# Removable Fire Walls
## Modular Concept Description

Concept Summary

Castellum fire walls are customs made and they can be completely removable, designed for easy assembly and disassembly at the jobsites, such as an electric substation. Each wall consists of prefabricated thermal panels, for certain applications such as Electrical Substations these panels could be designed to slide into a fire resistant support structure as shown in Figure 1- below. Detailed description is provided in the subsequent sections.

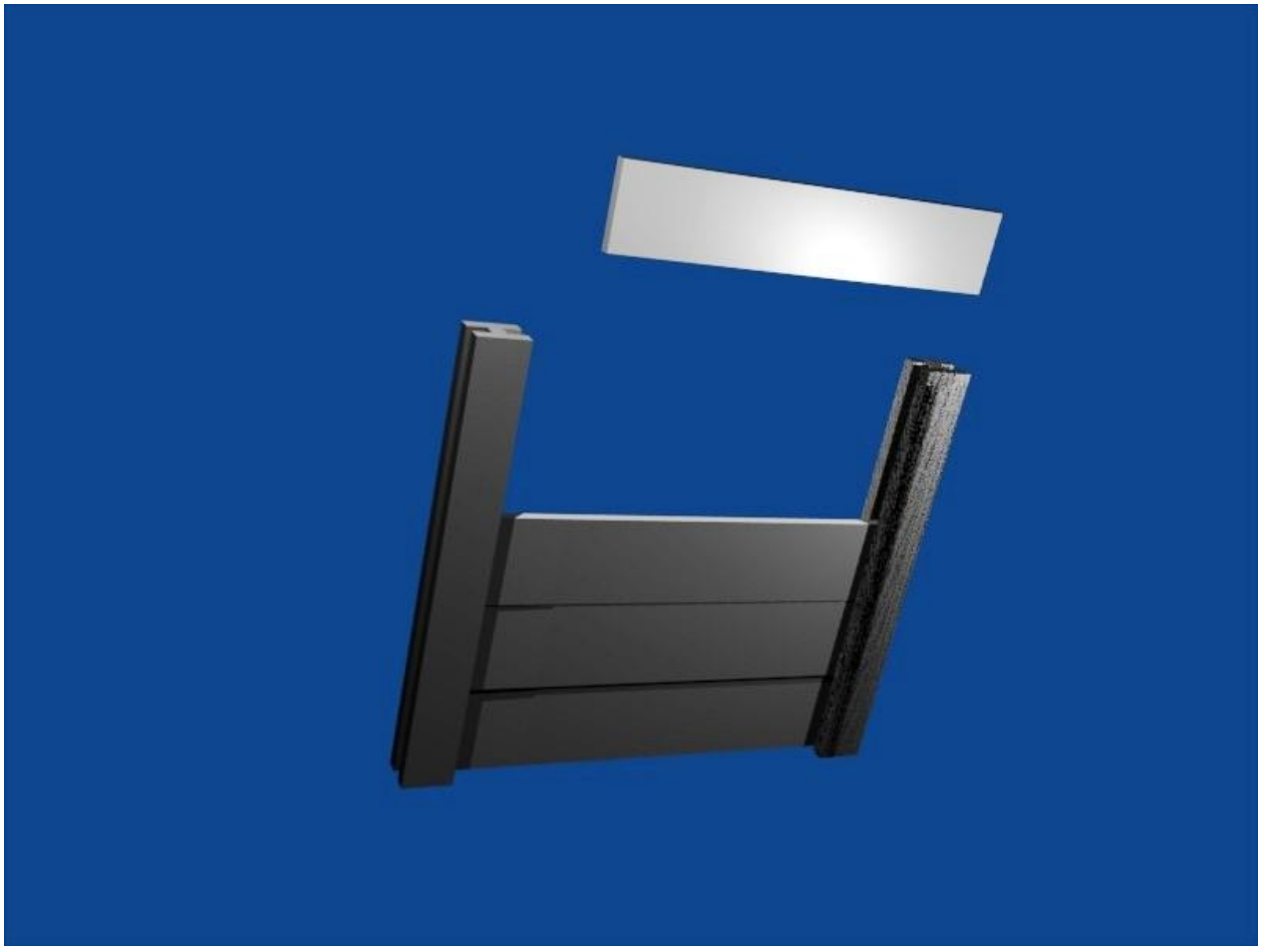


**Figure 1 - Perspective of a typical fire wall section or module under assembly. Various sections can be joined to form the complete wall to the desired dimensions and shape.**

