Cold Climate Housing Research Center

CCHRC

Designs for Rural Alaska Walls

Durable housing is critical in a climate like southwest Alaska, where homes face driving rain and snow throughout the year. This home in Quinhagak has been so compromised by moisture that it is structurally unsound.

CCHRC worked with the community of Quinhagak to build a super-efficient home in 2010 that was tailored to the southwest climate. This study looked at alternative wall designs that don't rely on spray foam insulation.

The Cold Climate Housing Research Center (CCHRC) has been helping Alaskans build efficient, affordable homes since 1999. While Alaska has unique housing challenges, the needs are greatest in rural parts of the state where builders face not only an extreme climate but also high material costs and a limited labor pool.

These challenges have led to a housing crisis in rural Alaska. In the Bethel region, for example, more than one-third of homes are under-ventilated, putting them at a greater risk of moisture and indoor air quality problems. On top of that, one third of homes are overcrowded, with more than one occupant per room, exacerbating air quality and health concerns. In this environment, durable housing is essential.

For this analysis, CCHRC inspected homes in the Bethel region to see how they were holding up to moisture, the greatest factor affecting homes in the climate of Southwest Alaska. Located by the Bering Sea, the region has high amounts of wind-driven precipitation in the summer and wet conditions in the winter. These cold, humid conditions make it difficult for wall systems to dry outward, often allowing moisture to build up inside the wall to damaging levels. This can lead to mold and rot, compromising the indoor air quality and structural integrity of a home.

The durability of a home depends largely on the building materials used. Whether on-site or in-transit, materials need to be able to withstand varying weather conditions and temperature extremes. In the past, this has led CCHRC to use spray polyurethane foam (SPF) insulation when designing homes for Southwest Alaska, as it is easy to ship and has a high R-value for its shipping cost. However, SPF also requires a high level of experience to install correctly. Any errors in application can drastically reduce the thermal efficiency and durability of the building envelope.

To improve upon this system, CCHRC considered alternative wall designs that do not use spray foam. This report evaluates the moisture performance, buildability, and cost of each one. Steel framing was selected for each wall assembly because it is moisture resistant, lightweight, and easy to ship. The target for whole wall thermal resistance was R-40.

CCHRC modeled the moisture performance of the wall systems with WUFI 6.0, using climate information from

OSB and Drywall

Oriented strand board (OSB) is not advisable for use in construction in the coastal climates of Alaska. Its inability to dry quickly after wetting events, including during transportation, leads to its eventual structural failure. Similarly, gypsum board (drywall) is a product that has demonstrated failures in coastal areas, especially when high humidity persists in the indoor environment.

Bethel. High interior relative humidity (60%) was used in these models to reflect the higher occupancy of rural Alaska homes. The wall designs in this analysis were analyzed for their hygrothermal performance and any potential durability risks. The walls presented here are the ones that handled moisture the best and are deemed appropriate for all of Alaska except for the North Slope. For application in the North Slope, insulation amounts and placement would need to be modified.

Buildability was evaluated based on a construction crew's familiarity with building. New construction techniques may add to the cost and timeline of a project because they require additional training and oversight, but these considerations are offset by a more durable, thermally efficient home.

Material and labor cost assessments include only the wall assemblies (not roof, floor, mechanical, etc.) of a 1,000 square foot home (hereafter referred to as the reference house), which is slightly larger than the average home in the Bethel Census Area (Wiltse, et al., 2014). Labor estimates are based on a union residential pay scale for a foreman, two journeyman carpenters, and one apprentice (Pacific Northwest Regional Council of Carpenters, 2017). Per diem is not factored in as it varies by location and may not apply to local labor forces.

Shipping costs were estimated at $35,000 for transporting two storage containers via barge from Anchorage to Bethel at summer 2017 pricing (Alaska Marine Lines, Personal Communication, July 06, 2017). Two 40-foot length high cube containers would be able to accommodate all materials for the reference house. This estimate only includes barge services and does not include the procurement of the containers nor the cost of transporting the containers to the final destination. Prefabricated modular construction, where the structure is assembled offsite and shipped to the site, was not pursued as part of this analysis.

