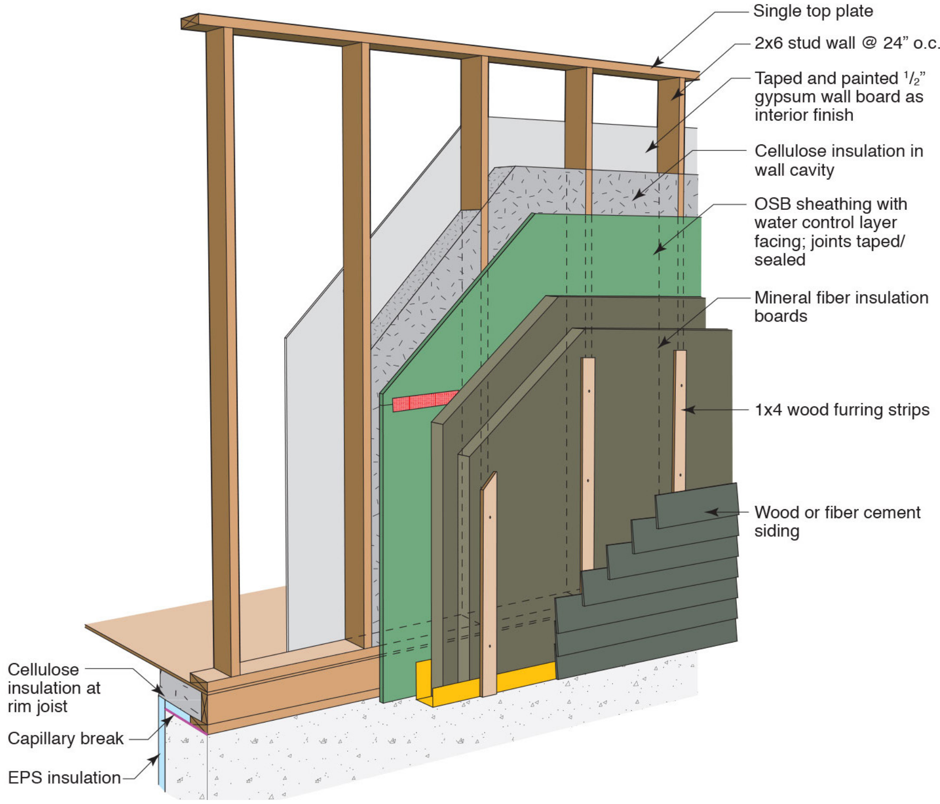
2x6 Advanced Frame Wall Construction with Mineral Fiber Insulation Board

High R-Value Enclosure

2x6 Advanced Frame Wall Construction with Mineral Fiber Insulation Board Details

- 2x6 wood frame wall at 24” o.c.
- Cellulose cavity insulation
- OSB sheathing with integrated water resistive barrier
- 4” mineral fiber insulation boards
- Furring creating a minimum 3/8” ventilation gap/drainage gap behind cladding



References

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Introduction

This overview summarizes 2x6 advanced frame wall construction using mineral fiber insulation board including the advantages and disadvantages of this construction strategy. 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: Blown or sprayed cellulose insulation in the cavities has a typical R-value of R-20 for 2x6 walls.

Mineral fiber used as the exterior insulation has an R-value of 3.8-4.3/inch.

Whole-wall R-value: Two-dimensional heat flow analysis with thermal bridging effects and average framing factors (16%) shows increases to the R-value of the assembly and improvements to the efficiency of the cellulose insulation in the stud space by decreasing the thermal bridging effects. Advanced framing walls with 4” of mineral fiber insulation board on the exterior have a whole wall R-value between R-35 to R- 37.

Air Leakage Control: Cellulose is an air permeable material used in the stud space of the wall allowing possible air paths between the interior and exterior as well as convective looping in the insulation. Dense pack cellulose has less air permeance but does not control air leakage. Mineral fiber insulation board is also not air impermeable (unlike EPS, XPS and foil-faced

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polyisocyanurate board foam). Air control is established at the face of the OSB sheathing with taped seams using an integrated water resistive barrier that is detailed to serve as both a water control and an air control layer.