This modular concept simplifies specification, assembly and disassembly, and minimizes manufacturing and installation costs without compromising thermal or mechanical performance. A set of standard-size panels and columns can be chosen and then combined to fit the fire wall dimensions needed for various applications.

Depending on the thickness of the panels, the walls can meet a desired fire wall resistance rating per Chapter 7 of the International Building Code, which is in accordance with the states' Building Codes and NFPA Standard 251. If required, the walls are capable of withstanding high wind loads, seismic forces, and point impact by selecting the appropriate panel and column mechanical reinforcement.

Panel Description

The thermal panels are cast from reinforced silicate based mix proven for decades to resist high temperatures. The material is water-based, easy to mix and apply, ambient-temperature curable, highly impermeable, non-hazardous, and maintenance free. The individual panels are reinforced with high temperature resistant fibers, this also prevent the panels from cracking during curing and under high temperatures.

All components are sufficiently embedded or surrounded by the silicate based material, in order to limit temperature rise in the fibers to a safe value, well below that at which fibers may begin to lose any significant percentage of its working strength. The following drawings show the general construction of the fire wall panels. As discussed above, the basic wall unit is a panel consisting of a pre-fabricated panel reinforced primarily with fibers (Figure 2). This subassembly could slide into the reinforced slots of the high-strength columns to form the wall (Figure 1), or it could be attached to metal structures or existing wall structures, depending on the application and thickness of the panels to meet the temperature requirements of each customer.

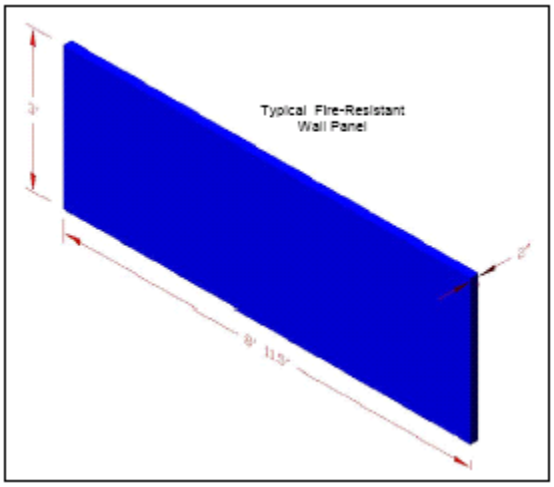



**FIGURE 2. View of the slide-in panel.**

Column Description

A steel I-beam, a reinforced concrete column, or a metal lattice structure can be used as the wall's strength member. In any design, the core must be protected with the mix material, as neither could withstand the high temperatures of fires in the intended applications, if no protection is applied in all cases, the concept would be of a sacrificial fire wall. The mix matrix is highly compatible with concrete and can be cast or applied over the concrete, in a similar manner as mortar. An I-beam or metal structure can be protected by cladding its exposed metal surfaces with panels bolted onto its flanges.

To make the concrete column removable, its reinforcement can be welded to a steel base plate at the butt-end. Another option is to cast a mirror image of the column's end in the foundation, such that the column mates into it and can be removed. To assure that the loads are transferred from the column to the foundation and the soil, the same mix grout is used to fill up the gap between the column and the cast foundation. The I-beam design also uses an attached base plate, as in conventional practice. The base plates of the columns are bolted to the foundation anchor bolts.

