

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

Innovative/optimised “fusible” link systems

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ABSTRACT

It is well known that the intrinsic fire resistance of single-storey unprotected steel-framed buildings is largely sufficient to guarantee the evacuation of occupants in the event of fire. In consequence, for this type of building, the main concern of national fire regulations in Europe is how to prevent the spread of fire to the whole building. To achieve this objective, two performances shall be usually satisfied, namely, the appropriateness of constructive systems to ensure that there is no progressive collapse between fire compartments, and the efficiency of fire walls to stop the fire inside the initial compartment regardless of the state of structures exposed to fire. In practice, many constructional solutions can be implemented in order to preserve the integrity of the fire walls, while accepting that the fire exposed part of the structure may collapse. One of the most common solutions is to place a non-load bearing wall between two independent steel structures and to connect it to them by means of "fusible" links. In fire situation, these fusible links have to allow the wall to be disconnected from the structure affected by fire without endangering the separating function of the wall, which shall remain fixed to the steel structure on the other side of the wall and therefore not exposed to fire. However, due to the lack of corresponding scientific evidence, questions are being very often raised about the real efficiency of such systems in fire situation, which, in certain cases, have also to provide an adequate seismic resistance, if they are used in seismic areas.

Today, concrete or masonry wall solutions are frequently used for the compartmentation of buildings, predominately for low-rise commercial and industrial steel buildings. However, as an alternative, lightweight sandwich panels (comprising two thin flat metal faces and an insulated core) could become an appropriate steel fire wall solution, offering numerous benefits in comparison to other solutions, including fire resistance, durability, flexibility, easy dismantling and fast construction times. But, there is an evident lack of technical information about the adequate fire performance of such type of wall solutions when they are implemented in single-storey buildings with unprotected steel structure, which constitutes a major obstacle for their large use.

In this context, the overall goal of the FISHWALL project is to develop a design guidance and recommendations for an innovative hybrid fire wall solution based on lightweight steel-faced sandwich panels associated with unprotected steel structure under both fire and seismic actions but considered individually. This will be achieved through the following specific tasks: i) Establishing of a full range of experimental evidence about the fire and seismic behaviour of the investigated hybrid fire wall solution by carrying out a number of tests; ii) Investigating intensively the fire and seismic performances of the above hybrid fire wall solution in combination with unprotected single-storey steel structures through a variety of parametric numerical studies by means of validated FE numerical models; iii) Developing both cost-effective and innovative "fusible" connection systems for fire walls to be used in combination with unprotected steel structures of single-storey buildings; and iv) Developing a design guidance and practical recommendations for the studied hybrid fire wall and fusible links solutions, on the basis of above studies, from which engineers can carry out very efficient design.

The present report briefly describes the fusible link solutions developed in the FISHWALL project, that can fulfil the safety requirement asked under both fire or seismic situations.

1 INTRODUCTION

The fusible link solution investigated as part of the project consists of steel joints with aluminium bolts acting as the fusible component. It should be noted that aluminium bolts have a relatively low melting temperature (below 500°C), and their resistance decreases significantly with temperature increase. Based on the results obtained during the FISWHALL project — both numerical and experimental ([1], [2], [3], [4], [5])— and considering on-site assembly constraints, the initially considered fusible link solutions were reviewed and adjusted to ensure their effectiveness in fire and seismic situations. Three fusible link solutions were finally developed for fire walls made of non-structural sandwich panels. These are described briefly in this report.

2 DEVELOPED FUSIBLE LINK SOLUTIONS

The fusible link solutions developed in the project FISWHALL are mainly intended to be used with the fire wall solution presented in Figure 1, consisting of lightweight insulated sandwich panels spanning horizontally between fire-protected supporting steel columns (by means of sandwich panels or any other fire protection product), located on one side of the wall only. The sandwich panels are not non-structural (and must be fixed horizontally, but the steel columns can be encased either horizontally or vertically. The maximum height of the wall is 20m when the panels are installed horizontally to enclose the columns. If the panels are installed vertically, the maximum height is only 12 m.

