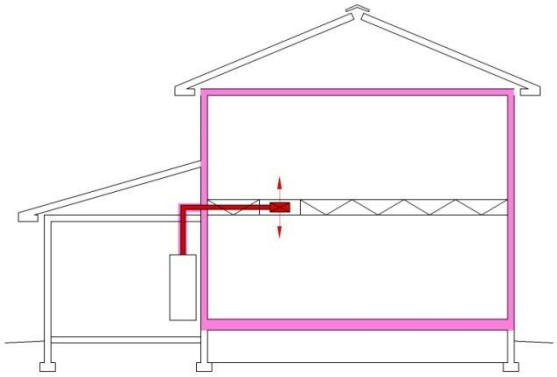
# Building with Ducts in Conditioned Spaces

## Open Web Floor Trusses



**Application:** This approach works only with two-story home designs.

**Description:** In two-story homes, the space between floors is already used to some extent to run ducts, pipes and wires. While ducts easily run between floor joists, it can be very difficult and sometimes impossible to run ducts across joists. Open web floor trusses can allow unrestricted access to rooms on the upper and lower floors.

The first decision you would need to make about open web floor trusses is how deep they should be. I-Joist floors are typically 12-inches deep. Unfortunately, this may not be adequate for the size of ducts required for the heating system.

So, the first step would be to consult the HVAC contractor for the necessary duct sizes. HVAC contractors should do a full system design, which includes ACCA Manuals J, S and D, to answer this question. Consider using rectangular duct that offers the same cross-sectional area with less height. Since systems are sometimes oversized, correct sizing calculation may result in smaller systems and duct work. Because higher insulation levels, more air tight construction and better windows can reduce heating and cooling loads significantly, duct sizes could be smaller than the contractor's previous experience would lead him or her to install. Smaller duct diameter means less depth to the floor joists.

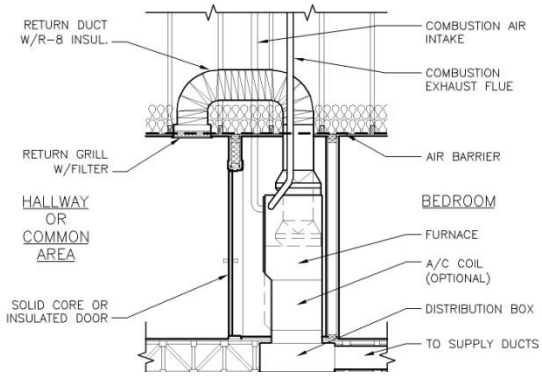



**Figure 1 - Interior furnace showing base can in joist space and short return in attic**

Increasing joist depth has several impacts. Most two-story buildings currently use 12-inch I-Joists. Builders who have installed open web trusses have often used 14 or 16-inch joists to accommodate larger ducts. Increasing joist depth would require additional siding and may affect other exterior details. Stair layout could also be affected by even a few inches difference in height. While stair height may be fairly easy to accommodate in a new plan, it can become tricky when modifying existing plans.

