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Architecture and Building Science



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Habitat for Humanity of Metro Denver

Energy Efficient Building Association & Building Science Consortium

Present

An Advanced Systems Engineering Approach to Affordable Single Family Homes



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Overall System Improvements

- **Advanced Framing System**
 - 2 x 6 24" o.c., O.V.E., insulating sheathing
- **Air Flow Retarder System**
 - Interior and Exterior
- **Thermal Envelope System**
 - 48% better than the 1993 Model Energy Code (current code required in Colorado)
- **Air Distribution System**
 - Innovative ductwork and ductwork location
- **Mechanical Systems**
 - Integration of ventilation and heating system



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Overall Performance Goals

- **Energy Consumption**
 - The house will use **48% LESS BTU's** than a like sized reference house that meets the 93 MEC for the location (current code required in Colorado)
- **Pollutant Control**
 - Controlled **Mechanical Ventilation** (@ 10cfm per person/occupancy based on # of BR + 1, i.e. 3BR House=50CFM)
 - **Source Control (dry foundations, combustion safety)**
- **Envelope Leakage**
 - Less than **2.5 sq. in. of leakage area per 100 sq. ft. of envelope surface area (CGSB @ 10 Pa)**
- **Durability**
 - Designed to **reduce wetting** and **designed to dry** should it get wet



Energy Use Comparison



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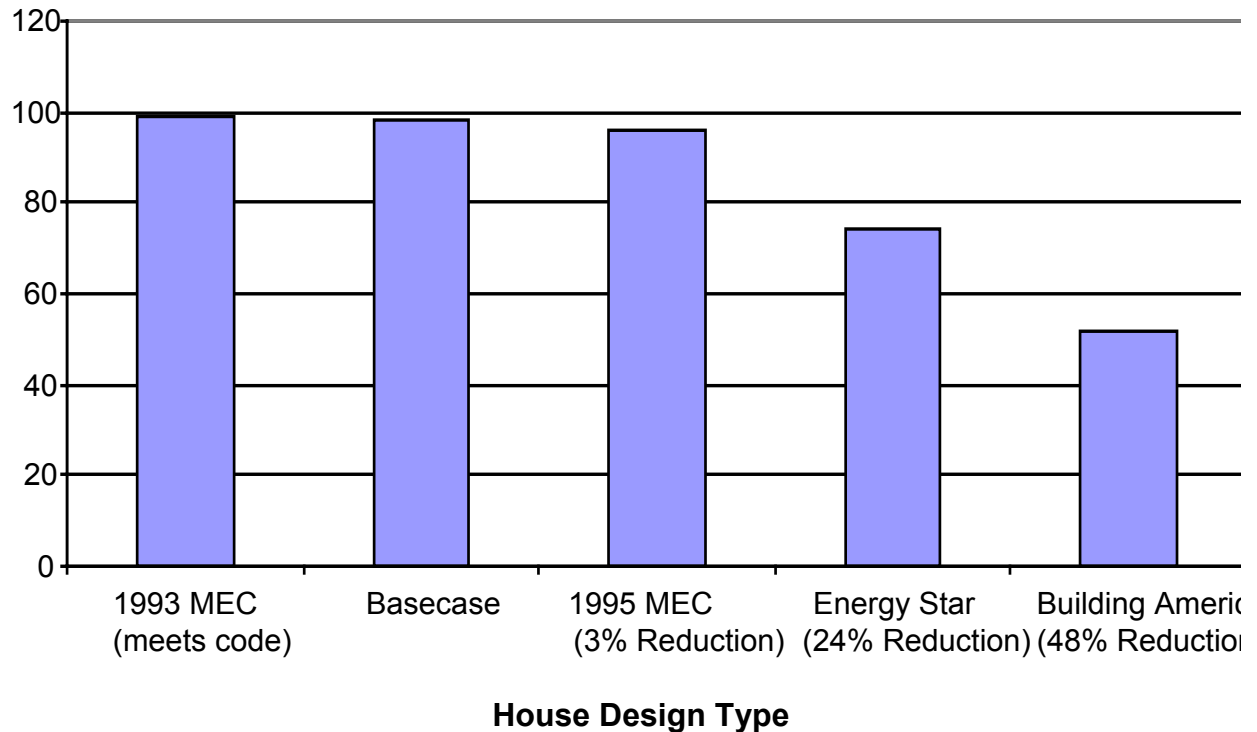
Predicted Heating and Hot Water Energy Use (MMBtu/yr)



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**Habitat for Humanity
Lakewood, Colorado**





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Advantages to Homeowner

- **Healthier** interior living environment
- More **durable** home
- More **comfortable** home
- Predictable lower utility bills
- Allows innovative marketing & financing (EEM mortgages, etc.)

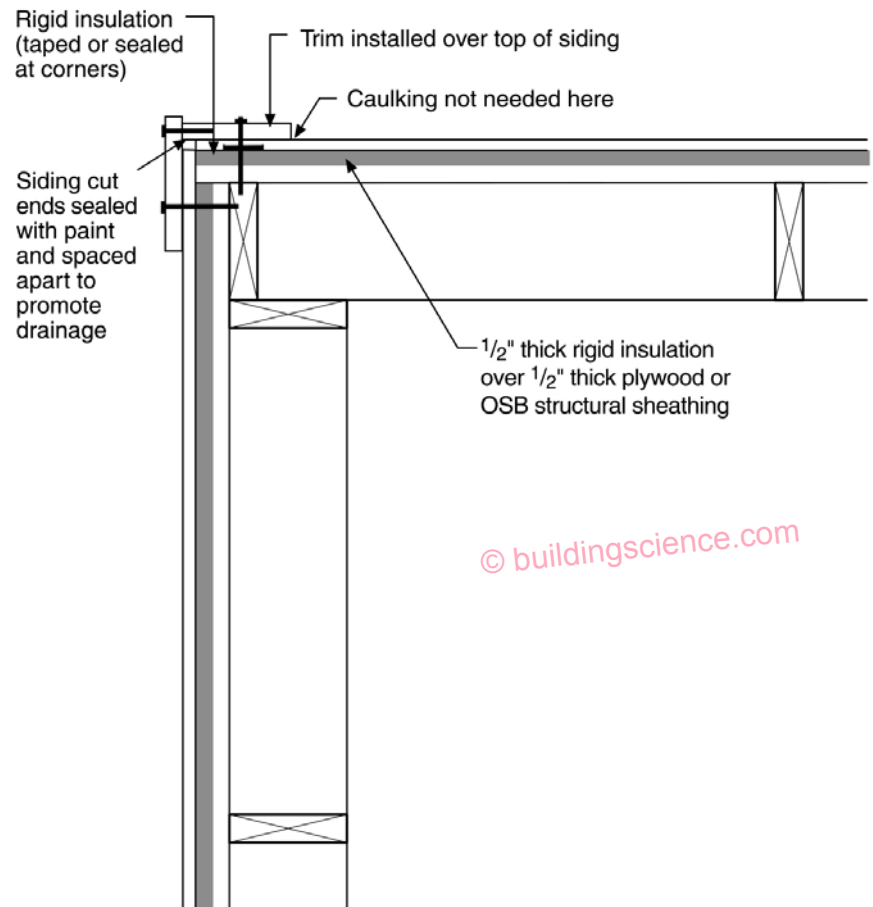


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Advanced Framing System

- **Insulating sheathing over plywood at corners for racking strength**





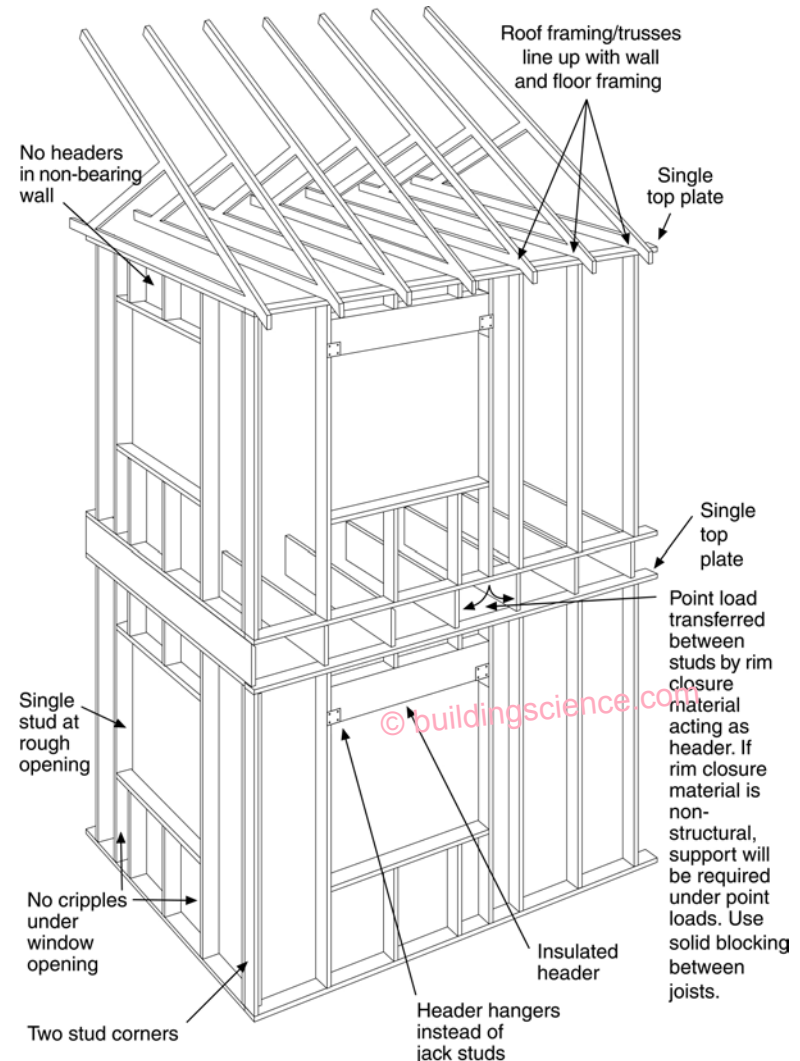
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Advanced Framing System

Framing Plan

- Use 2x6 @ 24" o.c. with stack framing
- Most efficient use of wood as a structural system-reduces waste
- Allows more wall depth for additional insulation than 2x4 @ 16" o.c.
- Reduces thermal bridging of wall elements (total percentage of framing thermal bridge goes down from 20% to 10%)





