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HOW TO MAKE CONTINUOUS INSULATION WORK

The Energy Code and Plaster Assemblies

Western Conference of Wall and Ceiling Institutes

Preface

Energy code regulations, particularly California's Title 24, require a more prevalent use of continuous insulation (CI) over all framed walls. The CI design approach is intended to prevent or minimize the thermal transfer often referred to as "thermal short circuiting" or "thermal bridging." This is related to the natural thermal conductivity of steel. Steel is a recyclable resource and sustainable material preferred by designers. The "prescriptive method" for code compliance is the most often used method to achieve energy savings. The prescriptive method is simply using a rigid foam product CI over the framing members to prevent the thermal transfer or act as a thermal break.

The plaster industry has always been proactive with energy issues by developing systems or assemblies with variations that can meet the designer's desires for aesthetics and comply with energy requirements. Some of these plaster systems/assemblies are decades old and have proven themselves very successful. Each assembly or system has unique characteristics and designers are encouraged to explore each one, discuss options with a quality wall and ceiling contractor, your local plaster bureau and then decide which is most appropriate for their specific project.

ALTERNATE METHODS
While the plaster industry will continue to research and develop plaster assemblies to meet owners' desires, provide energy savings and meet code regulations, there are alternatives to exterior CI that can meet energy code requirements. For example, system or component improvements in other areas of the building may allow designers to use more traditional plaster cladding assemblies. Another alternative idea is to move the continuous insulation to the inside of the wall cavity or framing member. Some CI plaster systems have extremely low assembled U factor ratings and may allow designers flexibility in other areas of design.

TECHNICAL SERVICES INFORMATION BUREAU
is a not for profit educational and information bureau for the wall and ceiling industry. With offices in Arizona, California and Nevada, the TSIB saw a need to create a publication to assist building owners, designers, contractors and code authorities with the selection of plaster systems/assemblies relating to the new energy requirements for cold formed steel framing.

WESTERN CONFERENCE OF WALL AND CEILING INSTITUTES, formerly known as the Western Conference of Lath and Plastering Institutes, is a collective of the wall and ceiling trade associations designed to research, observe and then promote industry practices in a non proprietary and unified voice. This brochure has been created as a collaborative effort with valuable input from all Western Conference member institutes.

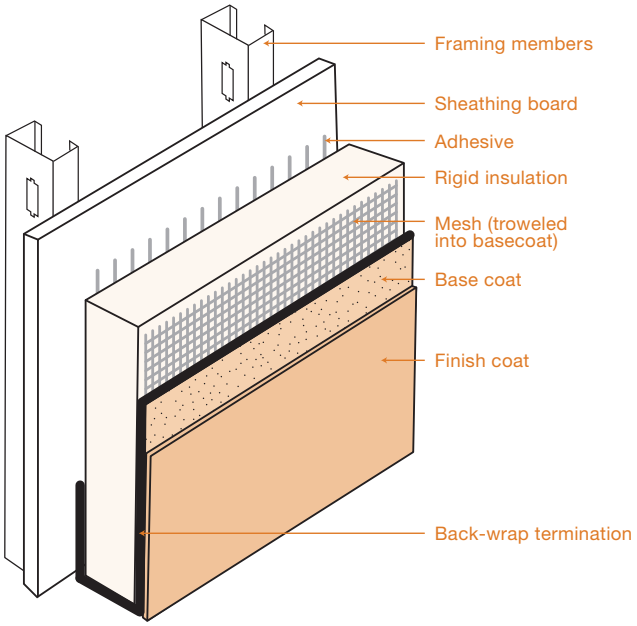
Exterior Plaster
Systems and Assemblies:

EIFS

EIFS (Exterior Insulation and Finish Systems) were developed for the express purpose to conserve energy and have the aesthetic appearance of stucco. Europe experienced the energy crisis before the United States and the solution to the problem was EIFS. It was discovered that 24-inch by 48-inch foam panels adhesively applied to the exterior of structures provided the continuous insulation (CI) and provided energy savings. A fiberglass mesh embedded into a proprietary polymer enriched cement provides a strong, yet flexible lamina to protect the foam. The lamina provides water resistance and a suitable base for the final decorative acrylic finish.

Designers and contractors are encouraged to first consider these adhesively applied systems to comply with energy code regulations. They provide the ultimate in protection against thermal transference (thermal bridging) at an economical cost. These systems are fully tested and code approved by each proprietary manufacturer. The Western Conference encourages designers to visit www.eima.com for more information about EIFS and contact EIFS manufacturers.

