
GYPSUM SHEATHING

A State of the Art Review

Thanks to steel framing and exterior insulation, this popular product is enjoying a resurgence

Gypsum sheathing is one of the lesser known and perhaps least understood gypsum products. It is a gypsum board product specifically developed for protected use on the exterior walls of a building. The product was designed to enclose a building with a weather-resistant and dimensionally stable substrate over which a weather-proof barrier is mechanically fastened through the sheathing and into the structural members.

Developed in the 1920s, gypsum sheathing was the first truly "new" innovative use of gypsum panels following the use of gypsum lath (plaster base) and wallboard substrates for interior walls and ceilings. Although "plaster board" had been invented in 1888, the modern age of lighter, stronger products we know today, did not begin until 1926 with the wide-



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spread introduction of cellulosic fibers and soap bubbles into the core.

Gypsum sheathing was uniquely

different from standard wallboard products in several ways: (1) for moisture resistance, the core was treated by the mixing of additives such as asphalt emulsions, oils and waxes during the manufacturing process, (2) the surfacing papers were treated to be more water-repellent than the normal cream-face and grey-back papers, (3) the special size (2' x 8') and edge configuration (v-tongue and groove) were radical modifications and (4) the product was also tested for contribution of structural racking properties.

Gypsum sheathing was developed as an economic alternative to 25/32" asphalt impregnated fiberboard sheathing. Both gypsum and fiberboard sheathing offered exceptional labor savings compared to 1" x 8" or 1" x 6" diagonally applied solid wood sheathing customarily used at that time. Both were fabricated with tongue and groove edges to minimize wind and water infiltration without the addition of building felt, and both were produced in convenient 2' x 8' sizes that were easy to handle and apply from scaffolding by one person.

There were differences. Fiberboard sheathing claimed insulation properties whereas gypsum sheathing was promoted for its fire-resistive characteristics. Because of the considerable cost advantage of gypsum sheathing, the fiberboard industry countered with a 1/2" thick 4' x 8' product. Eventually a 4' x 8' gypsum sheathing was made

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Jim attended Duke University and served several years in the U.S. Navy during the Korean War.

With a two year leave of absence from Flintkote, he worked for the Gypsum Association at NBS as a research associate in the Center for Fire Research.

He is a member of NFIPA, CSI, ASTM and the three model code groups ICBO, BOCA and SBCCI.

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“The use of gypsum sheathing continues to expand whereas the use of fiberboard sheathing had decreased almost to the point of obsolescence.”

available. Other features such as tested shear and corner-bracing requirements and high-density nailing bases were often cited as competing differences.

Billions of square feet were used during World War II for the construction of “temporary” housing, offices and military installations that had to be built quickly. Each product garnered excellent market shares during the post war housing boom.

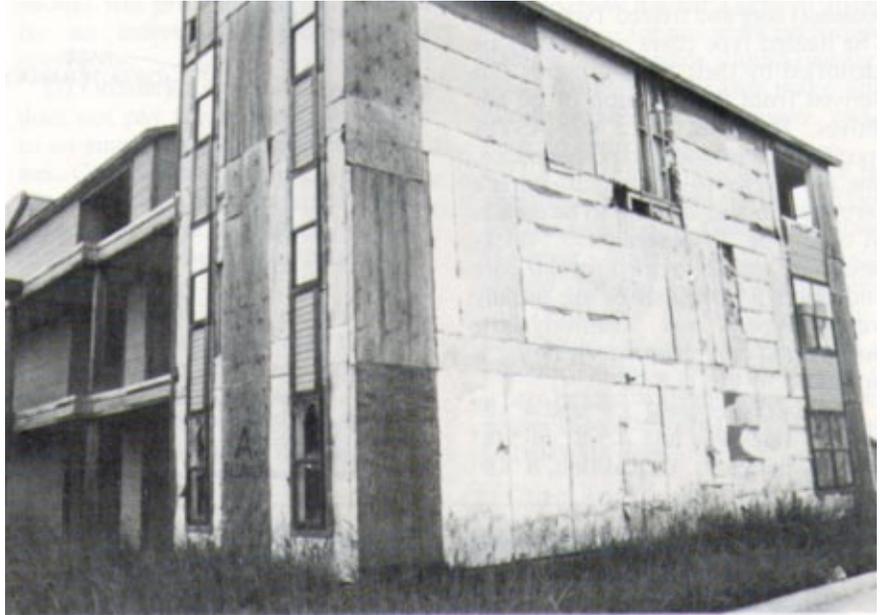
Recent renovations to the first planned “crescent” community of Greenbelt, Maryland, built in the 1930s demonstrated the long-term durability of both products.

Growth Continues Today . . .

