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Insulation For Swine Housing

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Insulation for Swine Housing

Concern for energy conservation is one good reason to consider high levels of insulation in swine buildings. Increased insulation will reduce fuel requirements in a farrowing and nursery building and may even make supplemental heat unnecessary in some buildings. Insulated walls are warmed with less temperature difference between the inside wall surface and the inside air temperature (see Figure 1). This cuts radiant heat loss and makes animals more comfortable. It also helps keep swine buildings dry by eliminating sweating or condensation on inside surfaces. In an unheated building, insulation will conserve more of the heat produced by the animals so that ventilation works more effectively. Summer comfort will also be improved with insulation.

Insulation Materials

There are four commonly-used types of insulation available. All insulations discussed here, with the exception of extruded polystyrene rigid insulation, must be pro-

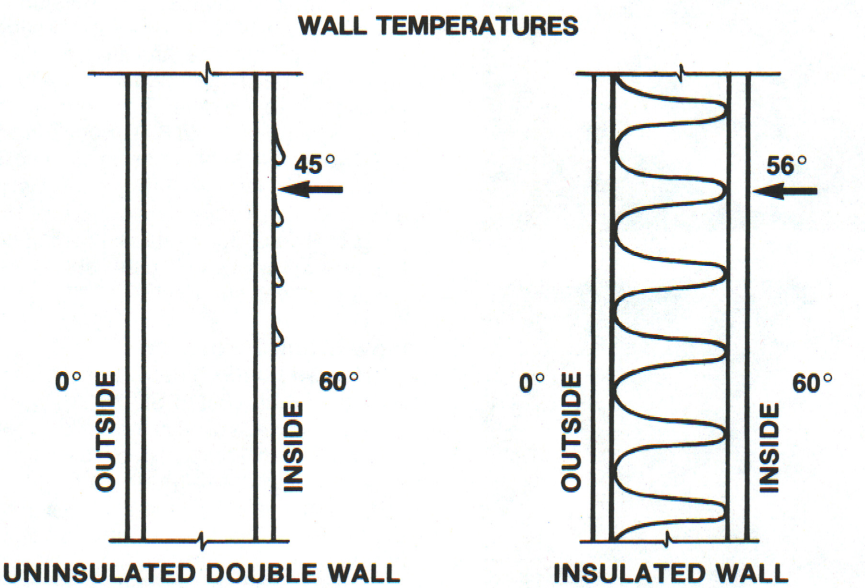

Figure 1. Insulation can make a difference in whether or not condensation occurs on inside wall surfaces. With wall temperatures of 0 F. outside and 60 F. inside and with relative humidity of 75%, condensation starts at 53 F.

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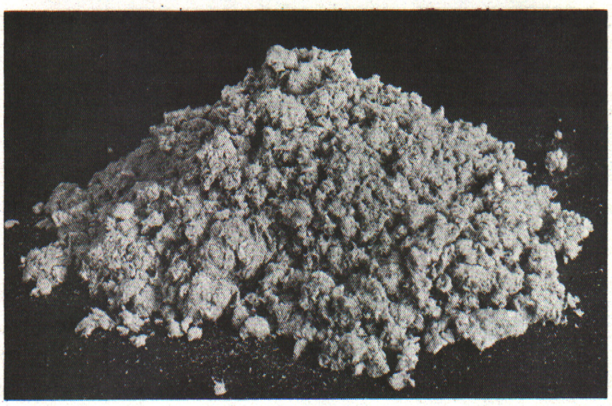
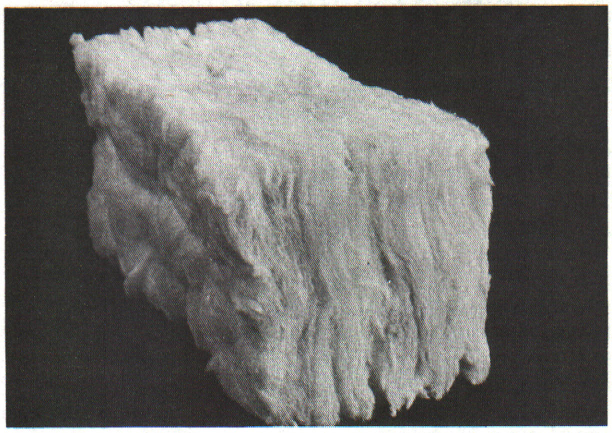
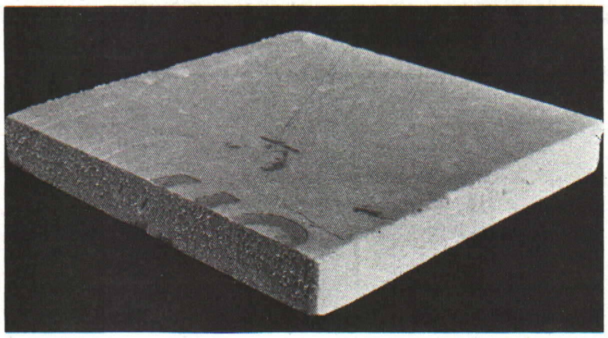
tected with a vapor barrier on the warm or animal side of the wall or ceiling. They may be classified as follows:



