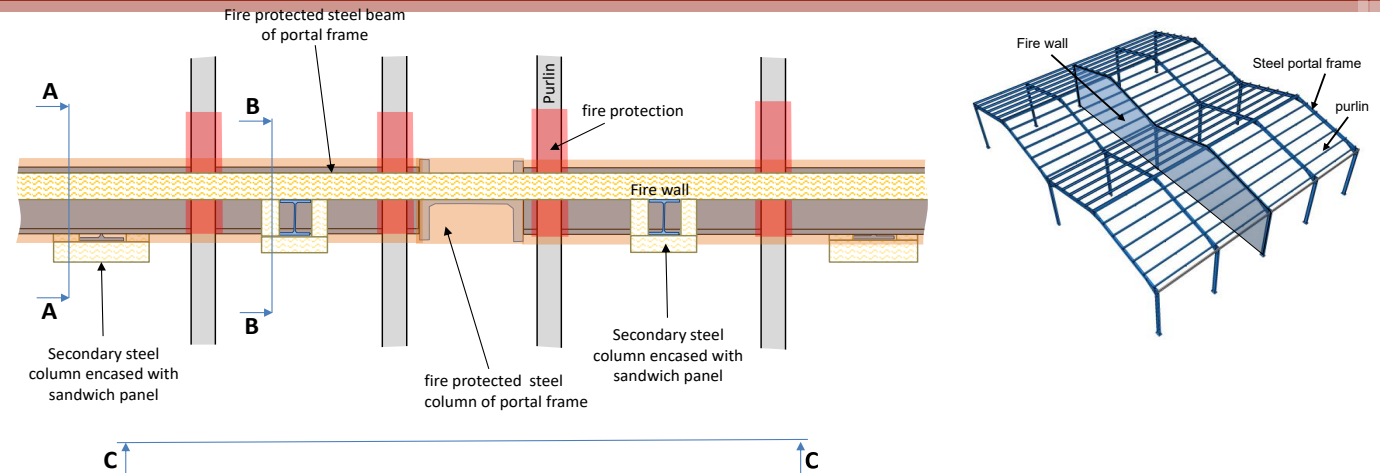
- Walls perpendicular to steel frame / Fire wall inserted between two rows of portal columns
  - ❖ Walls not extending beyond the roof



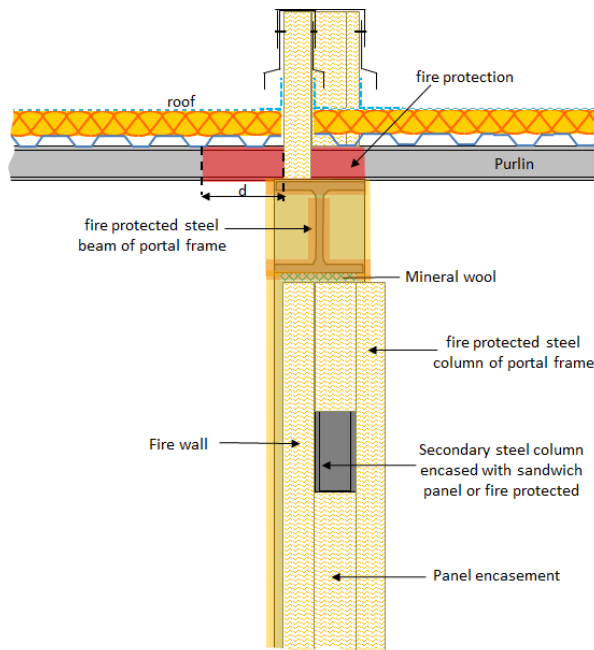
# Fire walls solidly attached to the supporting steel structure of building