Today, the use of gypsum sheathing continues to expand whereas the use of fiberboard sheathing has decreased almost to the point of obsolescence. During the past five years, consumption of gypsum sheathing has increased more than 42 percent. In 1985 for instance, over 328 million square feet of gypsum sheathing was installed.

Resurgence in the use of gypsum sheathing closely parallels growth patterns of light-gauge steel framing and the Exterior Insulation Finish Systems (EIFS) in commercial construction. It continues to be the product of choice in multi-unit wood-framed residential work where fire-resistant separations are a primary consideration.

For more than a half century the industry has produced gypsum sheathing conforming to ASTM C-79² “Standard Specification for Gypsum Sheathing Board” that first appeared as a tentative standard in 1930. Currently this performance orientated specification sets minimum and maximum criteria for water absorption, flexural strengths, core hardness, nail-pull resistance and humidified deflection. Manufacturing tolerances for dimensions (permissible variations) are included for compatibility and consistency as well as contractual reference.



Sheathing failure due to prolonged exposure to weather. Face paper has delaminated. Sealants were not used at joints or edges. Note that mixture of 2' and 4' wide product often results in improper off-set of joint location.



Failure due to long-term exposure to elements (over one year). Blow-off occurred due to over-driven and improperly spaced nails (12' o.c.). Sheathing protected under soffit area appears to be O.K.

Gypsum sheathing has been produced in 3/8", 4/10", 1/2" and 5/8" thicknesses. The 3/8" and 4/10" products were designed specifically for the manufactured housing industry, the author is not aware of anyone currently producing the 3/8" thickness.

Core types consist of regular (non-treated core), regular treated (water resistant) core and treated Type X core. The treated type cores can usually be identified by their brownish-grey tint derived from the emulsion of oil additives. However, since the ASTM specification is based on performance, one must refer to the manufacturer's certification and labeling to be certain of core type. In general, 1/2" thicknesses are usually treated regular core and the 5/8" thicknesses are usually treated Type X core. Relatively little non-treated core gypsum sheathing is produced in the U.S.

Standard sizes are 2' x 8' and 4' x 8' in 1/2" thickness and 4' x 8' in 5/8" Type X thickness. In addition, 4' x 9'

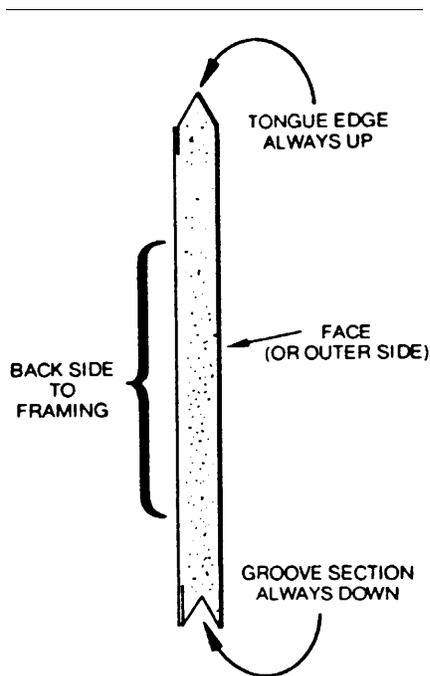


Diagram A — Cross section of 2' wide gypsum sheathing.

is popular in certain localities and a variety of lengths have been produced on special order for the modular and prefabricated housing industry. The 4' x 8' x 1/2" size has been manufactured, on occasion, with a center serration for snapping apart at the job-site for horizontal application. The 2' wide products are to be applied horizontally (at right angles or perpendicular to the framing). The 4' wide products are normally applied vertically or parallel with the framing.

Frequently-Asked Questions . . .

A question frequently asked is, "can the 4' wide gypsum sheathing be applied horizontally?" The answer is a conditional, *yes*. A horizontal application is possible if the joints are back-blocked with cross-bridging members or treated with a vinyl or aluminum tape or sealant (see limitation of use discussed later) and that the product is not part of the engineered structural performance of the wall. Most wall shear racking tests have been performed with the 4' wide products applied vertically or parallel with the framing. Shear strengths are dependent on nail-holding power. In an 8' x 8' wall section there would be thirty-three fewer nails required to properly fasten the sheathing in a horizontal rather than a vertical orientation.

Application direction is also important when the gypsum sheathing is being used as a component of a fire-rated assembly. In any event, it is advisable to be certain your local building official is in agreement with the details before proceeding with horizontal application of 4' wide sheathings.