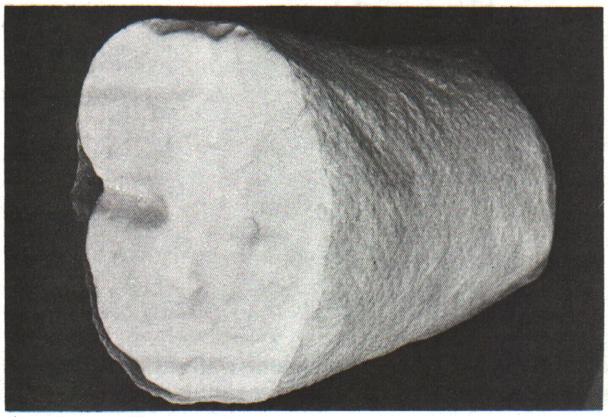
• **Loose-fill**



• **Batts and Blankets**



• **Rigid**



• **Foamed-in-place**

Loose-fill: The loose-fill type insulation is most often used in ceilings. It is usually not recommended for walls because it may settle and leave a part of the upper wall without insulation. This problem can be avoided if the material is properly blown or packed into the wall. The loose-fill mineral fiber materials, such as fiberglass and rock wool, are fire-resistant. *Cellulose fiber materials, however, require fireproofing treatment.* Select cellulose insulation to meet specification ASTM C-739 of the American Society of Testing Materials or GSA HAI-515C of the General Services Administration.

Batts or blankets: This type of insulation is often used in the walls in stud-frame construction and also in ceilings (see Figure 2). For most swine buildings, the batts and blankets are sized to fit between studs spaced 2 ft. on center. Mineral fiber is a common batting material, but cellulose fiber, correctly treated for fire resistance, can also be used.

Rigid insulation: This insulation material is available in board form of two general types (see Figure 3). One is wood or cellulose fiberboard, and the other is foamed plastic insulation. The first type is used mostly for its structural strength as sheathing. Its insulation value contributes only a small part of the total insulation value required in a well-insulated building. The second type of rigid insulation, including polystyrene and polyurethane, has little structural strength. Rigid foam insulation must be covered on the interior surface with a fire resistant material. *Check with your insurance company for its requirements before purchasing this insulation.*

Foamed-in-place plastic: This is a new type of insulation made from urea-formaldehyde. These component chemicals, combined with a catalyst, are forced out of a nozzle and into wall or odd-shaped cavities under pressure. The material shrinks during curing and will pull away from the sides of the wall cavity. Carefully controlled installation is important to assure that this material will perform satisfactorily.

R Value

Insulation is evaluated in R values which indicate the material's ability to resist heat passage. The higher the R value, the greater the insulating ability. To compare the insulating value of one material with another, divide the R value of one into the other. For example, 1 in. of mineral wool has a R value of about 3.70. For sand and gravel concrete, the R value is 0.08 per inch. By dividing 3.70 by 0.08, it is determined that inch for inch, mineral wool is over 46 times as efficient an insulator as concrete. To compute the insulating or R value for a typical building section, use Table 1. Figure 4 shows how to use Table 1 for determining the R value of a wall section.

