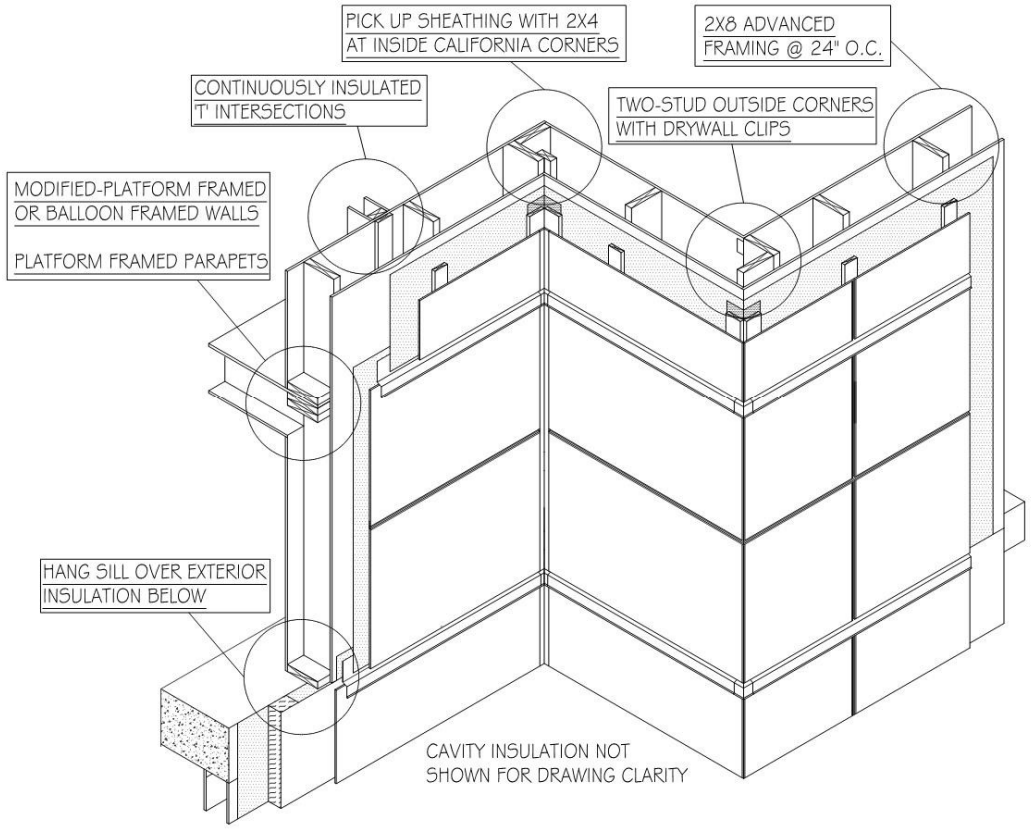
GUIDELINES FOR WALL ASSEMBLIES

Version 1.1 | October 2022



HOUSING DEVELOPMENT *consortium*

Exemplary Buildings Program

Advancing Ultra-Efficient Buildings in Affordable Housing

CONTENTS

OVERVIEW

The Housing Development Consortium of Seattle-King County (HDC) launched its Exemplary Buildings Program as a regional collaborative effort targeting nothing less than transformation of the affordable housing market.

The interrelated crises of climate change, equity, and housing demand both boldness and urgency. We believe it's possible to create equitable access to healthy, safe housing that is *both* affordable *and* ultra-efficient. How? Through the use of performance standards and building practices that reduce the overall premium (the additional costs of implementing ultra-efficiency) to the point where the premium can be financed through the operational savings generated by ultra-efficiency. To this end, HDC's Exemplary Buildings task force defined a comprehensive set of performance goals for ultra-efficient affordable housing; these are available to review and download on the Exemplary Buildings website: https://exemplarybuilding.housingconsortium.org.

Design Charrettes. Meeting those performance goals depends on broad engagement and a relentless focus on best practices. Design charrettes are a critical tool for both. Each intensive session brings together recognized thought and practice leaders in one of seven technical areas: Balanced Ventilation & Heat Recovery; Domestic Hot Water; Healthy Building Materials; Early Integrative Design; Solar Integration; Wall Assembly; and Water Conservation & Management.

Charrette participants, including experts from HDC's Exemplary Buildings task force, rigorously sift through all of the current and emerging technologies. Each is analyzed in the context of changing construction practices and local construction culture; the Puget Sound region's marine climate; codes and regulations; and cost.

The path to achieving cost efficiency includes standardization, training, and partnerships with suppliers. So a fundamental purpose of HDC's Exemplary Buildings Program is to present approaches that are repeatable, such that cost efficiencies can be accomplished at scale with partner suppliers and subcontractor familiarity. Each charrette produces a set of practical guidelines to support teams early in their design and pricing efforts, helping to streamline the process of building Exemplary Buildings.

We hope the guidelines facilitate the affordable housing sector's ability to achieve construction cost efficiency, quality, and durability while pursuing the performance goals of the Exemplary Buildings Program and the specifications for projects in King County, Washington. Performance data from the program's demonstration projects will be used to continually refine the guidelines and update these publications.

Partners. We're grateful for the time and exceptional talent of the charrette participants and for the generosity of our program funders and charrette sponsors. Their commitment to this vision is vital. A complete list of these supporters concludes this document.

Marty Kooistra
Executive Director
Housing Development Consortium of Seattle-King County (HDC)

PURPOSE OF THESE GUIDELINES

The comprehensive performance goals defined for HDC's Exemplary Buildings Program include performance targets specifically focused on the enclosure. These are:

- Improved airtight measures: Measured air leakage ≤ 0.17 cfm/ft2 @ 75Pa.
- Review and reduce thermal bridging at foundation, floors, balconies, decks, and roof.
- Component targets (overall targets):
  - Windows: ≤ U-0.22, SHGC optimized by orientation and ideally located within framing centers.
  - Slab-on-grade floors: ≥ R-10, continuous below slab TB at perimeter.
  - Above-grade floors: ≥ R-35.
  - Above-grade walls: ≥ R-22, ideally using advanced framing.
  - Roof: ≥ R-49.