Another question often asked is, "can water-resistant gypsum backing board (ASTM C-630) be substituted on an equivalent basis for gypsum sheathing?" Again, the answer is *yes* in many cases. The predominant difference between these two products is that the core of the water-resistant board ("green board") is required to be *more* water resistant than the core of gypsum sheathing. Surface water absorption values are the same. However, product terminology may present a problem as the codes only recognize the *sheathing* term for exterior usage.

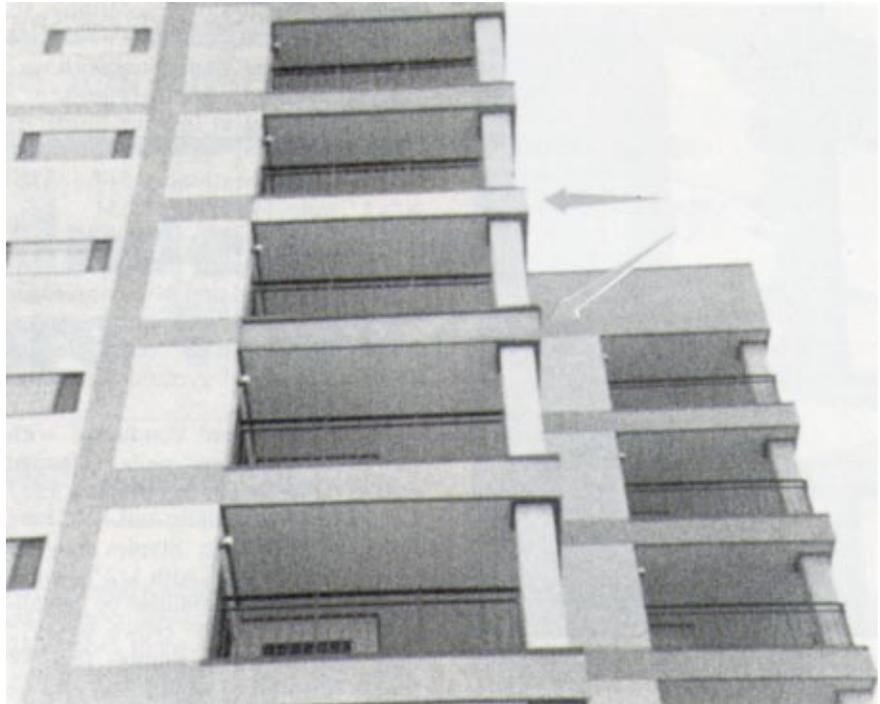
There are other important features of gypsum sheathing that the user should know. For instance, there is a face side and back side to gypsum sheathing. It should be applied with the face side out and the back side against the framing members. The back side can be identified by the overlapping seal of the paper surfacing.

It is also important to recognize that there is a top and bottom edge to the 2' x 8' v-tongue and groove sheathing. The v-tongue should be applied at the top to shed moisture and secure a tight alignment. See diagram A. The 4' wide products are produced with square edges.

Gypsum sheathing can be used successfully as a fire resistant membrane over metal roof decks in certain built up roofing designs and as an underlayment between combustible wood roof shingles and framing³. Type X may be required for specific designs.

STRUCTURAL CHARACTERISTICS⁴

Racking tests have been conducted for the Gypsum Association by an in-



Failure due to improper fastening of sheathing substrate and water infiltration behind finish system.



Severe winter exposure can create problems especially to unprotected ends and corners.

dependent laboratory according to ASTM Method E 72-77. Average ultimate racking load values with vertical application were as follows:

	Shear Load in lbs. per linear ft.	
	Dry	Wet*
1/2" x 4' wide sheathing	540	332
5/8" x 4' wide Type X	654	522

*Treated core only

Studs were spaced 16" o.c., fasteners 7" o.c. in field and 4" o.c. on edges and ends for 5/8" gypsum sheathing; 8" o.c. in field and 4" o.c. on edges and ends for 1/2" gypsum sheathing.

FASTENERS

These tests were conducted with galvanized "roofing" nails, 11 gauge shank, 7/16" head, a minimum 1-1/2" long for 1/2" sheathing and 1-3/4" long for 5/8" sheathing. Staples may be substituted for nails with 1/2" sheathing only. They should also be galvanized 16 gauge, 7/16" crown by 1-1/2" long with divergent points. Type W screws (drywall to wood) may also be used over wood framing in lieu of nails

provided the screw spacing is the same as for nails. For fire-rated construction, both the screw length and spacing must be the same as nails.

Application of gypsum sheathing over metal framing with screws requires conformance to the criteria of the designated fire test design unless there are more stringent requirements. Screws should be long enough to penetrate the metal framing by at least 1/4" of the threaded area. Drill point screws may be necessary for applications over 20 gauge or heavier metal framing.