How Much Insulation?

Heated building (farrowing and nursery). In the northern part of the United States, most engineers suggest a minimum R value of 14 in the walls. When a 2 x 4 stud space is filled with insulation, an R value close to 14 usually results. In the extreme northern United States, some engineers suggest 2 x 6 stud walls with a resulting R value of over 20 when the space is filled. In mild climates, an R value of 9 may be adequate.

Ceilings can accommodate more insulation than walls, and an R value of 23 is recommended (see Figure 5). Better insulation is obtained when the ceiling joists are covered with insulation. Otherwise, in very cold weather, the ceiling joists with an insulation value of only R=5(2 x 4) or R=7½ (2 x 6) can have lines of condensation on the ceiling under

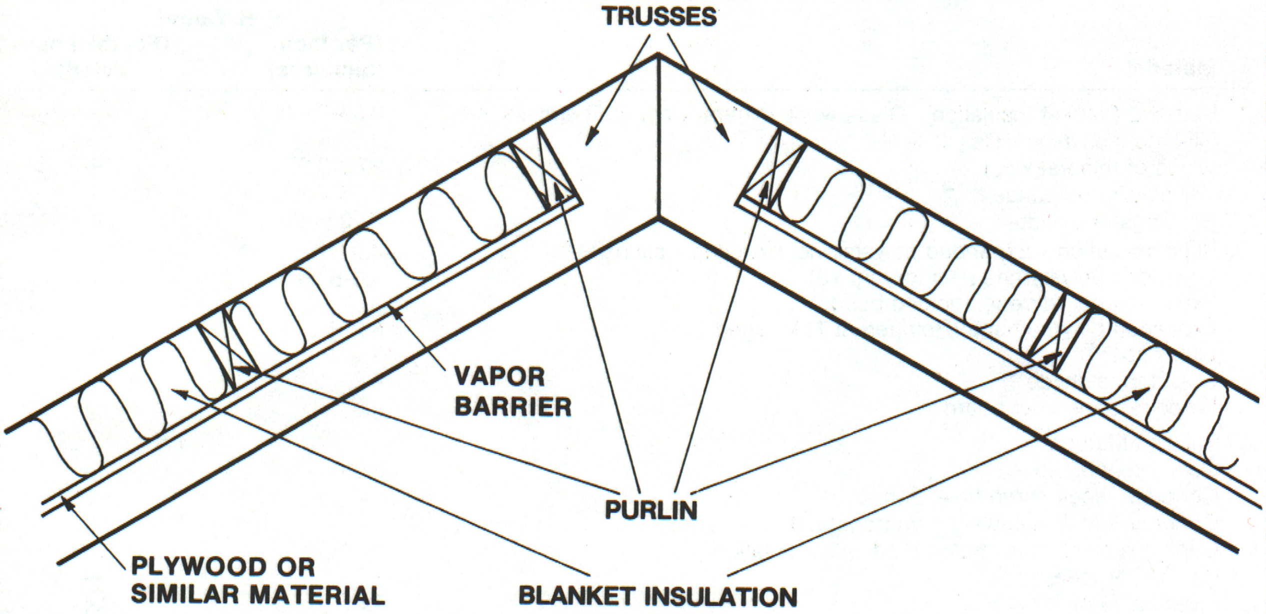


Figure 2. Blanket insulation as used in roof insulation.