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Advanced Framing System

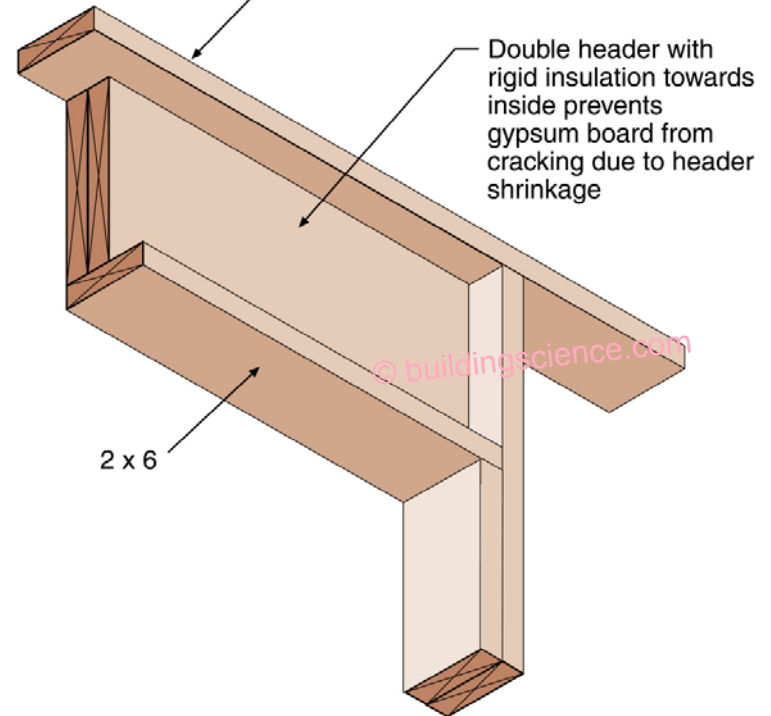
- Insulated headers
- No header necessary at non-bearing walls

Open insulated double header

Single top plate

Double header with rigid insulation towards inside prevents gypsum board from cracking due to header shrinkage

2 x 6



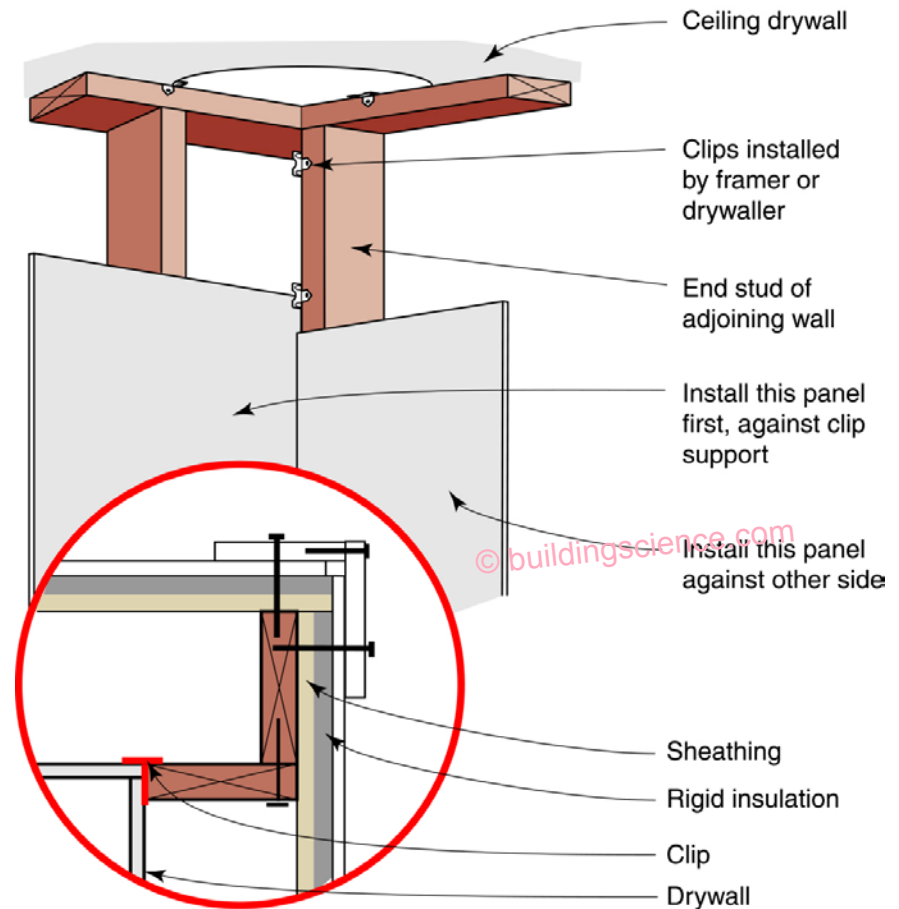


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Advanced Framing System

- **Drywall clips allow for better installation with less drywall cracking**



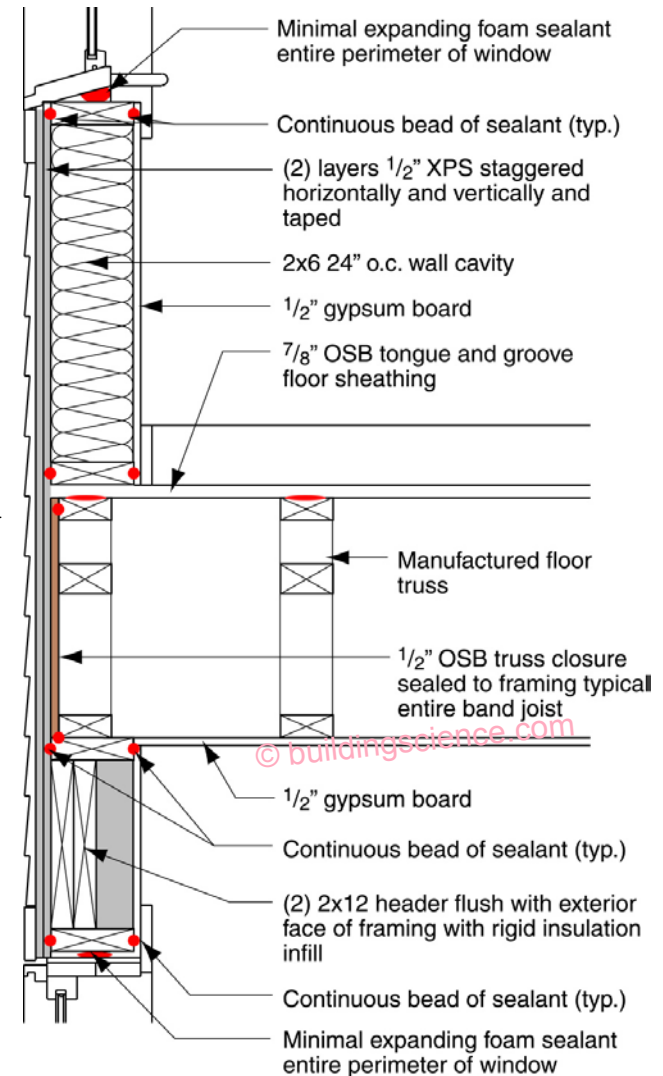


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Air Flow Retarder System

- Exterior
 - (2) 1/2" layers of XPS insulating sheathing - seams staggered horizontally and vertically, and taped





