


USG presents

# A COMPARATIVE GUIDE: UNDERSTANDING AND SPECIFYING ABUSE-RESISTANT WALL SYSTEMS

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**IT USED TO BE THAT WHEN HIGHLY DURABLE WALLS WERE DESIGNED FOR** buildings such as schools, community centers or correctional institutions, cement masonry units (CMUs), cast concrete and three-coat gypsum plaster were the only viable options. While those construction methods certainly remain sound choices for some building applications, architects have far more abuse-resistant (AR) alternatives today than ever before.

Abuse resistance has evolved from a product focus (masonry, plaster) to a systems approach encompassing the entire wall construction. Today's AR systems include every construction component, from framing to finishing and decorating materials. They not only ensure that a structure's interior walls will resist damage and remain secure, but accommodate many other design and construction considerations. From reducing installation time to performance flexibility, greater aesthetics, and improved maintenance and life-cycle costs, the right AR system will meet a particular building's needs better than any one product can.

## DEFINING ABUSE RESISTANCE

Before specifying a system, it is helpful to know what is meant by "abuse resistance." Although many manufacturers call products "abuse resistant," there is no industrywide definition for this concept or formal test methods by which to measure it. The American Society for Testing and Materials (ASTM) is in the initial stages of reviewing various test methods to measure abuse resistance, but until standards are established, specifiers have only the data from individual manufacturers to rely upon.

Most manufacturers strive to define abuse resistance in the same general way, but modifications to the current ASTM tests during the marketing of products make consistent comparisons difficult. When reviewing manufacturers' AR test data and product information, architects should ask:

- Are companies using current ASTM tests to measure their own products' performance?
- Do their tests represent the real-world conditions I anticipate in my project?

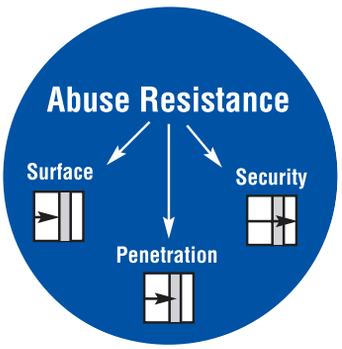
AIA/ARCHITECTURAL RECORD
**CONTINUING EDUCATION** Series

Use the learning objectives below to focus your study as you read **A COMPARATIVE GUIDE: UNDERSTANDING AND SPECIFYING ABUSE-RESISTANT WALL SYSTEMS**. To earn one AIA/CES Learning Unit including one hour of health safety credit, answer the questions on page 178 and follow the reporting instructions on page 218. Or, use the Continuing Education self report form located at www.architecturalrecord.com.

### LEARNING OBJECTIVES:

- Define abuse resistance in terms of three categories: surface damage, penetration and security.
- Compare the benefits of masonry and AR wall systems.
- Discuss abuse-resistance testing.
- Explain the components that make up abuse-resistant wall systems.

So what does "abuse resistance" mean? At the most fundamental level, abuse resistance can be defined generally as the ability of a wall to resist three primary types of harm:




**SURFACE DAMAGE** — Abrasion (scratching and gouging) or indentation (denting) of the wall face caused by ordinary contact with people or objects under heavy, but normal, use for a particular building. This damage is mainly aesthetically unattractive. A test that accurately replicates abrasion on AR products is the granual embedment test, where a weighted steel brush is cycled over a product sample until a measurable level of damage is observed. For indentation testing, the Universal Impact Tester replicates typical denting with a rounded punch.

**PENETRATION** — Impacts that penetrate the wall surface and enter the wall cavity causing damage such as holes or cracks that are unsightly, costly to repair and potentially dangerous. Hard-body impacts result from direct, concentrated contact with a tool or other hard object; soft-body impacts result from bodily contact with a building's human occupants. A Swinging Ram Impact Penetration apparatus is an excellent tool for testing penetration, for it tests both hard- and soft-body impact in a way that replicates real-life conditions.

**SECURITY BREACHES** — Forced entry or escape that causes significant wall damage or destruction and breaches the safety of a high-security building. The U.S. Department of State has the most stringent forced-entry tests.