## ➤ Walls in the plane of the portal frame

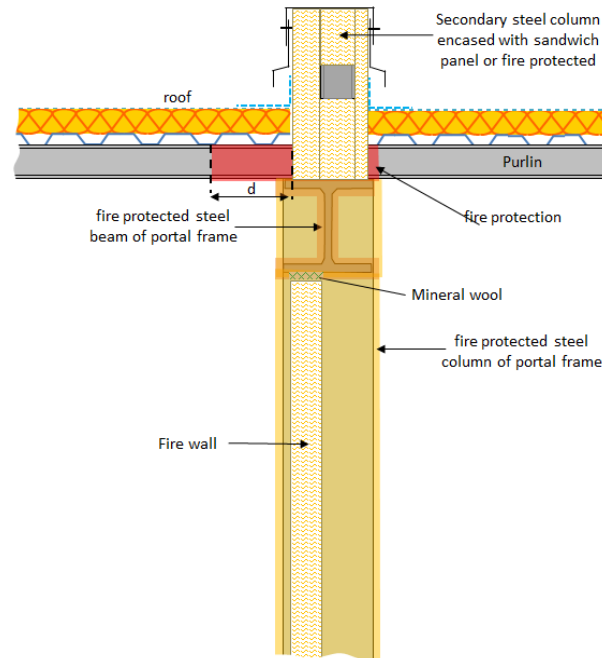
❖ Walls extending beyond the roof



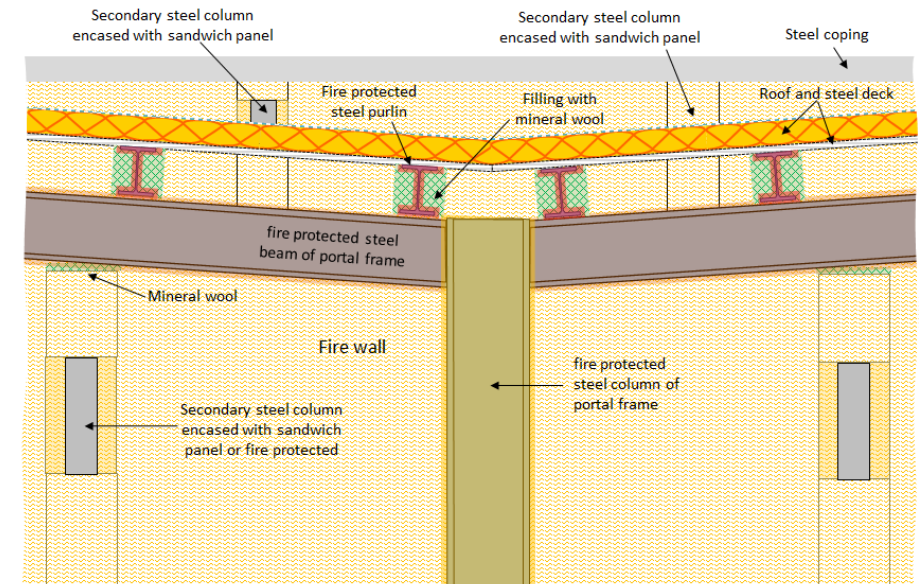
**View A-A**



**View B-B**



**Front view C-C**

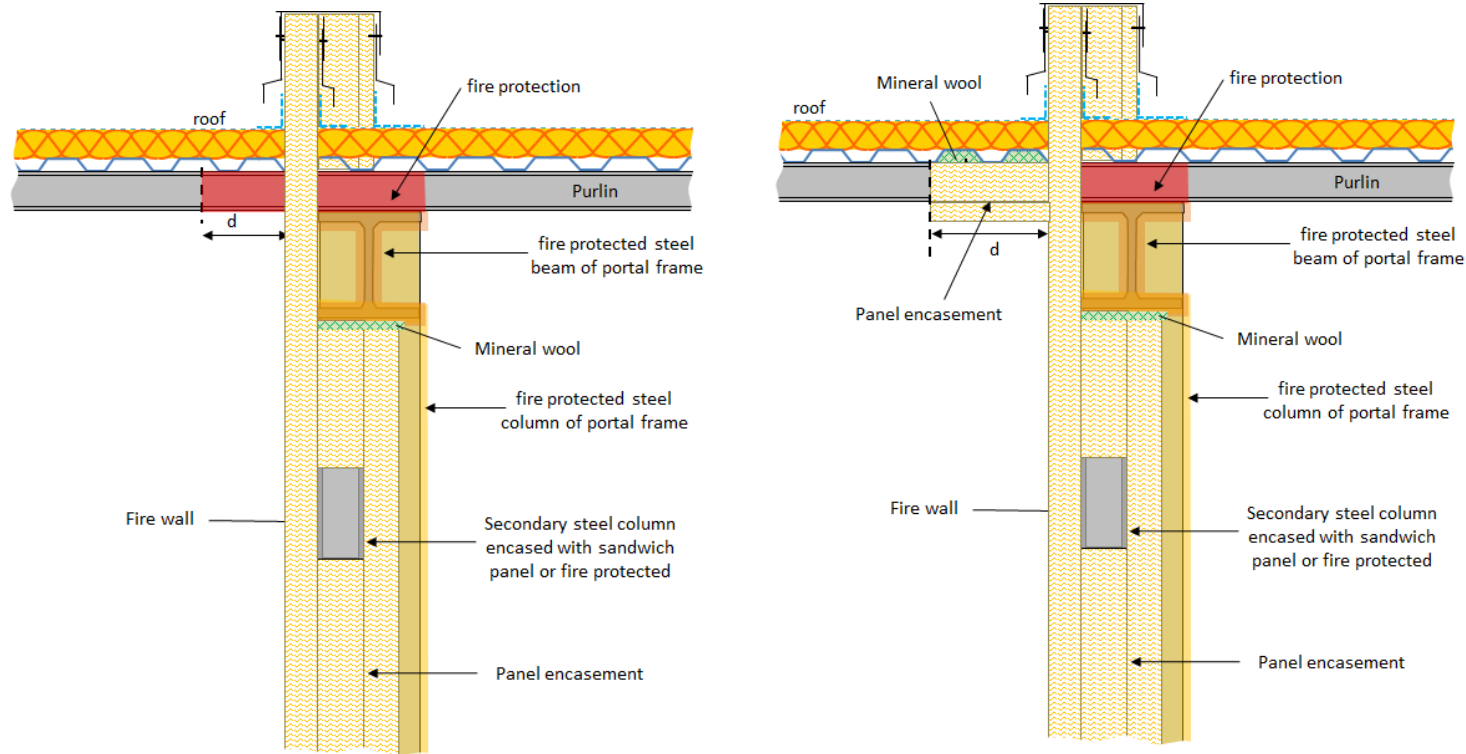




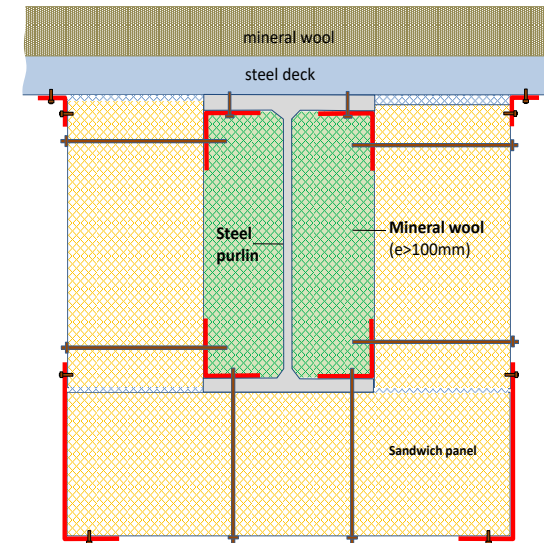
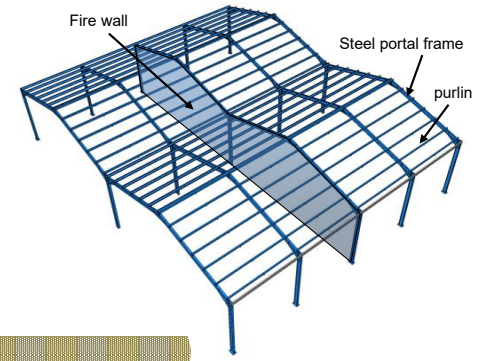
# Fire walls solidly attached to the supporting steel structure of building

## ➤ Walls in the plane of the portal frame

❖ Walls extending beyond the roof + fire wall against the frame



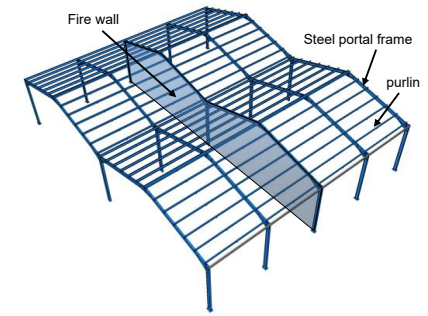
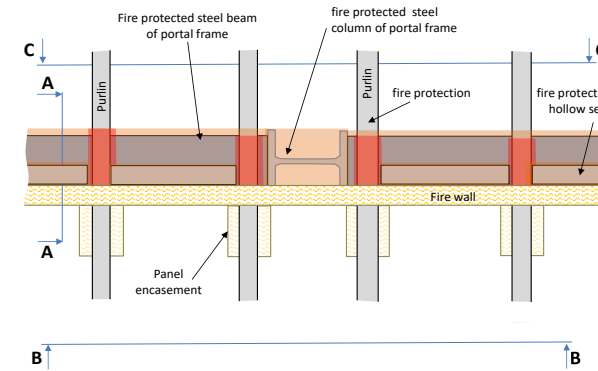
Wall placed against the portal frame



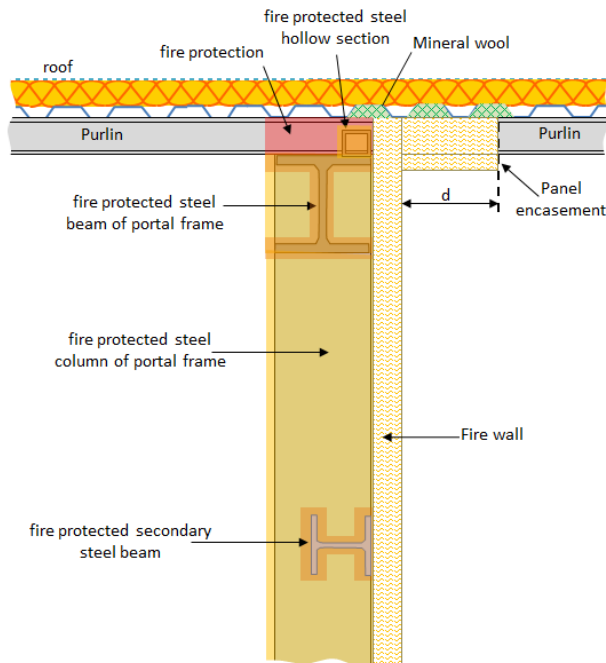
View at the purlin encasement end

# Fire walls solidly attached to the supporting steel structure of building

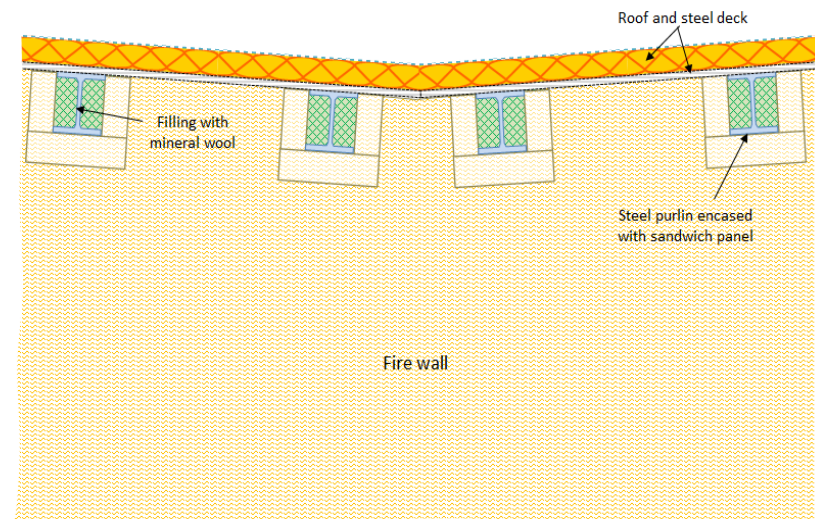
- Walls in the plane of the portal frame
  - ❖ Walls not extending beyond the roof



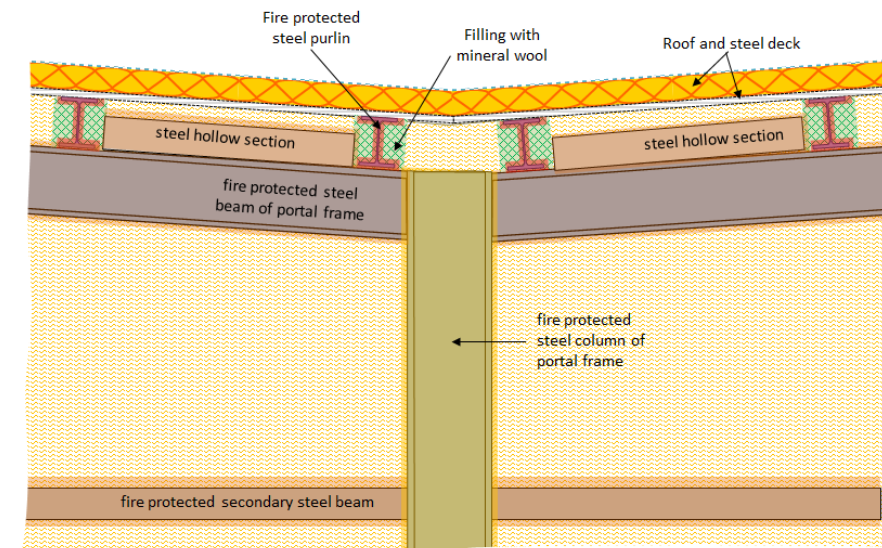
**View A-A**



**Front view B-B**



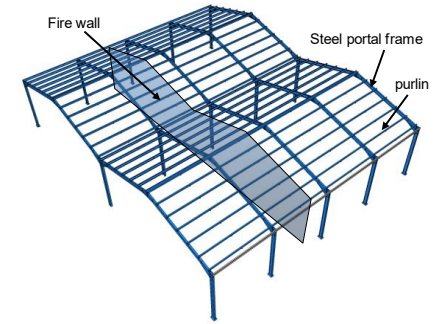
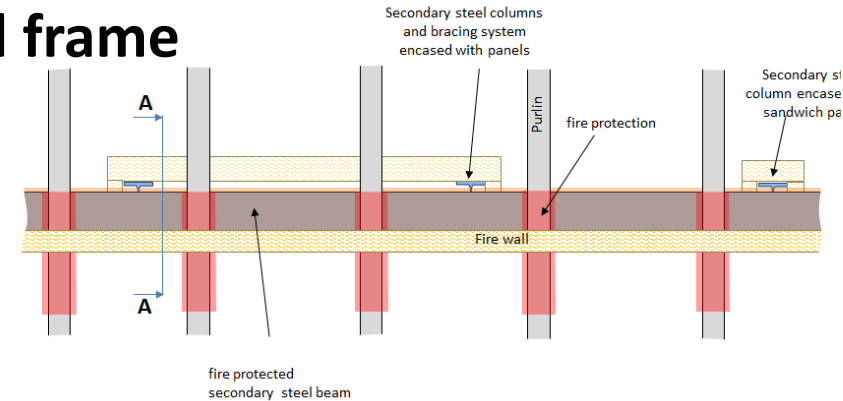
**Front view C-C**



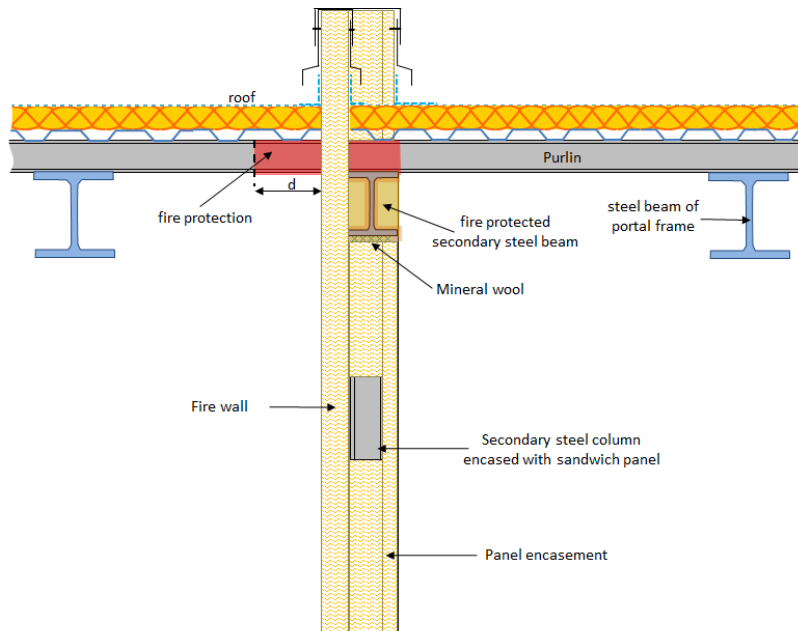
# Fire walls solidly attached to the supporting steel structure of building