With these criteria as a framework, HDC's first Exemplary Buildings Program charrette developed several simple and cost-efficient common wall assembly designs. The information in the following pages covers five wall types commonly used in affordable multi-family housing construction. For each wall type, guidelines have been provided to cover the following characteristics:

- Achieving Effective R22 Assembly Thermal Efficiency
- Framing Considerations
- Assembly Airtightness
- Water Management
- Vapor Control
- Cladding Attachment
- Material Durability

HDC's Exemplary Buildings Program and specifications for the enclosure require attention to details that are not reflected in overall assemblies—primarily thermal bridging and whole building airtightness. Some sample details have been included in this document and we hope that further strategies will be incorporated at a future date.

The guidelines have been updated in 2021 to include additional information to assist planning for the use of advanced framing, both to improve thermal performance and reduce construction costs. The help from Brent Robinson, PE, SE of DCI Engineers and Ben Frizzell, PE, SE of Coughlin Portern Lundeen is greatly appreciated in this update.

Since every building has unique circumstances, design and construction teams will need to independently verify the information provided here, but efforts have been made to present information that is true and accurate. We hope this document proves useful as a resource to assist with the design of affordable high-performing walls.

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Principal, 4EA Building Science
Lead, HDC Exemplary Buildings Program Wall Assemblies Charrette

ORGANIZATION

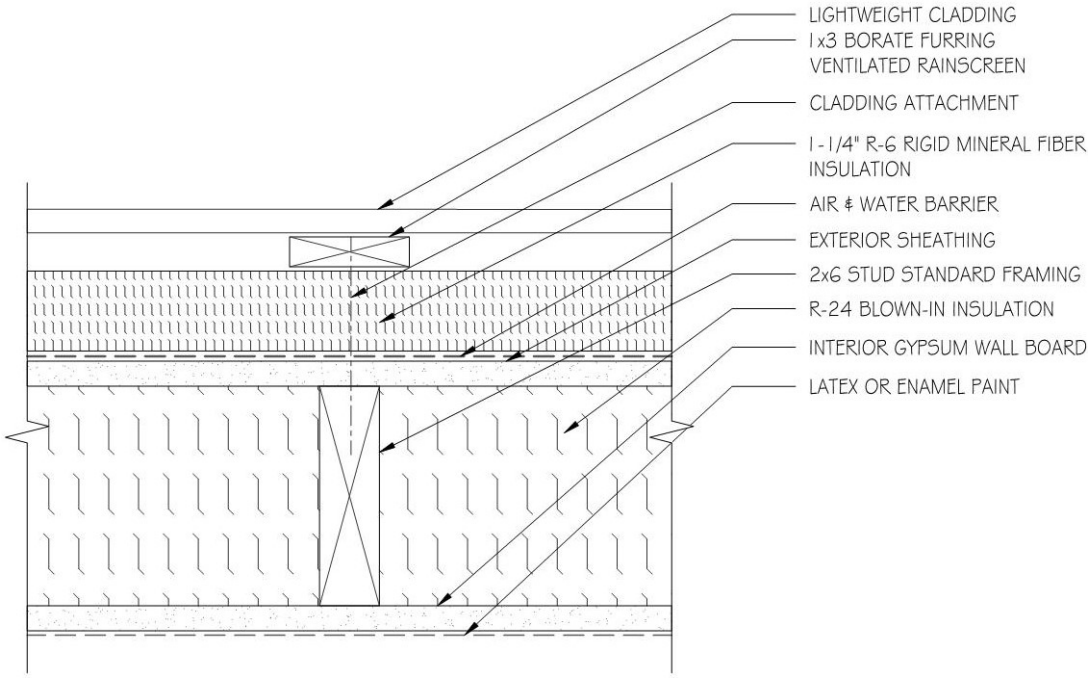
I. Sample Wall Guidelines

A. Wood-Framed 2x6 Walls with Exterior Insulation
B. Wood-Framed 2x8 Walls with Cavity Insulation
C. Steel-Framed 6” Walls with Exterior Insulation
D. Cast-in-Place Concrete Walls with Exterior Insulation
E. Cast-in-Place Concrete Walls with Interior Insulation

II. Advanced Framing Primer – Strategies For Success

III. List of References and Additional Resources

SAMPLE R22 WOOD-FRAMED 2x6 WALL



Cavity Insulation – R24 blown-in fiberglass insulation installed to Grade 1.

Continuous Insulation – 1.25" of continuous R-5 mineral wool insulated sheathing board with minimum density of 11 lb/ft3.

Sheathing –Exterior gypsum or structural sheathing as needed for structural and fire rating requirements. Consider plywood rather than OSB sheathing for improved moisture resistance, but choice is the discretion of the design team.

Framing – 2x6 standard framing at 16" o.c. or better; Douglas Fir assumed thermally. Maximum framing factor 25%.

Air and Water Barrier Option #1 – Fully adhered sheet air and water barrier. Sheet is vapor permeable with minimum wet cup 14 perm rating. Vertical 1x3 borate treated furring for ventilated rainscreen cavity.

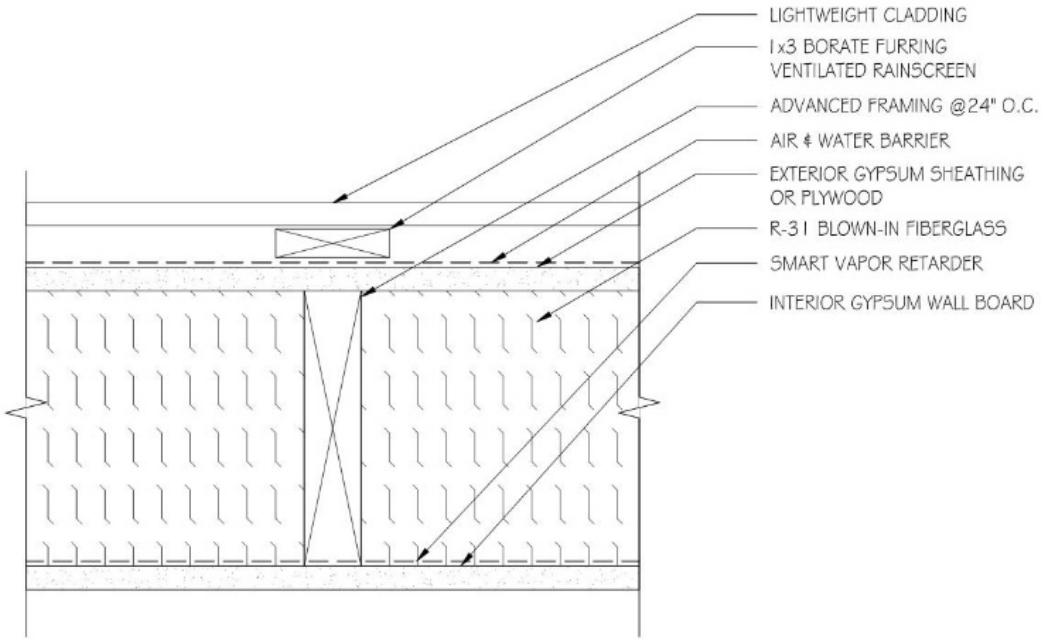
Air and Water Barrier Option #2 – Sealed sheathing air barrier with mechanically-attached sheet water barrier. Sheet is vapor permeable with minimum wet cup 28 perm rating. Vertical 1x3 borate treated furring for ventilated rainscreen cavity.