Damaged walls can occur in any building, of course, but are commonly found in the following types of facilities:

| INSTITUTIONAL | COMMERCIAL | RESIDENTIAL |
|---|---|---|
| Education | Hotels | Multifamily |
| Health Care | Restaurants | High-Rise Public Housing |
| Life Care | Stores | |
| Detention | Shopping Malls | |
| Government | Airports | |
| Museums | Banks | |

Surface damage is typically found, for example, on the walls of offices, hotel lobbies, restaurant dining rooms and medical clinic waiting rooms, among many other locations. It's caused by repeated contact with passersby, luggage, food or mail carts, vacuum cleaners, furniture, etc.

Penetration-type damage is typically found on the walls of hospital corridors or emergency rooms, high school gymnasiums and locker rooms, an apartment building's common hallways or a loading dock, among other heavily used places. It's often caused by impacts from gurneys or other equipment, or strikes from a tool such as a hammer.

Damage from security breaches is usually a concern for buildings where it is important to prevent someone from deliberately and completely breaking through a wall. Examples could include prisons, military installations, embassies, art museums and bank or jewelry-store vaults.

Once architects are clear about the types of buildings typically needing AR systems and the level of damage that usually occurs in various areas of those facilities, they should consider the following issues related to their project:

- **DESIGN REQUIREMENTS.** Would AR systems incorporating framed walls be more desirable to accommodate electrical and plumbing lines, as well as telecommunications and computer cables? Will weight and space limits require lighter, thinner walls? Will the spaces likely be remodeled in the future, requiring the relocation of walls?
- **FIRE AND ACOUSTICS STANDARDS.** AR systems offer fire resistance and sound control to varying degrees, depending on their components. Select the system that best meets specific project concerns.
- **CONSTRUCTION VERSUS LIFE-CYCLE COSTS.** While the tendency to focus on the initial cost of materials is a heavily weighed factor, specifiers should consider all the benefits an abuse-resistant system provides over the long term, including its design flexibility and ease of maintenance. Unexpected factors can come into play here: panel-based systems, for example, are much more easily altered or moved and are much easier to repair than masonry, which can be damaged and is difficult to repair to an aesthetically pleasing appearance.
- **AVAILABLE LABOR.** The lack of certain tradesmen in some regions may preclude the specification and use of plaster-based AR systems, but could leave open the option to use engineered panel systems that drywall installers and finishers could complete.
- **AESTHETICS.** While the surfaces of CMUs and cast concrete may be acceptable in some environments, AR systems that produce a smoother, more monolithic surface may be required or more desirable for certain projects.

## COMPARING AR MATERIALS

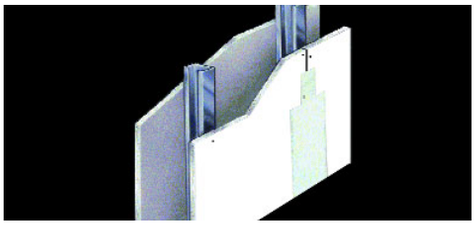
Viewing abuse resistance as a design consideration gives the specifier flexibility in tailoring the application to meet varying client needs. Understanding how various materials perform aids in choosing the right AR system for a particular client.

Masonry has been widely used for years to construct abuse-resistant walls. While it resists all three types of damage, masonry is not immune to abuse and may pose certain construction and maintenance challenges. Compared to various partition-wall systems, masonry also weighs considerably more and occupies more space. All of these factors reinforce the need to view abuse resistance in terms of the structure, the spaces within and their intended use.

Partition-wall AR systems are composed of one or more materials to achieve light-to-extreme levels of abuse resistance. Abuse-resistant drywall, engineered panels (such as gypsum wood fiber panels), veneer plaster, and conventional plaster and lath are the products most commonly specified for abuse resistance. Veneer plasters (the harder the plaster the better), engineered panels without face paper or laminate-faced panels combat abrasion best. Indentations are avoided with systems that incorporate panels with increased core or surface hardness. Penetration resistance is achieved by adding mass (usually through using layers of panels) or by using panels with improved core strengths or a reinforced backing of Lexan® (a polycarbonate material) or mesh.