Figure 1. Proprietary EIFS System



ONE-COAT STUCCO

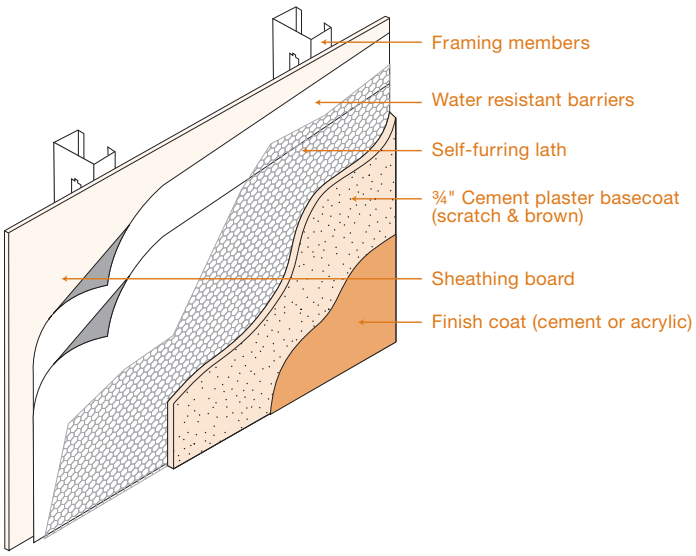
One-coat stucco is another good option for designers and contractors to consider. This system was developed in the southwestern United States during the 1970's energy crisis. The requirement for more R-Value on exterior walls meant builders needed to go from traditional two-by-four studs to two-by-six studs to make room for more insulation. The plaster industry created the one-coat stucco system over a one-inch rigid foam base to allow builders to continue using the two-by-four studs and still meet the higher R-Values set by the energy code.

One-coat stucco is a proprietary system incorporating a special blended cement over a tongue and groove Expanded Polystryene (EPS) foam sheathing board. The systems are typically considered more appropriate for residential and low rise commercial projects. They have had good success when applied per manufacturer's recommendations and with a textured cement finish. One-coat stucco is typically not recommended for smooth or sand finish textures and 1 1/2-inch 17 gauge woven wire is recommended in leiu of 1-inch 20 gauge wire. For more information about one-coat stucco visit www.nocsa.org.

GENERIC CEMENT PLASTER (STUCCO)

Generic or conventional three-coat cement plaster is part of the building code and can also be done over rigid foam substrates. ASTM C-926 confirms this fact in section 7.1.3: "Portland cement plaster shall be applied on furred metal plaster base when the surface of solid backing consists of gypsum board, gypsum plaster, wood or rigid-foam board type products." The Western Conference of Wall and Ceiling Institutes has developed multiple generic cement plaster assemblies incorporating a rigid foam (CI) to comply with ASTM C-926 and the Energy Codes. Many of these generic plaster assemblies have been installed in the western United States and monitored by regional plaster bureaus for performance and evaluated for serviceability. Plaster bureaus on the West Coast have compiled this data and their experiences to formulate three systems of generic code approved three-coat stucco with rigid foam (CI).

Figure 2. Generic Stucco System



Design Considerations:

Framing spaced at 16 inches on center has traditionally offered better stability for the cement plaster assembly and is typically recommended for best performance. It is recognized that framing spaced at 24 inches on center allows a savings in construction materials, lower U-factors and may promote additional energy savings. Framing spaced at 24 inches on center is possible when the plaster assembly receives skim coat and mesh (lamina) over the brown coat (PWA 104 and 106). This lamina is vapor permeable, increases crack resistance and overall assembly performance. The following are good design recommendations for Portland cement plaster and continuous insulation (CI).

- The deflection design criteria is required to be a minimum of L/360.
- All assemblies require a vapor permeable water-resistant barrier(s) installed in a "shingle-fashion" with water proof flashings. Liquid applied membranes shall be installed per manufacturers recommendations.
- 24-inch spacing of framing is only recommended when:
  - a sheathing is applied over the framing.
  - a skim coat and mesh (lamina) is applied over the brown coat.
- Tongue and groove rigid foam is not required for these stucco assemblies.
- Plaster mixes shall conform to ASTM C-926.

Plaster Wall Assembly – PWA 104
(Continuous insulation under cement plaster)

General: This assembly is recommended to have a fiberglass mesh trowleded into a skim coat of polymer enriched cement over the set brown coat. The lamina provides superior crack resistance. Eliminating the lamina increases the likelihood of cracking. Comply with chapter 25 of local and national building codes. Refer to Design Considerations of generic cement plaster for additional notes.

Framing: Minimum 18 gauge (43 mil). Stud spacing may be 24 inches on center when a lamina is used.

Sheathing (*optional*): Wood or gypsum based. Gypsum-based may be required for fire rating. Attach per code or the fire rated assembly test. A water-resistive barrier(s) is applied over the sheathing in "shingle-fashion" with appropriate flashings.

Rigid Foam: Extruded foam (XPS) or (EPS) with a minimum density of 1.5 pounds per cubic foot, maximum thickness of two (2) inches. Flame Spread Index 25 or less, Smoke Develop Index not more than 450. Flat (no grooves) foam may be used if a drainage mat is installed behind foam. The facing of rigid foam shall be a type allowing cement to bond.