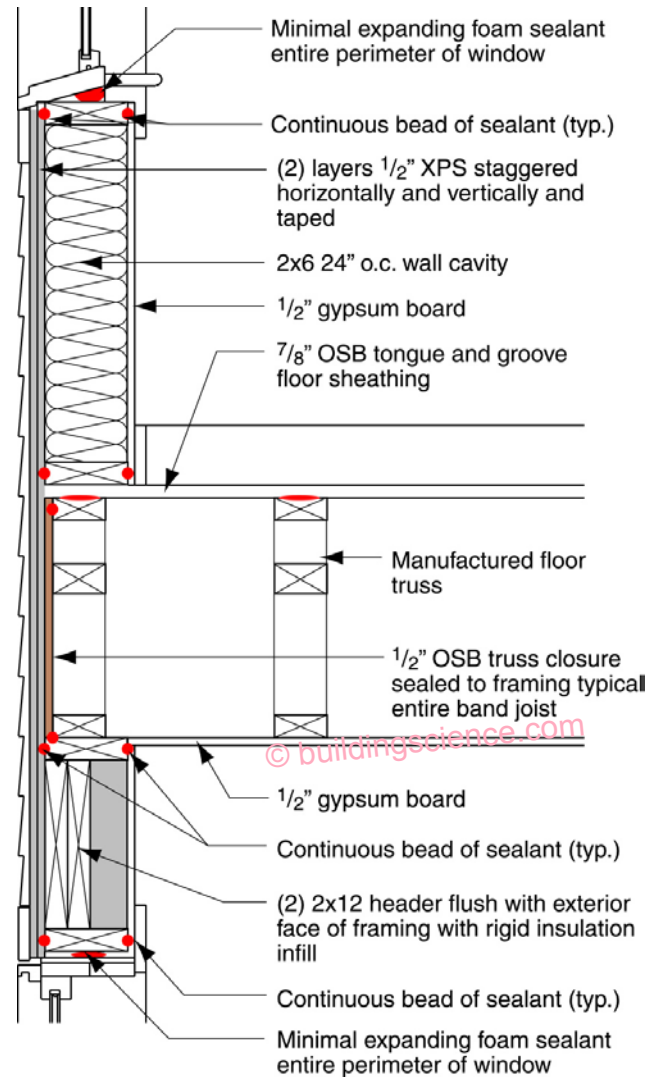
Air Flow Retarder System



- **Complete air sealing package at rim closure**



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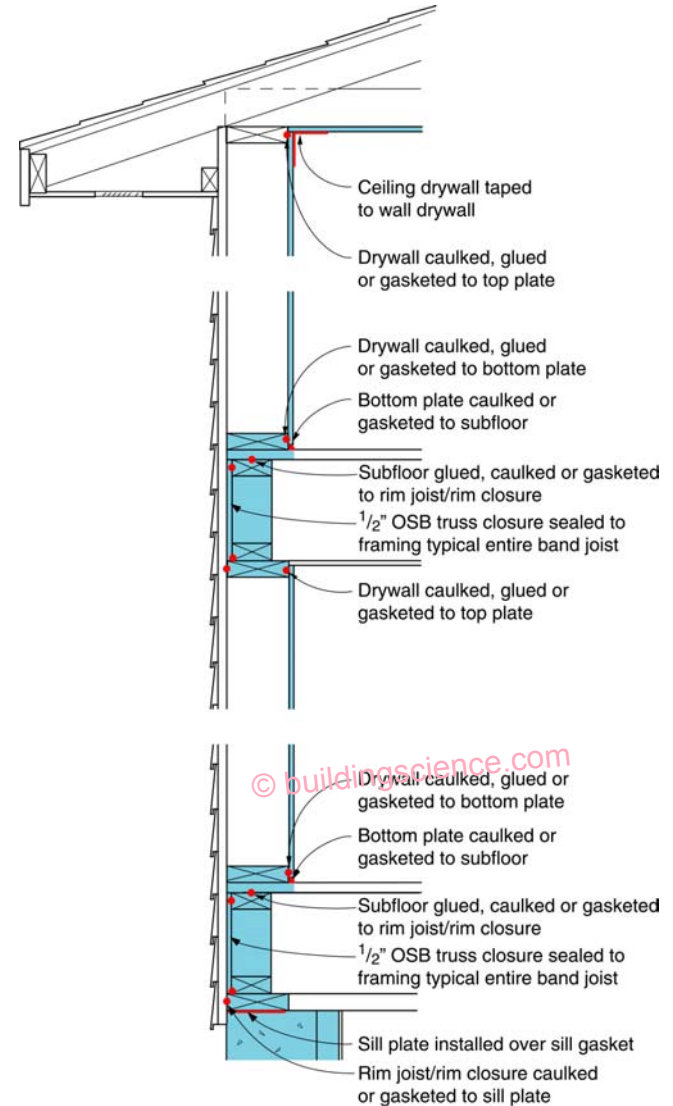
Air Flow Retarder System

- Interior

- ADA

Air Drywall Approach

- drywall glued to top and bottom plate



Note: shaded components designate air flow retarder system



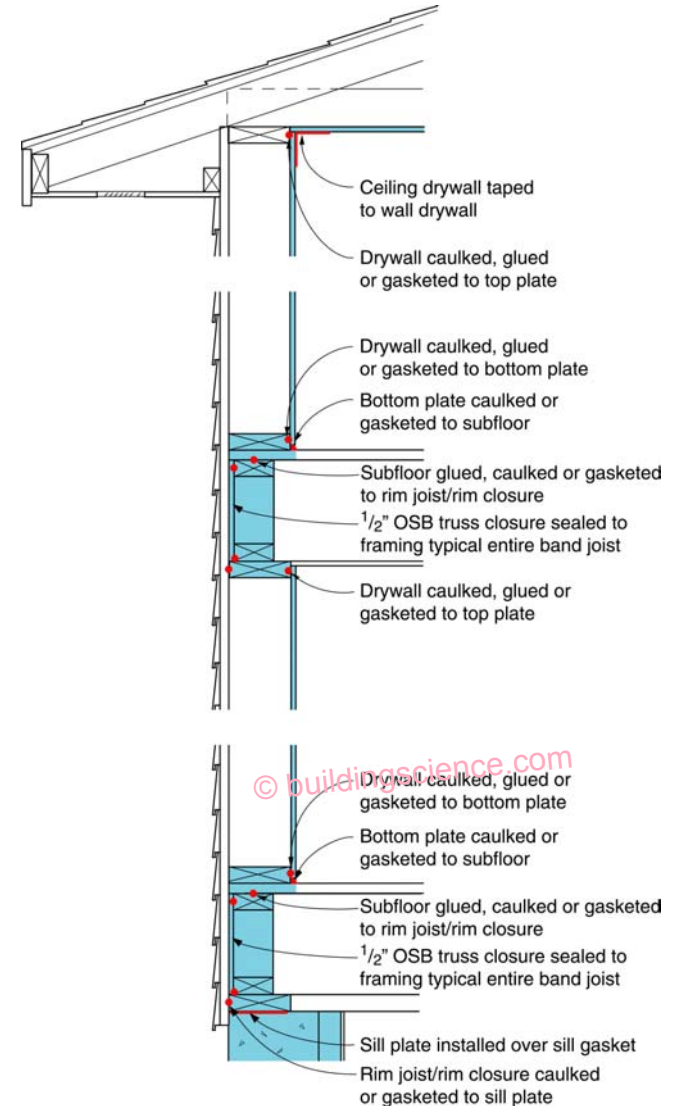
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Air Flow Retarder System

• Foundations

- Gasket at sill plate connections to foundation
- Sealant at slab foundation wall intersection



Note: shaded components designate air flow retarder system

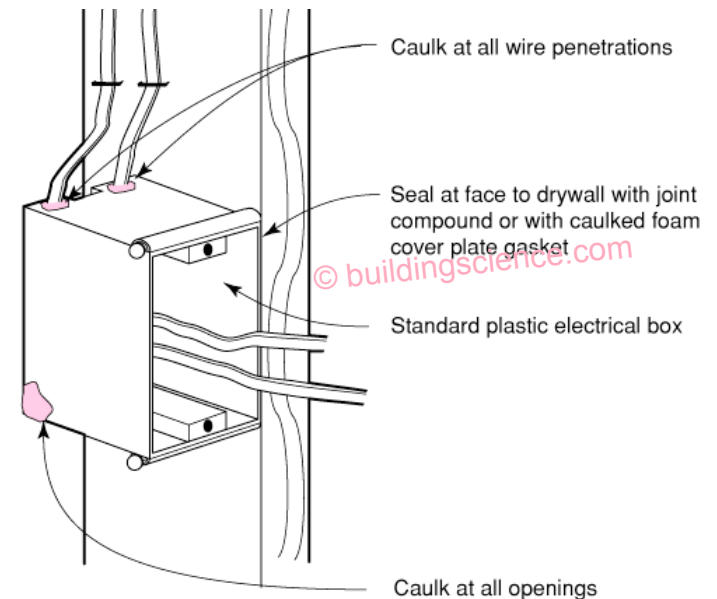
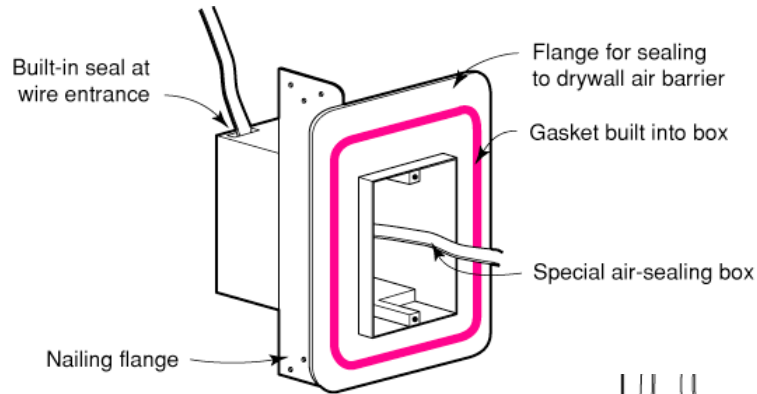


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Air Flow Retarder System

- **Airtight electrical boxes**



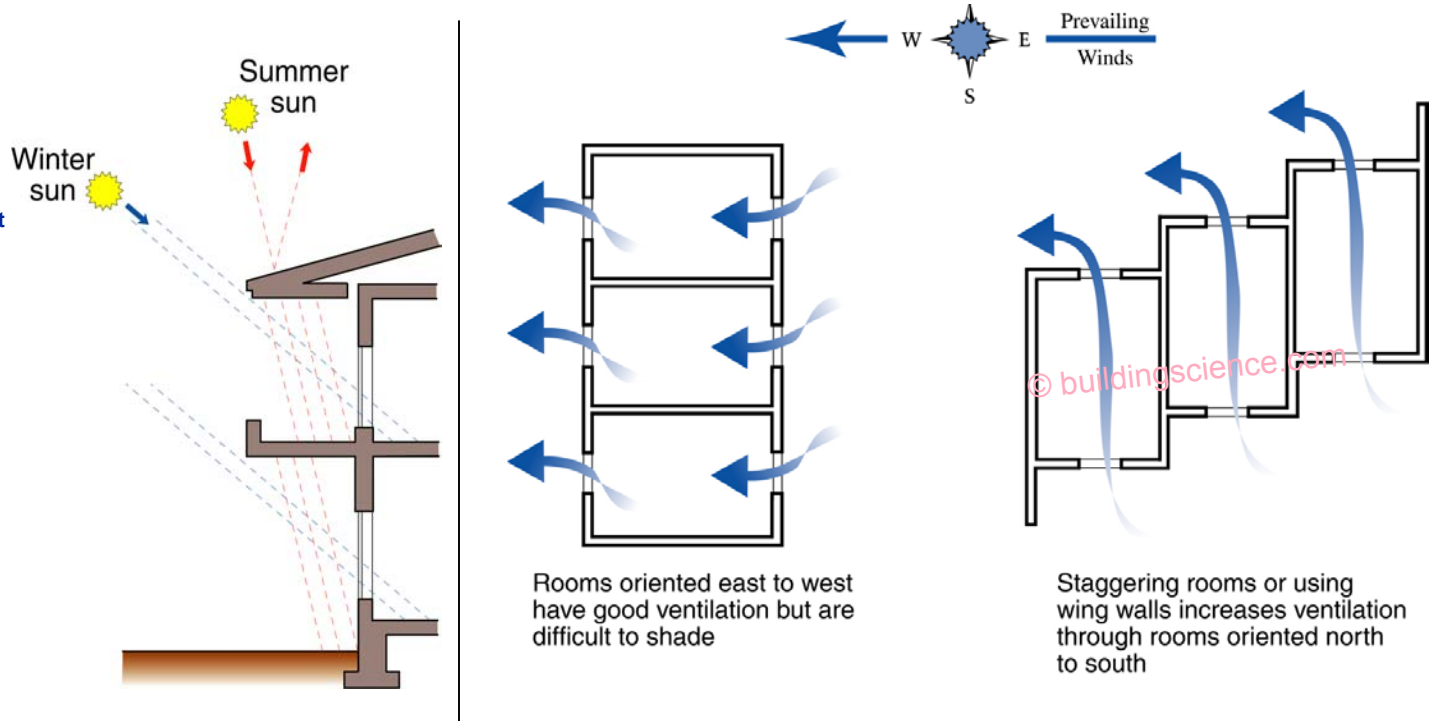


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Daylighting System

- Windows placement for optimal **daylighting** and **passive ventilation** opportunities with shading when necessary to reduce overheating