*A weighted swinging ram replicates "real-world" conditions by simulating the direct-concentrated impact of a tool or hard object against a wall system.*

# ABUSE-RESISTANT SYSTEMS



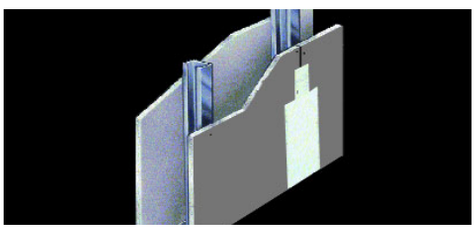
**LIGHT-DUTY UPGRADE**

Abuse-resistant gypsum panels provide a light-duty upgrade for surface damage and penetration resistance.

System components:

$^5/_8$" Type X paper-faced abuse-resistant gypsum panel, setting-type joint compound, paper tape; minimum $2^1/_2$" 20 ga. metal framing spaced 16" o.c. maximum.

Provides 1-hour fire-resistance rating.



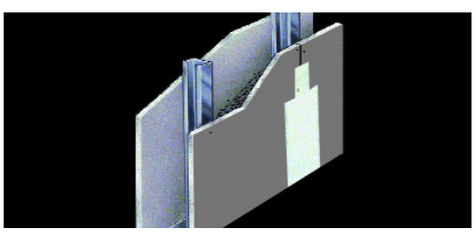
**LIGHT- TO MODERATE-DUTY UPGRADE**

Engineered gypsum fiber panels provide a light- to moderate-duty upgrade for surface damage and penetration resistance.

System components:

$^5/_8$" Type FRX engineered gypsum fiber panel, setting-type joint compound, paper tape; minimum $2^1/_2$" 20 ga. metal framing spaced 16" o.c. maximum.

Provides 1-hour fire-resistance rating.



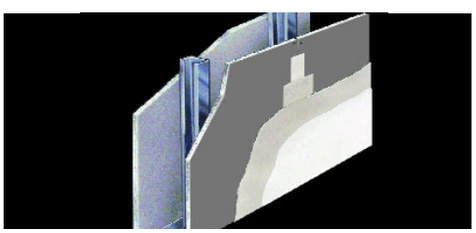
**MODERATE- TO HEAVY-DUTY UPGRADE**

Engineered gypsum fiber panels with mesh reinforcement provide a moderate- to heavy-duty upgrade for surface damage and penetration resistance.

System components:

$^5/_8$" Type FRX engineered gypsum fiber panel with mesh reinforcement on back, setting-type joint compound, paper tape; minimum $2^1/_2$" 20 ga. metal framing spaced 16" o.c. maximum.

Provides 1-hour fire-resistance rating.



**HEAVY-DUTY UPGRADE**

High-impact-resistant engineered gypsum fiber panels covered with high-strength veneer plaster basecoat and finish provide a heavy-duty upgrade for surface damage and penetration resistance.

System components:

$^5/_8$" Type FRX engineered gypsum fiber panel, setting-type joint compound, paper tape, high-strength gypsum veneer basecoat plaster (3,000 psi), high-strength non-lime gypsum finish plaster (3,000 psi); minimum $2^1/_2$" 20 ga. metal framing spaced 16" o.c. maximum.

## SPECIFYING SYSTEMS

When looking at a structure and the spaces within, defining a building's intended use and prioritizing its AR characteristics will lead naturally into the specification process. Given recent revolutionary changes in the technology of abuse-resistant products and systems, including the latest wood fiber engineered panels, architects have more flexibility than ever before in choosing a system that will perform well for a specific project.

In the case of light-duty applications such as retail public spaces and primary grade classrooms, a variety of $^1/_2$-inch abuse-resistant drywall panels is available. They offer increased resistance to surface abuse and impact for just cents more per square foot over standard $^5/_8$-inch drywall and still require joint treatment finishing only. Engineered wood fiber panels in $^1/_2$-inch and $^5/_8$-inch thicknesses go up much like drywall, require joint-treatment finishing only and offer even more surface and penetration protection for light-duty applications. Finishing certain AR panels with a one-coat veneer plaster also offers an upgraded, smoother surface and slightly more abrasion and penetration protection in this category.

Moderate-duty systems are appropriate for stairwells, common areas of multifamily housing and high school classrooms, for example. They provide moderate resistance to incidental impact and abrasion at a slightly higher cost than light-duty systems. For walls finished with joint treatment only, $^5/_8$-inch wood fiber panels designed for very high impact provide markedly more penetration resistance than comparable options at this level. Other moderate-duty systems include AR panels finished with one- or two-coat veneer plaster, the latter providing significantly more resistance to abrasion.