Lath: All lath must be self-furred, expanded metal lath (minimum 3.4 psy), welded or woven wire (minimum 17 gauge). Attach six (6) inches on center along framing supports with corrosion resistant self-drilling wafer head screw with length sufficient to have three threads through framing member.

Accessories: Control joints are recommended to create panels no larger than 144 square feet. If a lamina is used, spacing of control joints may be increased. Single-piece control joints and corner trims should be wire tied over continuous lath.

Cement (*scratch and brown*): Mix and application shall be per ASTM C-926. If a lamina is applied, hard floating the brown coat is not required (see Figure 4).

Lamina: Allow brown coat to set minimum 5 days after application prior to applying lamina. Caveats:

- Option 1: No lamina: Over the brown-cement plaster may crack more than a conventional cement plaster system.
- Option 2: Skim coat only: Cement plaster will crack similar to a conventional cement plaster system.
- Option 3: Skim coat and mesh: The fiberglass mesh (4–6 ounce) in the skim coat provides superior crack resistance (see Figure 4).

Finish: Cement or an acrylic finish coat may be applied to this assembly. Verify with the manufacturer that the finish coat is compatible with polymer skim coat (lamina).

Fire Rating:

- **One-Hour (*based on UL No U-425 or GA WP 8005-8007*):** Framing not to exceed 24 inches on center. Exterior side incorporates a 5/8-inch gypsum sheathing and rigid foam with flame spread index of 25 or less. Interior – one or two layers 5/8-inch type X GWB.

- **Two-Hour (*based on OSU T-4851 or GA WP 8416-17*):** Framing not to exceed 16 inches on center, single layer type X gypsum sheathing. Interior – two (2) layers 5/8-inch type X GWB.

U Factor: Overall U factor rating varies with size of steel stud, spacing, cavity insulation, and continuous insulation (CI). Refer to Table B foldout and CI requirements.

Fugure 3. Termination at Stem Wall/Foundation – PWA 104-fdn (REV. 01/10)

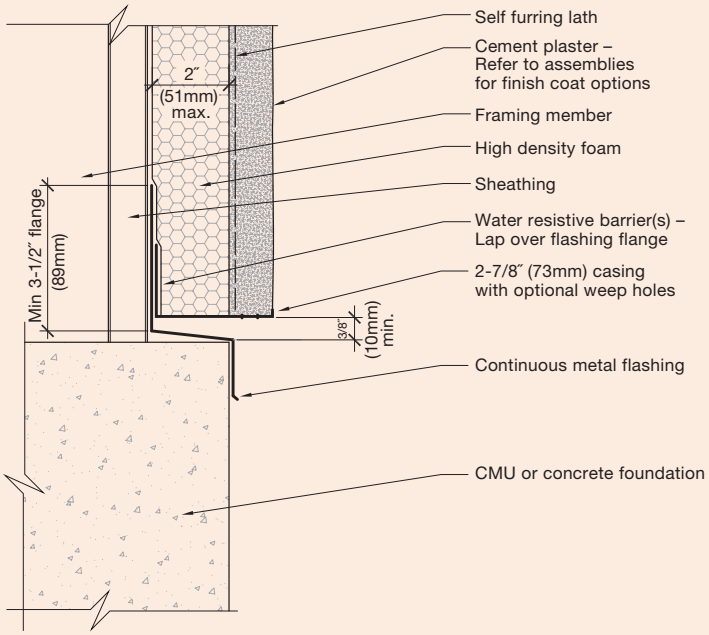
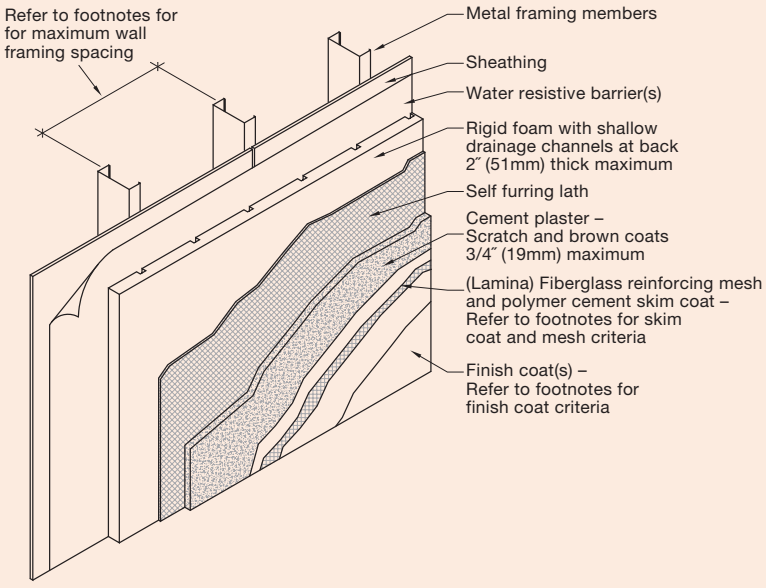


Figure 4. Insulated Cement Plaster Wall Assemblies – PWA 104 (REV. 01/10)



FOOTNOTES:

1. Standard framing is 16 inches on center.
   Framing spacing may be increased to 24 inches on center when a polymer enriched skim coat and mesh are applied over the brown coat of plaster.
2. Verify with the manufacturer that the finish coat is compatible with the polymer skim coat.