Vapor Control – A Class III vapor retarder such as latex paint.

Note Regarding Furring Attachment with Continuous Insulation Option #2: Furring can be attached to framing through insulation with #12 fasteners at 16" o.c. and minimum 1" embedment into stud. This applies to lightweight claddings under 10 psf in weight, which includes most metal and fiber cement panels, and allowable wind loads less than 70 psf.

Final fastener spacing and size shall be confirmed by design team or cladding manufacturer.

SAMPLE R22 WOOD-FRAMED 2x8 WALL



Cavity Insulation – R-31 in cavity using blown-in Fiberglass to a minimum density of 1.6 lb/cu.ft.

Sheathing – Exterior gypsum or structural sheathing as needed for structural and fire rating requirements. Consider plywood rather than OSB sheathing for improved moisture resistance, but choice is the discretion of the design team.

Framing – 2x8 framing at 24" o.c. using advanced framing techniques where structurally feasible. Douglas Fir assumed thermally. Maximum framing factor 20%.

Refer to advanced framing section for further detail.

Air and Water Barrier Option #1 – Fully adhered sheet air and water barrier. Sheet is vapor permeable with minimum wet cup 14 perm rating. Vertical 1x3 borate-treated furring for ventilated rainscreen cavity.

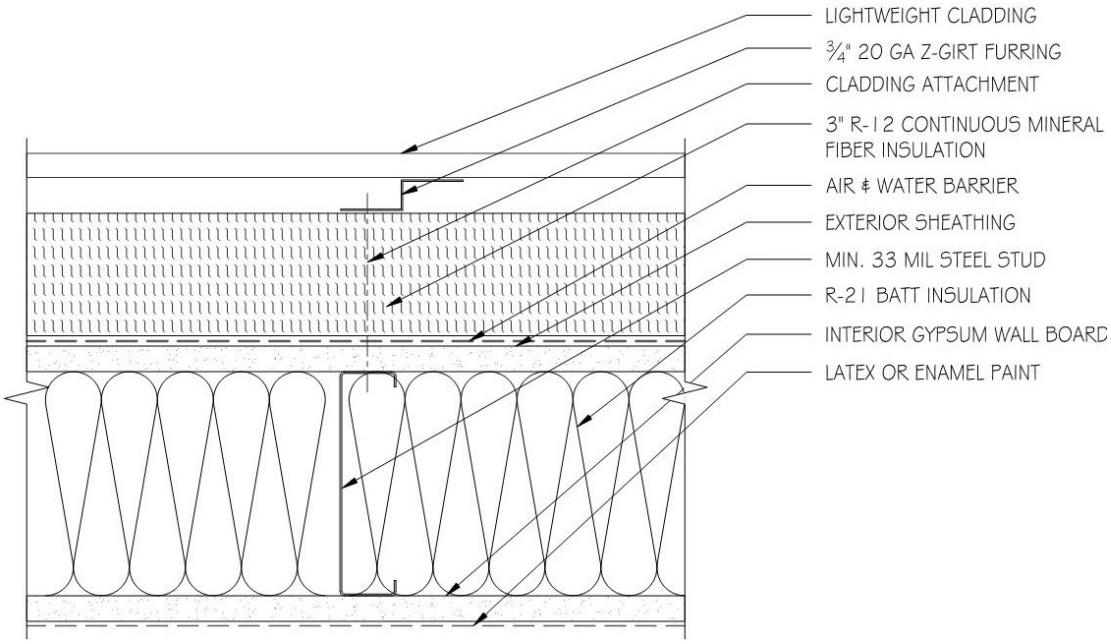
Air and Water Barrier Option #2 – Sealed sheathing air barrier with mechanically-attached sheet water barrier. Sheet is vapor permeable with minimum wet cup 28 perm rating. Vertical 1x3 borate treated furring for ventilated rainscreen cavity.

Vapor Control – A Class II polyamide sheet smart vapor retarder.

Note Regarding Fiber Cement Panel Cladding Attachment: In locations where wind loads are above 27 psf (45 psf ultimate), there may be limitations on the attachment of fiber cement panels in corner zone areas if exterior gypsum sheathing is used due to nail gun length limitations. Builder and design team would need to review on a project-by-project basis.

Note on Interior Humidity: This assembly is intended for medium interior moisture gains and lower and should be revisited by design teams if interior occupancy anticipates regular high humidity conditions at or above 50% RH during wintertime.

SAMPLE R22 STEEL-FRAMED 2x6 WALL



Cavity Insulation – R21 batt insulation installed to Grade 1.

Continuous Insulation Option #1 – 3" (R-12) mineral wool insulation combined with fiberglass clips or similar thermally broken clips for cladding attachment.

Continuous Insulation Option #2 – 3" (R-12) mineral wool insulated sheathing board with minimum density of 14 lb/ft3 (see note below).

Framing – 6" steel stud, minimum 20 gauge (33 mil) or greater recommended, or as otherwise required for structure.

