THE HIGH-RISE CAVITY SHAFTWALL SYSTEM BEGAN WITH THE WORLD TRADE CENTER

On April 4, 1973, New York Governor Nelson Rockefeller cut the ribbon on the world’s two tallest buildings, proclaiming, “It’s not too often we see a dream come true. Today, we have.” The World Trade Center, which began as a pavilion at the 1939 World’s Fair dedicated to the concept of “world peace through trade,” stood 110 stories and 1,368 feet in height.

But before ground was broken to construct the World Trade Center, the team was reengineering core systems to accommodate this record-high building. The architects and engineers asked major gypsum board manufacturers to develop a gypsum-based alternative to conventional masonry elevator enclosures. Their answer would be the gypsum shaftwall system (known today as Cavity Shaftwall System). The gypsum shaftwall system utilizes gypsum board framed by metal studs and channels to enclose elevator shafts, stairwells and vertical service shafts. These shaftwalls incorporate built-in characteristics designed to withstand the positive and negative air pressure forces exerted by high-speed elevators.

ADVANTAGES OF THE CAVITY SHAFTWALL SYSTEM

In addition to maintaining structural integrity, gypsum shaftwall systems provide many benefits. They are lightweight, easy to install, weather-, sound- and fire-resistant and more economical than other types of shaftwall construction. Originally designed for and installed in the World Trade Center, gypsum shaftwalls are four to five times lighter and considerably less expensive to install than other types of enclosures. They weigh approximately 10 pounds per square foot of wall compared to 40 or 50 pounds per square foot for other types of wall systems. This is key to a project like the World Trade Center. A weight savings of this magnitude rapidly translates into major savings, especially considering the unprecedented height of this high-rise.

Further, buildings utilizing the gypsum shaftwall system require less structural steel and less extensive underground support pilings. In addition, the core of the gypsum panels in the gypsum shaftwall system contains about 21 percent water by weight, creating a fire barrier with a 2-hour rating from either side. If the shaftwall gypsum panel is exposed to fire, the water is slowly released as steam to effectively retard heat transmission. The Cavity Shaftwall System is typically installed using 1-inch-thick gypsum shaftliner panels inside a minimum 2-1/2-inch metal structural framing with an integral space to hold the panels in place on the shaft side. Metal J-track runners are placed horizontally on the top and bottom and vertically at partition ends. They also frame openings. Two layers of 5/8-inch or 1/2-inch fire-rated gypsum wallboard then fasten to the outside of the stud, creating the corridor side of the enclosure.

REINFORCEMENTS DEVELOP AS A RESULT OF 9/11/2001

Since that first installment in the World Trade Center, gypsum shaftwall systems have become standard equipment in nearly every medium- and high-rise building to come off the drawing boards. But the systems currently built underwent reinforcements after the deliberate destruction of the World Trade Center on September 11, 2001.

In response to 9/11 events, officials of the City of New York created Local Law 26, which was signed by Mayor Michael Bloomberg on June 24, 2004. The new law amended the Building Code and Fire Prevention Code to incorporate retroactive requirements and prospective provisions. To address stair and elevator enclosures, Local Law 26 added the new requirement of hardened shafts as components in Cavity Shaftwall Systems.

As stated, high-rise buildings with an occupied floor 75 feet or higher above lowest level of fire department access must have impact-resistant stair and elevator enclosures, constructed with impact-resistant materials. Local Law 26 mandated that high-rise office buildings, constructed pursuant to applications filed on or after July 1, 2006, be built with impact-resistant stair and elevator enclosures, and required that the Commissioner of Buildings adopt a rule establishing the technical standards for their installation. Chapter 32-05 stated that for Impact-Resistant Stair and Elevator Enclosures, a compliant wall assembly shall be substantially identical to, and shall provide an impact resistance equivalent to or exceeding the performance of one of the following:
STUD WALL

Materials: Impact-resistant construction board will be sheathed on the impact face of the stair or elevator enclosure wall assembly. It shall undergo testing by a laboratory acceptable to the commissioner in accordance with the requirements of ASTM C1629 (Standard Classification for Abuse-Resistance—Non-Decorated Gypsum Panel Products & Fiberglass-Reinforced Cement Panels). The impact face shall be considered as the exterior of the stair or elevator enclosure, on the occupied side of the building, and shall be comprised of two layers of construction boards. The construction board used as the base layer panel shall meet or exceed Classification Level 2, as measured by the method described in ASTM C1629, and the face panel shall be a minimum 5/8-inch gypsum construction board. The wall assembly shall have a minimum two-hour fire-resistance-rating as measured by the method described in ASTM E119. It shall also meet or exceed Soft Body Impact Classification Level 2 (195 ft.-lbs.) as measured by the method described in ASTM C1629.

Installation: Studs shall be minimum 3-1/2-inch depth metal studs, at least 33 mils thick (20 gauge). Vertical studs shall be spaced a maximum distance of 24 inches on center. Runners shall be securely attached at the floor and ceiling to structural element members in such a manner that provides lateral resistance in excess of the equivalent energy of Soft Body Impact Classification Level 2 of ASTM C1629. The installation of top and bottom runner tracks shall be subject to controlled inspection. Construction boards shall be attached with No. 8 self-drilling bugle-head screws, 12 inches on center maximum with a minimum depth of 5/8-inch penetration into the wall cavity. Screw attachments shall meet the requirements of ASTM C1002, Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases. Joints between adjoining sheets of construction board shall be staggered from base layer with face panel layer.