## ➤ Walls inserted between two rows of portal frame

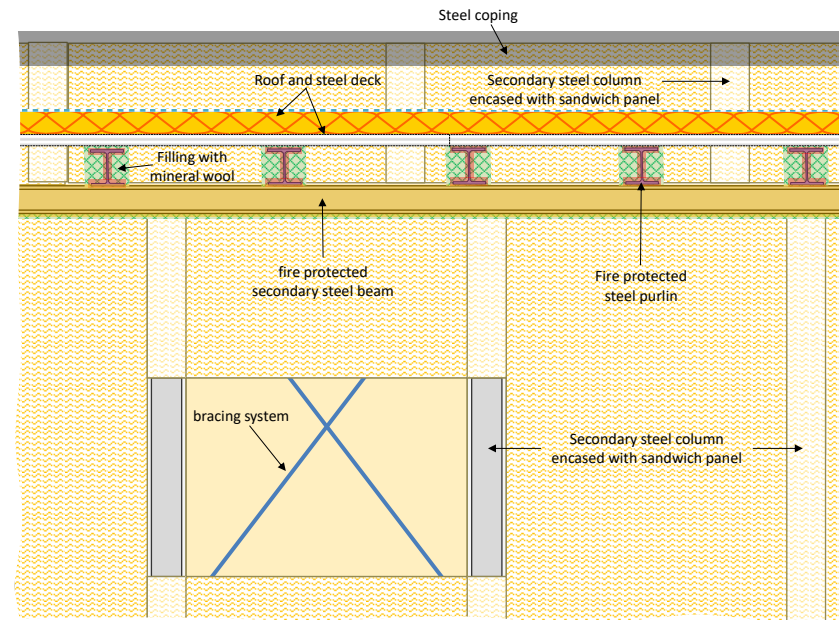
❖ Walls extending beyond the roof



**Side view A-A**



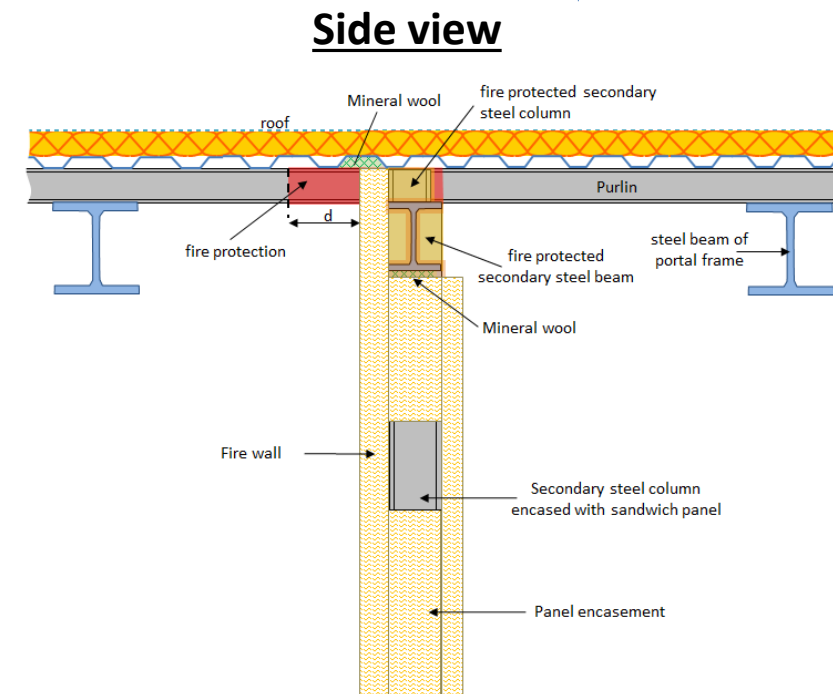
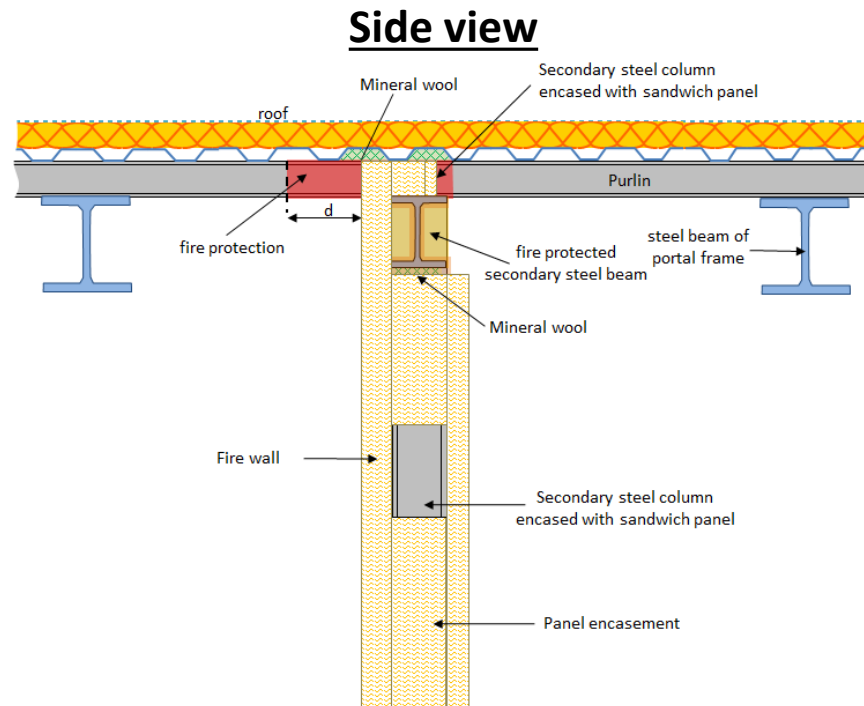
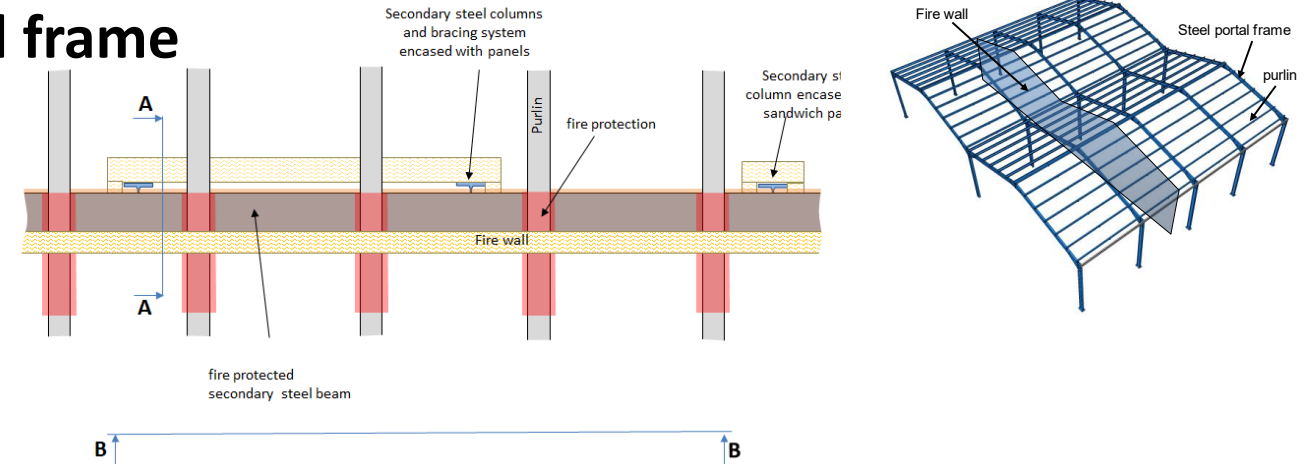
**Front view B-B**



# Fire walls solidly attached to the supporting steel structure of building

## ➤ Walls inserted between two rows of portal frame

❖ Walls not extending beyond the roof

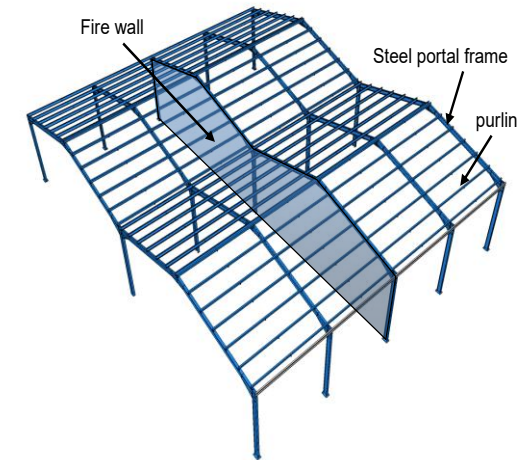
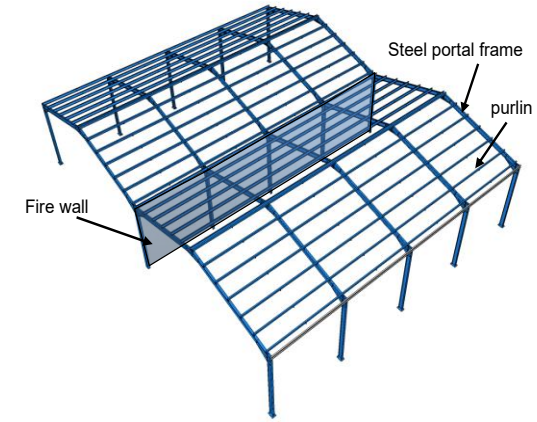