Plaster Wall Assembly – PWA 105
(Continuous insulation over cement plaster)

General: This assembly is installed the same as a conventional cement plaster per building code and ASTM C-926. Assembly 105 is highly crack resistant due to the EPS foam and lamina, may have limited surface abuse resistance compared to PWA 104 or PWA 106. Comply with Chapter 25 of local and national building codes. Refer to Design Considerations of generic cement plaster for additional notes.

EPS foam panels are adhesively applied to the cement brown coat and a 4 to 6-ounce fiberglass mesh is troweled into a skim coat of polymer enriched cement over the entire surface. This is not an EIFS system. PWA 105 is a cement plaster assembly with continuous insulation covering the cement plaster.

Framing: Minimum 20 gauge (33 mil) maximum spacing 16 inches on center with no sheathing.

Sheathing (*optional*): May be wood or gypsum based. Gypsum based required for fire rating of two-hours. Attach per code and/or fire test. The water-resistive barrier(s) is applied over the sheathing in "shingle-fashion" with appropriate flashings.

Lath: All lath must be self-furred, expanded metal lath (minimum 2.5 psy), welded or woven wire (minimum 17 gauge). Attach six (6) inches on center along framing supports with corrosion resistant self-drilling wafer head screws with length sufficient to have three threads through framing member.

Accessories: Control joints in the cement plaster are not required for this assembly. Expansion joints must be honored through the assembly.

Cement Basecoat (*scratch and brown*): Mix and apply per ASTM C-926. Floating (densification) of the brown coat is not required. Allow brown coat to cure 7 days prior to applying the EPS foam.

EPS (Expanded Polystyrene) Foam: Minimum density of 1.0 pound per square foot and a maximum of four (4) inches thick. Maximum thickness shall be determined as the average foam thickness over the entire wall assembly. Flame Spread Index 25 or less, Smoke Develop Index not more than 450. Foam should be rasped to provide a level flat surface. It is recommended to use materials by an EIFS manufacturer, but this is not an EIFS system.

Lamina: May be applied the day after the foam has been adhered to the brown coat (basecoat). Apply skim coat of polymer enriched cement onto EPS and embed fiberglass mesh into skim coat. Allow lamina to set for a minimum of 24 hours prior to applying finish coat.

Finish: Use only an acrylic finish: ensure compatibility with skim coat.

Fire Ratings:

- **One-Hour (*based on UL U-434 or GA WP 8122*):** No sheathing required – Framing spaced no further than 16 inches on center. Spacing may be increased to 24 inches on center when sheathing is used. Encapsulate EPS foam with lamina. Exterior – Portland cement plaster 7/8-inch thick. Interior – single layer 5/8-inch type X.

- **Two-Hour (*based on OSU-T-4851 or GA WP 8202*):** Framing spaced no further than 16 inches on center. Encapsulate EPS foam with lamina. Exterior – one layer 5/8-inch type X gypsum sheathing and 7/8-inch Portland cement plaster. Interior – two (2) layers 5/8-inch type X GWB (applied vertically).

U Factor: Overall U Factor rating varies with size of steel stud, spacing, cavity insulation, and continuous insulation (CI). Refer to Table B foldout.

Ideal Assembly for Retrofit Projects

Figure 5. Termination at Stem Wall/Foundation – PWA 105-fdn (REV. 01/10)

