PRIEST & ASSOCIATES CONSULTING, LLC

ENGINEERING EVALUATION

UTILITIES IN THE FLANKING WALLS OF

GYPSUM AREA SEPARATION FIREWALLS

Project No. 10879

Prepared for:

Gypsum Association
962 Wayne Avenue, Suite 620
Silver Spring, Maryland 20910

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4607 Verdi Road
Pleasanton, TX 78064
www.priestassociates.com

Solutions for the Building Materials Industry

1-877-505-7743 Office
210-410-8217 Mobile
deg.priest@priestassociates.com

Abstract

Priest & Associates Consulting (PAC) has reviewed the differences between "cavity-type" common walls and "solid" gypsum Area Separation Firewalls used in the separation of dwellings in townhouse construction. Construction characteristics, published listings, and fire test performance have been analyzed. PAC has concluded that unnecessary restrictions have been placed by IRC Section R302.2 on the H-Stud ASW system by not allowing utilities in the adjacent flanking walls. Unlike typical "cavity wall" type common wall construction, services installed within the unrated "protected" wall framing of a gypsum ASW firewall/party-wall system would not be expected to detract from the 2-hour fire rating when tested per ASTM E119/UL263.

The conclusions reached by this evaluation are true and correct, within the bounds of sound engineering practice. All reasoning for our decisions is contained within this document.

Submitted by,

Howard Stacy
Senior Scientist
360-957-0311

July 3, 2020

Reviewed and Approved,

Deg Priest
President

July 3, 2020

INTRODUCTION

The purpose of this Engineering Evaluation (EEV) is to justify that the placement of utilities (plumbing, electrical lines/conduit, mechanical equipment, ducts or vents) in the flanking walls of gypsum area separation firewall/party-walls separating townhouse construction can be allowed without detracting from the listed 2-hour fire rating.

Utilities (including HVAC and plumbing components of various types) in gypsum area separation firewalls (also known as H-Stud ASW systems) are not currently allowed in the *International Residential Code*. The current International Residential Code (R302.2 Townhouses) does not address the unique characteristics of an H-Stud ASW system when compared to typical cavity-type wall construction, and the IRC is considering the H-Stud system in the same manner as a common wall.

> ***R302.2 Townhouses.*** *Common walls separating townhouses shall be assigned a fire-resistance rating in accordance with Section R302.2, Item 1 or 2. The common wall shared by two townhouses shall be constructed without plumbing or mechanical equipment, ducts or vents in the cavity of the common wall. The wall shall be rated for fire exposure from both sides and shall extend to and be tight against exterior walls and the underside of the roof sheathing. Electrical installations shall be in accordance with Chapters 34 through 43. Penetrations of the membrane of common walls for electrical outlet boxes shall be in accordance with Section R302.4.*
>
> *1. Where a fire sprinkler system in accordance with Section P2904 is provided, the common wall shall be not less than a 1-hour fire-resistance-rated wall assembly tested in accordance with ASTM E 119 or UL 263.*
>
> *2. Where a fire sprinkler system in accordance with Section P2904 is not provided, the common wall shall be not less than a 2-hour fire-resistance-rated wall assembly tested in accordance with ASTM E119 or UL 263.*

The one common wall option in the code is a standard framed cavity wall system which has a restriction that prohibits plumbing, mechanical equipment, ducts or vents within the wall cavities. The H-Stud ASW is a solid system entailing H-Stud framing and 1-inch gypsum shaft wall liner panels built structurally independent between dwelling units with a framed wall on each side. It is our opinion that unnecessary restrictions have been placed on the H-Stud ASW system by not allowing utilities in the adjacent flanking walls based on the fact that there is no interconnection of the flanking walls between adjacent dwelling units with the use of the H-Stud Area Separation Fire Wall system. Under the ASW system design attributes, the flanking “protected” walls do not become involved during testing per ASTM E119/UL263.

This document is intended to provide an expert opinion on the properties of the materials, products, or assemblies identified in this report as related to meeting a specific code or standard. Suitability to use is to be determined by the end-user.