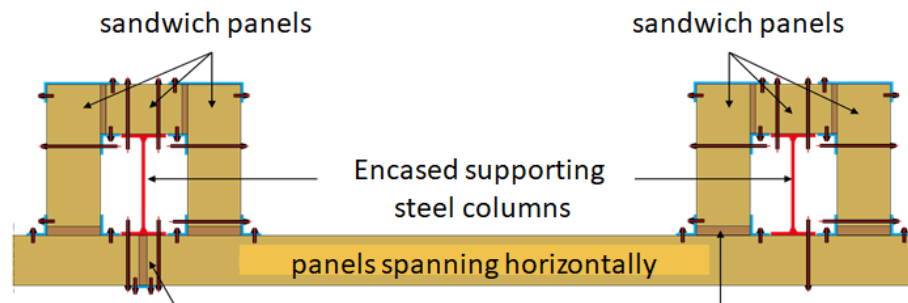
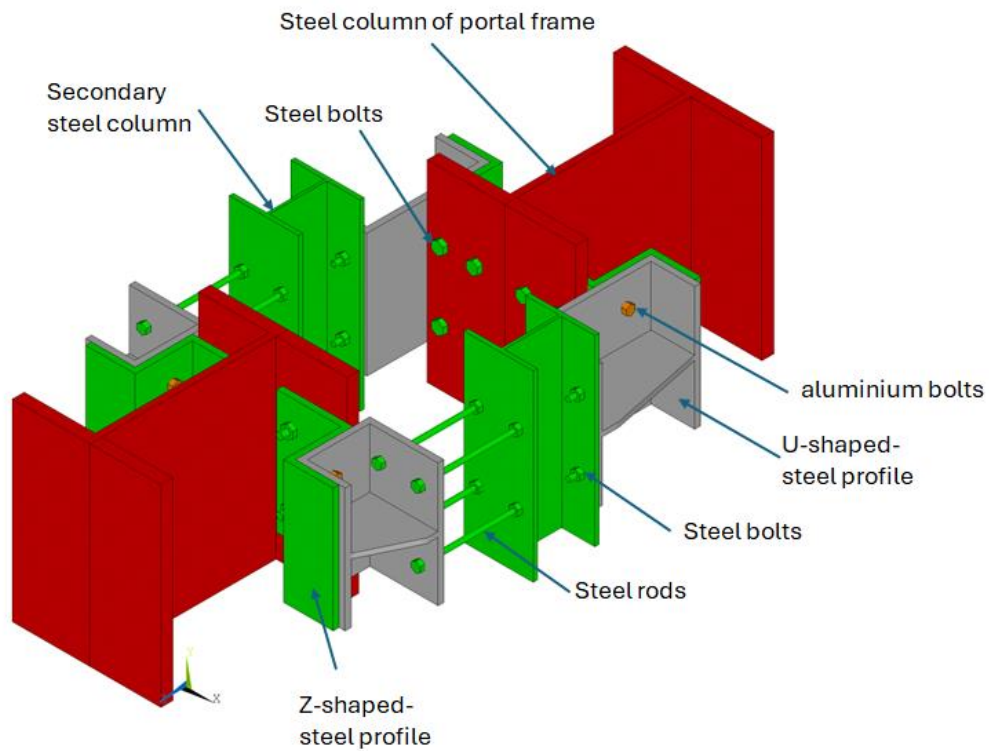
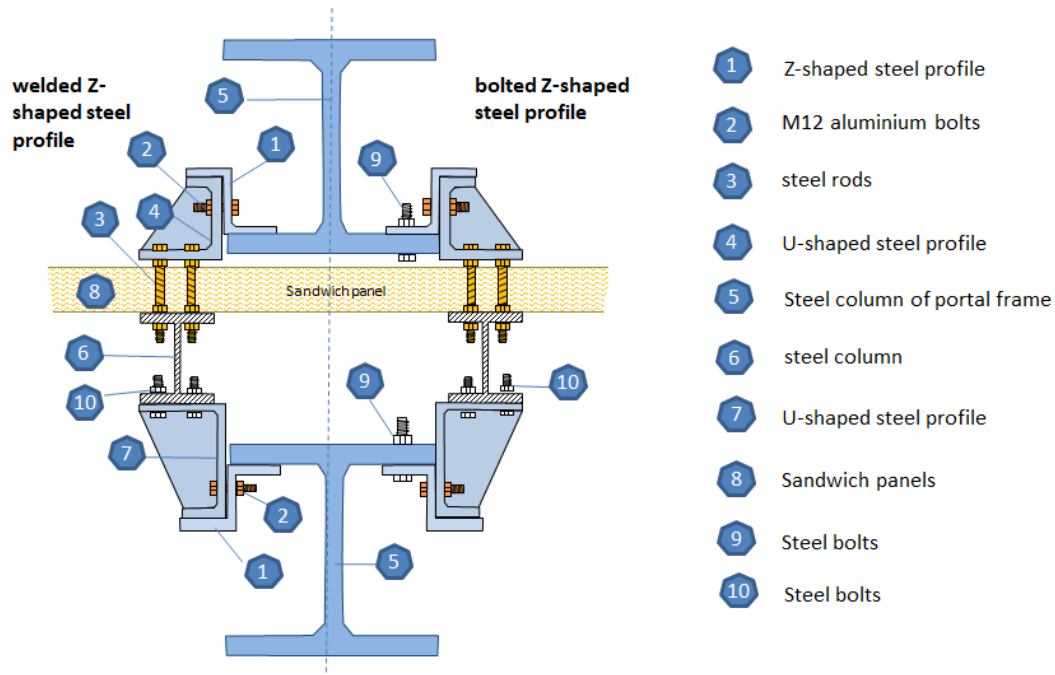