Air and Water Barrier Option #1 – Fully adhered sheet air and water resistive barrier. Vapor permeable with minimum wet cup 14 perm rating. 20 gauge G90 galvanized steel Z-furring for ventilated rainscreen cavity.

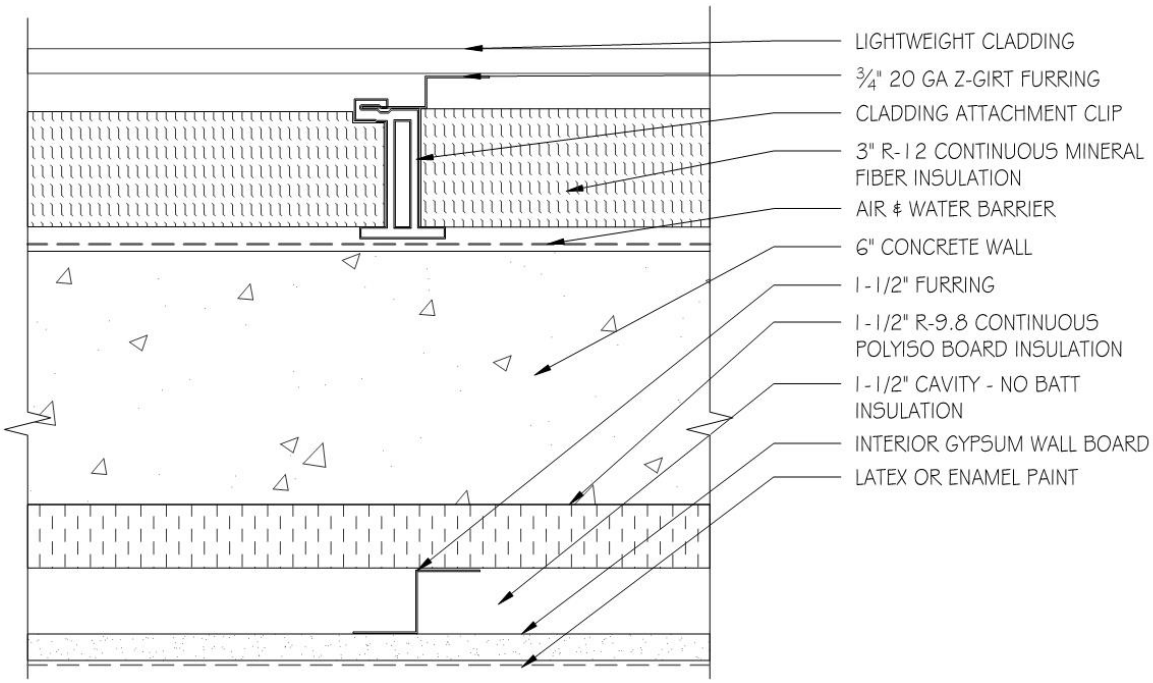
Air and Water Barrier Option #2 – Sealed sheathing air barrier with mechanically-attached sheet water barrier. Sheet is vapor permeable with minimum wet cup 28 perm rating. 20 gauge steel Z-furring for ventilated rainscreen cavity.

Vapor Control – A Class III vapor retarder such as latex paint.

Note Regarding Furring Attachment with Continuous Insulation Option #2: Z-Girt furring can be attached to framing through insulation with #12, #3 Philips pan head, partially threaded drill-point Trufast screw fasteners at 12" o.c. with engagement into stud + 3 threads and a minimum bearing width of 1.5". This applies to lightweight claddings under 5 psf in weight, which includes most metal and fiber cement panels, and allowable wind loads less than 60 psf.

Final fastener spacing and size shall be confirmed by design team or cladding manufacturer.

SAMPLE R22 EXTERIOR INSULATED ABOVE-GRADE CONCRETE WALL



Exterior Continuous Insulation – 3” (R-12) mineral wool insulation combined with fiberglass clips or similar thermally broken clips for cladding attachment.

Interior Continuous Insulation – 1.5” (R-9.8) non-halogenated (NH) polyiso board insulation.

Cavity Insulation – None.

Concrete – 6” minimum normal weight concretec, thickness per structural.

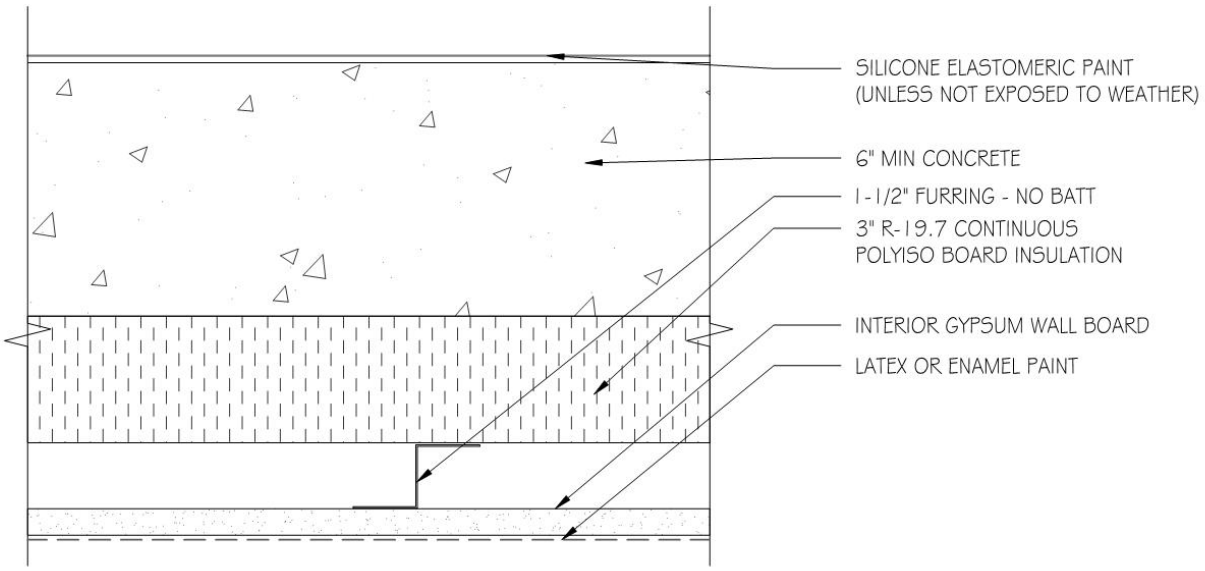
Interior Furred Wall – 1.5” interior furring at 16” o.c. with a gypsum wall board thermal barrier required.