# Fire walls associated with fusible links

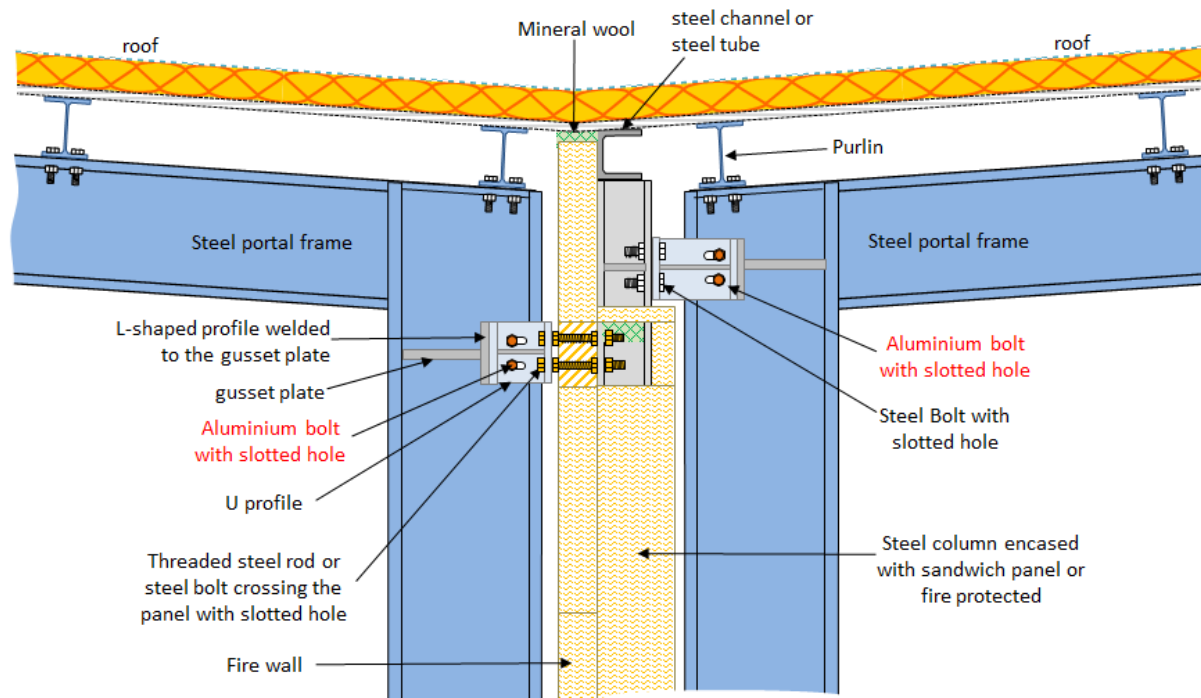
## ➤ Covered wall implementation

- ❖ Partition fire walls perpendicular to the portal frames
- ❖ Partition fire walls parallel to the steel portal frames
- ❖ Walls extending or not beyond the roof

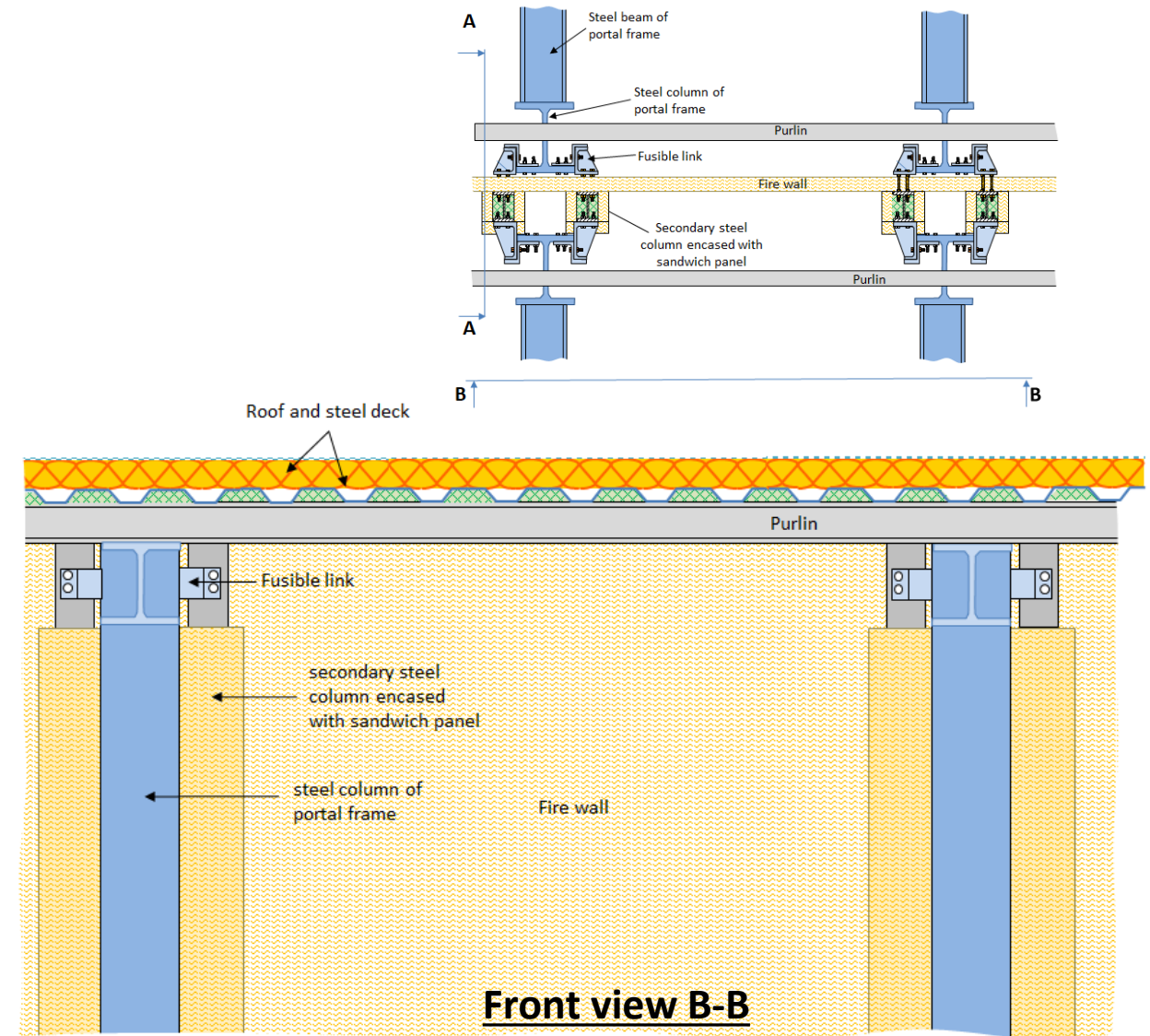


# Fire walls associated with fusible links

- Walls perpendicular to the portal frames
- ❖ Walls not extending beyond the roof