For heavily used areas such as dormitories, health care facility corridors and loading docks, walls must resist intentional and heavy surface and impact damage. Two-coat veneer plaster systems over very high impact wood fiber panels or two layers of AR drywall panels and an AR veneer plaster face will provide substantial abrasion, indentation and penetration resistance for $1^1/_2$ to two times the cost of standard drywall. Again, assessing the type of heavy-duty use allows specifiers the freedom to tailor an AR assembly to meet the project requirements.

For the most demanding applications — security-related facilities such as jails, currency exchanges and art galleries — AR systems that incorporate specially formed steel sheets and high-strength plasters provide greater penetration and abrasion resistance than 8-inch core-filled CMUs. This type of AR system also supports the weight of wall-mounted sinks and beds, as well as heavy artwork and shelving. Additionally, these systems can weigh nearly one-third of what CMU walls do and take up less than half the space, which are important considerations in buildings with multiple floors or smaller rooms. At the point when these systems' steel sheets are erected, the walls also allow for easier installation of plumbing and electrical lines, much like cavity stud partitions. As a result, they indirectly reduce costs for plumbing and electrical installation.

## THE FINISHING TOUCH

The desired level of finish also may help dictate the type of AR system chosen for a project. The corridors of a correctional facility or school, for example, may require only the most basic of finishes. However, the abuse-resistant walls of an office building lobby or retail store may require a more highly polished look.

Paint or various coatings can decorate masonry walls, but will not provide a smoothly finished surface. Plaster-and-lath systems provide a monolithic surface that is then painted.

Panelized systems can be finished to a high level with paint, veneer plaster or wallcoverings for a more sophisticated look.

## A WORD ABOUT CEILINGS

Architects should not overlook their projects' ceilings when considering abuse resistance. From students impaling pencils in ceiling panels to accidental damage done by maintenance crews, ceilings can be subject to scratches, dents and penetrations just like walls. Drywall is usually the best choice for designing abuse-resistant ceilings. It is typically attached using traditional furring methods or via engineered suspension systems. For smaller areas, gypsum board panels also can be installed directly to metal studs. However, drywall may not provide the access or sound control desired.

For suspended ceiling systems, the most durable panels are cast products, which are formed and cured in a mold. They are harder and resist damage better than standard acoustical panels. And since their color is uniform throughout the panel, rather than simply painted on the surface, nicks are less visible. Cast-manufactured products are available in a variety of patterns.

# CASE STUDIES

## SCHOOL OPTS FOR WOOD FIBER PANELS OVER CMUS

When architect Spencer Armour of Memphis-based Braganza Associates P.C. designed the Sacred Heart Catholic School in Southaven, Miss., he knew the 55,000-square-foot project required abuse-resistant walls, but needed to contain costs and allow for future room configurations as well. So, instead of using concrete block, he opted for FIBEROCK® Brand Abuse-Resistant Panels from USG Corporation. They provided the necessary durability for the gymnasium, corridor and cafeteria walls, and created movable wall partitions with a monolithic appearance. "Most importantly, the square-foot cost of using FIBEROCK was at least half the cost of building with concrete block," said Armour.

## SECURITY WALL SYSTEM IS JUDICIOUS CHOICE

Walls that stand up to forced entry and ballistics were crucial for a new criminal courts building in the Broward County Judicial Complex in Fort Lauderdale, Fla., especially for the holding cells and passageways. Project designer Carlos Marciales of Michael A. Shift & Associates, Inc., (Fort Lauderdale) chose the STRUCTOCORE™ Security Wall System from USG Corporation for its security-level durability and more. The system's specially formed steel sheets and high-strength plasters create walls that are nearly 40 percent thinner than concrete block. "We saved a lot of labor time, and the walls weighed significantly less," said Marciales, whose firm pioneered STRUCTOCORE's use in the project's elevator shafts.

## PLASTER SYSTEM STANDS UP TO ADOLESCENT ENERGY

The adage "Time will tell" certainly applies to the performance of walls at Hillenbrand Hall, a 300,000-square-foot, $3 million dormitory built six years ago at Purdue University, West Lafayette, Ind. "We built these walls to last," said John Richardson, the dormitory's manager. Instead of using less expensive drywall, the school invested in a three-coat plaster system comprising STRUCTO-BASE® Gypsum Plaster and RED TOP® Keenes Cement from USG Corporation for attractive yet durable walls. Six years later, Richardson comments, "We haven't performed any maintenance but painting on these walls. They'll probably last for decades before needing resurfacing."