Air and Water Control – Fully adhered sheet water resistive barrier, vapor permeable with minimum 14 wet cup perm rating. 20 gauge steel Z-furring for ventilated rainscreen. Concrete acting as the air barrier.

Vapor Control – None required.

Cladding Clip Anchorage – Design team and builder to coordinate the final attachment of the cladding clip to the concrete wall. Concrete screws or expansion anchors recommended.

SAMPLE R22 INTERIOR INSULATED ABOVE/BELOW-GRADE CONCRETE WALL



Interior Continuous Insulation – 3” (R-19.7) non-halogenated (NH) polyiso board insulation installed with joints and seams taped or sealed.

Cavity Insulation – None.

Concrete – 6” minimum normal weight cast-in-place concrete.

Interior Furred Wall – 1.5” interior furring at 24” o.c. with a gypsum wall board thermal barrier required.

Water Control – Silicone elastomeric paint, if exposed to weather. Below-grade waterproofing and drain mat if exposed to earth.

Air Control – Concrete.

Vapor Control – None required.

ADVANCED FRAMING PRIMER – STRATEGIES FOR SUCCESS

Advanced Framing – General

EBP Recommendation

Engage with the project structural engineer and contractor/estimator early in the project to evaluate the feasibility of advanced framing.

Benefits

- Advanced framing uses less lumber. Wood framing is often a major project construction cost, and the use of advanced framing may present opportunities for savings.
- Using less wood framing in walls will leave more space for insulation. This results in a better insulated thermal envelope and operational savings on heating and cooling.

Considerations

- Framing sub/contractor should be familiar with the advanced framing approach.
- Advanced framing is best suited for buildings with simple massing and limited façade modulation.
- Cladding attachment may have limitations in areas with elevated wind zones.
- Use of Type III Fire Retardant Treated Wood may have greater limitations with advanced framing due to strength reductions.
- Projects pursuing advanced framing should assume a framing factor of <20% for the thermal envelope, rather than 25% or similar for standard framing.

Advanced Framing – Details

EBP Recommendation

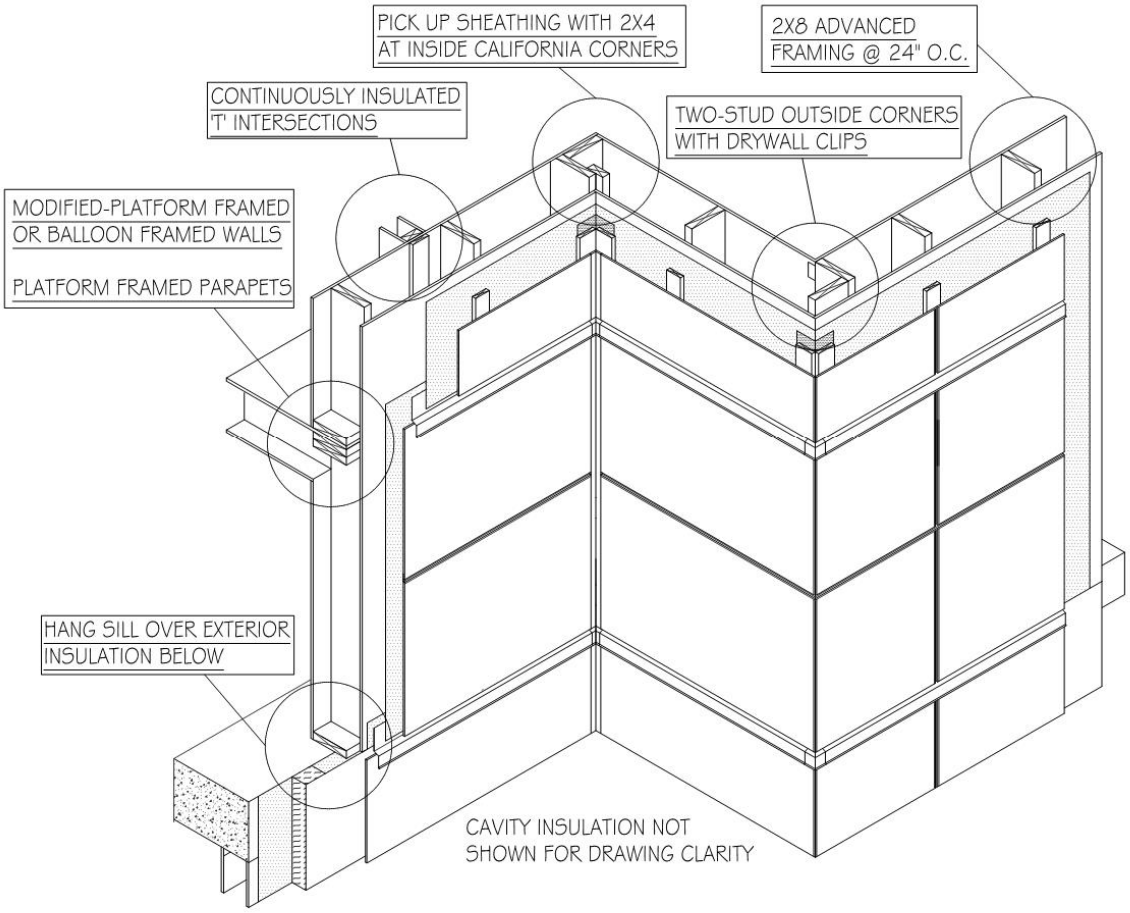
Incorporate the following details into the advanced framing package:

- **2x8 wall studs spaced at 24 inches on center**
- **Two-stud outside corners with drywall clips**
- **Use a 2x4 trim studs at inside California corners**
- **Continuously insulate across partition intersections with a 2x4 trim stud.**
- **Consider using 2x4 for any studs that do not need to support both sheathing and wall board.**
- **Single jack studs at small exterior openings (design team to confirm feasibility).**
- **Single member header with added insulation**
- **Use double top plate as needed.**
- **Minimize cripple studs**

Considerations

- Consult with project structural engineer on this approach.
- Review framing details for blind corners and other areas where insulation can't be placed.

