Truss Wall Construction

High R-Value Enclosure Report Case Study

Truss Wall Construction Details (*Wall 5*)[1]

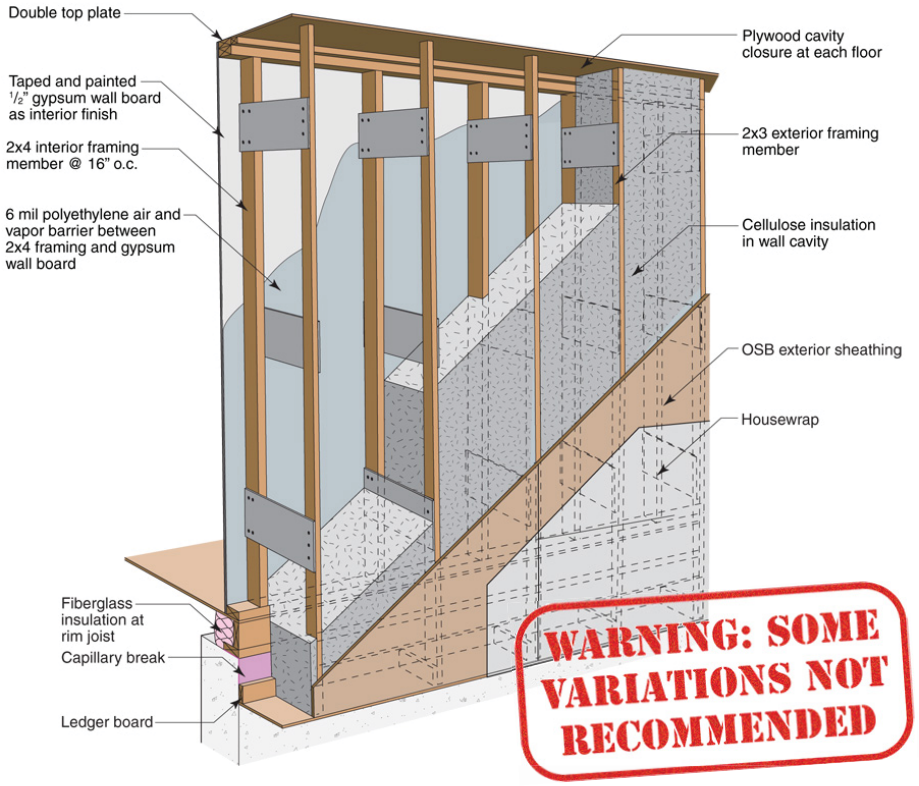
- 2x4 interior framing member
- 2x3 exterior framing member
- 6 mil polyethylene vapor barrier to interior
- Cellulose cavity insulation
- OSB exterior sheathing
- Housewrap

Scoring: How It Rates

The scoring of each wall system is based on the following five categories. A score of 1 is the lowest score in each category and represents the worst possible technology for each category or highest possible relative cost. A score of 5 is the highest score available in each category, and is representative of the best available technology available on the market or lowest relative cost.

Thermal Control	4
Durability	3
Buildability	2
Cost	3
Material Use	3
Total	**15**

The truss wall system can achieve a very high whole wall R-value with minimal thermal bridging and would be perform well in extreme climates provided the air barrier was detailed perfectly minimizing the high risk of air leakage condensation durability issues. It is time consuming to construct and susceptible to premature enclosure failures resulting from poor construction and detailing.



Introduction

This overview summarizes the truss wall construction including the advantages and disadvantages of this construction strategy. A more detailed analysis and direct comparison to several other walls can be found online.[1] The scoring system is subjective based on the relative performance and specifications between different wall systems. Complex two dimensional heat flow analysis and one dimensional hygrothermal modeling were used to determine moisture related durability risks for analysis.

For a more complete analysis of this and other wall constructions, go to www.buildingscience.com.

Thermal Control

Installed Insulation R-value: The thickness of truss walls varies greatly and because it is not a common wall construction, there does not appear to be a established standard construction insulation thickness. These walls are typically insulated with blown cellulose insulation (R-3.7/inch) or fiberglass batt insulation (R-3.5/inch), and overall installed insulation R-values in excess of 50 are possible.

Whole-wall R-value: Using two dimensional heat flow analysis with thermal bridging effects and average framing factors shows that adding the insulation to the exterior of the framing addresses the thermal bridge at the rim joist, studs and top plate. There is a large range of R-values possible with this type of construction, but 12" of cellulose provides a whole-wall R-value of approximately R-36.[1]

Air Leakage Control: Cellulose insulation is an air permeable material allowing possible air paths between the interior and exterior as well as convective looping in the insulation. Although densepack cellulose has less air permeance than some other air permeable insulations, it does not control air leakage.

Typical Insulation Products: Blown cellulose.