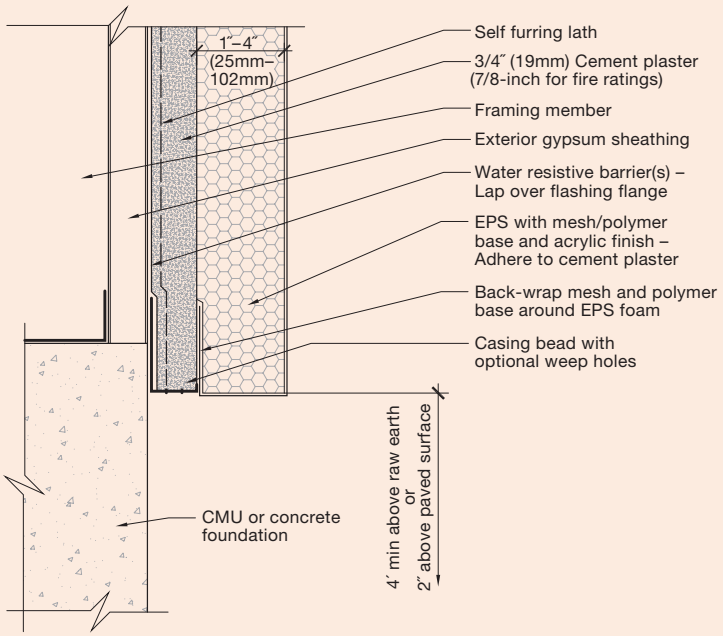
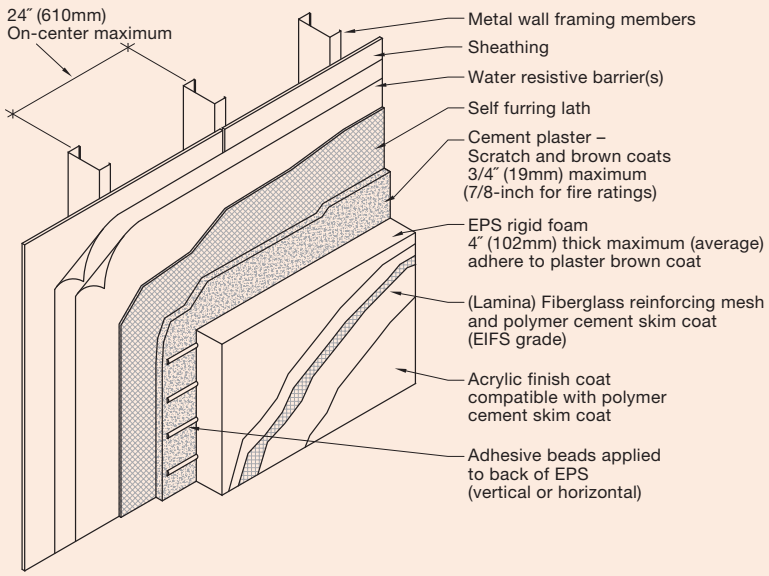


Figure 6. Cement Plaster Wall Assembly – PWA 105 (REV. 02/10)



Plaster Wall Assembly – PWA 106
(Exterior insulation with Z channels)

General: This assembly incorporates the use of Z furring to create a designed cavity for continuous insulation (CI), providing a sturdy, high abuse resistance and energy efficient assembly. The conventional cement plaster is installed over the outer layer of sheathing and Z furring, install per code, ASTM-1063 and ASTM C-926. Refer to Design Considerations of generic cement plaster for additional notes.

Framing: Minimum 18 gauge (43 mil). Spacing is to be 16 inches on center and may be up to 24 inches on center with lamina.

Sheathing: Gypsum based sheathing required for two-hour fire rating and non combustible construction. The water-resistive barriers are applied over the outer layer of sheathing in "shingle-fashion" with appropriate flashings. Comply with chapter 25 of local and national building codes. It is recommended to use vapor permeable water resistive barriers.

Z Furring: Minimum 18 gauge (43 mil) and should align with vertical framing members. The thickness (depth) of the Z furring shall not exceed 2 inches, unless approved by an engineer. Attachment to framing shall not exceed 24 inches on center.

(CI) Continuous Insulation: Rigid foam may be EPS, XPS or a Polyisocyanrate product. Flame Spread Index 25 or less, Smoke Develop Index not more than 450.

Thermal Break Tape: Gypsum panels on each side of the Z furring provide a moderate thermal break. To complete the thermal break, a foam tape (minimum 3/16-inch thick) shall be applied on the face of the Z furring (see Figure 8).

Lath: All lath must be self-furred, expanded metal lath (minimum 3.4 psy). Attach six (6) inches on center along framing supports with corrosion resistant self-drilling wafer head screw with length sufficient to have three threads through framing member.

Accessories: Apply trim accessories as per ASTM C-1063. Single-piece control joints may be installed over continuous lath.

Cement (*scratch and brown*): Mix and apply per ASTM C-926.

Lamina (*optional*): Recommended when framing is spaced 24 inches on center. Applied over the brown coat to aid in crack resistance. Verify finish coat and skim coat are compatible.

Finish: Cement or an acrylic finish coat.

Fire Rating: Non Combustible Construction

- **Two-Hour: (*based on FM-WP 288 – load bearing*):** Framing not to exceed 24 inches on center. Exterior – 1/2-inch regular gypsum sheathing, 5/8 inch type gypsum sheathing and 7/8-inch cement plaster. Interior – two layers 5/8-inch type X gypsum sheathing.

- **Four-Hour (*based on UL U-450 – non-load bearing*):** Framing spaced no further than 16 inches on center. Exterior – 5/8-inch type X gypsum sheathings and 7/8-inch cement plaster. Interior – three (3) layers of 5/8-inch type X GWB. Stud cavity filled with spray applied fire resistive material (Type D- C/F and II insulation with an average and minimum density of 13 and 11 pcf.)

U Factor: Overall U factor rating varies with size of steel stud, spacing, type of thermal tape, cavity insulation, and continuous insulation (CI). Refer to Table B foldout.