REFERENCES

1. ASTM C1396, “Standard Specification for Gypsum Board”
2. Gypsum Association Fire Resistance Design Manual, GA-600
3. Babrauskas, V., “Ignition of Wood: A Review of the State of the Art,” *Interflam* 2001, Interscience Communications Ltd. London (2001), pp. 71-88
4. ASTM D1929, “Standard Test Method of Determining Ignition Temperature of Plastics”

GYPSUM AREA SEPARATION FIREWALLS (H-STUD AREA SEPARATION WALLS)

Gypsum Area Separation Firewalls are described in the Gypsum Association publication GA-620-2011. These are fire-rated wall assemblies of gypsum panels and steel studs designed for use as walls having a fire-resistance rating of 2 hours. H-Stud ASWs have been evaluated as fire walls and party walls, as referenced in 2018 IBC (and earlier editions) Section 706.1.1.

H-stud ASWs are installed as “common” walls for the separation of occupancies in multi-family townhouse construction as referenced in 2018 IRC (and earlier editions) Section R302.2.

H-Stud ASW systems are **Solid Type** area separation fire or party walls utilizing nonrated independently framed wood stud or steel stud “protected wall” assemblies on each side, as shown in Figure 1. The gypsum H-stud ASW barrier is nonbearing, and is supported on both sides by loadbearing unrated wood or steel framing assemblies through the use of aluminum clips. The “protected walls” form the interior walls of the occupied spaces. When installed following the design listing, the ASW serves as a fire barrier and protects the wall on the unexposed side from temperatures exceeding the conditions of acceptance established by the E119 standard.

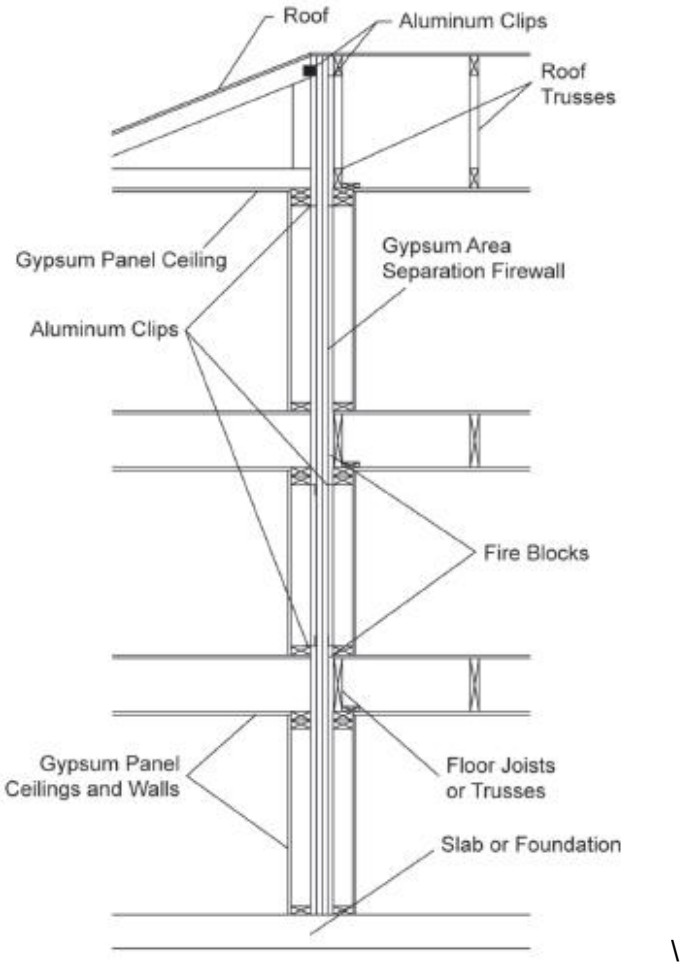
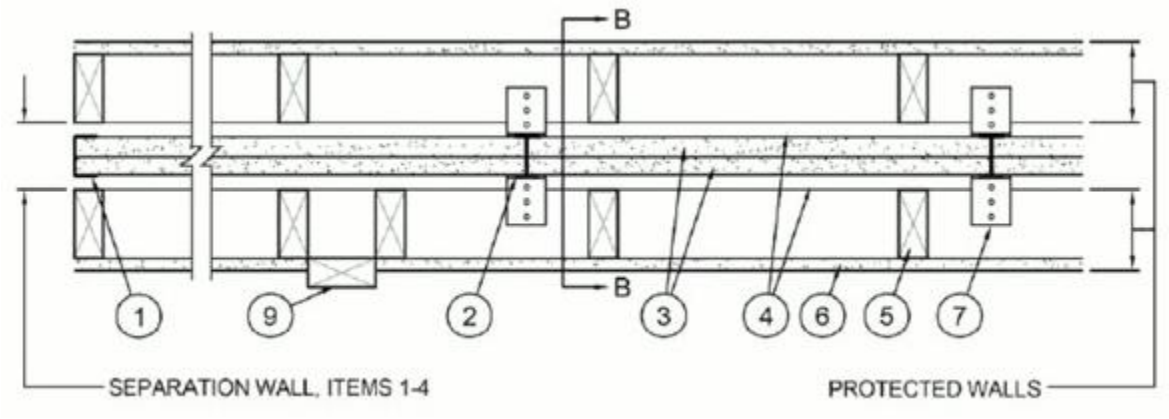