Wall	**Insulation**	**R-Value**	**Material Cost**	**Labor Cost**
Exterior insulated wall	8" exterior EPS	36	$12,900	$10,500
Plywood Structural Insulated Panel	6.5" polyurethane foam	41	$19,100	$8,300
Metal Insulated Panel	6.5" polyurethane foam	38	$10,800*	$9,000
Double Stud Walls	12" fiberglass or cellulose	48	$10,500	$15,000

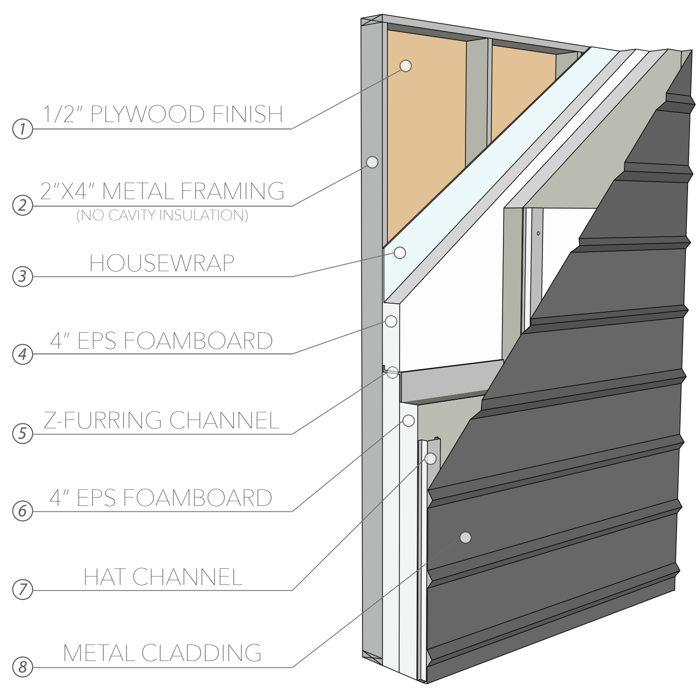
This table presents costs for building different types of walls on the test house.
* Commercial rate, only applicable for multiple homes.

Exterior Insulated Wall

The exterior insulated wall places the majority of the insulation outside of the framed walls to effectively eliminate thermal bridging. Due to the high humidity that is commonly encountered in rural Alaska homes (60% and upwards), this design will have no interior cavity insulation to shift the dew point to the exterior of the plywood sheathing.

The exterior insulated wall requires little construction experience. However, training on window and door installations in the thick outboard insulation is critical to ensure proper layout and weatherproofing. Information on preferred materials and installation methods for exterior insulated homes can be found in the REMOTE Manual at cchrc.org/manual-remote-walls.

Currently, rock wool insulation is not readily available in Alaska, but would be an appropriate choice for rigid insulation material. Polyisocyanurate insulation is not recommended for the exterior as its thermal performance declines at temperatures colder than 40ºF. Unfaced EPS is the recommended insulation as it is slightly more vapor open than other rigid foam insulations.



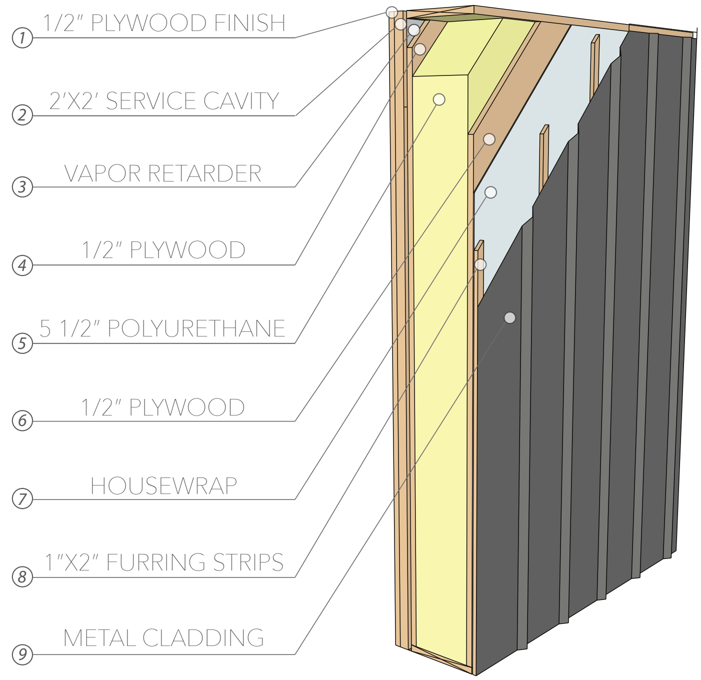
By shifting the majority of the insulation to the outside of the wall, the exterior insulation wall design reduces the potential for condensation in the framing.