Figure 7. Termination at Stem Wall/Foundation – FDN 106 (REV. 02/10)

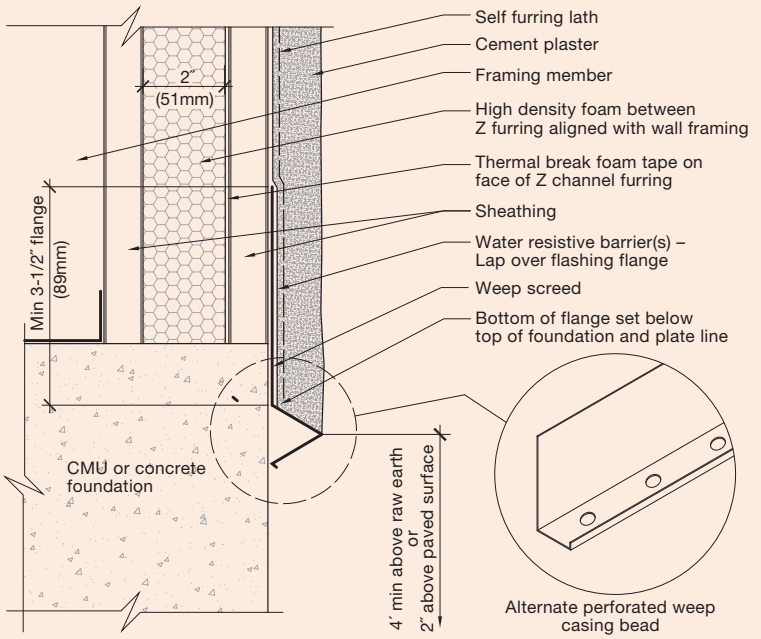
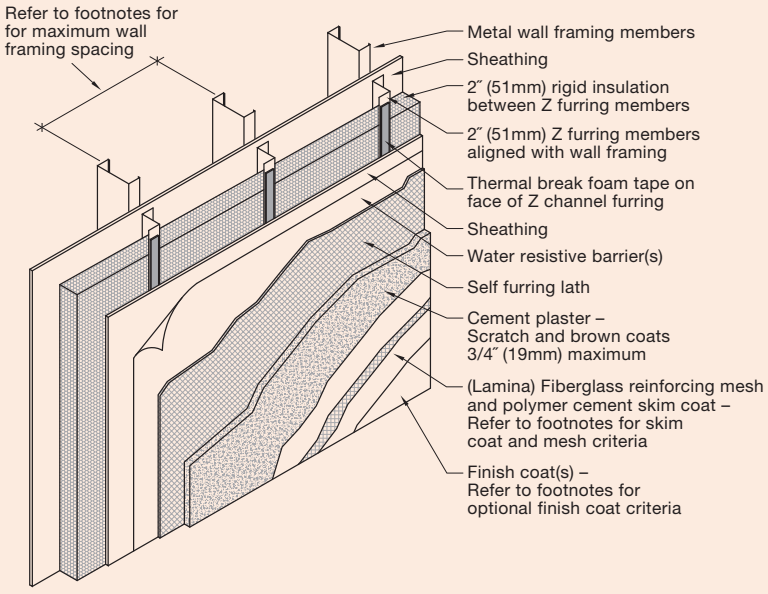


Figure 8. Insulated Cement Plaster Wall Assembly – PWA 106 (REV. 01/10)



FOOTNOTES:

1. Standard framing is 16 inches on center.
   Framing spacing may be increased to 24 inches on center when a polymer enriched skim coat and mesh (lamina) are applied over the brown coat of plaster.
2. Verify with the manufacturer that the finish coat is compatible with the polymer skim coat.

Definitions

ASRHAE: American Society of Refrigeration, Heating and Air-Conditioning Engineers

Assembly: Generic wall construction composed of generic and/or proprietary materials.

Cement Finish Coat: A blend of Portland cement, lime and sand and pigments, also known as stucco.

(CI) Continuous Insulation: Insulation that is continuous across structural members without thermal bridges other than fasteners and service openings. May be installed on the interior or exterior of the structural members.

Control Joint: A single piece trim accessory designed for limited movement (typically less than 1/4-inch) and in one direction only.

EIFS: A proprietary cladding system that incorporates a layer of (CI) foam and resembles cement plaster. Continuous insulation over or under cement plaster is not an EIFS, EIFS is a finish cladding and the weather-resistive barrier.

EPS: Expanded Polystyrene foam also known as "bead board." Typically white with varying degrees of density.

Expansion Joint: A two piece trim accessory designed for greater movement and in more than one direction.

Fiberglass Mesh: An alkali resistant mesh made specifically for being troweled into a polymer enriched cement skim coat. Typically 4 to 6 ounces per square yard, heavy duty mesh (high impact areas) is 20 ounces per square yard.

Polymer Enriched Cement: A blended cement with polymers to provide very thin, flexible and crack resistant cement.

Poly Isocyanurate: A high density and rigid closed cell foam sheathing containing a low conductivity gas. Typically has a plastic or rigid type facing.

R-Value: The rated R-Value is the thermal resistance of the insulation alone as stated by the manufacturer.