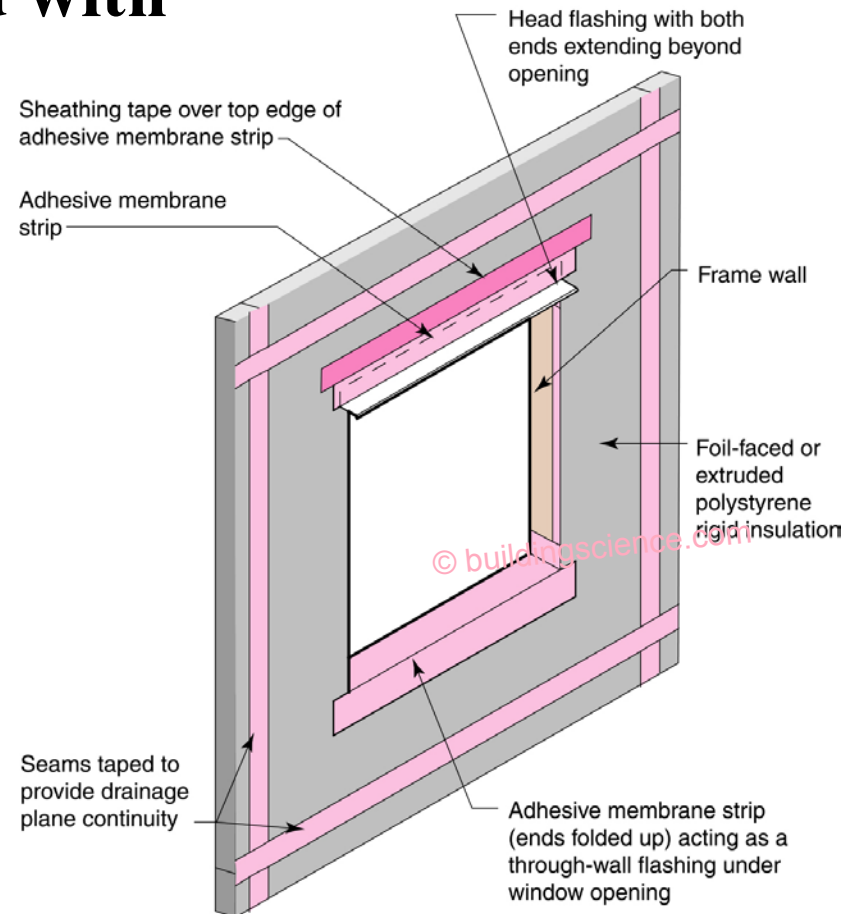


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Water Management System

- High performance windows with Low-E insulating glass
- Sill wrapped with membrane for moisture protection



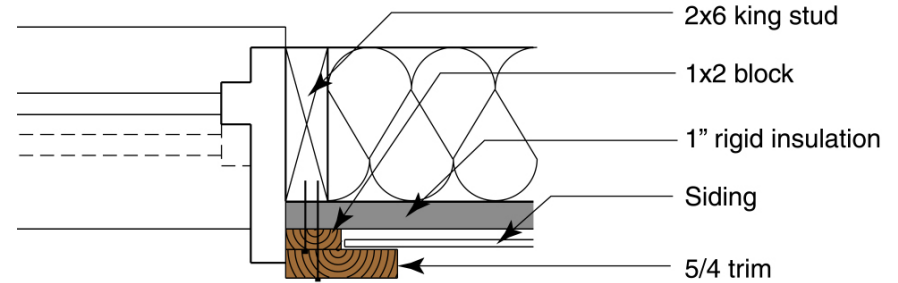


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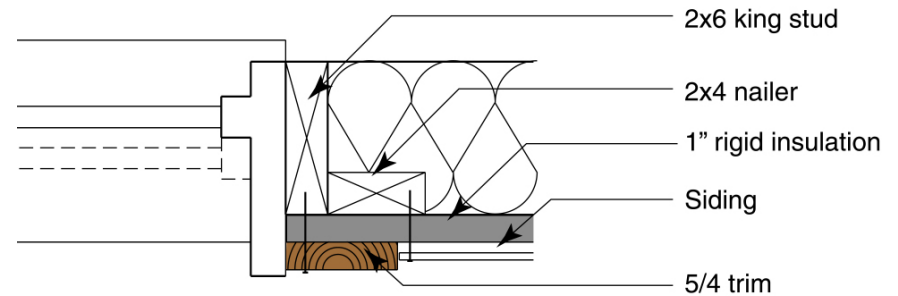


Water Management System

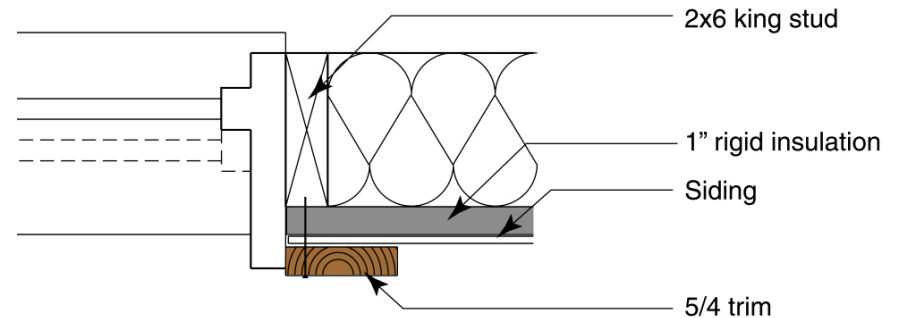
Window Trim Alternative One



Window Trim Alternative Two



Window Trim Alternative Three



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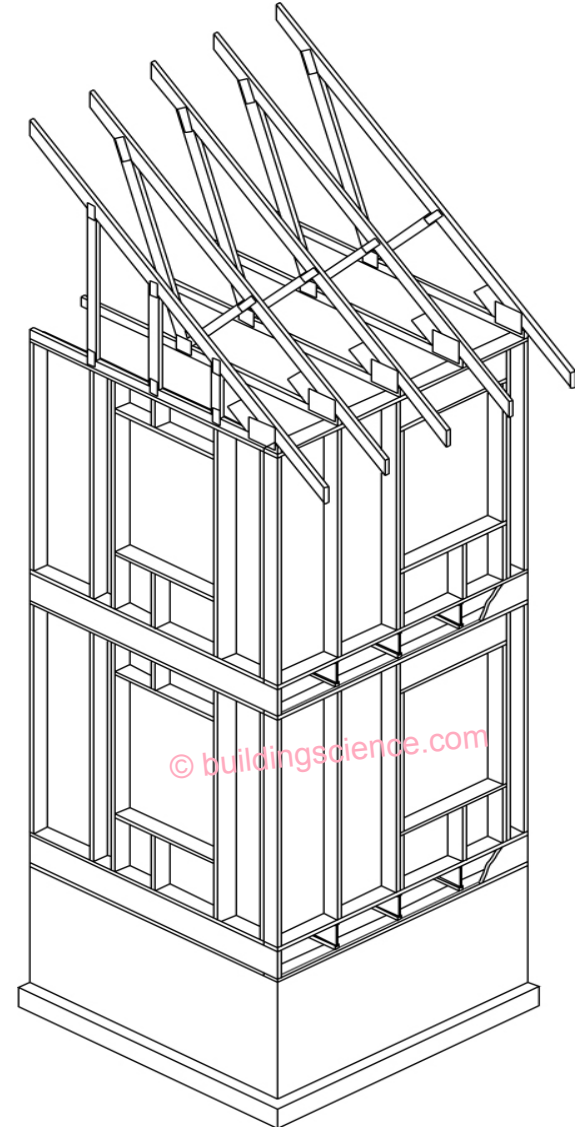


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Thermal Envelope System

- **2 x 6 @ 24" oc walls allow for increased wall insulation**
- **Less thermal bridging (Fewer framing members)**