Plywood Structural Insulated Panel Wall

Structural Insulated Panel (SIP) walls are comprised of a pre-made assembly that utilizes two plywood skins as structural members with an insulated core.

Panelized walls can be assembled in a shorter time frame than conventional stick frame walls, offsetting higher material costs with labor cost savings. The speed of installation allows for interior building materials to be quickly protected from the weather, an advantage given Alaska's short construction season. As with any wall assembly, installation details are critical to the overall performance of the walls. Trained crews will be sure to seal seams between panels to prevent air leakage through the wall assembly that can lead to moisture failures. An interior vapor retarder is necessary to block the movement of air through the assembly. Different tapes can be applied, per manufacturer's instructions, to interior seams and exterior seams to create an airtight system. Liquid-applied flashing products can help weatherproof window details in a SIP wall as they require minimal labor training and are fairly easy to fix.

Polyurethane core SIPs are preferable to EPS cores due to a higher R-value per inch, which allows the panel to be less thick.



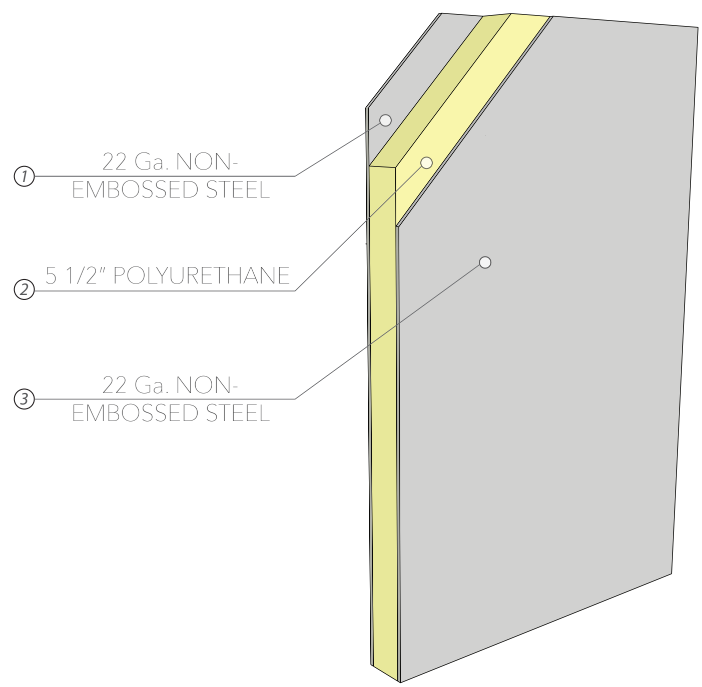
SIP panels consist of thick foam sandwiched by plywood structural boards. While they create a highly insulated envelope, air and vapor sealing is critical to ensure the walls stay dry.

Metal Insulated Panel Wall

The third wall assembly evaluated was a foam core panel skinned with metal. Metal insulated panels are typically used in commercial applications.

Similar to SIPs, the speed of installation and the durability of the metal skin make these panelized walls attractive for residential applications as well. The exterior can be coated in a manufacturer-supplied paint that is corrosion and UV resistant, making the panels tailored for coastal environments. Weatherproofing the windows and doors requires the use of factory flashing, pre-bent to the appropriate direction to divert water away from the assembly. Sealing of the seams between the panels is critical to wall integrity and maintaining the air and moisture barrier. Just like conventional SIPs, these metal panel walls require an interior stud cavity to run services.

Due to the commercial nature of this product, small orders may not be economically feasible. The ideal application for this building material would be quick construction of multiple houses.