System: A proprietary wall system composed of specific materials approved by the system manufacturer.

Thermal Break: A material or product that interrupts or restricts the temperature conductivity through metal.

Thermal Bridging: Also known as thermal short circuiting. Refers to an unrestricted path of temperature transmission through an insulated barrier.

Title 24: Title 24 is the California Building/Energy Code, based on National Codes and enhanced to meet the requirements set by California.

U Factor: The U factor is the transmission of heat in time through a material or assembly.

Water Resistive Barrier (WRB): A moisture barrier complying with section 1404.2 of the International Building Code. Alternative WRB's may be used with local building official approval and installed per manufacturers recomendations.

XPS: Extruded Polystyrene foam, closed cell foam structure makes a highly water resistant rigid foam board.

Western Conference of Wall and Ceiling Institutes

- Drywall Information Trust Fund
- Lathing and Plastering Institute of Northern CA
- Northwest Wall and Ceiling Bureau
- Sacramento Valley Lath and Plaster Bureau
- Plastering Industry Bureau of San Francisco & San Mateo
- Technical Service Information Bureau

TABLE A

Maximum Allowable U Factors – Steel and Wood Framed Wall Assemblies

NATIONAL CLIMATE ZONES

Zone	1	2	3 (NV)	4* (OR 4C)	5* (OR 5B)	6** (WA 1)	7** (WA 2)	8
STEEL FRAME								
Commercial (ASHRAE 90.1-2007)	.124	.124	.084	.064	.064	.064	.064	.064
Residential (1) (ASHRAE 90.1-2007)	.124	.064	.064	.064	.064	.064	.042	.037
Residential (2) (IECC 2009)	.082	.082	.082	.082	.082	.057	.057	.057
WOOD FRAME								
Commercial (ASHRAE 90.1-2007)	.089	.089	.089	.064	.064	.051	.064	.036
Residential (1) (ASHRAE 90.1-2007)	.089	.089	.089	.064	.051	.051	.042	.036
Residential (2) (IECC 2009)	.082	.082	.082	.082***	.057	.057	.057	.057

1.Under the ICC with living areas including hospitals, firestations and prisons
2.Under the IRC (single family, R3, R2 & R4 buildings three stories or less)
** Oregon Efficiency Code 2010: Check updates for residential construction*
*** 2009 Washington Building Code: National zones 6 & 7 = WA zones 1 & 2: 2006 code still in effect as of 08/01/10 and U Factors may be different.*
**** Zone 4 coastal = .057*
Notes: Check which code and year (eg. ASHRAE 07 or IECC 09) standards your area is following.
Arizona: All federal work will follow Table A. Check local jurisdiction for specific requirements.

To view the National Climate Zone map go to http://resourcecenter.pnl.gov/cocoon/morf/ResourceCenter/dbimages/full/973.jpg

CALIFORNIA CLIMATE ZONES (CA. ENERGY CODE 2008)

	STEEL FRAME			WOOD FRAME			
Zone	**1, 6, 7**	**2, 4, 5 & 8–16**	**3**	**1, 5, 8**	**2, 4, 9–14 & 16**	**3, 6, 7**	**15**
Commercial	.098	.062	.082	.102	.059	.110	.042

	STEEL FRAME	WOOD FRAME	
Zone	**ALL ZONES**	**1–10, 12, 13**	**11, 14–16**
High-rise Residential	.105	.059	.042

Zone	**1**	**2**	**3–5, 10**	**6–9**	**11–13**	**14–16**
Low-rise Residential: Currently state guidelines follow R-Value minimums for cavity insulation between wood framing and a "package" found in section 151 of the CA. Building Efficiency Standards. Data is not available for steel frame construction.						
Package C	R29	R29	R25	R21	R29	R29
Package D	R21	R13	R13	R13	R19	R21
Package E	R21	R19	R19	R19	R19	R21

NOTE: Commercial: All non-residential contruction
High-rise: Residential projects over three stories
Low-rise: Other than hotel/motel that is Occupancy Group R, Division 1 and is muti-family with three stroies or less or a single family residence of Occupancy Group R, Division 3 or Occupancy Group U building located on a residential site.

To view the California Climate Zone map, go to http://www.energy.ca.gov/maps/building_climate_zones.htm

As the requirements are changing as energy codes evolve, it is recommended to verify the most current U Factor or R-Value requirements set by your local/state energy commision. Many projects utilizing wood-frame construction may meet the maximum U Factor of a wall without continuous insulation.