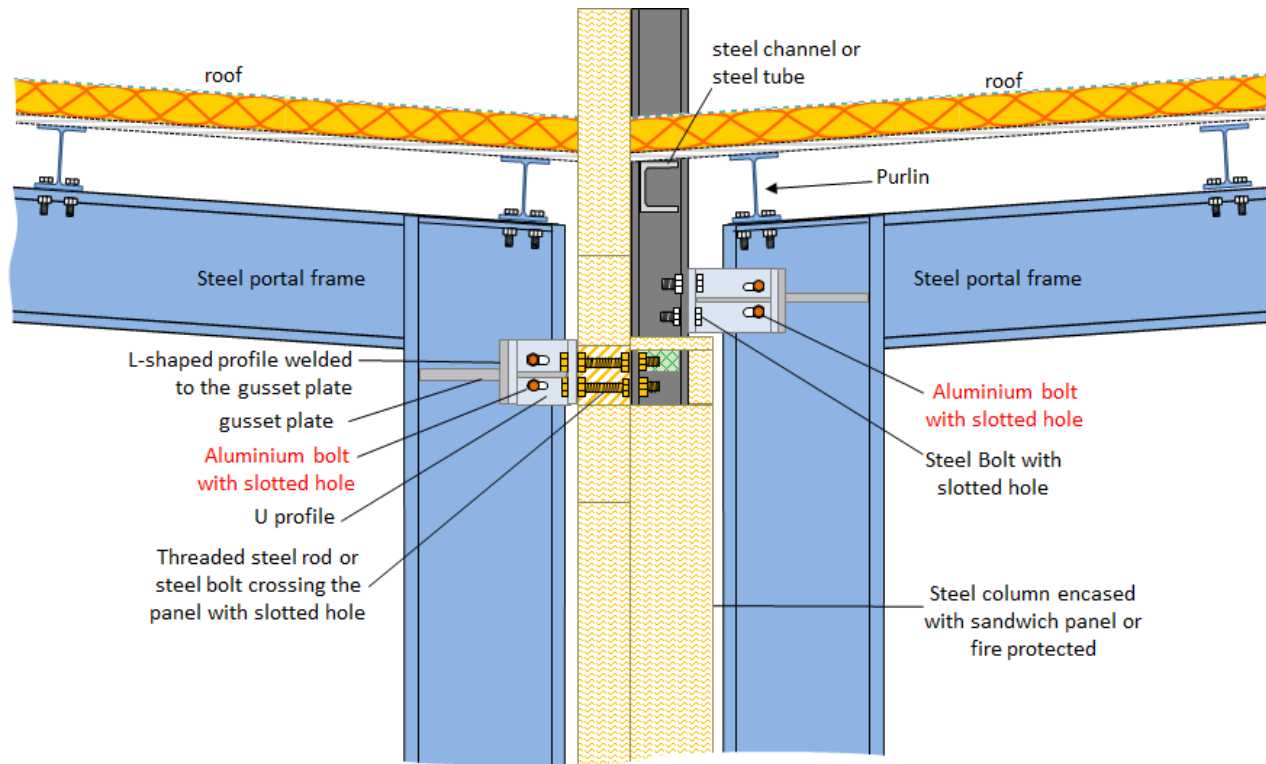
**side view A-A**



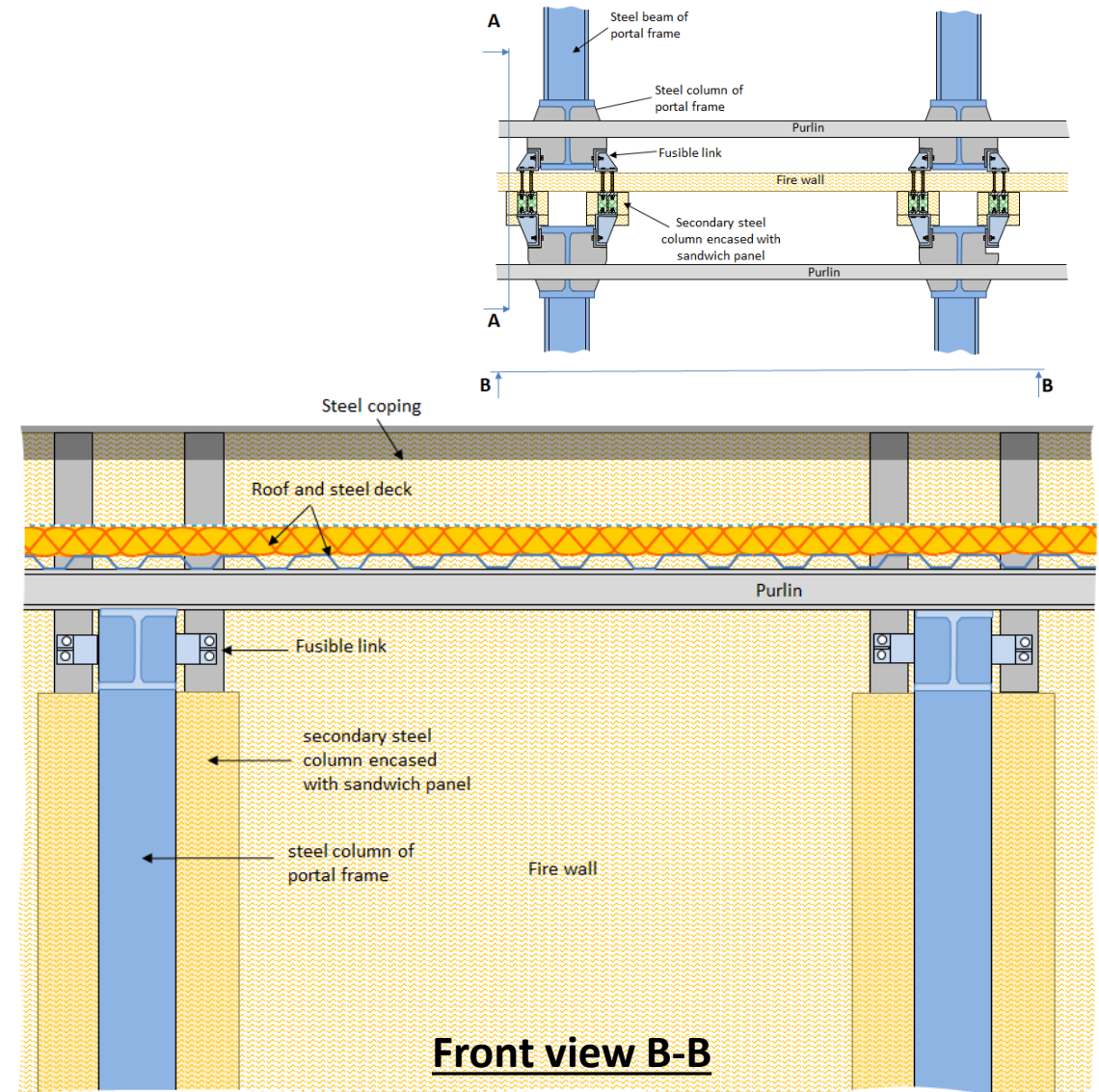
**Front view B-B**

# Fire walls associated with fusible links

- Walls perpendicular to the portal frames
- ❖ Walls extending beyond the roof



**side view A-A**



**Front view B-B**



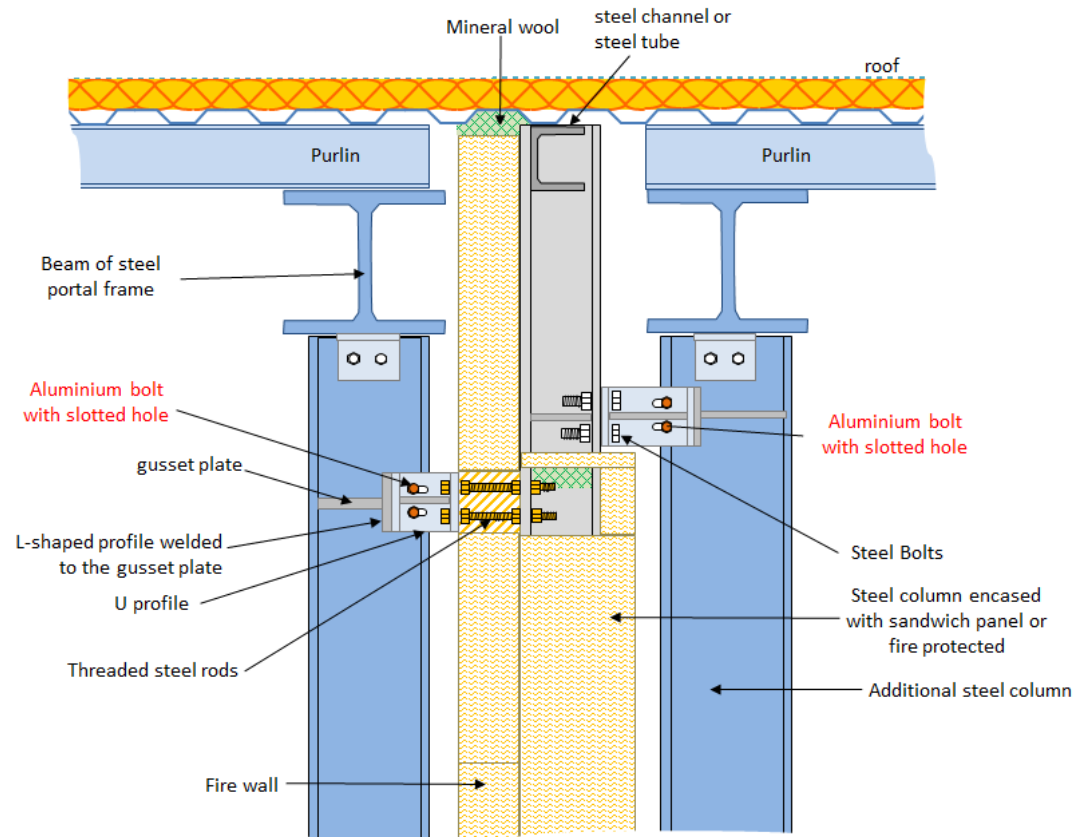




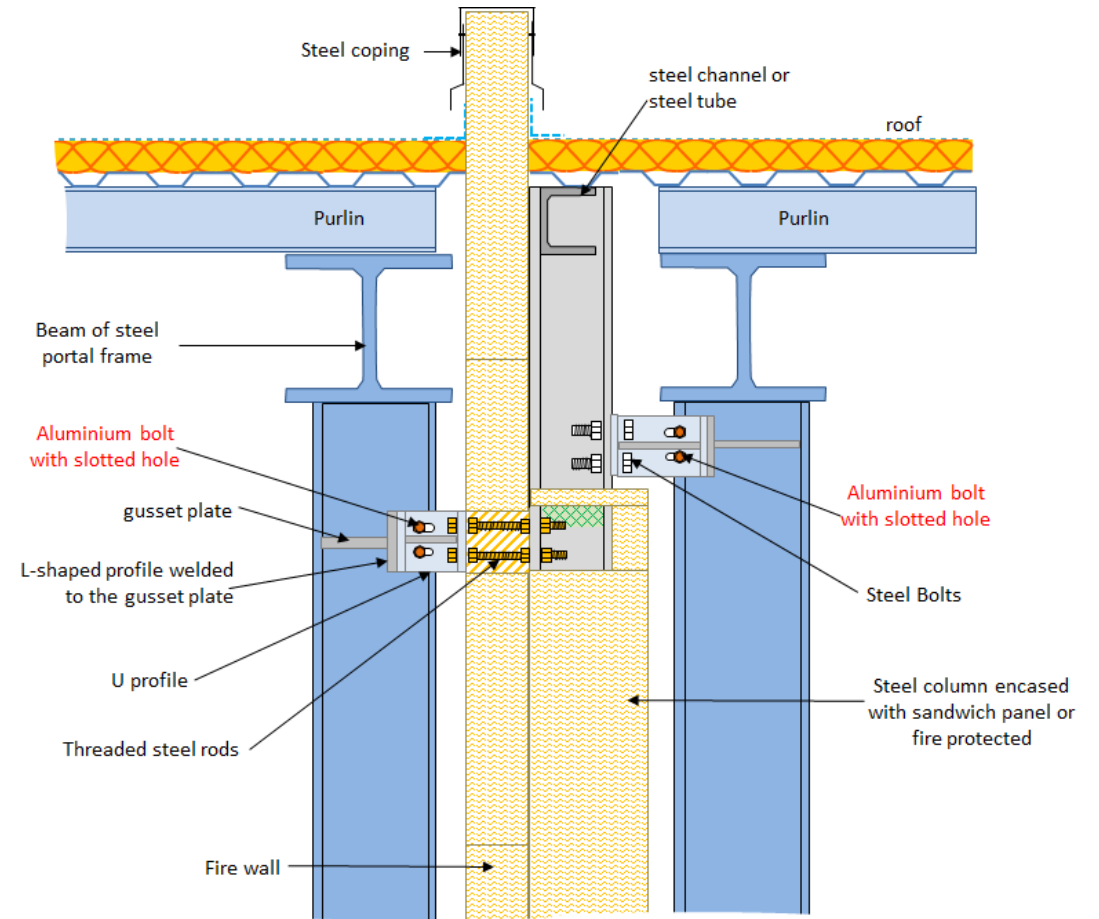
# Fire walls associated with fusible links