## MORE SOURCES OF AR INFO

To learn more about abuse resistance and obtain details on specific products and systems, there are several places to which architects and builders can turn. Look for continuing education seminars on the topic sponsored by organizations such as the American Institute of Architects. Manufacturers of AR systems, such as USG Corporation, which has worked extensively over the last 20 years to develop abuse-resistance guidelines, offer seminars, technical brochures and guidelines on the topic. Also visit the Web sites of gypsum product manufacturers and masonry companies, where specifiers often can find special sections devoted to abuse resistance.

## ABOUT USG

USG is a Fortune 500 company with subsidiaries that are market leaders in their key product groups: gypsum wallboard, joint compound and related gypsum products; cement board; gypsum fiber panels; ceiling tile and grid; and building products distribution. The company offers a range of abuse-resistant wall systems featuring use of SHEETROCK® Brand Gypsum Panels, FIBEROCK® Brand Abuse-Resistant Panels, veneer plasters and plasters.

For more information about the company's abuse-resistant systems, write USG at P.O. Box 806278, Chicago, IL 60680-4124, call USG's Customer Service Department at 1-800-USG-4YOU or visit the company's Web site at www.usg.com.

## LEARNING OBJECTIVES:

- Define abuse resistance in terms of three categories: surface damage, penetration and security.
- Compare the benefits of masonry and AR wall systems.
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## INSTRUCTIONS:

Refer to the learning objectives above. Complete the questions below. Then turn the page upside down and check your answers. Fill out the self report form on page 218 and submit it or use the Continuing Education self report form on *Record's* web site - www.architecturalrecord.com - to receive one AIA/CES Learning Unit including one hour of health safety welfare credit.

## QUESTIONS:

1. What is meant by the term "abuse resistance?"

2. What components are used for resisting different amounts of abuse in AR systems?

3. What is the most abuse-resistant type of ceiling material?

4. What are the advantages of AR wall systems over masonry construction walls?

5. What finishes are available for abuse-resistant applications?

## ANSWERS:

1. Generally, abuse resistance is defined as the ability of a wall to resist harm from an abrasion that damages the surface of the wall, an impact that penetrates the wall surface and a penetration that causes significant wall damage and breaches the security of the building.

2. For light-duty, AR drywall panels, drywall panels with improved face paper and engineered wood fiber panels are available. For moderate-duty, wood fiber panels designed for high impact or AR panels with veneer plaster or laminate-faced panels are available. For heavy use, these AR wall systems can be used together, such as a two-coat veneer plaster system over high-impact wood fiber panels or two layers of AR drywall panels and an AR veneer plaster face. In security applications, AR systems can incorporate high-strength plaster reinforced by steel sheets or concrete block.

3. Commonly, ceilings are acoustical panels on a suspended grid. These usually have a painted surface and are easily damaged. The panels can be made abuse resistant by using more durable cast products with color throughout the panel so that scratches are less visible. Abuse resistance is highest when ceilings are made of gypsum board panels, which can be attached on furring strips directly to ceiling rafters, or through suspension systems.

4. Traditionally, masonry walls were used for resisting abuse, either surface damage or penetration. Masonry has the added advantages of being fire resistant and the materials are available and inexpensive. However, the development of AR wall systems offers advantages over masonry. Most noticeable is the weight difference; masonry weighs five to eight times more than AR wall systems of drywall, wood fiber or veneer plaster. A second advantage is the construction time. While masonry requires a 60- to 90-day curing time during the construction process, AR wall systems are brought to a job site ready to install with only a joint treatment necessary for finishing. The next critical element is labor. Masonry labor has become specialized, difficult to find in some areas and expensive. Masonry construction also requires water availability and constant temperature levels. The other advantages of AR wall systems are that they require less floor space and they can reduce the cost of plumbing and electrical installation while providing better abuse resistance for abrasion and penetration than concrete masonry units.

5. Abuse-resistant finishes can be left basic, finished with a paint coating or covered with plaster. Plaster applied to the wall surface gives a smooth finish that can be painted or wallpapered to give a more sophisticated appearance.