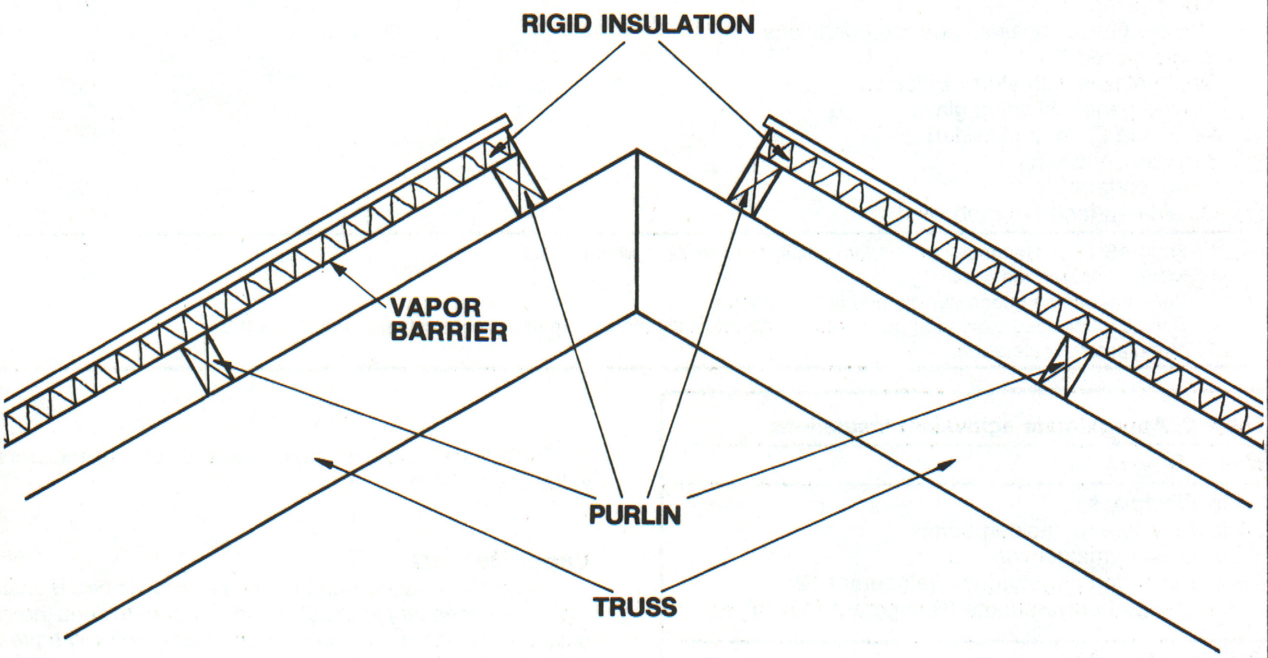


Figure 3. The use of rigid-type insulation material in a roof.

each joist. This protection usually requires 6-8 in. of loose fill to cover the top of the ceiling joist.

Unheated buildings. Pig and worker comfort, as well as better feed efficiency, encourage the use of adequate insulation in finishing houses and breeding and gestation houses. In northern areas, the same insulation values as used in fan-ventilated buildings are recommended with a minimum R value of 14 suggested for finishing and breeding herd buildings. Finishing pigs perform better at temperatures of 50 F and above in winter. Many finishing units use natural ventilation with adjustable inlets and outlets to control inside temperatures above freezing in winter. In mild climates, an R value of about 9 will conserve heat in winter and help keep hogs cool in summer.

Table 1. Insulation value of various building materials.*

Material	R Value† (Per inch thickness)	R Value† (For thickness listed)
1. Batt and Blanket Insulation - Glass wool, mineral wool or fiberglass	2.55-3.67‡	—
2. Fill-type insulation - Cellulose	3.7	—
Glass or mineral wool	2.89-3.31	—
Vermiculite (expanded)	2.13-2.27	—
Shavings or sawdust	2.22	—
3. Rigid insulation - Expanded polystyrene, extruded - plain	4.0	—
Expanded polystyrene (Refrigerant 12)	5.0-5.26	—
Expanded polystyrene, molded beads	3.57	—
Expanded polyurethane (Refrigerant 11) - aged	6.25§	—
Glass fiber	4.0	—
Urea formaldhyde**	4.0	—
Wood or cane fiber board	2.5	—
4. Building Materials		
Concrete, poured	0.08	—
Concrete block, three hole, 8 in.	—	1.11
Concrete block, lightweight aggregate, 8 in.	—	2.00
Concrete block, 8 in., holes filled with insulation	—	5.03
Lumber, fir, pine	1.25	—
Plywood, ⅜ in.	1.25	0.47
Plywood, ½ in.	1.25	0.62
Hardboard, tempered, ¼ in.	1.00	0.25
Particle board, medium density	1.06	—
Insulating sheathing, 25/32 in.	—	2.06
Gypsum or plaster board, ½ in.	—	0.45
Wood siding, ½ in. x 8 in. lapped	—	0.81
Wood siding, ¾ in.	—	0.98
5. Window Glass, includes surface conditions		
Single glazed	—	0.80
Single glazed with storm windows	—	1.82
Double pane insulating glass	—	1.5-1.75
6. Air Space (¾ in. and larger)	—	0.96
7. Surface Conditions		
Inside surface	—	0.68
Outside surface (15 mph wind)	—	0.17