Figure 1. Typical Gypsum Area Separation Firewall Construction

Standard construction requires a minimum ¾ in. air space separation between the protected wall and the gypsum H-Stud ASW fire barrier.

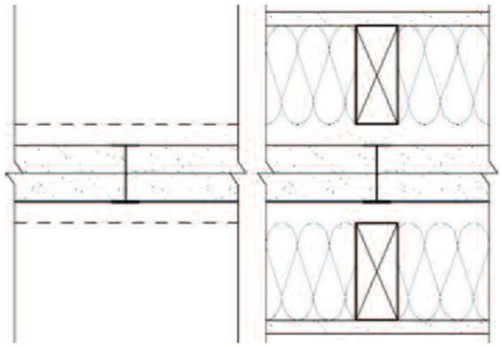
Aluminum clips are incorporated into the assembly to act as a fusible link between the assembly and both sides of adjacent framing members. Aluminum angle clips, having a melting point of 1220 °F, are used to attach the H-Stud to both sides of adjacent framing members. When the fire wall is subjected to high temperatures, the clips on one side of the assembly will melt and break away, allowing distortion of the framing members on the fire side without jeopardizing the performance of the fire wall itself.

UL and GA fire-resistance-rated designs (Ref. 2) are shown in Figures 2 and 3. UL Design listings for ASW systems include U336, U347, U366, U373, U375, U388, and V411.



1. **Steel track** – nom. 2 in. wide
2. **Steel Studs** – “H” shaped studs formed from No. 25 GA. steel, nom. 2 in. deep
3. **Gypsum Board** – Two layers of 1 in. thick type X gypsum wallboard liner panels, 24 in. wide
4. **Air Space** – Minimum ¾ in. air space (to prevent contact of combustibles to steel framing)
5. **Protected Wall Framing** – Wood or steel studs
6. **Gypsum Board** – Nom. ½ in. “regular” (unclassified) GWB
   - Plywood or OSB sheathing can be substituted for GWB
   - As an alternate, min. 6 in. wide ⅝ in. type X GWB battens may be used to cover steel “H” studs
7. **Aluminum Clips**

Figure 2. Typical UL ASW System Listing



GYPSUM WALLBOARD, STEEL H STUDS

Two layers 1" x 24" proprietary type X gypsum panels inserted between 2" floor and ceiling runners with 2" steel H studs between adjacent pairs of gypsum panels. **(NLB)**

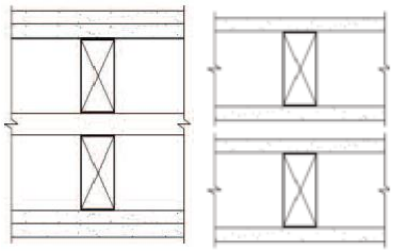
A 3/4" minimum air space must be maintained between steel components and adjacent framing (indicated by dashed lines in sketch). As an alternate, the steel components may be covered with 6" wide battens or full sheets of 1/2" type X gypsum wallboard.

