Technical Features − Fire Construction
How To Select The Best
Residential Fire Separation Walls

GYPSUM FIRE WALL'S EFFICIENCY GIVES IT PERFORMANCE EDGE

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INTRODUCTION Residential fire walls must meet three structural considerations. First, they must form two separate membranes so that in a fire one side can collapse without compromising the entire fire barrier. Second, the walls must have details that insure that if the adjacent structure collapses in a fire, the fire wall won't collapse. Third, the walls must be designed for a uniform lateral load of 5 psf in order to insure lateral stability.

Residential fire walls offer important, specialized construction to protect occupants from fire in multifamily townhouses and other attached dwellings. Not only should these assemblies provide rated fire protection, (usually 2 hrs.), but they must also be designed to be structurally stable enough to withstand the collapse of an adjacent structure without losing their integrity as a wall.

Traditional thinking suggests that a wall must have great strength to withstand the force of a collapse on one side of it. Masonry has long been considered an acceptable material for residential fire walls because of its hardness and perceived strength. Codes frequently favor concrete masonry construction over comparable fire−rated gypsum drywall assemblies because of this traditional thinking.

Originally, masonry was the only acceptable and prevalent material available. And even though drywall has been widely accepted in fire wall construction for more than fifteen years, many codes still favor traditional masonry construction over comparable gypsum drywall assemblies for fire walls.

Comparison Of Structural Performance

A careful investigation of the structural criteria needed to meet the stability requirements for fire walls based on concrete masonry reveals favorable performance data for drywall construction that may surprise some designers.

The two principal code bodies that address the area separation−type fire/party walls are BOCA (See reference 1 below) −Building Officials Code Administrators International Inc. and SBCCI (See reference 2 below)−Southern Building Code Congress International. These code bodies identify such assemblies in their codes as either "fire wall," "party wall" or "townhouse separation wall." Each has essentially the same structural requirement:

"Such wall shall be continuous from the foundation to the underside of the roof sheathing . . . [or shall penetrate through the roof as a parapet]." (See reference 1 below) and "Walls shall have sufficient structural stability under fire conditions to allow collapse of construction on either side without collapse of the wall . . ." (See reference 2 below).

These statements alone are not very definitive for designing such walls in either masonry or gypsum drywall. For guidance, the most widely accepted reference document is that of the National Concrete Masonry Assn. (NCMA), TEK 95, "Design Details for Concrete Masonry Fire Walls."

This document recommends either a double wall or a single wall laterally supported for stability unless designed as a self−supporting cantilever. The document further states that the wall be designed to withstand a uniform lateral load of 5 lb./sq. ft. (See reference 3 below). The double wall comprising two separate fire−rated walls is most frequently used in load−bearing situations since the fireside portion of the double wall can collapse with the adjoining structure leaving the opposing fire wall in place.

However, the common masonry fire wall configuration separating residential wood−frame construction is the single wall in a non−load bearing mode as a divider between the wood−frame construction on each side. Lateral support can be provided to stabilize the wall at intermediate floors and roofs but the lateral attachment to the structure must be designed so that collapse of the fire−side structure will not cause the fire wall to fail.

The fire wall is not an impenetrable buttress as many expect, for a 5 lb./sq. ft. lateral design load (the stated recommendation of the NCMA−See reference 3 below) is no different than that of a common interior wall. Also, it is noteworthy to recognize that the code does not require resistance to collapse of the adjacent structure into the fire wall but rather that the fire wall remain standing after collapse.

The reality of field construction practices is the widespread use of unreinforced hollow concrete masonry. These masonry fire walls are often cantilevered off the foundation without any lateral support at intermediate floors or roof. As a result they may not meet the required 5 lb./sq. ft. lateral load design when erected to necessary building heights. For instance, at a design load of 5 lb./sq. ft. the wall height capacity of unreinforced hollow 8−in. concrete masonry units (CMUs) is about 10.3 ft. (See reference 4 below) when free standing as a cantilever and 18.0 ft. (See reference 5 below) when simply supported at roof or intermediate floor. If 12−in. CMUs are used, the heights increase to only 14.7 ft. (See reference 4 below) and 25.4 ft. (See reference 3 below) respectively.

Let's now take a look at the allowable lateral load of a typical freestanding unreinforced masonry fire wall. For example, an unsupported CMU fire wall 24 ft. tall in a typical two−story townhouse would have a design load capacity (laterally) of only 1 lb./sq. ft. (See reference 4 below) for 8−in. CMUs or 2.2 lb./sq. ft. (See reference 4 below) for 12−in. CMUs. Both of these load capacities are well below the design requirement of 5 lb./sq. ft.