Metal insulated panels are strong and durable and provide a good option for the harsh conditions of southwest Alaska, especially if large orders can be placed for the construction of multiple houses.

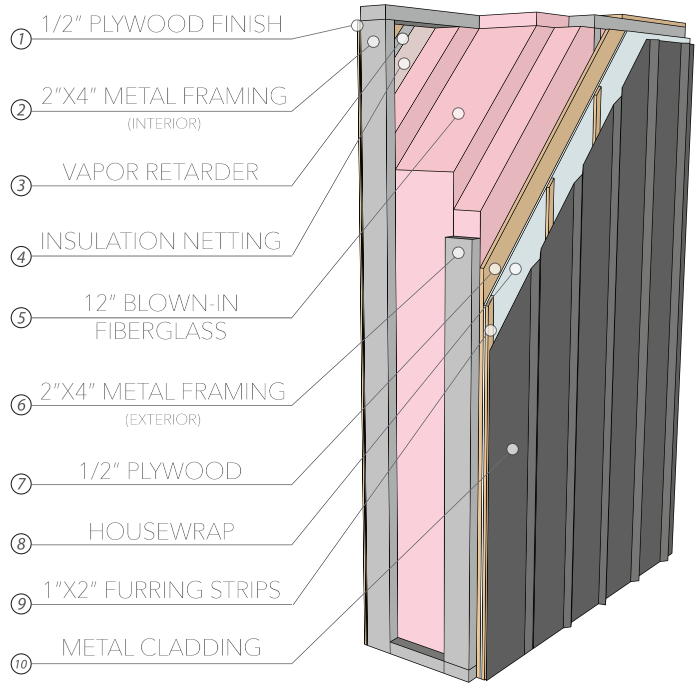
Double Stud Walls

The last wall assembly analyzed was a double wood or steel stud wall with the interstitial space filled with fiberglass or cellulose insulation. A rainscreen is crucial to maintaining the moisture resistance and integrity of thick walls.

Fiberglass and cellulose insulation are readily available, however, blown-in fiberglass insulation is not as common as fiberglass batts for insulating wall cavities. Blown insulation products can be costly to ship due to the volume and weight of insulation needed to achieve desirable R-values for Alaska's climate zones. These insulations are susceptible to water damage, so keeping the material dry during shipping and on-site storage is imperative.

Rain Screen

A rain screen is a system (typically comprised of furring strips) that utilizes an air gap between the siding and the weather barrier to allow water to drain and the wall to dry out. Rain screens make wall assemblies more robust and resistant to moisture damage that can eventually cause rot and structural failure. **A rain screen is essential to each wall presented, except for the insulated metal panel wall.**



Double stud walls allow for a thick thermal envelope using various types of insulation. A high performing wall incorporates appropriate insulation and and weather proofing details.

Conclusion

High-performance wall designs for rural Alaska have to meet and exceed a multitude of considerations. They need to be warm, affordable, easy to ship and build, and made from materials available to Alaska's limited housing market. On top of that, they need to last under heavy use and over multiple generations. These factors, combined with extremely cold temperatures and a short construction season, make it hard for those living in rural communities to obtain quality housing.

Based on initial analyses, the wall designs presented in this snapshot show strong potential for application in rural Alaska. Exterior and interior moisture management are critical to the longevity of high performance walls, and the building envelope will perform best when complemented with balanced ventilation inside the home. Materials for the wall designs were selected based off reasonable availability in Alaska's housing market, however these designs may evolve as new materials enter the marketplace.

REFERENCES

Pacific Northwest Regional Council of Carpenters. (2017). AGC OF ALASKA - SCHEDULE "A" Carpenter Journeyman Residential . Retrieved from nwcarpenters.org/wp-content/uploads/2016/01/Alaska-AGC-Residential-Schedule-A-9-1-17-to-8-31-2018-1.pdf

Wiltse, N., Madden, D., Valentine, B., Stevens, V. (2014). 2013 Alaska Housing Assessment. Fairbanks, AK: Cold Climate Housing Research Center. Prepared for: Alaska Housing Finance Corporation.

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