TABLE B

Overall Assembly U Factors for Stud Walls

Metal Framing	R-Value of Continuous Foam Board Insulation	ASHRAE 90.1-07 (except low-rise residential) Cavity Insulation R-0	R-11	R-13	R-15	R-19	R-21
16″ O.C.	R-0	0.352	0.132	0.124	0.118	0.109	0.106
	R-4	0.146	0.087	0.083	0.080	0.076	0.074
	R-6	0.113	0.074	0.071	0.069	0.066	0.065
	R-7	0.102	0.069	0.066	0.065	0.062	0.061
	R-8	0.092	0.064	0.062	0.061	0.058	0.057
	R-10	0.078	0.057	0.055	0.054	0.052	0.051
Wood Framing	**Foam Board Insulation**	**Cavity Insulation R-0**	**R-11**	**R-13**	**R-15**	**R-19**	**R-21**
16″ O.C.	R-0	0.292	0.096	0.089	0.083	0.067	0.063
	R-4	0.132	0.068	0.063	0.060	0.051	0.048
	R-6	0.104	0.074	0.059	0.056	0.048	0.042
	R-10	0.073	0.048	0.045	0.043	0.038	0.036

CALIFORNIA ENERGY CODE STANDARDS

Metal Framing	Continuous Foam Board Insulation	Metal Frame (non res & high rise res) Cavity Insulation R-0	R-13	R-15	R-19	R-21*	R-30*
16″ O.C.	R-0	0.458	0.217	0.211	0.183	0.178	0.157
	R-4	0.162	0.116	0.114	0.106	0.104	0.096
	R-6	0.122	0.094	0.093	0.087	0.086	0.081
	R-7	0.109	0.086	0.085	0.080	0.079	0.075
	R-8	0.098	0.079	0.078	0.074	0.073	0.070
	R-10	0.082	0.068	0.068	0.065	0.064	0.061
	R-14	0.062	0.054	0.053	0.051	0.051	0.049

- ** Higher density fiberglass bat may be required*
- *Cellulose maybe subsituted but must fill cavity & have a binder*
- *Continuous insulation may be installed on inside of wall*

NOTE: R-Values for low-rise residential & wood frame construction can be found in "reference appendices for the 2008 building energy efficiency standards" tables 4.3.1 & 4.3.4. www.energy.ca.gov/title24/2008standards/

The information provided is for general use only and not jobsite specific. Formal calculations should be done by a qualified energy engineer or designer. Performance or "trade-offs" methods can be used by designers to alter the U Factor requirements established by the Energy Codes. Each state has approved software to assist with U Factor Calculations.

All assemblies require weather resistive barrier(s) and flashings installed in a shingle fashion. Plaster Bureaus make no warranties, expressed or implied, on the plaster assemblies. The use of these assemblies are recommended to be installed by contractors who have completed the Western Conference of Wall and Ceiling Institutes' educational seminar on "Insulated Cement Plaster Assemblies."

TABLE C

Calculating the Need and Amount of CI
(Continuous insulation)

Determine the type of building (Commercial vs. Residential) and where (the Climate Zone) the structure is being built. The national code has eight climate zones, California has sixteen and they are not in correlation to the national zones. Use Table A to determine the maximum allowed assembled U Factor, (i.e., .098 or .105). This is the number your wall assembly must meet.

Use Table B to determine the assembly options to create the U Factor required by code. Variables include:

- Spacing of framing members (16 vs 24 inches on center)
- Cavity insulation
- Continuous insulation (CI) may be required to achieve a wall's overall U Factor
- Note: Framing spacing for 16″O.C. U Factors improve with 24″ O.C. spacing

CONTINUOUS INSULATION MATERIALS:

EPS foam boards are typically 24″ x 48″ and are a minimum of 3/4″ to 4″ thick but can vary in density and performance (R-Value, Compressive and Flexural strength, etc.)

Classification of foam	Density	R-Value
Type I	0.90 lb/ft^3	3.6 per inch
Type VIII	1.15 lb/ft^3	3.8 per inch
Type II	1.35 lb/ft^3	4.0 per inch
Type IX	1.80 lb/ft^3	4.2 per inch
Type XIV	2.40 lb/ft^3	4.2 per inch
Type XV	2.85 lb/ft^3	4.3 per inch

XPS foam boards are commonly 24″ x 96″ and are a minimum of 1″ to 2″ thick but can vary in density and performance (R-Value, Compressive and Flexural strength, etc.)

Classification of foam	Density	R-Value
Type XII	1.20 lb/ft^3	4.6 per inch
Type X	1.35 lb/ft^3	5.0 per inch
Type XIII	1.60 lb/ft^3	3.9 per inch
Type IV	1.55 lb/ft^3	5.0 per inch
Type VI	1.80 lb/ft^3	5.0 per inch
Type VII	2.20 lb/ft^3	5.0 per inch
Type V	3.00 lb/ft^3	5.0 per inch

Polyisocyanurate rigid boards are typically 48″ x 96.″ Polyisocyanurate for walls is not the same rigid foam as used in roof construction, verify the product is suitable for wall assemblies. The R-Value can vary greatly between manufacturers. Check with each manufacturer before assuming the R-Value per inch. The following are general R-Values only for aged polyisocyanurate.

Thickness	R-Value
1 inch	6.7
1-1/2 inches	10.5
2 inches	14.4
2-1/2 inches	17.8

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