Typical Insulation Products: Blown cellulose is used to insulate the stud space. Mineral fiber insulation boards are used as the exterior insulation. Blown cellulose is used at the rim joist.

Durability

Rain Control: Rain leakage into the enclosure is the leading cause of premature building enclosure failure. The mineral fiber insulation board, although hygrophobic, is not suitable for creating a water control layer at the surface of the insulation as may be done with foil-faced polyisocyanurate or extruded polystyrene (XPS) insulation boards. Rain control is addressed using a water resistive barrier integrated with the OSB sheathing coupled with taped seams.[1] Alternatively, a fluid-applied water control layer can be used over plywood or OSB sheathing.

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. Using mineral fiber insulation board decreases the risk of air leakage condensation by increasing the temperature of the condensation plane, but condensation is still possible in cold climates as mineral fiber insulation is not an air barrier material. An air barrier is required in this wall system to ensure that through-wall air leakage is eliminated (ideally) or at least minimized.[2] An air barrier should be stiff and strong enough to resist wind forces, continuous, durable, and air impermeable. Air control is established at the face of the OSB sheathing with taped seams where the integrated water resistive barrier described above is detailed to serve as both a water control and an air control layer.[3]

Vapor Control: Wintertime condensation caused by outward vapor drive is controlled in the wall assembly by insulating to the exterior of the OSB sheathing. The ratio of exterior mineral fiber insulation to the total wall assembly insulation is critical to controlling the risk of condensation at the sheathing. The wall assembly manages summertime inward vapor drive through a vented cladding and the water resistive barrier integrated with the OSB sheathing described above which also acts as a vapor retarder. The level of vapor control is determined in the IRC and should be consulted as installing the incorrect vapor control layer or installing the vapor control layer in the incorrect location can lead to building enclosure failure.[4]

Drying: Mineral fiber insulation board allows drying to the exterior. Additionally, the wall also is able to dry to the interior. Poly vapor barriers should be avoided so that inward drying can occur. The minimum level of vapor control on the interior surface is determined by the IRC. In this "flow through assembly", the prescriptive portion of the IRC relating to vapor control allowing omission of a poly vapor barrier is met by installing sufficient mineral fiber insulation on the exterior. Installing a vapor barrier on both sides of the enclosure 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 be taken to build with dry materials where possible, and allow drying of wet materials before close in. Cellulose is often sprayed in damp, and manufacturers recommend drying before close in and moisture content limits.

Durability Summary: The primary durability risks associated with these wall assemblies involve moisture damage related to rain water penetration and air leakage condensation. Both air and water control are established at the face of OSB sheathing with taped teams and integrated water resistive barrier.

Buildability

Exterior insulation up to $1^1/_2$" requires minimal changes to standard enclosure construction practices. Exterior insulation in excess of $1^1/_2$" requires changes to window and wall construction and detailing which requires training and monitoring during the initial implementation.

Cladding can be easily attached to the studs through 1" of exterior insulation. Thicker levels of insulation (>2") require strapping or furring strips anchored to the framing with long fasteners. Some cladding manufacturers allow their cladding to be fastened to the strapping directly.

Cost

Advanced framing wall construction decreases the cost required for framing. Cost of mineral fiber insulation increases with its thickness. Also, with insulation board thicknesses over 1½", furring strips would be required for cladding attachment which add to the cost. But there are measurable cost benefits of saving energy, as well as improvements to comfort, which is difficult to quantify.

Material Use

If advanced framing is applied correctly (single top plates, correctly sized headers, two stud corners, etc.) the redundant wood framing from standard construction is removed, and the amount of framing will decrease. With mineral fiber insulation board thicknesses over 1½", furring strips would be required for cladding attachment.

Summary

This is highly insulated wall system that will work in extreme climates as part of a high-R enclosure.