CONCEPT DETAIL – ADVANCED FRAMING AXON



Advanced Framing – Floor Plans

EBP Recommendation

Optimize floor plans and unit layouts for use with advanced framing.

- Use a 24" grid as the layout for floor plans.
- Align floor plan directly above the wall studs when possible.
- Window rough opening widths should fit within the 24" framing module.
- Stack unit walls to limit or eliminate the use of beams at exterior floor lines.
- Use interior walls for shear walls and load bearing walls when possible.

Benefits

- Optimizing layouts will simplify the use of advanced framing, use less lumber, and reduce cost.

Considerations

- Structural design team shall coordinate framing requirements with builder to identify where framing can be optimized to achieve advanced framing techniques.
- Review use of 2x4 or 2x6 walls for load bearing partitions containing stud packs.
- Refer to Walsh Construction presentation in References for examples of efficient layouts.

Advanced Framing – Semi-Balloon Framed Exterior

EBP Recommendation

Reduce thermal bridging at floor lines by eliminating rim joist and using hangers off top flange.

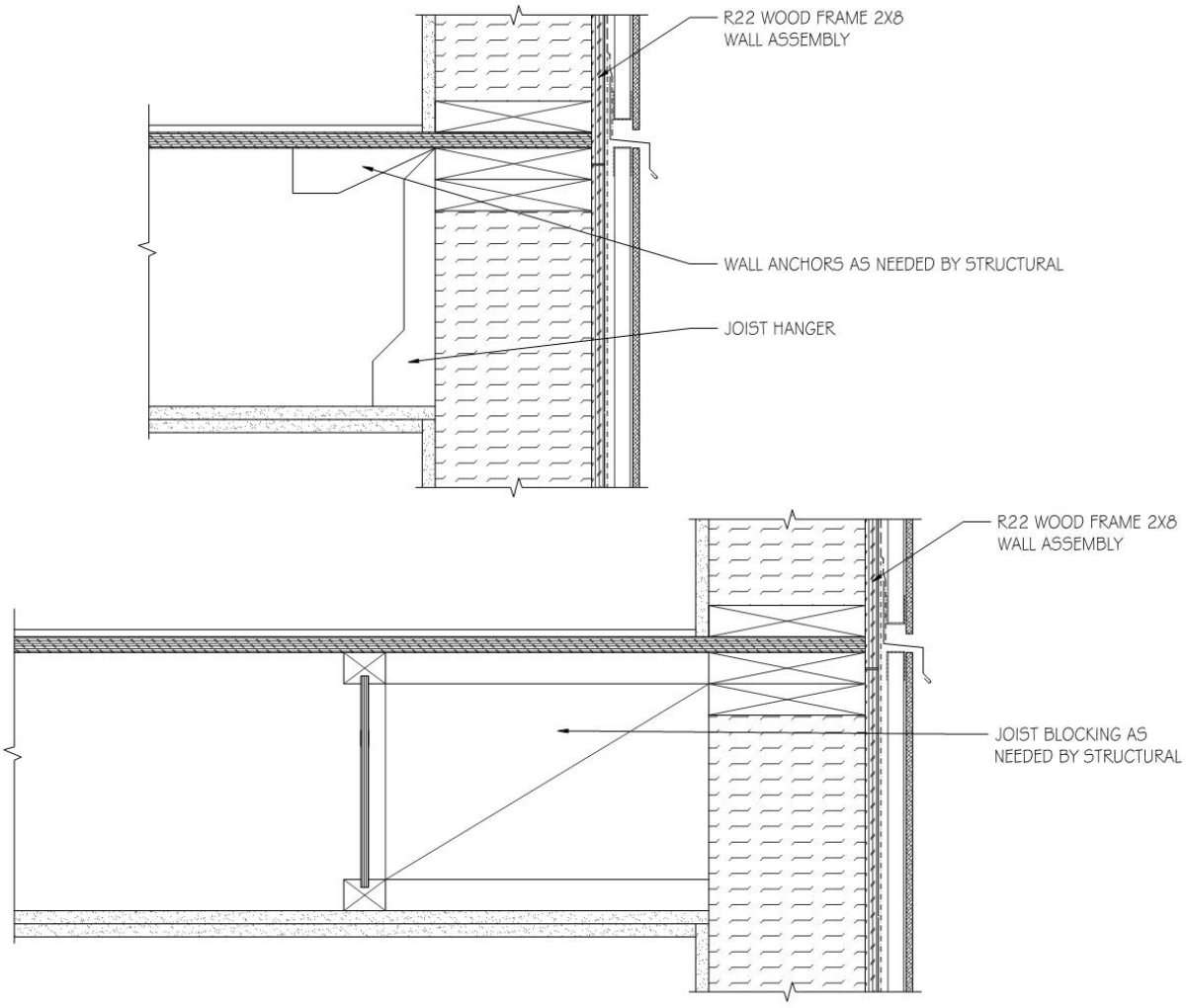
Benefits

- Reduced thermal bridging at floor lines.
- Eliminates rim joists.
- The area where wood shrinkage occurs is reduced to a small zone.

Considerations

- Unit stacking is important to limit the load bearing requirements of the top plate.
- Insulation will need to be supported in cavity at floor lines.
- Can be achieved with modified platform framing (see details below). Alternatively, balloon framing may be considered.
- Some framers in Northwest are not familiar with this technique and may require some additional coordination with the builder.

CONCEPT DETAIL – MODIFIED PLATFORM FRAMING



Advanced Framing – Platform Framed Parapets

EBP Recommendation

Platform frame parapets, if possible, with roof air barrier stripped continuously below parapet sill plate.