Figure 1: Fire wall solution considered in the project

The fusible link solutions consist of common steel joints with aluminium bolts acting as the fusible component. They can be any of the following solutions:

- Links composed of Z-shaped steel profiles and U-shaped steel profiles arranged back-to-back and assembled with aluminium bolts (see Figure 2 and Figure 3). Each Z-profile may be welded or bolted to the column of the building steel structure, while the U-profiles are bolted to the column supporting the sandwich panels, using four threaded steel rods passing through the fire wall on the wall side and four steel bolts on the other side.
- Links composed of L-shaped folded plates welded to a gusset plate placed between the column flanges and U-shaped steel profiles, assembled with aluminium bolts (see Figure 4 and Figure 5). The U-profiles are bolted to the column supporting the sandwich panels, using four threaded steel rods passing through the fire wall on the wall side and four steel bolts on the other side.
- Links consisting of an L or T-shaped steel profile assembled with aluminium bolts to a steel channel that extends horizontally between the columns of the building steel structure (see Figure 6 and Figure 7). The L-shaped profiles are attached to the wall steel column by means of four threaded steel rods passing through the fire wall on the wall side and four steel bolts on the other side.



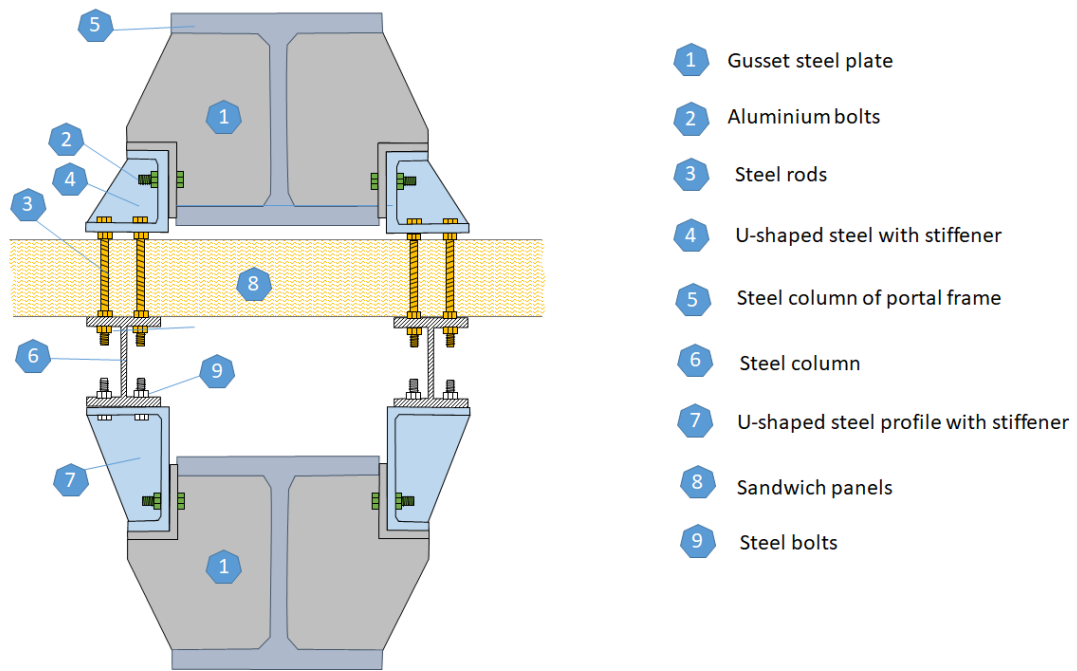


Figure 4: Schematic of the second link solution – sectional view