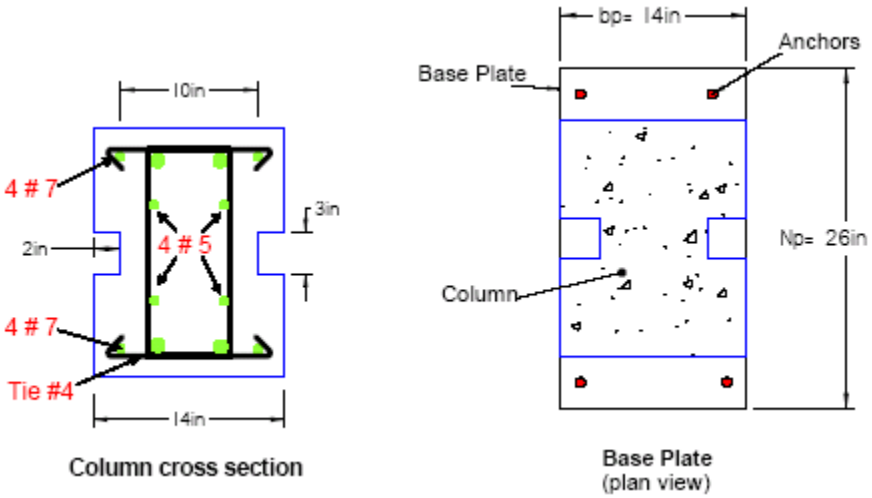



**Figure 3. Details of the fire wall columns.**

The cross section of the column has an 'H' profile to accommodate the slide-in panels in the slots of the 'H'. As many panels as needed are simply stacked on their edges to achieve the required height. The slot dimensions and its reinforcement are designed according to the operating specifications.

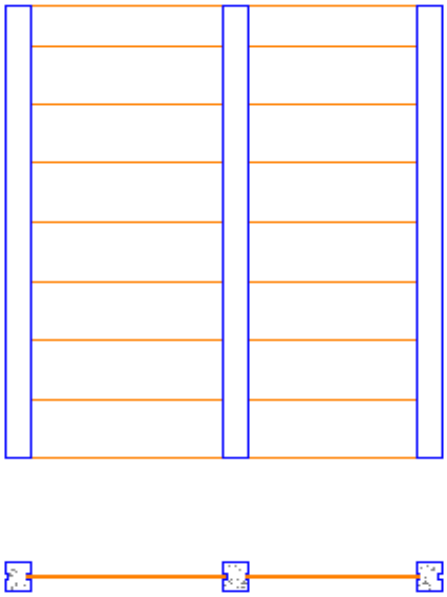


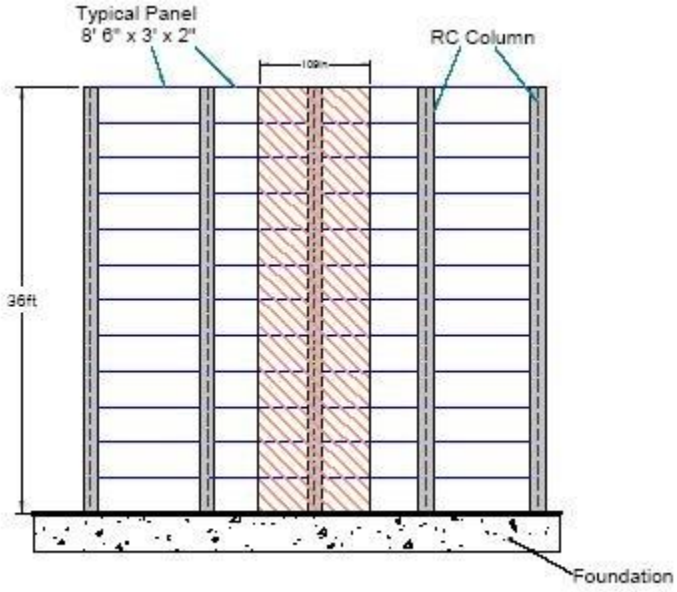
**Figure 4. Front and top views of a typical modular fire wall.**