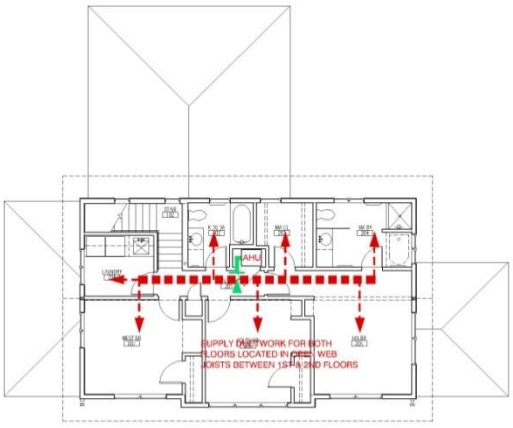



**Figure 2 - Open web truss layout with furnace in central closet.**

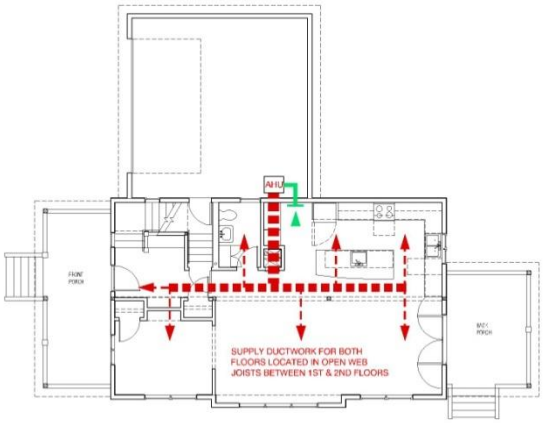
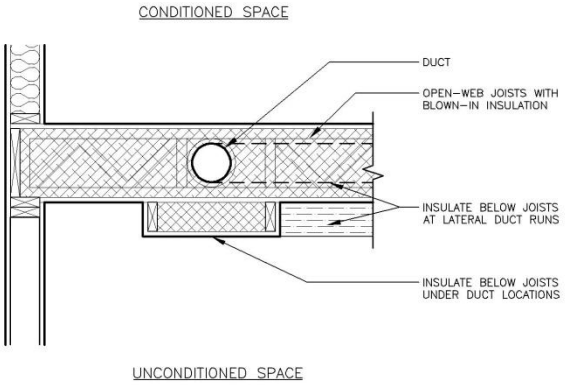


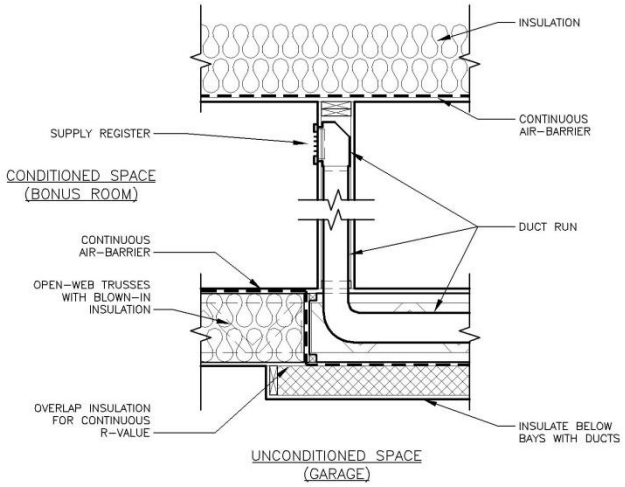

**Figure 3 - Open web floor trusses with furnace in garage.**

The metal connector plates of the trusses can be hazardous to flex duct. Pulling flex duct across a sharp edge can easily damage the duct. One way to eliminate this problem would be to ask the truss manufacturer to install vertical members in the trusses to create a special channel, called a duct chase. Manufacturers have great flexibility on where to place them, so they should be able to accommodate any duct distribution. Of course, the duct system must be carefully designed in advance to specify the locations and then the trusses must be installed correctly so the channels line up. Be sure to inform other trades not to block the chases with pipes, wires, or recessed lights.

The furnace can be located on the first or second floor. Most builders following this approach, choose the second floor with a downdraft furnace. The base can is dropped into the joist bay in order to reduce the height of furnace assembly. Because the furnace is now inside the home and above a living space, it's necessary to protect against water damage from condensate generated by furnace or cooling coil. The drain pan detail can be tricky to work out. A moisture sensor might be an acceptable alternative.

With the supply plenum already protruding into the joist space, it can be directly connected to a supply trunk. Branch ducts may be insulated flex duct to reduce noise. One consequence of this approach is that the space between floors is now extremely vulnerable to air leakage and vapor condensation. It's essential to protect the entire rim joist. This can be done by covering the entire rim with high density spray foam, which combines the




properties of insulation, air barrier and moisture barrier. Another common approach is to press fiberglass insulation into the joist bay, and then cut a square of rigid insulation (usually extruded polystyrene or foil-faced urethane) and fit it between joists so that it covers the fiberglass. Finally caulk around the rigid insulation to prevent moisture-laden air from reaching the cold rim joist. Both methods will seal and protect the building.