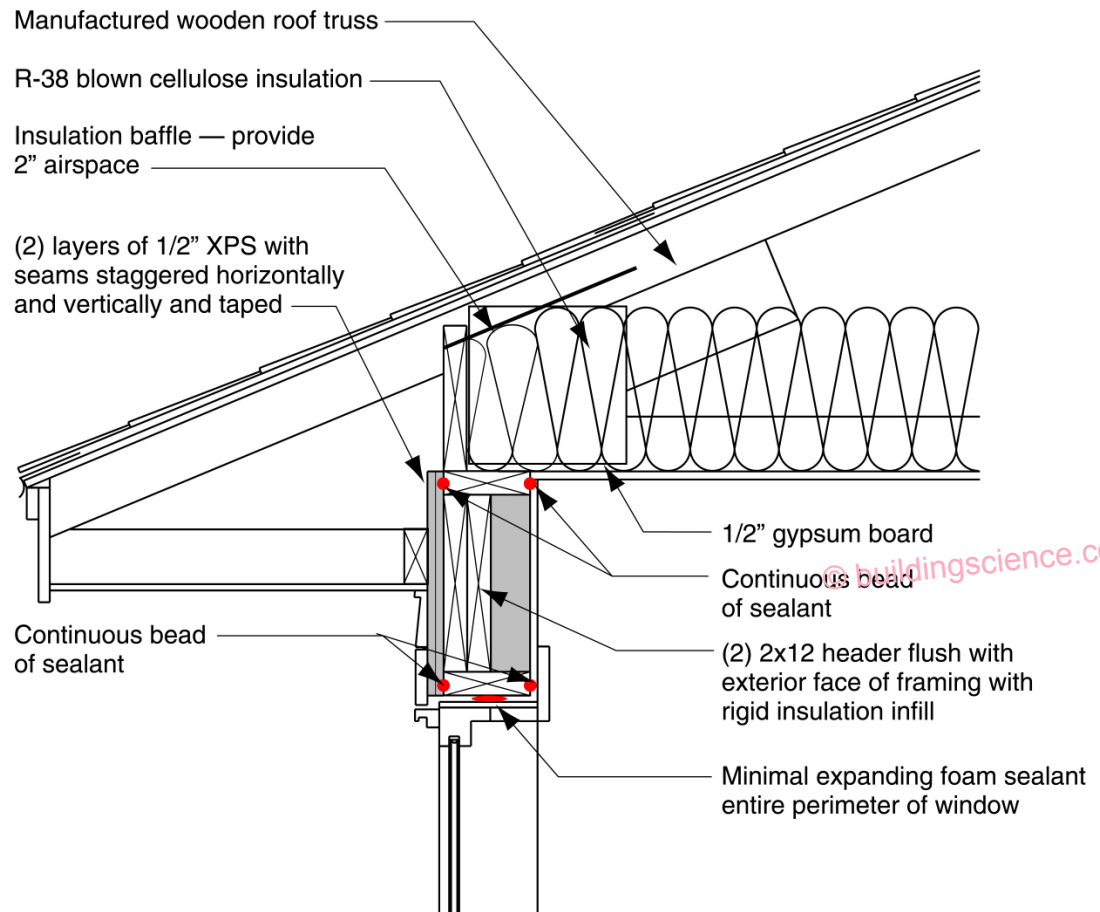


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Thermal Envelope System

- Increase truss depth for **roof insulation**



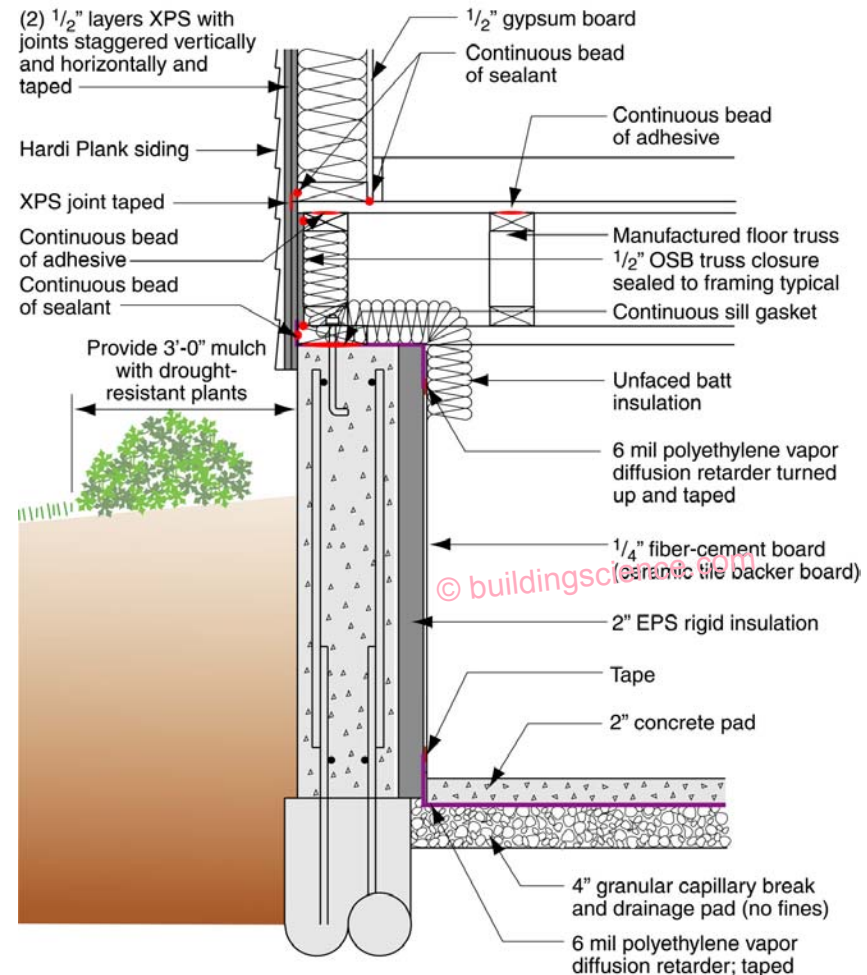


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Thermal Envelope System

- Conditioned crawl space walls insulated with 2" EPS (R-7)





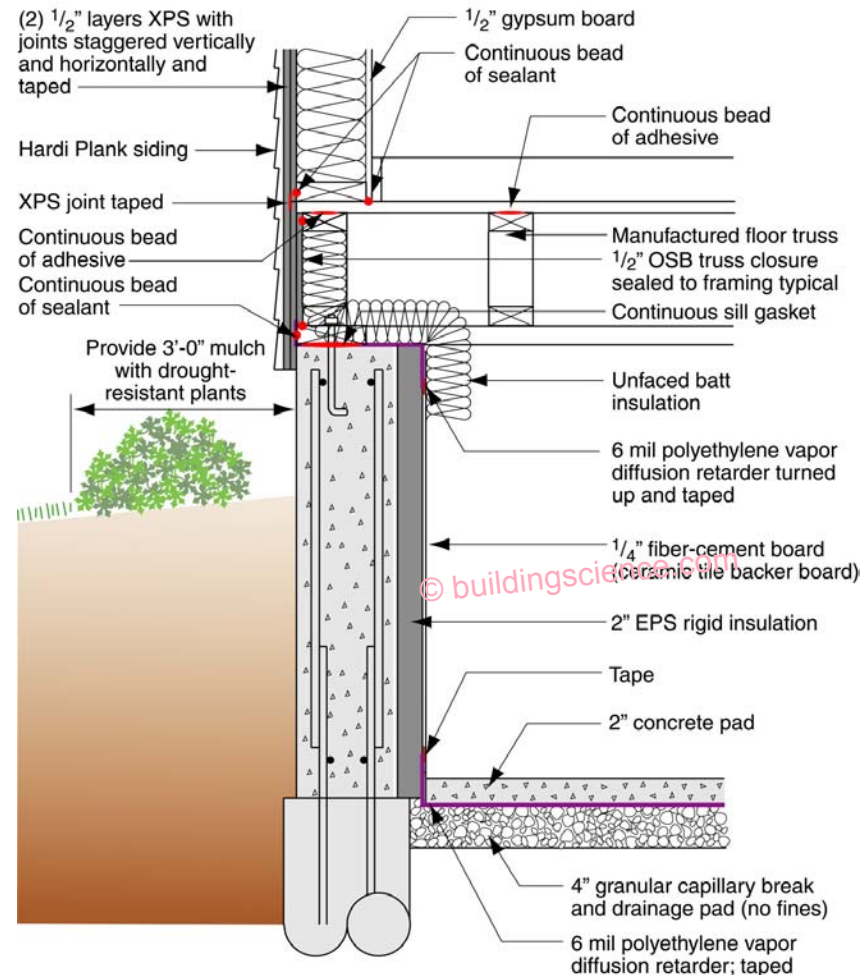
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Foundation System

- **Construction techniques that keep the wall dry and the crawlspace mold free**

- Final grade slopes away from foundation wall
- 3' wide perimeter of mulch with drought-resistant plantings
- Damp-proofing around exterior perimeter of wall





Foundation System



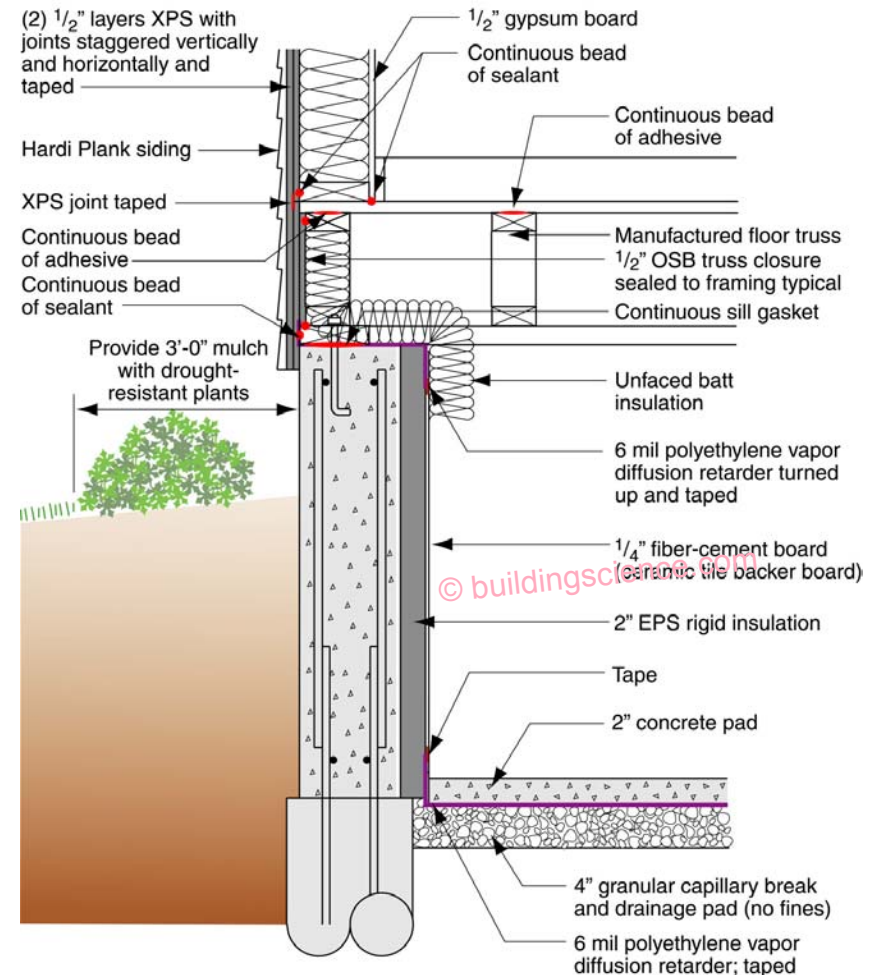
- **Construction techniques that keep the wall dry and the crawlspace mold free**