CONCRETE AND MASONRY WALLS

Concrete or masonry walls shall satisfy the impact-resistance requirements of this section provided that the enclosure walls are anchored to structural members that provide lateral support as required by the seismic provisions of RS 10. The assembly shall be rated for two-hour resistance, as measured by the method described in ASTM E119.

OTHER WALL ASSEMBLIES (INCLUDING CAVITY SHAFTWALL SYSTEMS)

Impact Face: Boards or materials constituting the impact face of the stair or elevator enclosure assembly shall be tested by a laboratory, acceptable to the commissioner, to provide an impact resistance equivalent to gypsum panel meeting Hard Body Impact Classification Level 3 resistance (150 ft.-lbs.), as measured by ASTM C1629. When more than one layer of material is required to meet the impact-resistance requirement, such layers shall be tested in tandem.

Assembly: The wall assembly shall have a minimum two-hour fire-resistance-rating as measured by the method described in ASTM E119. The wall assembly shall meet or exceed Soft Body Impact Classification Level 2 as measured by the method described in ASTM C1629.

Installation: Wall assemblies shall be anchored to structural members in such manner that provides lateral resistance in excess of the equivalent energy of Soft Body Impact Classification Level 2 of ASTM C1629. The installation shall be subject to controlled inspection.

The International Building Code (IBC) establishes the minimum requirements for high-rise buildings in Section 403. As a result of the September 11, 2001 attacks, the International Code Council’s Board of Directors appointed an Ad hoc Committee on Terrorism Resistant Buildings (TRB). The TRB was the proponent that eventually was able in the 2009 IBC to have verbiage added similar to Local Law 26. This created the IBC Section 403.2.3—pertaining to “Structural
Integrity of Interior Exit Stairways and Elevator Hoistway Enclosures in High-Rise Buildings.” Implemented to further protect these elements and incorporated into the IBC, the revisions state, “For high-rise buildings of Risk Category III or IV in accordance with Section 1604.5, and for all buildings that are more than 420 feet in building height, enclosures for interior exit stairways and elevator hoistway enclosures shall comply with Sections 403.2.3.1. – 403.2.3.4.” These sections echo the requirements of Local Law 26 (listed above).

THE FUTURE

The Cavity Shaftwall System has many advantages, and it is a strong, viable option for the future life and safety of high-rise buildings. New gypsum board innovations will continue to arise as proposals and testing lead to tomorrow’s next breakthrough. Mark Chapman is Senior Manager of Construction Services at National Gypsum Company. He currently oversees National Gypsum’s construction services department, which provides technical support to the construction industry for NGC products, gypsum board systems and specifications. He also serves on the Gypsum Association building code and technical committee. He has been involved with the development of construction systems and in the construction field for more than 30 years. Contact Mark at mkgrmc@NationalGypsum.com or 1-800-NATIONAL.

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HOW IMPACT AFFECTS A CAVITY SHAFTWALL SYSTEM

For a Cavity Shaftwall System to be considered impact resistant, it must meet the test standards of ASTM (American Society for Testing and Materials) C1629. ASTM C1629 is the “Standard Classification for Abuse-Resistant Non-Decorated Interior Gypsum Panel Products and Fiber-Reinforced Panels.”

Stair and elevator enclosures in high-rise buildings (with an occupied floor located more than 75 feet above the lowest level of fire department vehicle access) with an assigned Risk Category of III or IV and all buildings more than 420 feet in height (between the grade plane and the average roof height of the highest roof) are required to have resistance to hard- and soft-body impact.

Impact-resistant gypsum board is designed to counteract intrusion into the wall cavity. To categorize how well gypsum board resists impact, ASTM divides its classification into three levels: Level 1 through Level 3. Level 1 represents the lowest performance rating and Level 3 represents the highest performance rating achieved by testing any given property.

The shaft enclosure must meet or exceed a Soft-Body Impact Classification Level 2 (in accordance with ASTM C1629) and have a layer of impact-resistant material with a Hard-Body Impact Classification Level 3 (in accordance with ASTM C1629).

SINGLE DROP SOFT-BODY IMPACT (modified ASTM E695)

This test measures the ability of a gypsum panel to withstand a single impact of a heavy, soft object. This test is conducted by swinging a leather bag loaded with steel pellets into the panel. When the panel breaks, the height of the drop and weight of the bag are used to calculate the foot-pound measurement required to break the panel. The test was originally developed to measure relative resistance of wall, floor, and roof construction to impact loading.

<table>
<thead>
<tr>
<th>Classification Level</th>
<th>Soft-Body Minimum</th>
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<tbody>
<tr>
<td>1</td>
<td>90 ft.-lbs. (112 J)</td>
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<tr>
<td>2</td>
<td>195 ft.-lbs. (265 J)</td>
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<tr>
<td>3</td>
<td>300 ft.-lbs. (408 J)</td>
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HARD-BODY IMPACT (Annex A1)

This test measures the ability of a gypsum panel to withstand the impact of a hard object, such as a hammer or the heel of a boot. A panel is impacted with a 2-3/4 steel cylinder mounted to a ram. Weights are added to the ram and the panel is impacted one time. The maximum amount of impact force the panel can withstand without breaching the stud cavity is reported. This is a new test proposed by manufacturers of high-performance panels.

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<tr>
<th>Classification Level</th>
<th>Hard-Body Minimum</th>
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<tbody>
<tr>
<td>1</td>
<td>50 ft.-lbs. (68 J)</td>
</tr>
<tr>
<td>2</td>
<td>100 ft.-lbs. (136 J)</td>
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<tr>
<td>3</td>
<td>150 ft.-lbs. (204 J)</td>
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