Other Components

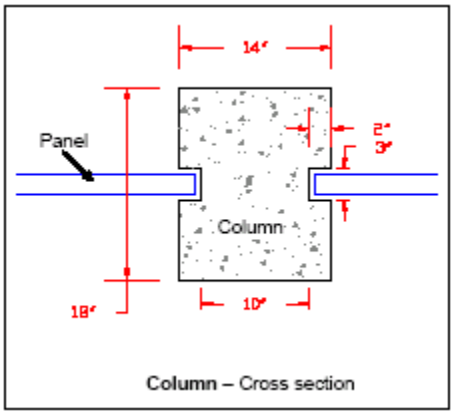
Depending on the wall height and other site-specific mechanical requirements, one or more sets of horizontal stiffeners running from column to column can be inserted (and bolted if needed to the wall columns). These pre-stressed stiffeners are made also from the reinforced silicate based mix material.

The edges are angled to mate with its neighboring panel and seal out heat and flames. This interface also aligns the panels to form a smooth surface.

All exposed bolt heads, foundation steel, lattice structures, gaps and joints will be covered or filled with the mix material to seal out flames and heat. The panels and columns can be drilled (and then sealed) to accommodate electrical ground-leads. Repairs in the field to damaged or modified panels are simple to make with fresh mix.




**Fire Wall Panel System** - Elevation




**Column** – Cross section

Material Data

The following are accurate representative values and could vary slightly according to actual processing and final geometric arrangement in the field:

**1. Mechanical properties at ambient temperature:**

a. Specific gravity: 134 pcf
b. Modulus of elasticity, E, ksi:
   2,500 – 5,000 Unreinforced (UR);
   15,000 – 25,000 Reinforced (SR)
c. Shear Strength, $F_v$, ksi (reported as Modulus of Rupture):
   1.1 (UR);
   14.4 (SR)

**2. Electrical conductivity and other electrical properties (UR):**

Dielectric strength = 90 v/mil; Dielectric constant ~ 5,
Resistivity = 52 x $10^{10}$ ohm-cm

**3. Thermal properties:**

**a. Thermal conductivity** (Hot Wire Method ASTM C-1113)

| After heating to | Btu-in/hr-ft$^2$-°F) |
|---|---|
| 400°F | 4.20 |
| 8000°F | 4.41 |
| 1200°F | 4.69 |
| 1825°F | 4.90 |

**b. Thermal expansion coefficient**

| | |
|---|---|
| From 100°F to 2000°F | 3.75 x $10^{-6}$ / °F |
| From 38°C to 1093°C | 6.72 x $10^{-6}$ / °C |

**c. Fire rating requirement:**

1,205°C continuous working temperature

**4. Available durability data for exposure to:**

**a. Ultraviolet**
All materials used in the walls are inorganic. No organic binding resins or epoxies are used. Therefore, these materials are inherently impervious to ultraviolet radiation degradation.

**b. Weathering**

An independent environmental testing laboratory has performed extensive freeze-thaw cycling tests on samples of the same silicate based material used in our fire walls. The stability in the value of the relative dynamic modulus of elasticity over the large number of freeze/thaw cycles constitutes clear evidence of the excellent durability of our material under such severe accelerated weathering.

In addition, the material's neutral pH guarantees that the matrix will not attack its reinforcement.

Other Considerations

**1. Wall Panels and Columns**

a. For panel walls designed to withstand a 35-psf-wind load or higher, wind load clearly governs over a typical 0.5 g seismic load.
b. The reinforced panels can be reinforced to withstand a design concentrated load at any location of the wall.
c. We can provide a supporting column thermal protection compatible with the panel ratings.
d. The panel subassemblies can be lifted simply by using standard lifting hooks that are inserted into hook openings at the top of each panel frame.
e. Any exposed bolt heads, foundation steel, metal structures, gaps and joints will be filled with the mix material to seal out flames and heat.

**2. Column Fire Protection**

a. Any supporting concrete columns could be fully protected with a C-shape mounting panel for continuous exposure up to 1,200**°C.**