- **Capillary break between foundation wall and mud sill**



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Foundation System



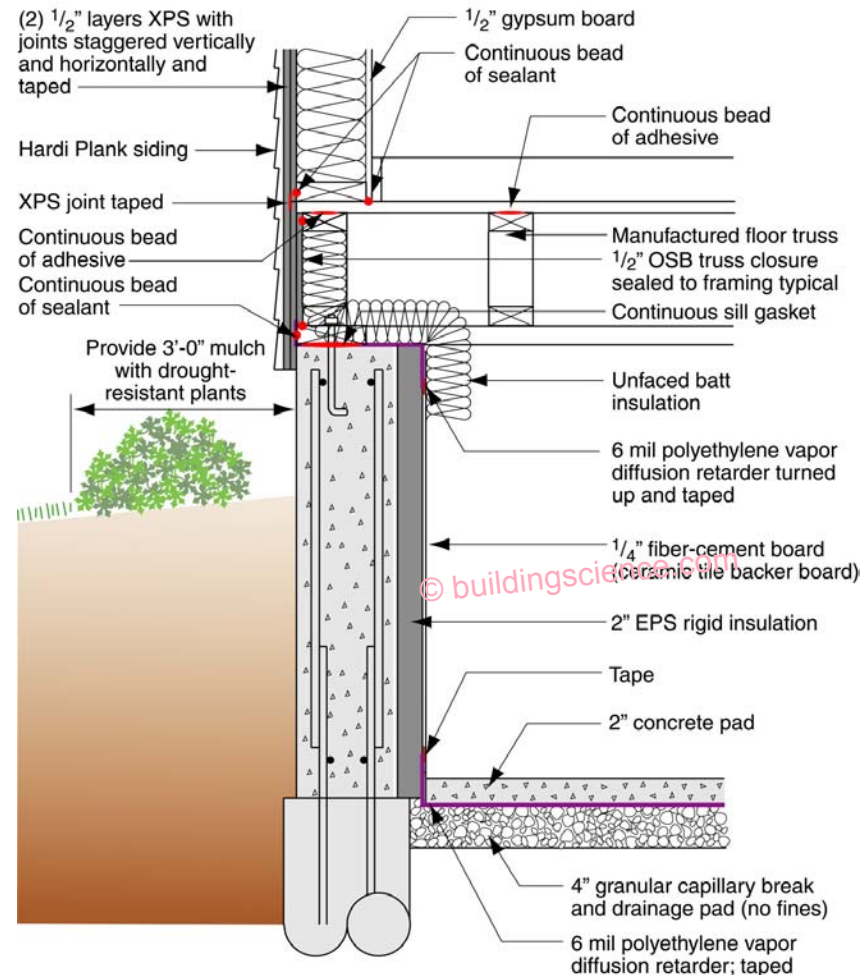
- **Construction techniques that keep the wall dry and the crawlspace mold free**



- **Insulating sheathing increases the temperature of the first condensing surface**
- **1/4" cementitious thermal barrier contains no media for mold growth**



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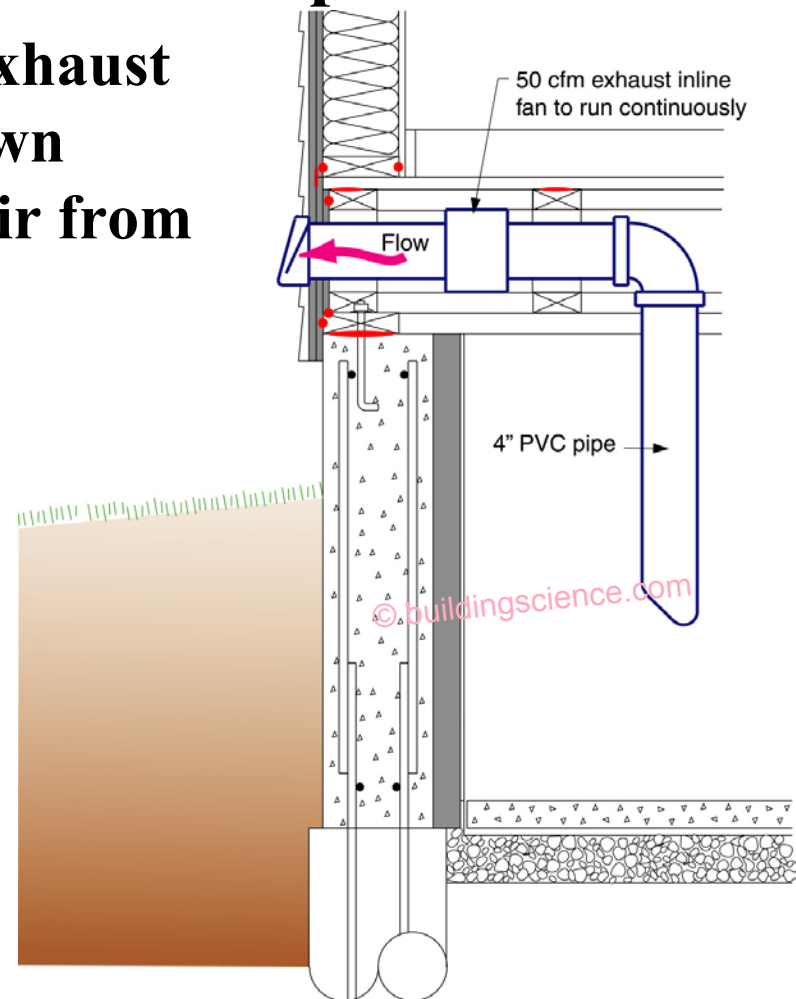


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Foundation System

- **Construction techniques that keep the wall dry and the crawl space mold free**
 - **Continuous exhaust fan draws down conditioned air from the house**



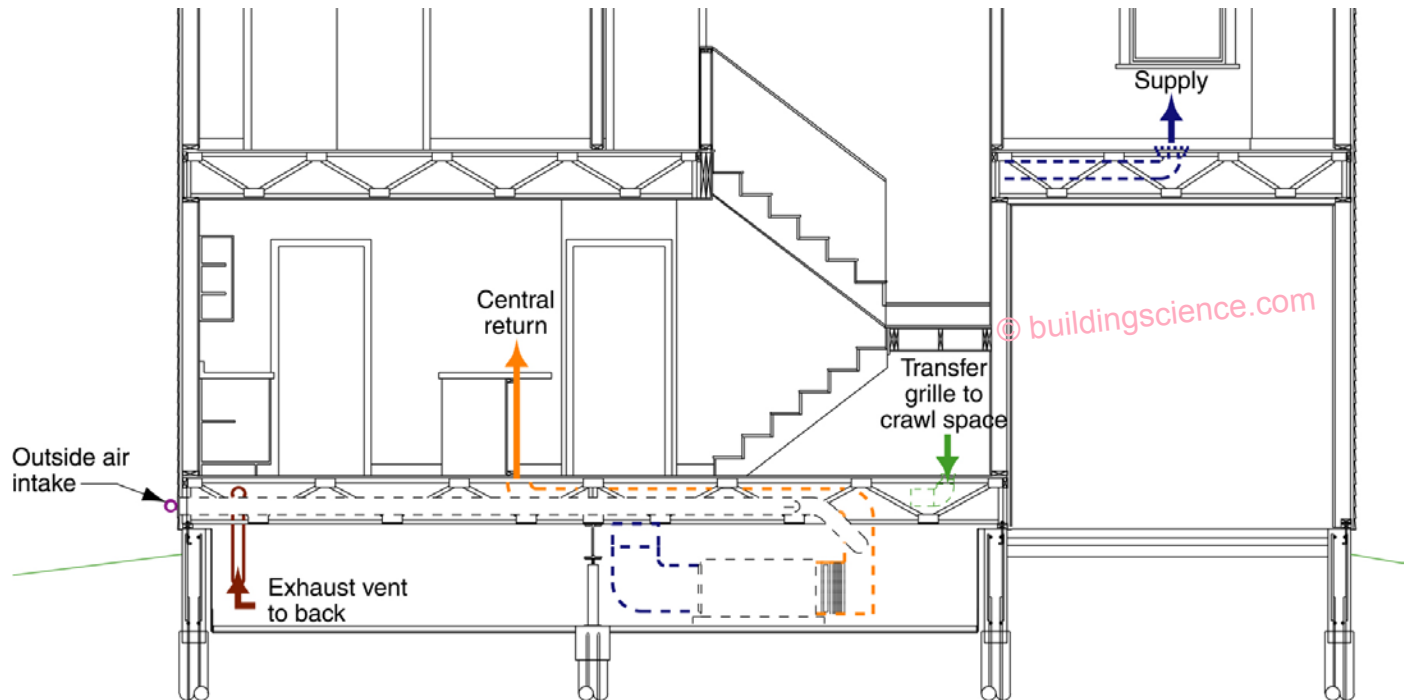


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Foundation System

- Construction techniques that keep the wall dry and the crawl space mold free
 - Crawl space is **CONDITIONED** with air from the house, **not** flushed with outside air as a typical **VENTED** crawlspace



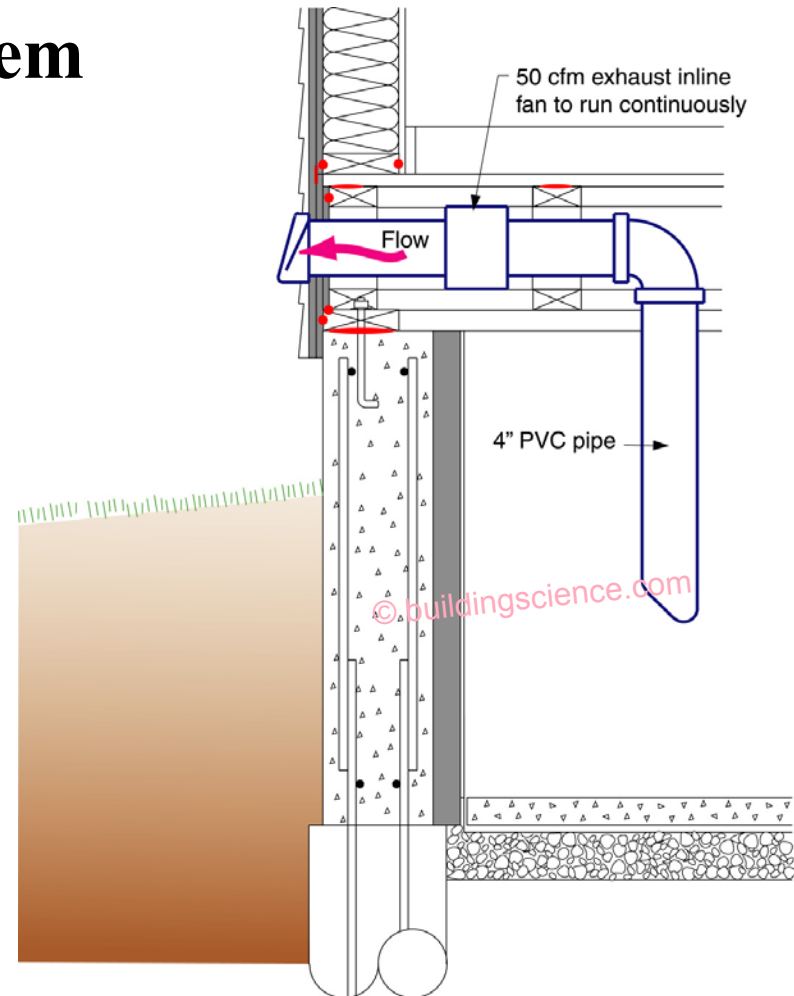


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Foundation System

- **Constant exhaust from the crawlspace acts as soil gas and radon reduction system**