Bonus rooms over unconditioned garages create special challenges for the open web truss approach. Because the truss web members interfere with batt insulation, only blown-in insulation should be allowed in exterior floors framed with open web trusses. Since the ducts are already running between floors, it's logical to continue them into the insulated floor below the bonus room. Unfortunately, there isn't enough vertical space for ducts *and* the full insulation thickness in the same joist cavity. It's best to keep the duct out of the insulated floor. You may be able to run the duct up an interior wall and deliver air near the ceiling of the bonus room blowing out toward the exterior wall. With adequate velocity and the proper grille, this will keep the room comfortable. If you decide that it is necessary to run a duct to the exterior wall, then you will have to frame a soffit below the joist to hold the full insulation level (usually R38). High R-value rigid insulation could also be used in this location. In this situation, rectangular metal duct mounted close to the floor may be a good choice.

A very similar approach can be used with I-Joists. Most I-Joists can be drilled in the field with holes up to the full height of the web member. Check with the manufacturer for hole size and placement guidelines. Some manufacturers can cut holes to your requirements in the factory. Here again, designing the duct system in advance, documenting all these details on the building plans. Careful communications are essential for success.

**Advantages:**

+ Allows high degree of flexibility in location of heating equipment, duct runs and registers.
+ Works with any ceiling height.
+ Avoids scheduling problems.
+ Lower potential for trade conflicts of scheduling problems.

**Disadvantages:**

– Can increase stair height and require additional siding material.
– May raise overall building height by several inches.
– Requires careful location of plumbing and electrical (especially recessed lights).
– Insulation and sealing of the rim joist requires extra care.
– Additional cost of trusses.

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**Key challenges:**

❖ Avoiding conflicts with plumbing and recessed lights.
❖ Creating a well-insulated and moisture-protected rim joist.
❖ Filling the floor cavity with blown-in insulation, instead of batts.
❖ Sealing the joist bays between the heated and unheated spaces.

**Cost considerations:**

$ Additional cost of trusses (if any), siding and exterior trim.
$ Plans with some rooms over unheated spaces can be expensive to address.
$ Ducts can be shorter and may reduce cost. Heating system size can be reduced, which may reduce cost.

**Keys to Success:**

✓ Careful planning and communication.
✓ Proper drain pan for second-story furnaces.

# Project Team Member Guidelines

*All team members should participate in a pre-design meeting with the project team to identify and solve potential issues. Additional guidelines for each team member are outlined below:*

## Designer:

- Identify a central location for the air handler, supply plenum and trunk. Identify each duct path all the way to the register. Be aware of noise issues when locating the furnace.
- Pay special attention to furnace room details, such as clearances, access, drain pan, condensate drain and overall height.
- Specify the location of duct channel in the truss. Be sure the framers know where the channel needs to be.
- Identify all potential obstructions in the joist space, especially recessed lights. Include them in the plans.
- Detail the method for sealing the rim joist.
- Specify blown-in insulation and full insulation depth for floors over unheated spaces.

## General Contractor:

- Require the designer and all trades to attend a pre-design meeting to discuss the ducts inside approach and everyone's responsibilities.
- Ensure proper air sealing and vapor retarder installation around rim joist.
- Ensure accessibility to all furnace components for maintenance and repair, such as filters, access panels, controls, etc.
- Ensure there is adequate space around the furnace or air handler to meet the minimum clearance requirements in the code.

## Framer:

- Be sure the duct chase (if there is one) lines up across all the trusses or joists.
- Check the dimensions of the furnace room to be sure it is large enough for maintenance and repair of equipment, such as filters, access panels, controls, etc. Check with HVAC contractor about necessary clearances.

## HVAC Contractor:

- Size the heating equipment and design the ductwork taking into account the smaller heat load and shorter duct runs.
- Carefully consider the supply plenum as it fits into the joist space. Don't forget to accommodate a drain pan and drain line.
- Select quiet furnace equipment.
- Always install sealed combustion equipment with proper combustion air supply ducting to the outside.
- Avoid locating ducts joints near obstacles that will interfere with fastening and sealing ducts.
- Seal all ducts with mastic paste.
- Connect the fresh air duct and damper to the return duct near the grille.

## Insulator:

- Carefully insulate and air seal the rim joist, including those adjacent to unheated spaces, such as garages.
- Use blown-in insulation in floors over unheated spaces.

## Plumber:

- Insulate PEX pipe near ducts.
- Be sure that a condensate drain is installed at the furnace location.

## Electrician

- Be sure to know where ducts are to be located to avoid conflicts with electrical wiring and fixtures, especially important with recessed lights and ceiling fans.