Whether masonry fire walls are installed to meet the required 5 lb./sq. ft. design load or built taller with less load capacity, one must realize that the common masonry fire wall is not designed nor is likely able to resist the collapse of a structure into itself. The general success of these walls, however, justifies the proposition that collapsing structures in a fire fall down and away from the fire wall, rather than into it.

One other misconception regarding masonry fire walls that should be clarified is the question of durability. It is true that masonry is quite durable in a fire situation. However, the fire test evaluations of masonry were conducted in a load−bearing mode which causes the masonry to be considerably more stable laterally than when unloaded. Masonry is weak in tension. Therefore, the application of a bearing load compresses the masonry bond and improves its lateral stability. As explained above, these residential fire walls are non−load bearing and thus the masonry is weaker to lateral loads than what might have been demonstrated by fire test.

Finally, masonry walls have been evaluated to lose 30 to 60% of their strength due to fire (See reference 6 below). Accordingly, one must expect that repair or replacement of a fire wall after a fire event will be necessary regardless of the construction material−−masonry or drywall.

How Do Gypsum Drywall Fire Walls Stack Up?
Steel−framed gypsum drywall assemblies designed specifically for fire wall, party wall and townhouse separation wall construction have gained acceptance in use for over 15 years. They meet the stringent requirement of the code for fire resistance, structural stability and in−service performance.

The USG Area Separation Wall System (from U. S. Gypsum) conforms to the requirements for fire−resistive construction under the evaluation reports of:

BOCA Research Report No. 87−63, and SBCCI Report No. 9033.

The USG Area Separation Wall has been fire tested at Underwriters Laboratories and is listed with a 2−hr. fire resistive rating under UL Design U336. The test further verifies stacked construction for four−story buildings up to 44 ft. in height.

Structural stability to 5 lb./sq. ft. under fire conditions is achieved by providing lateral support from the structure to the fire wall at intermediate floors and roof. The connection is by way of a special aluminum clip that also performs as a breakaway fuse by melting or yielding from the rise in temperature on the fire side of the wall, allowing the fire−engulfed structure to collapse independent of the fire wall. The melt point of the aluminum clip is 1,220°F., a temperature met within ten minutes under fire conditions. The breakaway feature of the aluminum clip has been accepted by the three model codes and other jurisdictions.

What better evidence can one provide of the durable performance of these gypsum drywall assemblies than their performance under actual fire situations? Demonstrated fire resistive performance has been recorded at numerous actual fire sites.

At Sayrebrooke Townhouses in Sayreville, N. J., a solid−type USG Area Separation

Wall withstood an arson fire in an unoccupied unit on April 25, 1979. The duration of the fire was estimated by a local code official to be in excess of 2−1/2 hrs., with no evidence of penetration of the fire wall. Also, the aluminum breakaway clips functioned exactly as they were designed, allowing the fire−damaged structure to fall away without pulling down the fire wall.

At Greenhouse Apartments in Lexington, Ky., in a fire started in an occupied townhouse unit another USG Area Separation Wall withstood the fire for about 30 min., until the fire department arrived. The surface of the wall was only blackened in that time. The fire marshal and unit owners were extremely pleased with the performance of the gypsum drywall system.

Still another project that experienced a fire with positive results was the Forest Pointe condominium project in Cliffton Park, N. Y. In this project a fire started in a fireplace flue on December 23, 1989, resulting in little damage to the USG Area Separation Wall.

Thus, it is clear that, while masonry is well accepted as an effective fire separation wall, drywall systems, such as the USG Area Separation Wall, also perform equally well. These two construction types appear to perform similarly in a fire situation. Indeed, when considering weight and cost, drywall actually has an edge. While masonry features raw bulk strength, the comparable drywall assembly depends on innovative engineering design and innate elasticity. The resulting wall is thinner, lighter and less expensive while providing equal resistance to fire and lateral load.

References

1. BOCA National Building Code/1990, Section 907.0.

2. SBCCI Standard Building Code/1988 Paragraph 403.5.

3. NCMA−TEK 95, "Design Details for Concrete Masonry Fire Walls."

4. Calculated. Design assumptions: cantilevered; allowable flexural tensile stress 23 lb./sq. in., increased one−third for wind; 100 lb./cu. ft. hollow block, Section Modulus S=81 (8−in. CMU) and 160 (12−in. CMU) per NCMA−TEK 2A, "Sizes and Shapes of Concrete Masonry Units."

5. NCMA−TEK 63, "Partially Reinforced Concrete Masonry Walls."

6. NCMA−TEK 117, "Evaluation of Concrete Masonry Walls After Being Subjected to Fire."