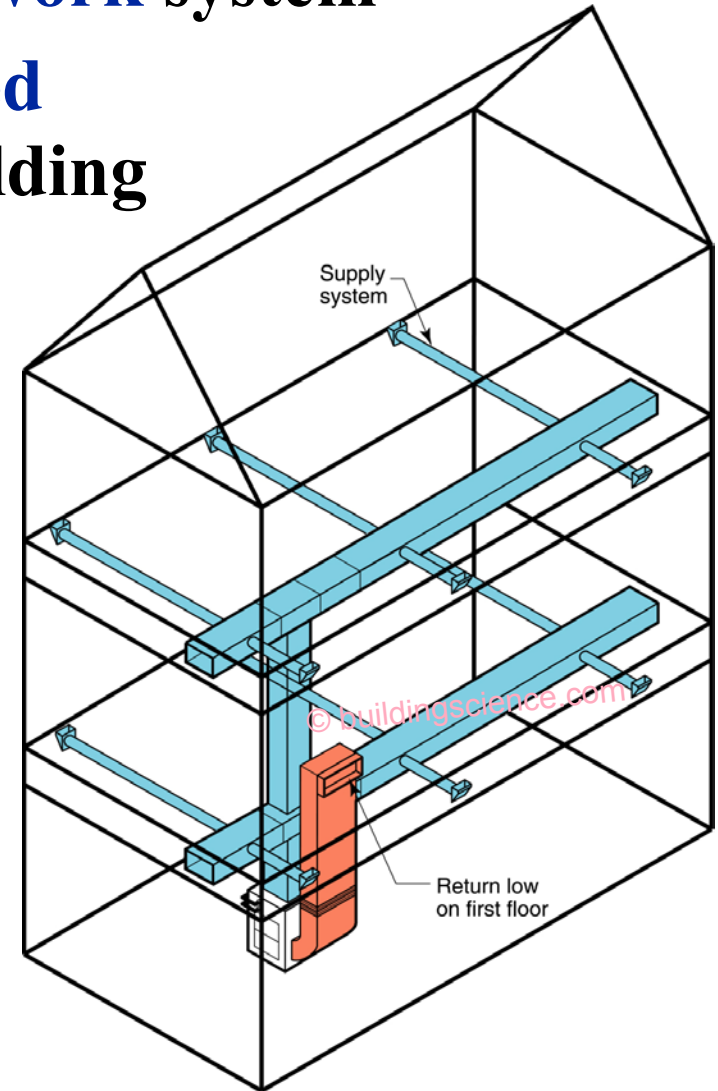


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Air Distribution System

- Innovative **ductwork** system
- **Ductwork located inside of the building envelope** (i.e. not in vented attics, exterior walls, attached garages)



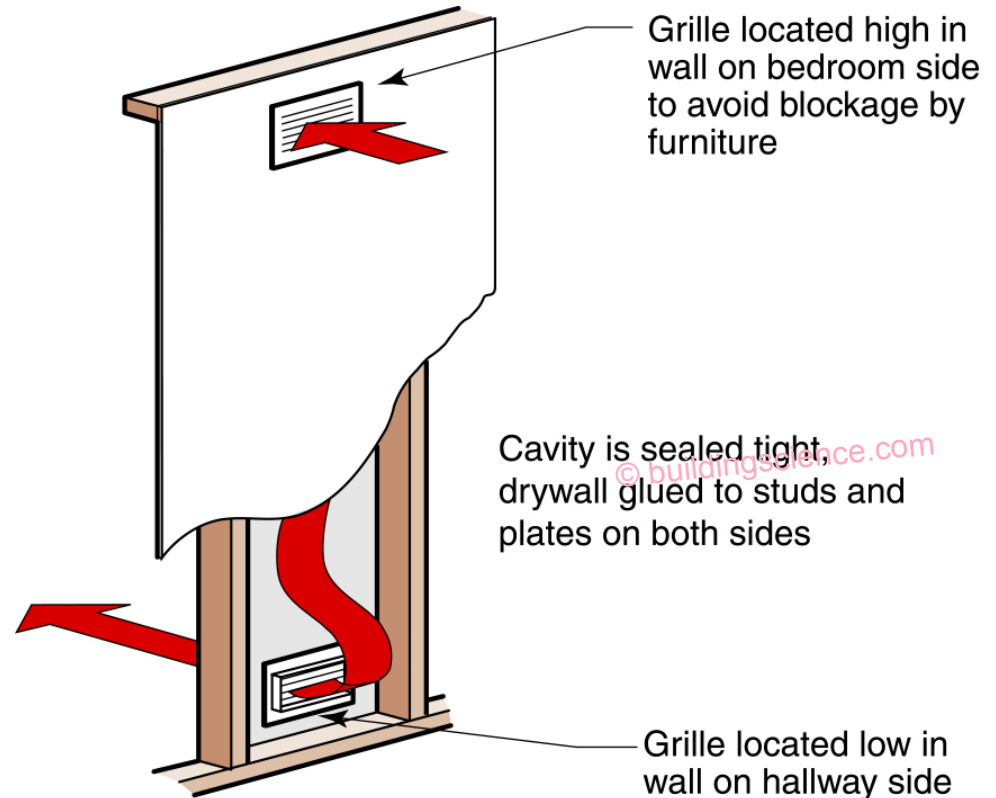


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Air Distribution System

- All bedrooms have transfer grilles through to hallways for pressure equalization or return ducts



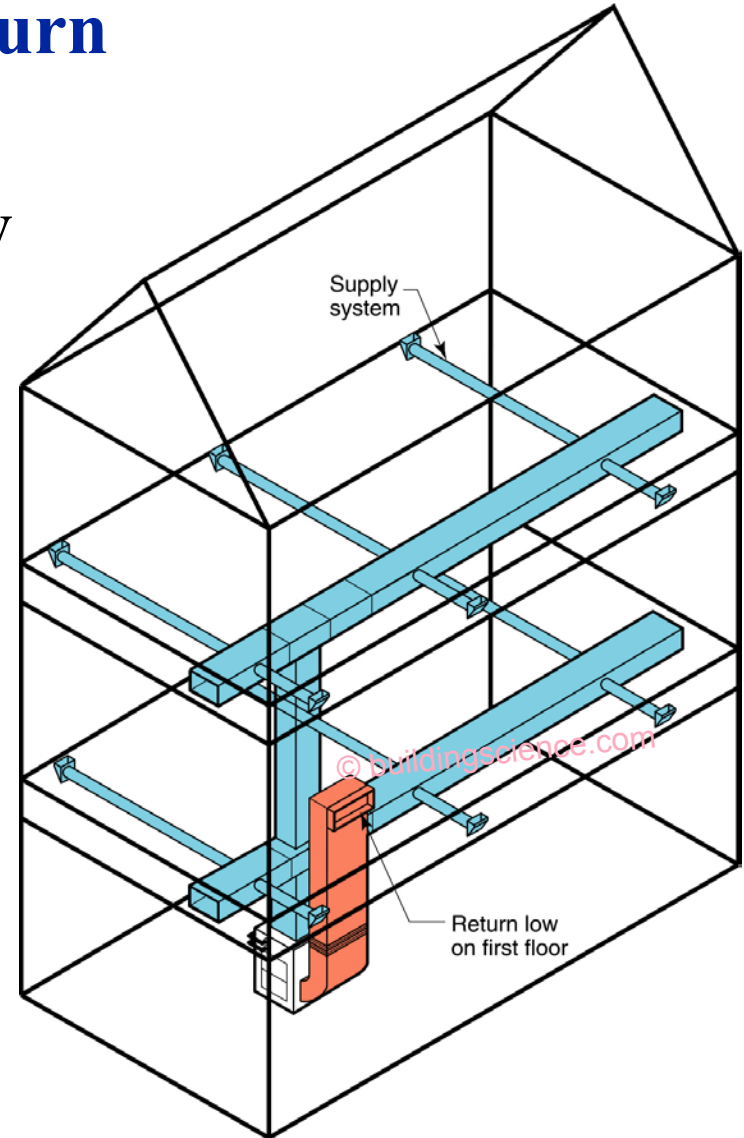


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Air Distribution System

- **One central return**
 - low in first floor hallway



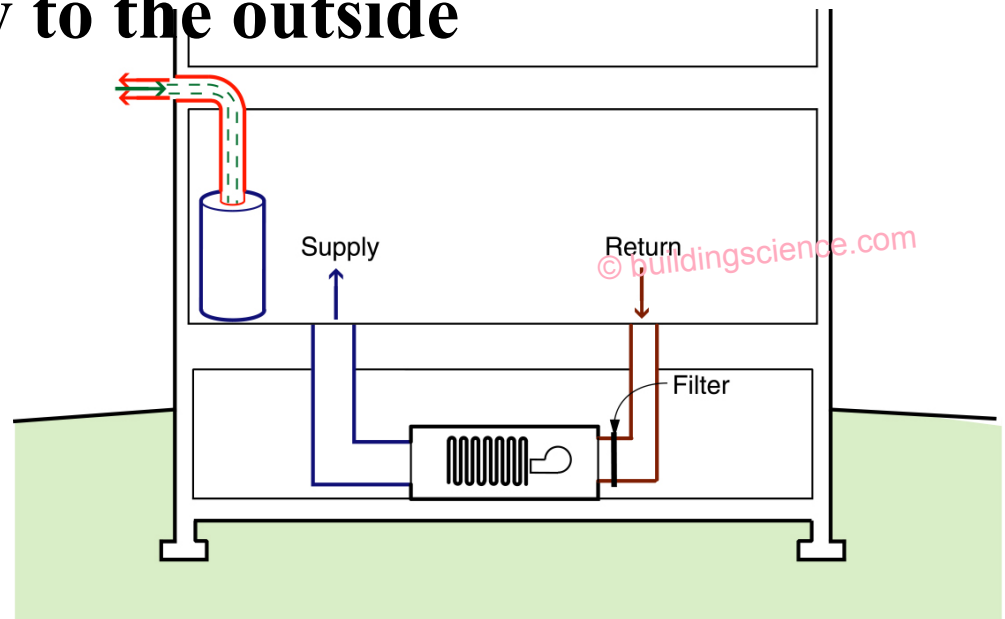


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Mechanical System

- **92% efficient** closed combustion furnace
- **Furnace located within the conditioned space**
- **Products of combustion vented directly to the outside**