Sound tested with 2 x 4 stud wall faced with 1/2" gypsum wallboard each side of system and 3 1/2" glass fiber insulation in stud space.

Figure 3. Typical Gypsum Association ASW System Listing

"CAVITY TYPE" COMMON WALL CONSTRUCTION

Typical fire-rated "cavity type" common wall construction consists of loadbearing wood or steel framing with gypsum membrane protection on both sides encasing the wall cavities and covering the loadbearing stud framing. The membrane protection must be sufficient to protect the framing from collapse during the fire exposure period and limit temperatures on the unexposed side from exceeding the temperature rise limits of the ASTM E119/UL263 test standard.



Examples of typical 2 hour rated "cavity-type" conventional wall construction.

ASTM E119 TESTING OF GYPSUM AREA SEPARATION FIREWALLS (H-STUD ASW)

In determining the fire-resistance rating of Gypsum Area Separation Firewalls, compliance with ASTM E119 or UL 263 criteria for unexposed surface temperature rise and ignition of cotton waste due to passage of flame or gases is required for 2 hours. The solid ASW gypsum barrier between flanking support framing for the structures on each side of the separation is nonbearing, and the temperature rise limits of the ASTM E119/UL 263 standard on the unexposed wall surface must be met.

Gypsum H-Stud ASWs are tested with the flanking wall construction on the unexposed side of the assembly, and the test is conducted with the bare H-Stud ASW surface directly exposed to the furnace conditions. Thermocouples measure temperatures at three locations on the unexposed side:

1. Directly over the unexposed surface of the gypsum shaft liner panels,
2. On the inside face of studs forming the protected wall framing, ¾ in. away from the unexposed face of the H-Stud ASW (for determination of the "Finish Rating"), and
3. On the unexposed face of the protected wall.

Temperature measurements at Locations 1 and 2 are for supplemental thermal information. The temperature measurement at Location 1 assesses the performance of the gypsum panels in relation to the requirements for type X shaft liner outlined in ASTM C1396 (Ref.1). Thermocouples at Location 2 provide a measurement of the "membrane protection rating" (the determination of the thermal protection afforded to the framing members by the ASW panels, also referred to as the "Finish Rating"). The temperatures measured at Location 3 are used in the determination of the fire classification of the system.

An example of a typical test configuration is shown in Figure 4.

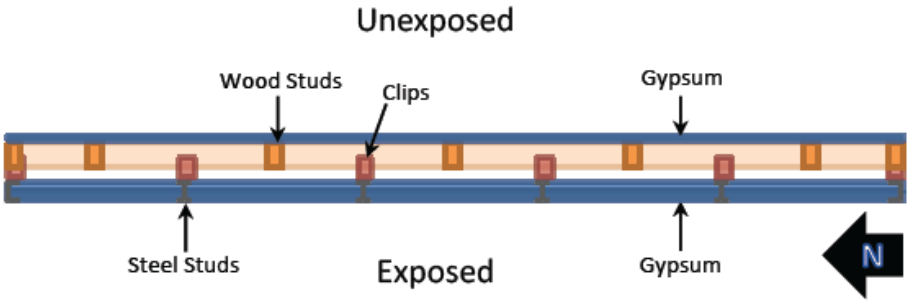


Figure 4

Recent successful testing of a 2-hour H-Stud ASW (proprietary, held confidential) exhibited the following results:

1. Location 1 - gypsum shaft liner panel unexposed surface temperature met ASTM E119 temperature rise criteria at 2 hours, attaining an average temperature of 336 °F
2. Location 2 - exposed face of wood studs attained a Finish Rating temperature of 270 °F at 2 hours
3. Location 3 - unexposed surface attained an average temperature of 174°F at 2 hours

The ASTM E119 Conditions of Acceptance are as follows:

1. The average temperature rise of any set of thermocouples shall not be more than 250 °F above the initial temperature, and
2. The temperature rise of any single thermocouple may not exceed 325 °F above its initial temperature

For this test, the starting temperature was 86 °F, and the E119 conditions of acceptance for temperature rise were met in all 3 cases.