## ➤ Walls parallel to the portal frames

### ❖ End gable frame



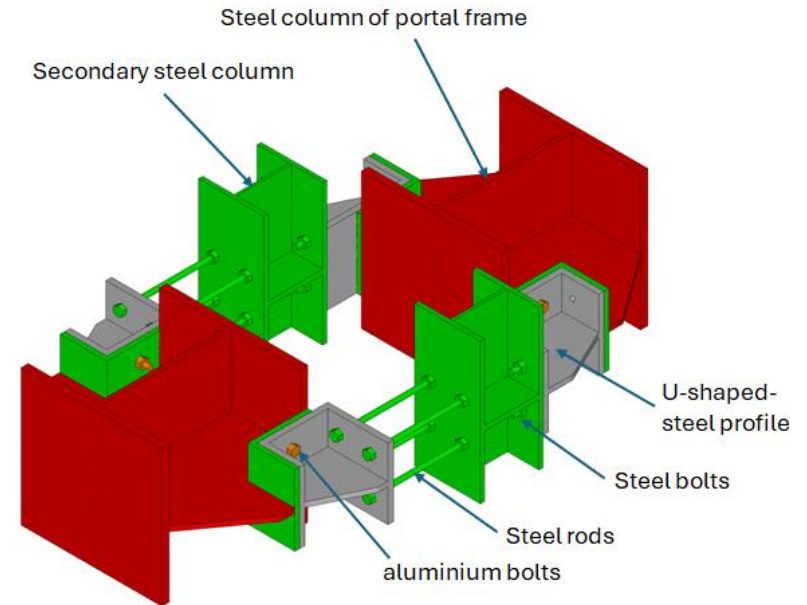
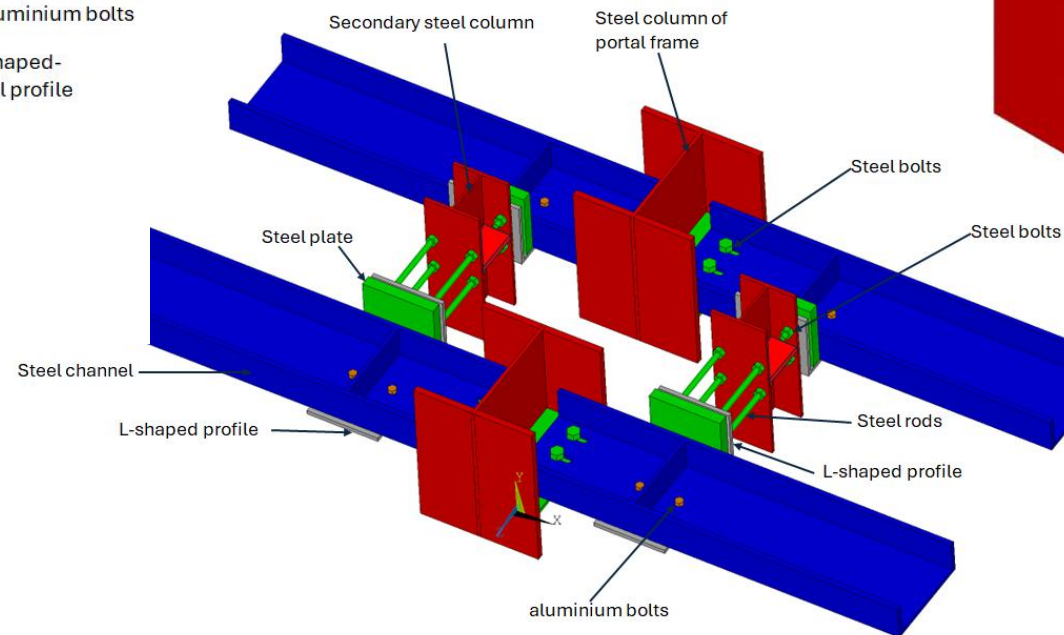
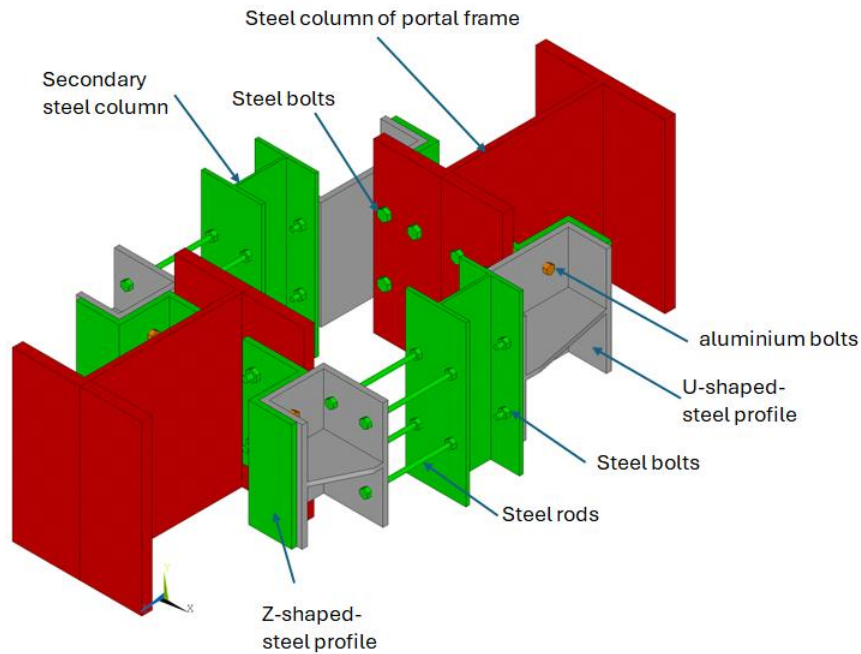
**Wall not extending beyond the roof**