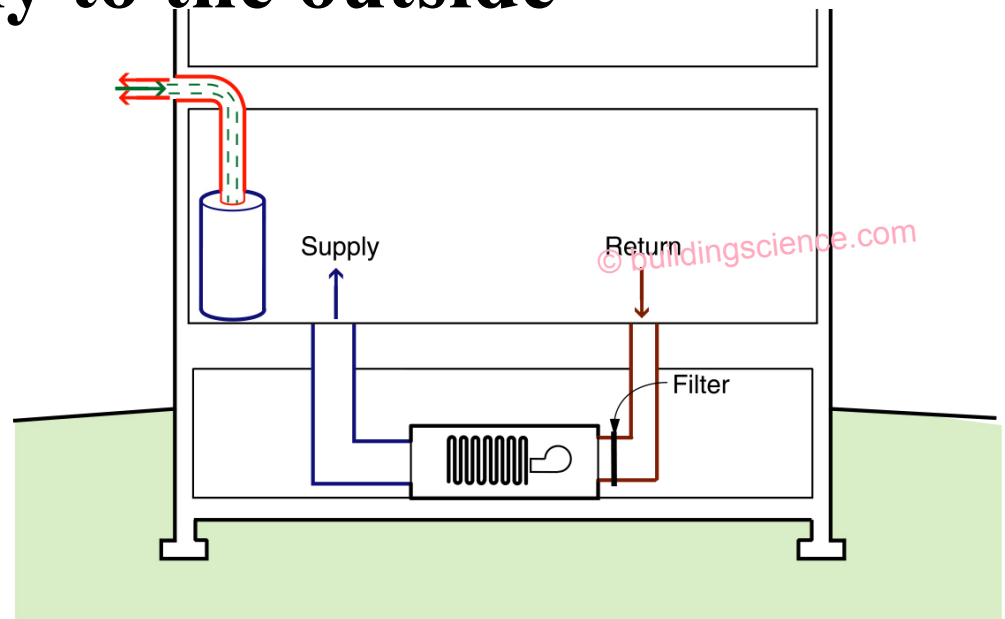


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Mechanical System

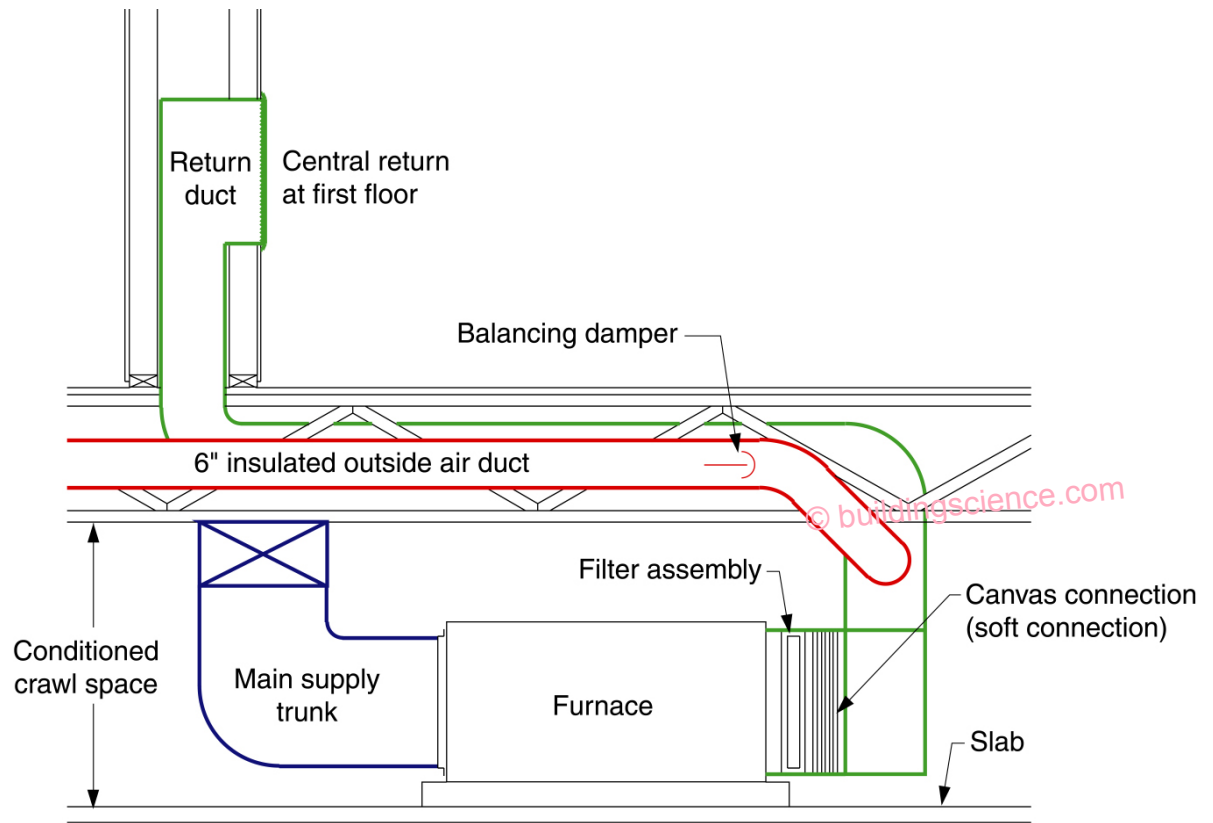
- **61% EF Hot water heater**
- **Located within the building envelope**
- **Combustion products are vented directly to the outside**



Mechanical System

- **Ventilation Scheme**
 - **Outside air is supplied through a 6" insulated duct to the central return.**

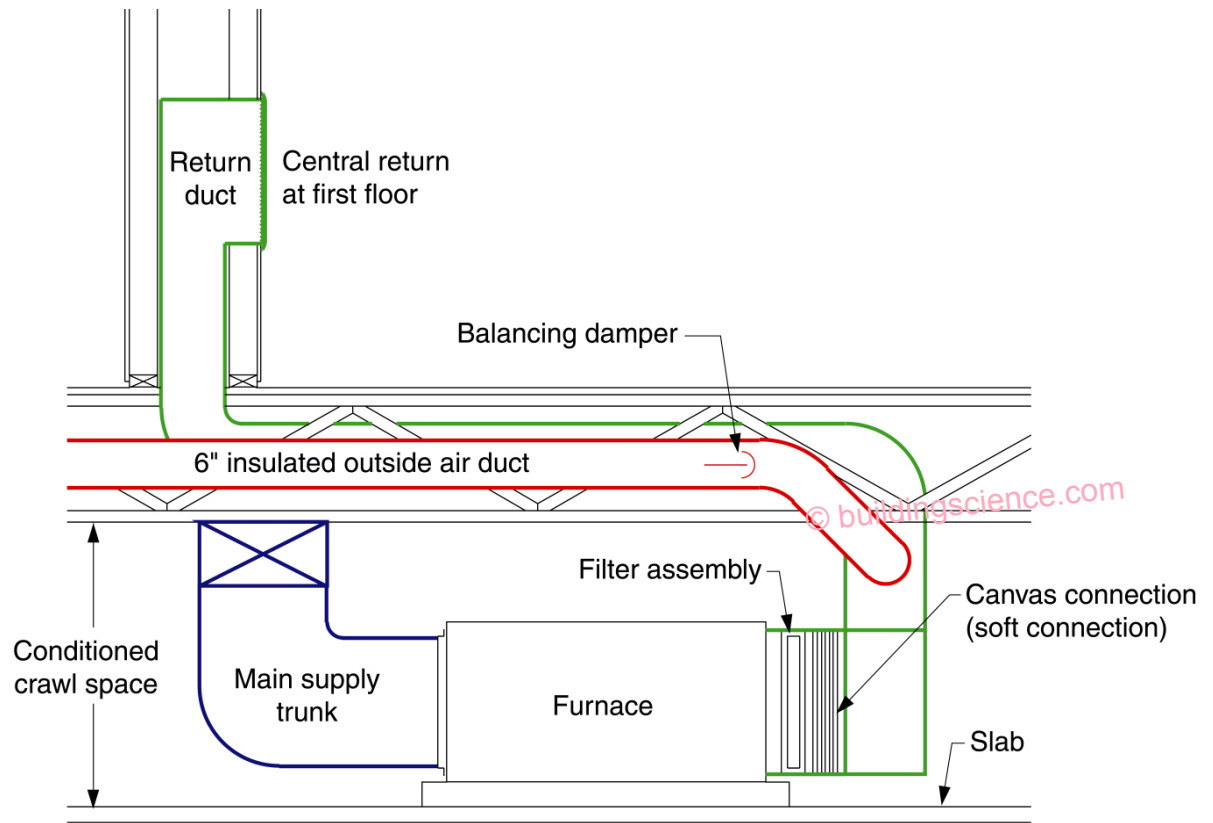
continued



Mechanical System

- **Ventilation Scheme**
 - **“AirCycler™” control brings in outside air periodically even when the air handler is not on**

continued





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Mechanical System

- **Ventilation Scheme (con't)**
 - Continuous exhaust through the crawl space
- **Intermittent point source exhaust**
 - High performance, quiet (low-sone) Panasonic fans in all baths and kitchen