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Durability

Rain Control: Rain leakage into the enclosure is the leading cause of premature building enclosure failure. Rain control is typically addressed using a shingle lapped and/or taped drainage plane such as building paper or a synthetic WRB (i.e. homewrap). Intersections, windows, doors and other penetrations must be drained and/or detailed to prevent the penetration of rainwater beyond the drainage plane.[2]

Air Leakage Control: Air leakage condensation is the second largest cause of premature building enclosure failure with this type of wall construction. It is very important to control air leakage to minimize air leakage condensation durability issues. An air barrier is required in this wall system to ensure that through-wall air leakage is eliminated (ideally) or at least minimized. An air barrier should be stiff and strong enough to resist wind forces, continuous, durable, and air impermeable.[3]

Air need not leak straight through an assembly to cause moisture problems; it can also leak from the inside, through the wall, and back to the inside; or it can leak from the outside, through the wall, and back to the outside. Condensation within the stud space is possible if this type of airflow occurs, depending on the weather conditions. Hence, wall designs should control airflow into the stud space.[4]

The truss wall has a much higher R-value that standard construction, and the exterior sheathing is well insulated from the interior conditions. This wall system has greater risk for severe air leakage condensation since the sheathing is considerably colder than standard construction.

Vapor Control: Fiberglass and cellulose are highly vapor permeable materials, so a separate vapor control strategy must be employed to ensure that vapor diffusion does not result in condensation on, or damaging moisture accumulation in, moisture sensitive materials. The permeance and location of vapor control is dependent on the climate zone. Installing the vapor control layer in the incorrect location can lead to building enclosure failure.[5]

There is a higher risk of vapor diffusion condensation if the vapor barrier is not detailed correctly due to the lower wintertime temperature of the sheathing in the truss wall relative to standard construction.

Drying: Cellulose and fiberglass insulation allow drying to occur relatively easily, so drying is controlled by other more vapor impermeable enclosure components such as a vapor barrier and OSB sheathing. Installing a vapor barrier on both sides will seal any moisture into the stud space, resulting in low drying potential, and possibly resulting in moisture-related durability risks. Ventilation behind vapor impermeable claddings and interior components (e.g. kitchen cabinets) can encourage drying.

Built- in Moisture: Care should always be taken to build with dry materials where possible, and allow drying of wet materials before close in. If a polyethylene vapor barrier is installed with relatively vapor impermeable OSB sheathing, drying could be slow if built-in moisture is present.

Durability Summary: The primary durability risks associated with these wall assemblies involve moisture damage related to rain water penetration or condensation (most likely the result of air leakage, but also potentially the result of vapor diffusion).

Cellulose insulated walls are slightly more durable than fiberglass insulated walls because cellulose insulation is capable of storing and redistributing small amounts of moisture. Cellulose insulation is typically treated with borates that have been shown to protect itself and neighboring wood material from mold growth and decay. Cellulose insulation also has decreased flame spread potential relative to other insulation materials.

Buildability

This wall construction is not a standard construction practice. The gussets used to space the exterior framed wall off the structure are time consuming to construct, and require tight tolerances to ensure smooth sheathing and cladding. This wall is highly susceptible to construction workmanship and requires a perfect air barrier in cold climates since the potential for wintertime condensation is high. Penetrations such as windows and doors require plywood boxes be installed through the wall.

Cost

This construction requires increases in both time and materials for the enclosure. The wall framing material is essentially doubled, and constructing the exterior wall with gussets is time consuming. The increased thermal performance and decreased thermal bridges may be worth the extra time and money in specific cases.

Material Use

There is a significant increase to framing since every framing member in the structural wall has a corresponding exterior framing member attached with wood gussets.

Total Score

The truss wall system can achieve a very high whole wall R-value with minimal thermal bridging and would be perform well in extreme climates provided the air barrier was detailed perfectly minimizing air leakage condensation durability risks. It is possible to reduce the risk of condensation by using a combination of the truss wall in combination with an air impermeable insulation. One advantage of the truss wall is that it is used in both new construction and retrofit situations to decrease energy consumption, and improve occupant comfort. The truss wall allows the extra insulation to be placed on the exterior of the structural wall that does not affect the interior space, unlike the double stud wall.

References

1 Straube, J., & Smegal, J. (2009). *Building America Special Research Project - High-R Walls Case Study Analysis*. Retrieved from buildingscience.com.

2 Lstiburek, J. W. (2006). *Water Management Guide*. Westford: Building Science Press Inc.

3 Lstiburek, J. (2008, 08 20). *BSD-104: Understanding Air Barriers*. Retrieved from buildingscience.com.

4 Straube, J. (2009, 04 22). *BSD-014 Air Flow Control in Buildings*. Retrieved from buildingscience.com.

5 Lstiburek, J. (2008, 10 17). *BSD-106 Understanding Vapor Barriers*. Retrieved from buildingscience.com.