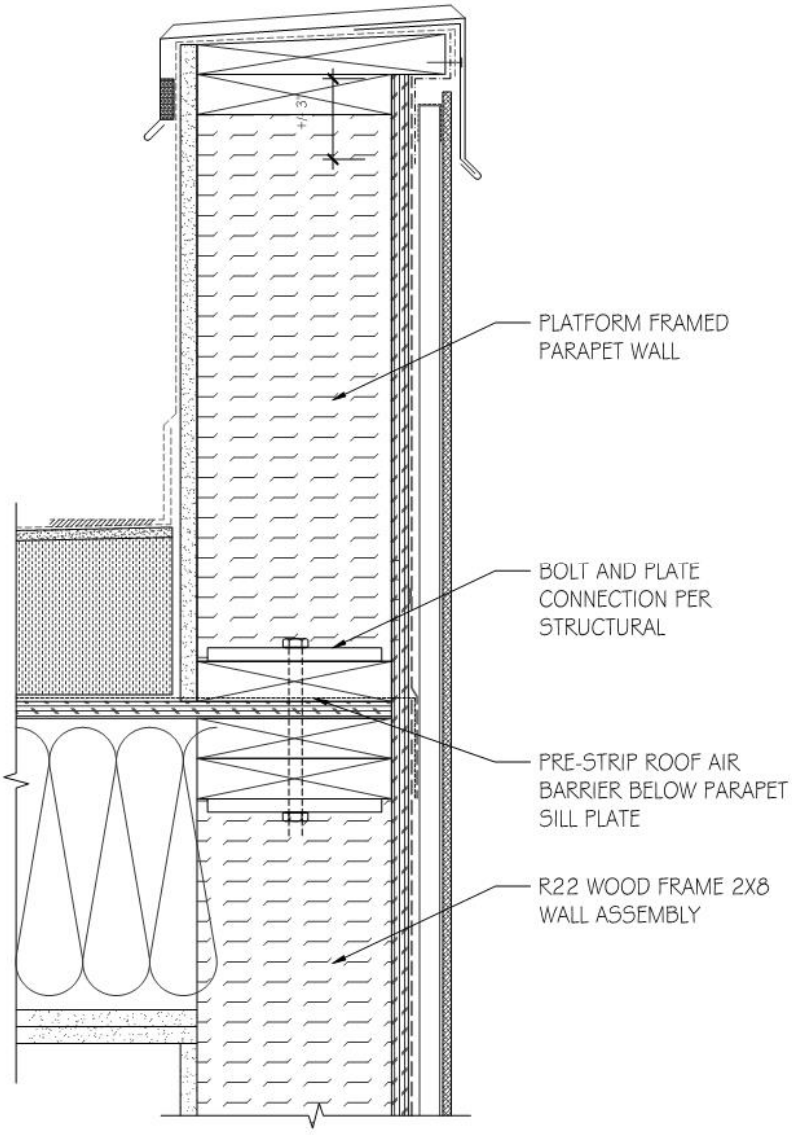
Benefits

- Continuous air barrier below parapet wall improves air tightness.
- Getting temporary roof / air barrier onto the roof before parapets are framed can allow for earlier dry-in.
- Limiting interior air into parapet cavity improves durability.

Considerations

- Consult with project structural engineer on height limitations for this approach.
- Can be achieved with either bolt or strap connections.

CONCEPT DETAIL – PLATFORM FRAMED PARAPET



Advanced Framing – Slab Edge Transitions

EBP Recommendation

Align face of slab edge insulation with face of wood frame sheathing on floor above.