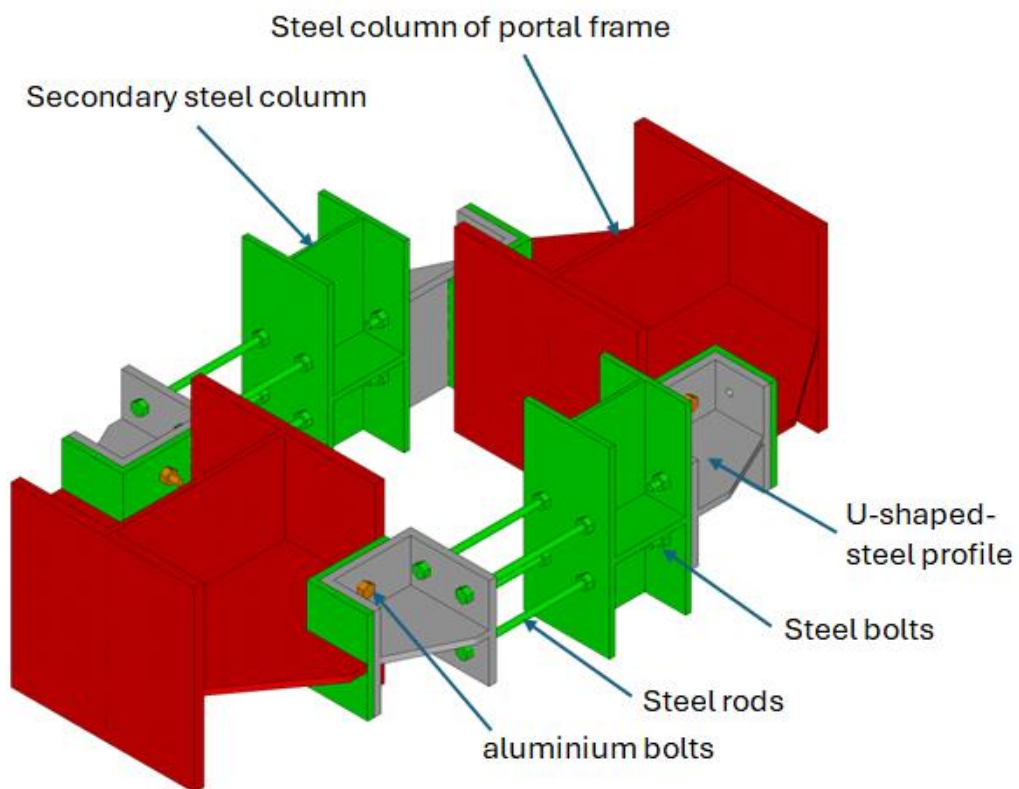


Figure 5: Schematic of the second link solution– 3D view

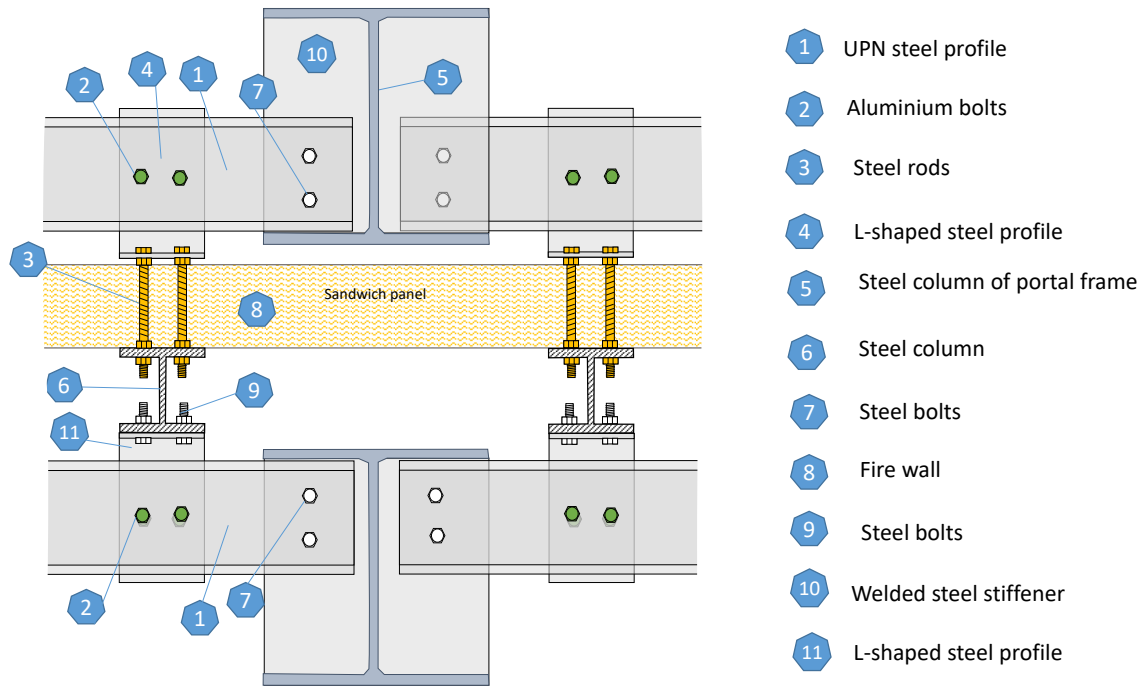


Figure 6: Schematic of the third link solution with L-shaped profiles– sectional view

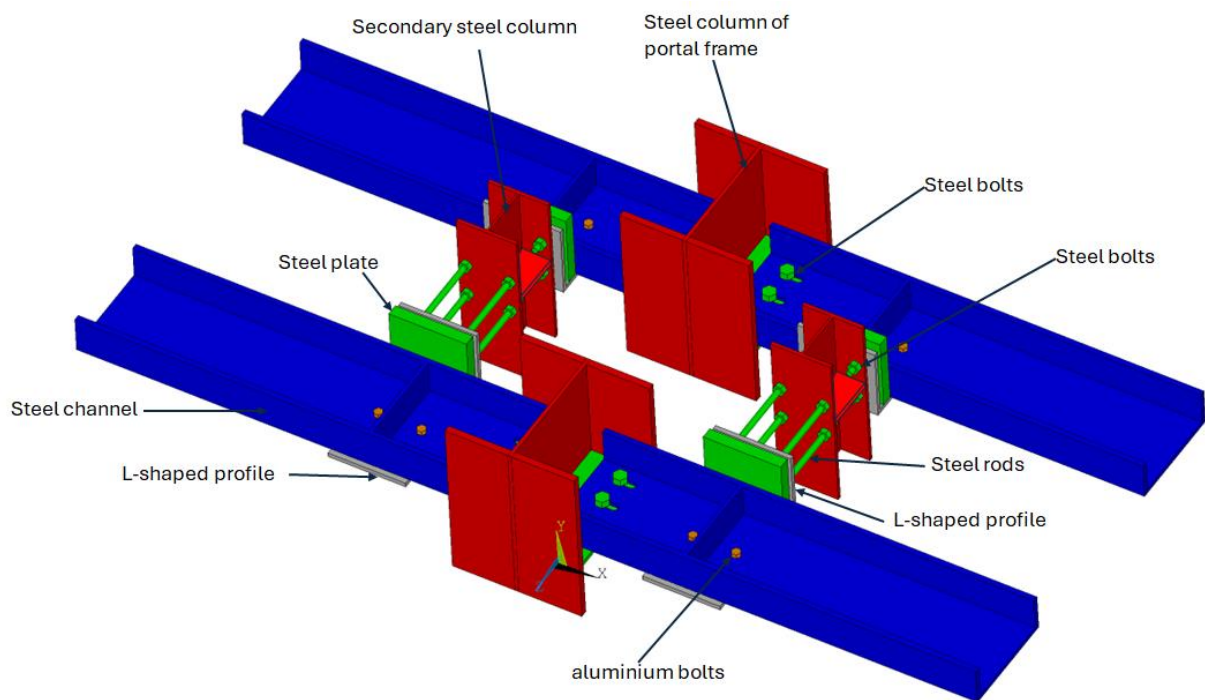


Figure 7: Schematic of the third link solution with L-shaped profiles – 3D view

3 CONCLUSIONS

This report aimed at describing briefly the fusible link solutions developed in the FISHWALL project, which can be designed according to guidance and recommendations provided in the design guide for fire walls made of sandwich panels implemented in single-storey steel framed buildings [6].

4 REFERENCES

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