**Wall extending beyond the roof**

# Fusible Links

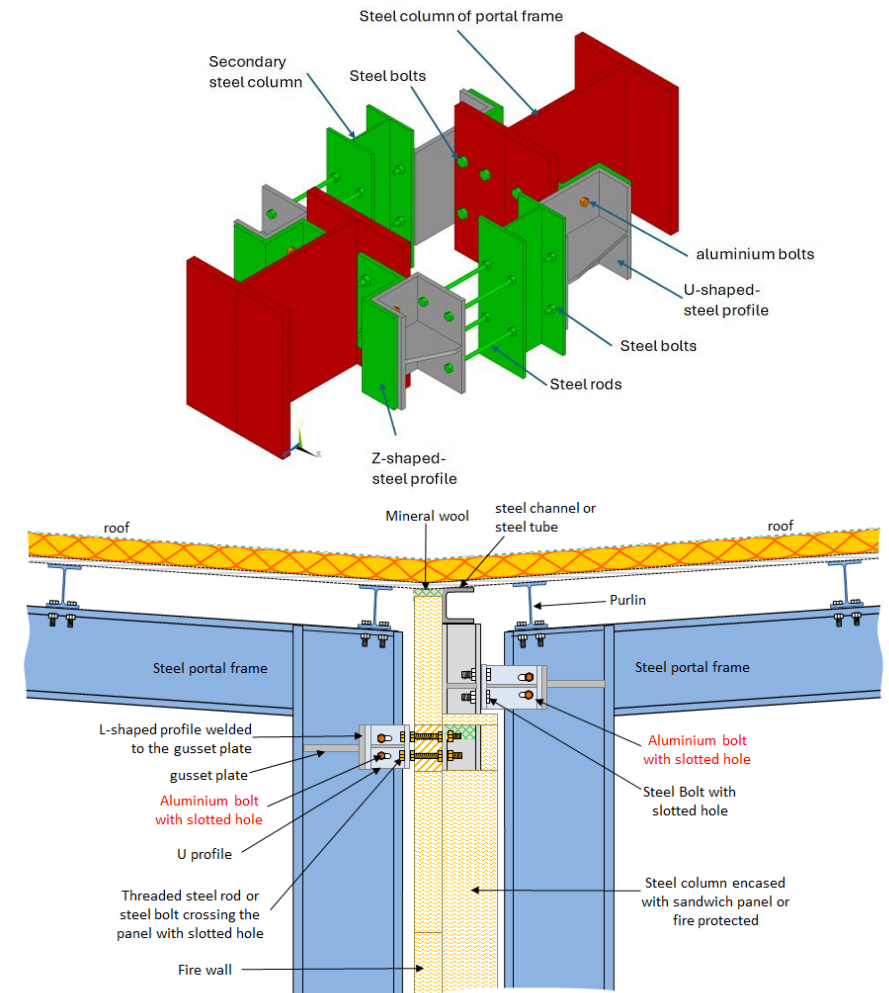
## ➤ Covered solutions



# Fusible Links

## ➤ Positioning

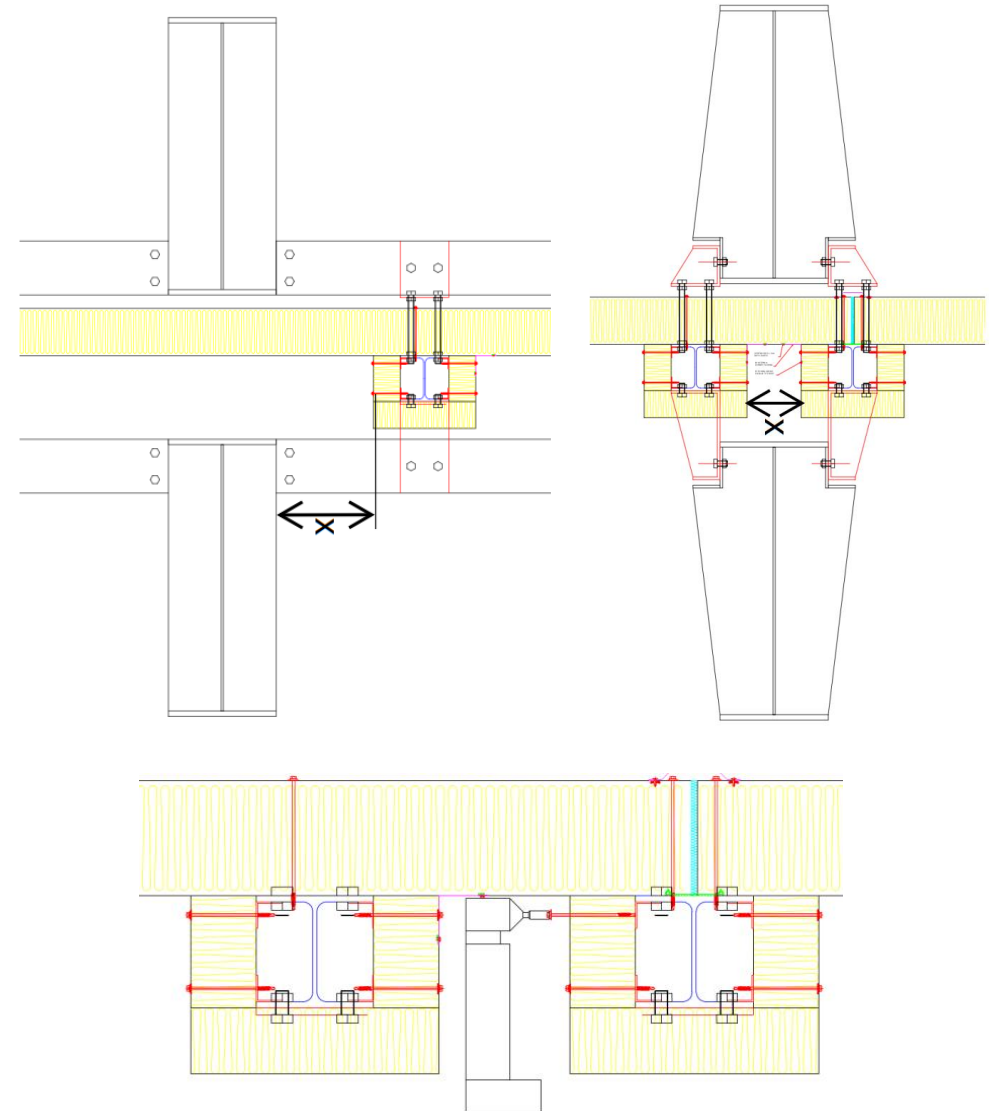
- ❖ A fusible link must be placed on either side of the columns of the steel structure
- ❖ The fusible links must only be placed at the top of the columns of the steel structure, as close as possible to the roof
- ❖ The fusible links must not be installed at level of a junction between sandwich panels



# Fusible Links

## ➤ Positioning

- ❖ The columns that support the wall must be set back far enough from the columns of the steel structure to allow for the installation of the panels
- ❖ Ensure there is sufficient space between the columns to enable the encasement system to be fitted correctly, depending on the wall thickness

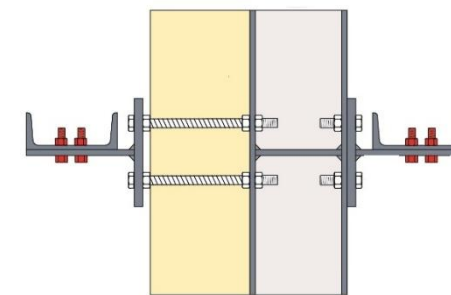




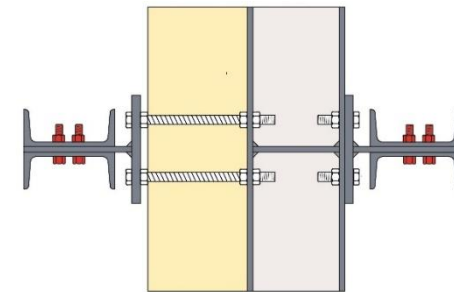
# Fusible Links

## ➤ Design provisions

- ❖ A minimum of four M12 steel rods
- ❖ Avoid class 4 cross-sections
- ❖ U-shaped steel profile with at least 6 mm thick
- ❖ L-shaped steel section with at least 10 mm thick
- ❖ Use of steel bolts and steel rods of at least class 8.8
- ❖ For seismic prone region:
  - Larger diameter of aluminium bolts are preferable, M16 instead of M12
  - A double U profile configuration couple with a T-shaped steel profile may be used to limit the number of aluminium bolts



single U solution

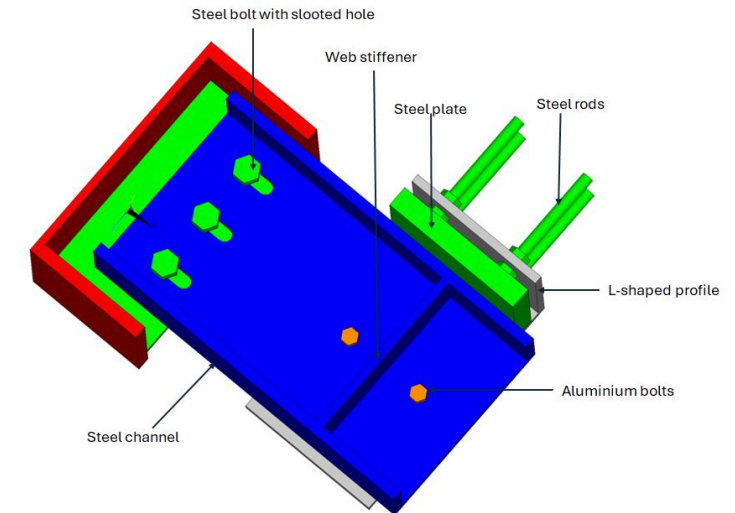
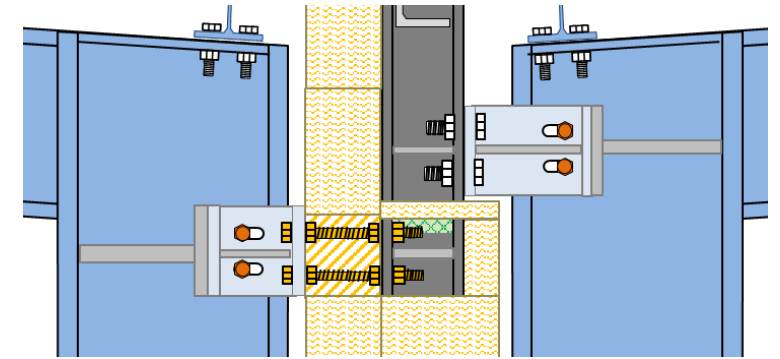


double U solution

# Fusible Links

## ➤ Design provisions

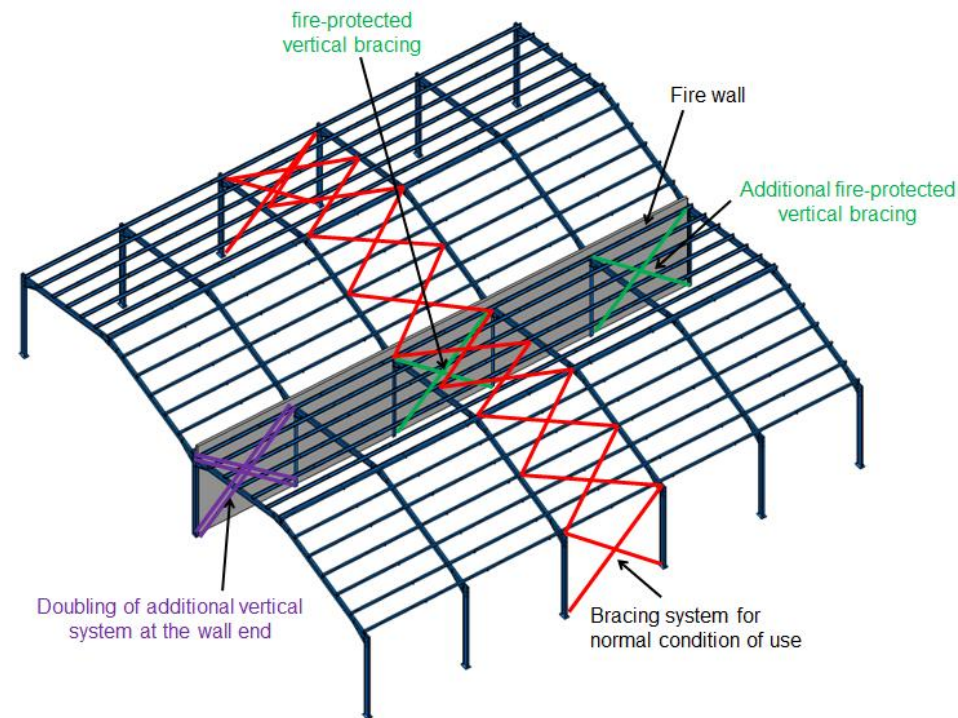
- ❖ Web stiffeners must be placed in the centre plane of steel rods and bolts for the steel column supporting the wall
- ❖ The steel grade of the stiffeners is not lower than that of the steel profiles
- ❖ The thickness of the stiffeners is not smaller than the thickness of the profile flange
- ❖ For fusible links consisting of an L-or T shaped steel profile assembled with aluminium bolts to steel channels bolted at its ends to the columns of the steel structure, slotted holes must be accommodated at joints to allow the free longitudinal thermal expansion of the steel channels



# Bracing systems

## ➤ Walls perpendicular to the portal frames

- ❖ Use additional vertical bracing systems at both ends of fire wall, to ensure integrity of wall. These bracing systems should be designed to support a lateral load due to normal wind actions (calculated according to the combination of actions for the fire situation), calculated for a gable area that is limited to the width between gable columns
- ❖ Provide double vertical bracing systems (i.e. have bracing systems on both sides of fire walls) or fire-protect the bracing system
- ❖ The bracing systems must be arranged in a way that they will not cause problems for normal temperature design, for example by compromising movement of an expansion joint