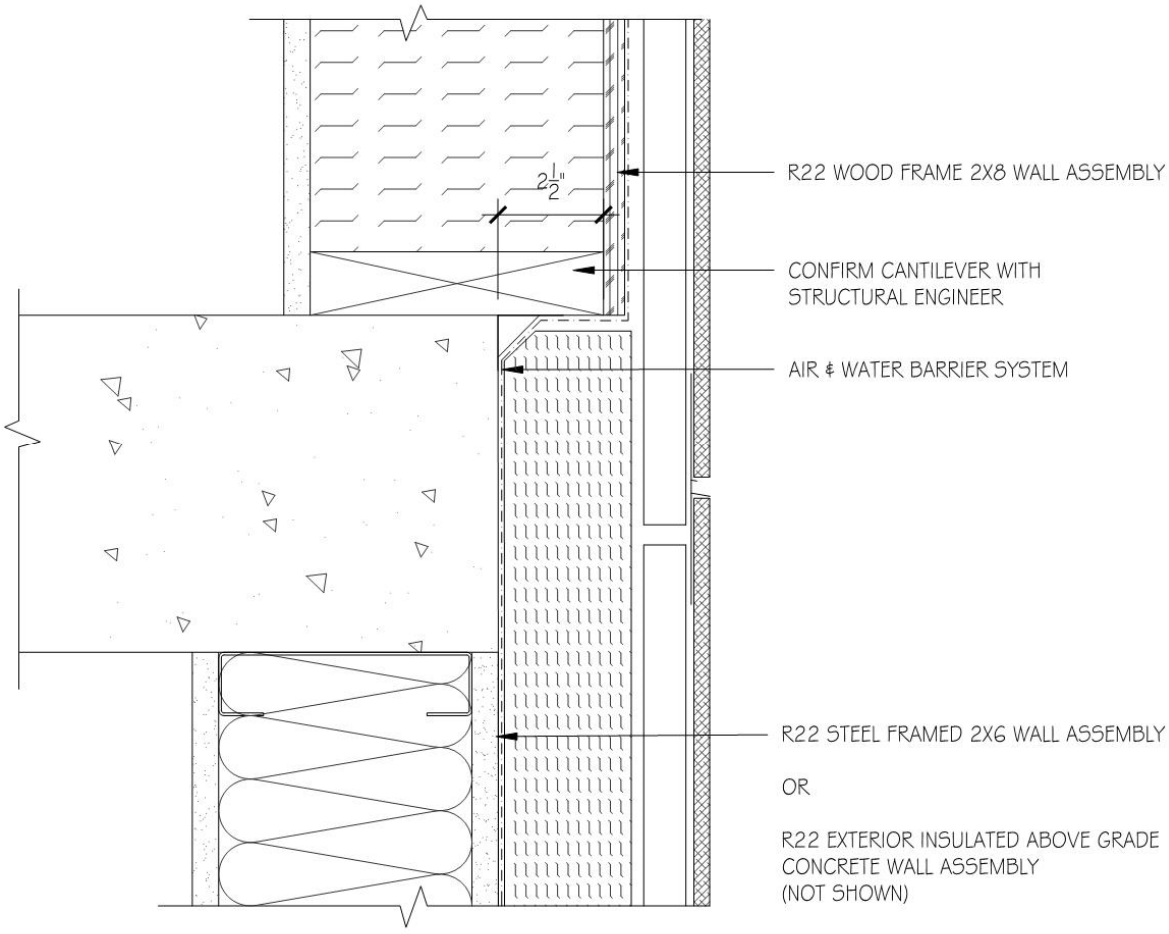
Benefits

- Reduces thermal bridging
- Aligns cladding

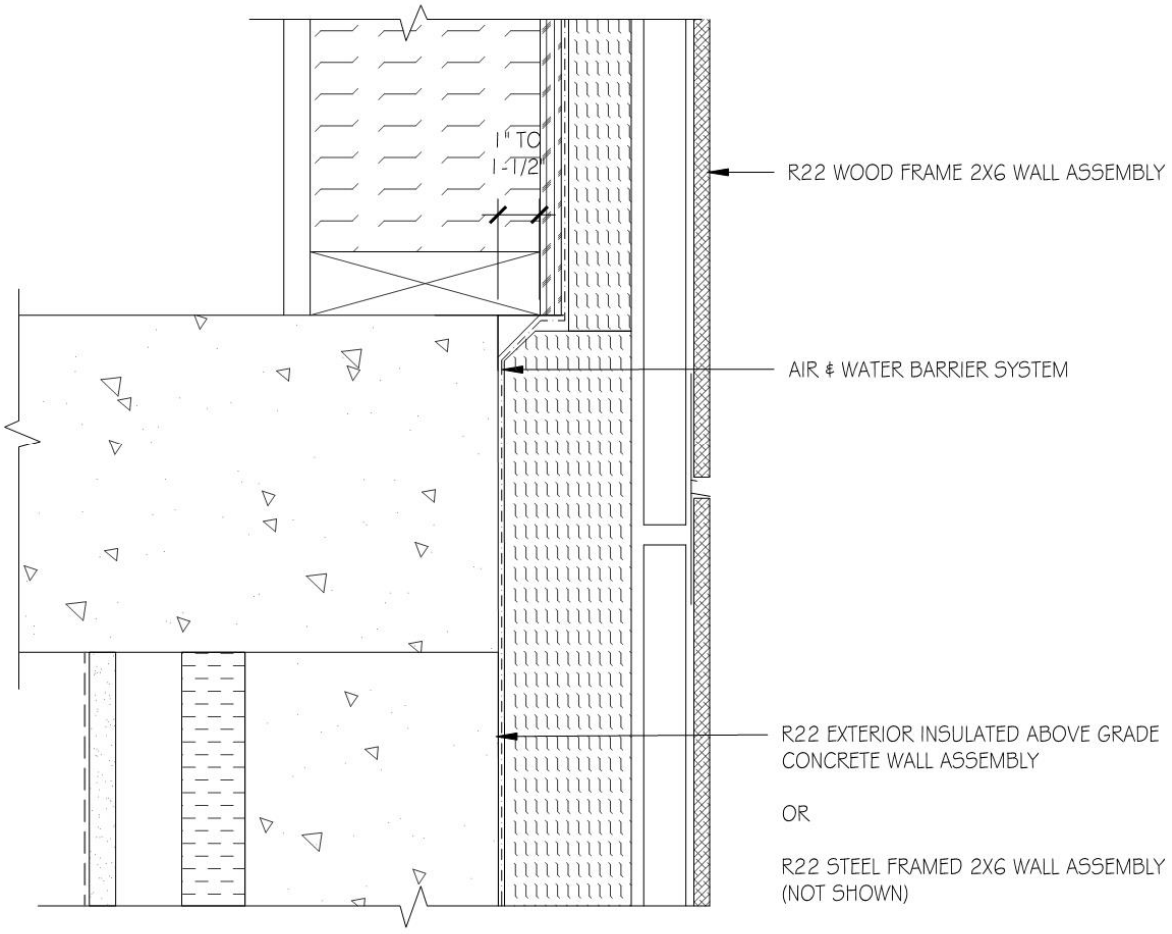
Considerations

- For use with 2x8 framing. Consult with project structural engineer to confirm allowable sill plate cantilever.

CONCEPT DETAILS – SLAB EDGE TRANSITION 1



CONCEPT DETAILS – SLAB EDGE TRANSITION 2



REFERENCES & ADDITIONAL RESOURCES

The following resources are valuable tools that assisted in the development of these guidelines. They can assist design and construction teams in achieving the requirements of HDC's Exemplary Buildings Program beyond the information presented in this document.

RDH and BC Housing: Illustrated Guide to R22+ Effective Walls in Wood-Frame Construction in British Columbia

https://www.bchousing.org/research-centre/library/residential-design-construction/ig-R22-effective-walls-residential-construction

RDH and Walsh Construction: High-R Walls for the Pacific Northwest – A Hygrothermal Analysis of Various Exterior Wall Systems

https://www.buildingscience.com/sites/default/files/migrate/pdf/RR-1014_High-R_Walls_Pacific_Northwest.pdf

Walsh Construction: Exploring A Path Towards Cost – Efficient, Energy- Efficient Affordable Housing

https://www.phnw.org/assets/2019Conference/Presentations/PHnw2019_Exploring%20a%20Path%20to%20More%20Cost%20Effective%20Energy%20Efficicent%20Passive%20House%20Affordable%20Housing_Mike%20Steffen.pdf

Structure Magazine: Anchorage of Wood Structure Walls (Modified Platform Framing)

https://www.structuremag.org/wp-content/uploads/2018/07/C-StructuralComponents-McComb-Aug18.pdf

City of Seattle: Tip 341 – Advanced Framing

http://www.seattle.gov/DPD/Publications/CAM/CAM341.pdf

STAY CONNECTED

If you're considering developing an exemplary building and would like a sounding board or technical assistance, please reach out to us. If you've applied our guidelines, we hope you'll share your feedback. Continuous learning is both a guiding principle and a core method of HDC's Exemplary Buildings Program; your experiences will help us continually improve our model and refine the practices we champion.

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Edwards Mother Earth Foundation

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