Air Space Discussion

From a fire-resistance perspective, ASW's require a minimum of ¾ in. air space to separate wood framing and other combustibles within the protected wall from the steel H-Stud framing members in the ASW. The H-Studs conduct heat from the exposed side of the assembly and can reach surface temperatures above the E119 limiting conditions and potentially high enough to ignite combustibles in direct contact with the hot surface of the stud. The specified minimum ¾ in. air space has been demonstrated to be sufficient to prevent this from occurring. If conditions dictate that provisions for the air space cannot be made, the various listed designs provide for the H-studs to be covered by ⅝ in. type X gypsum board battens or 1 in. thick mineral wool batt.

In the ASW test discussed above, this air gap was sufficient to keep the exposed face of the wood stud flanking wall below the E119 temperature rise conditions for the duration of the test. The maximum temperature measured on the face of the studs located ¾ in. away from the nonfire side of the gypsum ASW fire barrier reached an average of 270 °F after 2 hours of fire exposure.

UTILITIES IN THE FLANKING WALLS

The justification for allowing utilities including combustible polymeric piping, conduit or other flammable materials within the flanking "protected" walls of a gypsum H-Stud ASW is based on the fact that the solid ASW fulfills its role as a fire barrier and protects the wall on the unexposed side from temperatures exceeding the conditions of acceptance of the E119 standard. The prescribed air space in the ASW system is critical in this regard.

The placement of utilities within the wall cavities of typical common walls could conceivably detract from the fire rating of the assembly due to combustion within the wall spaces during the fire exposure or excessive heat transfer through metallic components to the unexposed side. This is perhaps the reason for the prohibition of utilities within the common dwelling separation in Section 302.2 of the IRC. It has been demonstrated in this evaluation that this cannot occur with the "solid" H-Stud ASW construction since there is no interconnection of the flanking walls between adjacent dwelling units.

The allowance for utilities within ASWs is further supported by a discussion of the comparative ignition characteristics of wood and various polymeric materials that could be installed as utilities within the flanking wall construction.

Babrauskas (Ref. 3) has reviewed the ignition temperature of wood as measured during radiant heating or tube-furnace heating and determined that the minimum ignition temperature for wood was found to be 250 °C (482 °F).

Values for the ignition temperature of various plastics are included in ASTM D1929 "Standard Test Method of Determining Ignition Temperature of Plastics" (Ref. 4) and are shown in the table below. Data for the "Spontaneous Ignition Temperature (SIT)" are considered to reflect best the performance of polymeric materials on the nonfire side of the ASW, since piloted ("flash") ignition (ignition in the presence of a flame source) is not expected to occur.

TABLE 2 SIT (°C)

Material ID	Average $\bar{x}$	Repeatability Standard Deviation s_r
Polymethylmethacrylate (PMMA)	450.0	0.0
High Density Polyethylene (HDPE)	370.0	0.0
Polyamide 11 (PA11)	423.3	5.8
Polycarbonate (PC)	550.0	0.0
Polypropylene (PP)	353.3	5.8
Polyvinylidine Fluoride (PVDF)	510.0	0.0

These data indicate that plastics require a temperature of 353 °C (667 °F) or higher for unpiloted ignition to occur.

The comparison of the ignition temperatures of wood and various polymeric materials demonstrates that the wood framing members of the flanking walls would be the most combustible component in an ASW assembly containing utilities. Therefore, the presence of plumbing or mechanical equipment, ducts or vents within the cavities of the protected wall in an ASW system would not be expected to detract from the fire rating of the 2-hour dwelling separation when tested per ASTM E119 or UL263.

CONCLUSION

Priest & Associates Consulting has reviewed the differences between “cavity-type” common walls and “solid” gypsum Area Separation Firewalls used in the separation of dwellings in townhouse construction. Construction characteristics, published listings, and fire test performance have been analyzed. PAC has concluded that unnecessary restrictions have been placed on the H-Stud ASW system by not allowing utilities in the adjacent flanking walls. Unlike typical “cavity wall” type common wall construction, utilities installed within the unrated “protected” wall framing of an ASW firewall/party-wall system would not be expected to detract from the required 2-hour fire rating when tested per ASTM E119/UL263.

END OF REPORT