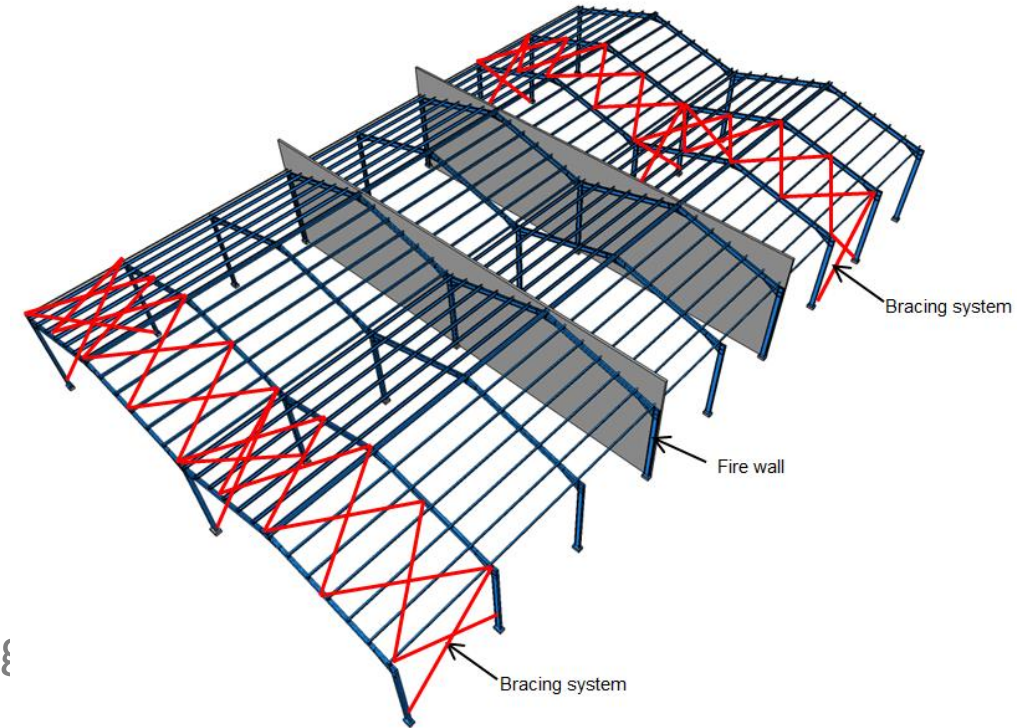
# Bracing systems

## ➤ Walls parallel to the portal frames

- ❖ Install sufficient bracing systems to ensure the stability of the structure parts not exposed to fire. May lead to additional bracing systems for normal conditions
- ❖ Design each bracing system to provide adequate stability in normal condition and to support in fire condition a horizontal uniform load [N/m] taken as:

$$F = 1,19 \times (G + \psi \times S_n) \times l_f$$

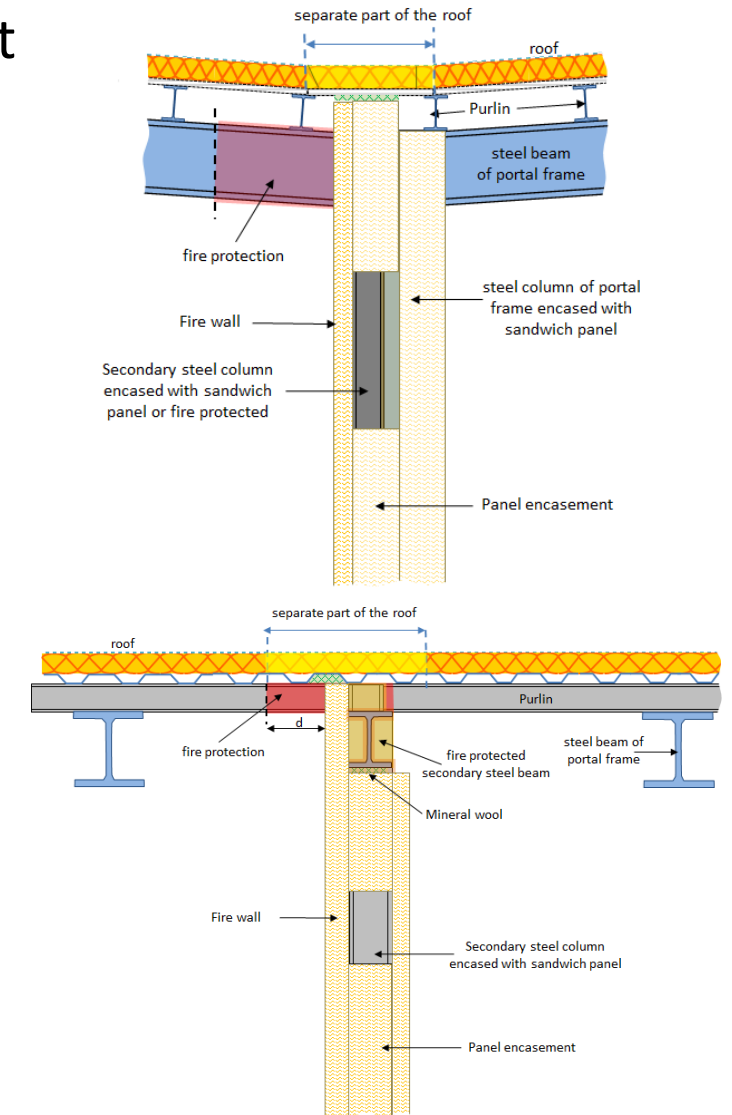
where  $l_f$  is the spacing between steel frames,  $G$  is the permanent action including service overloads,  $S_n$  is the snow load and  $\gamma$  ( $\Psi_{1,1}$  or  $\Psi_{2,1}$ ) is the load factor according to load combination coefficients defined in EN 1990 and corresponding national annexes.





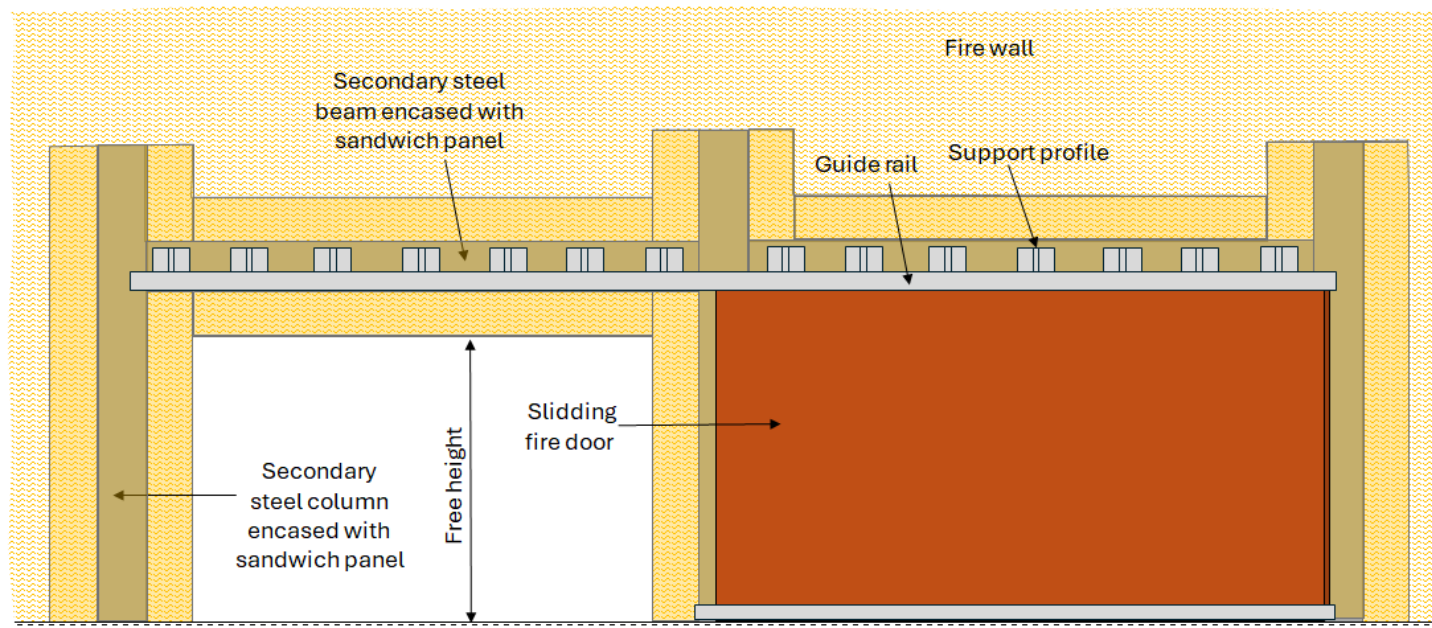
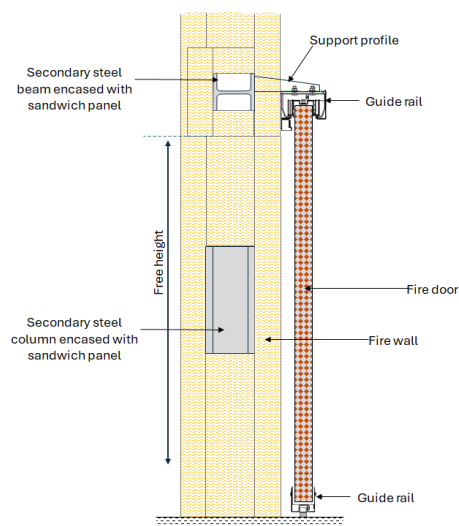
# Roof near the separation fire walls

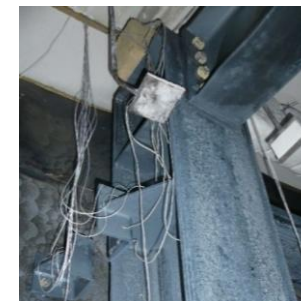
- Whatever the fire wall solutions, the roof should be independent from one fire compartment to the next, respecting the following recommendations:
  - ❖ Purlins or other additional supports should be provided on both sides of fire walls perpendicular to steel portal frames.
  - ❖ The roof should be stopped on both sides of the fire wall.
- In addition to the extension of the wall above the roof, national fire codes may specify special requirements for the building roof in the vicinity of fire walls (fire protection measures for an appropriate length on each side of the wall).



# Fire doors

- As an alternative to a rigid frame (like concrete frame), large sliding fire door can be installed in walls made with sandwich panels, using a fire-protected steel portal frame
- The vertical part of this frame can be made from the steel columns supporting the firewall. The column spacing shall be adapted locally to the width of the fire door.
- The steel frame provides also supports for the upper rail system and the fire seals which are fixed to the frame through the panels.





# Thank you for your attention!

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