NOTE: Nail or screw heads or the crown of staples should bear firmly against the face of the sheathing, but not cut through the face paper. Staples should be driven with the crown parallel to the framing. Fasteners should be no closer than 3/8" from the ends and edges of the sheathing.

Corner Bracing — Where continuous diagonal bracing is required, many building codes allow the use of four foot wide panels of 1/2" gypsum sheathing applied vertically to be used in place of 1" x 4" wood let-in bracing.

Shear Walls — Where wind or seismic forces require shear walls to resist these lateral forces, most building codes provide allowable shear values for walls having gypsum sheathing applied to wood framing. Specific values with construction requirements and limitations are contained in the major model building codes (Basic/National Building Code, Standard Building Code and Uniform Building Code) or Federal Property Standards.

A review of the Gypsum Association's GA-252 brochure on gypsum sheathing finds a list of "Limitations of Use" as follows:

1. Gypsum sheathing should not be used as a nailing base.

Comment: Unlike other sheathing materials such as plywood, flakeboard or high-density fiberboards, gypsum sheathing does not provide nail or screw holding qualities necessary for other components or claddings to be fastened directly to the sheathing.

2. Exterior finish systems applied over gypsum sheathing should be applied with mechanical fasteners through the sheathing into the wall framing. Alternate methods of application are solely the responsibility of the party making the recommendation.

Comment: Although somewhat controversial, this limitation applies very broadly to *any* adhesive-only application of products such as glass, metal, wood, plastic, cementitious or other claddings commonly found in the market place that may place undue shear stresses on the matrix between the core and paper surfaces. The statement certainly allows adhesive-only applications provided the system producer tests and assumes responsibility. Over the years failures have occurred due to severe wind pressures, different coefficients of expansion and extended exposure to moisture and ultraviolet rays prior to the exterior finished surface application. Problems have also developed due to improper fastening, the chemical degradation of solvents or other ingredients used in some adhesives and/or by water infiltration behind the system.



Drywall mechanic installing gypsum sheathing over steel studs for use as a base for a modified stucco system.

ASTM C-79 states that the paper of gypsum sheathing be *firmly bonded* to the core. This is a highly subjective requirement as the bond can vary depending on conditions. A formal procedure to measure bond does not exist.

ASTM has addressed this issue many times over the years without resolution.

3. Application of gypsum sheathing to framing by adhesives only is not recommended.

Comment: Tests were conducted with mechanical fasteners only.

4. Maximum stud spacing is 24" o.c.

Comment: On specific designs for structural or fire resistance, stud spacing will frequently be a minimize of 16" o.c.

5. Not recommended for exterior ceilings, soffits or sills.



Gypsum sheathing easily adapts to design variations and is an excellent substrate for a variety of weather-proof finishes.

Comment: Treated core products such as gypsum sheathing and water-resistant backing boards were designed for wall application only. Many ceiling decorations may not be compatible with the water-repellant treatment of the surface. Deformation (sagging) may occur and, under certain conditions, such as the higher temperatures around recessed lighting fixtures, the emulsions and waxes used in the core treatment may, over a period of time, migrate to the surface and cause staining.

6. May be stored outside for up to one month, if stacked off the ground under protective covering.

Comment: Care should be taken to avoid condensation under heavy vinyl tarping. Longer term storage should be inside warehousing.

7. May be left exposed to the elements for one month after application, or up to six months if cutouts, corners and joints in the sheathing are filled with a flexible sealant at the time of application. Building felt, applied immediately after the sheathing application, properly lapped, attached and anchored by metal lath or exterior stucco, is an alternate for the flexible sealant.

Comment: Self explanatory, however, this does not recognize the recent development of vinyl or aluminum pressure-sensitive tapes that are finding widespread satisfactory usage in lieu of joint sealants such as caulking or mastics.

Used within its designed limitations, gypsum sheathing is an outstanding product with exceptional value to the construction industry . . . fire resistance, structural performance, long-term protection of a structures vital framing elements and important economic advantages. Benefits that are difficult to find concentrated in most other sheathing products.

The author's concern has been one of expanding knowledge of the product with some clarification of its limitations. The views expressed do not necessarily represent those of the Gypsum Association of gypsum producers.

LITERATURE REFERENCES

¹U.S. Bureau of Mines/Gypsum Association Mineral Industry Survey 1985.

²ASTM C-79-84 "Standard Specification for Gypsum Sheathing Board" under jurisdiction of ASTM Committee C-11 on "Gypsum and Related Building Materials and Systems."

³GA-201-85 Gypsum Association "Using Gypsum Board for Walls and Ceilings" page 36.

⁴GA-25284 "Fire Resistant Gypsum Sheathing" published by the Gypsum Association.