* From ASHRAE Handbook of Fundamentals, 1977, except where noted.
† Mean temperatures of 75° F.
‡ Varies depending upon density and fiber diameter.
§ R=6.25 is for aged expanded polyurethane. As originally blown, expanded polyurethane has R=8.3-9.0.
** Manufacturer's literature.

Table 2. Approximate equivalent insulations.

Wall - R = 14
3½ in. Fiberglass
3½ in. Polystyrene, molded beads
3½ in. Urea formaldehyde
2½ in. Expanded polystyrene (Refrigerant 12)
2 in. Expanded polyurethane (Refrigerant 11) - aged
Ceiling - R = 23
10 in. Vermiculite
8 in. Fiberglass
6 in. Cellulose fiber - fill-type
4 in. Expanded polystyrene (Refrigerant 12)
Roof/Ceiling and Walls - R = 9
2¼ in. Expanded polystyrene, extruded - plain
2½ in. Fiberglass batt
8 in. Concrete blocks with Urea formaldehyde

Table 2 lists approximate equivalents of insulation for R values of 9, 14, and 23.

Vapor Barriers

Since the relative humidity in swine buildings is quite high, it is necessary to install a vapor barrier to keep the insulation dry. When wet, insulation of all types will have a lower R value.

Moisture in the form of water vapor can move through most building materials. In winter, the water vapor will move from the warm, moist inside to the dry, cold outside. As it moves outward, it is cooled until the vapor condenses in the insulation. This condensation not only reduces the insulation value but can cause structural damage to the wall. To prevent this problem, install the vapor barrier on the warm side of the insulation just under the inside lining material. The most common vapor barrier is 4- to 6-mil plastic film. It must be installed carefully to avoid punching holes or tears in the plastic. Even if a blanket insulation has a selfcontained vapor barrier, it is advisable to install the separate plastic film.

Perimeter Insulation

Many hog houses have cold floors, especially along the foundation, because of a lack of perimeter insulation. Moisture can condense on a cold floor which creates additional problems for the pigs.

There are several ways to provide perimeter insulation. One is through placing insulation on the outside of the foundation (see Figure 6a). Protect the insulation by using ⅜-in. foundation grade plywood or similar product. Depending on the climate, provide from 1-3 in. of polystyrene or equivalent and extend at least 16 in. below grade. It is advisable to seal the bottom with treated lumber or similar barrier to discourage rodents. Another possibility is to extend the wall insulation down 2 ft. (see Figure 6b). Another method of providing perimeter insulation is to pour the foundation with insulation in the center (see Figure 6c). Place the rigid insulation in the center of the form, and fix it in place. Carefully pour concrete on both sides at about an equal rate. Since the insulation is less dense than concrete, it tends to float. Vibrating increases this tendency to float, so be careful to properly secure the insulation before pouring the concrete.

There are concrete form ties available that permit placing the insulation against one side of the form, pouring half the concrete, moving the forms out from the insulation and pouring the other half of the wall on the other side of the insulation. Even though more time and labor are involved, the insulation is easier to hold in place with this method.

Windows and Doors

Windows and uninsulated doors have very low R values (single-glazed windows, R = 0.80), permitting a large amount of heat loss. A glass window will lose 10 times more heat than a well-insulated wall section of the same area. An insulated wall is also less expensive to build than windows.

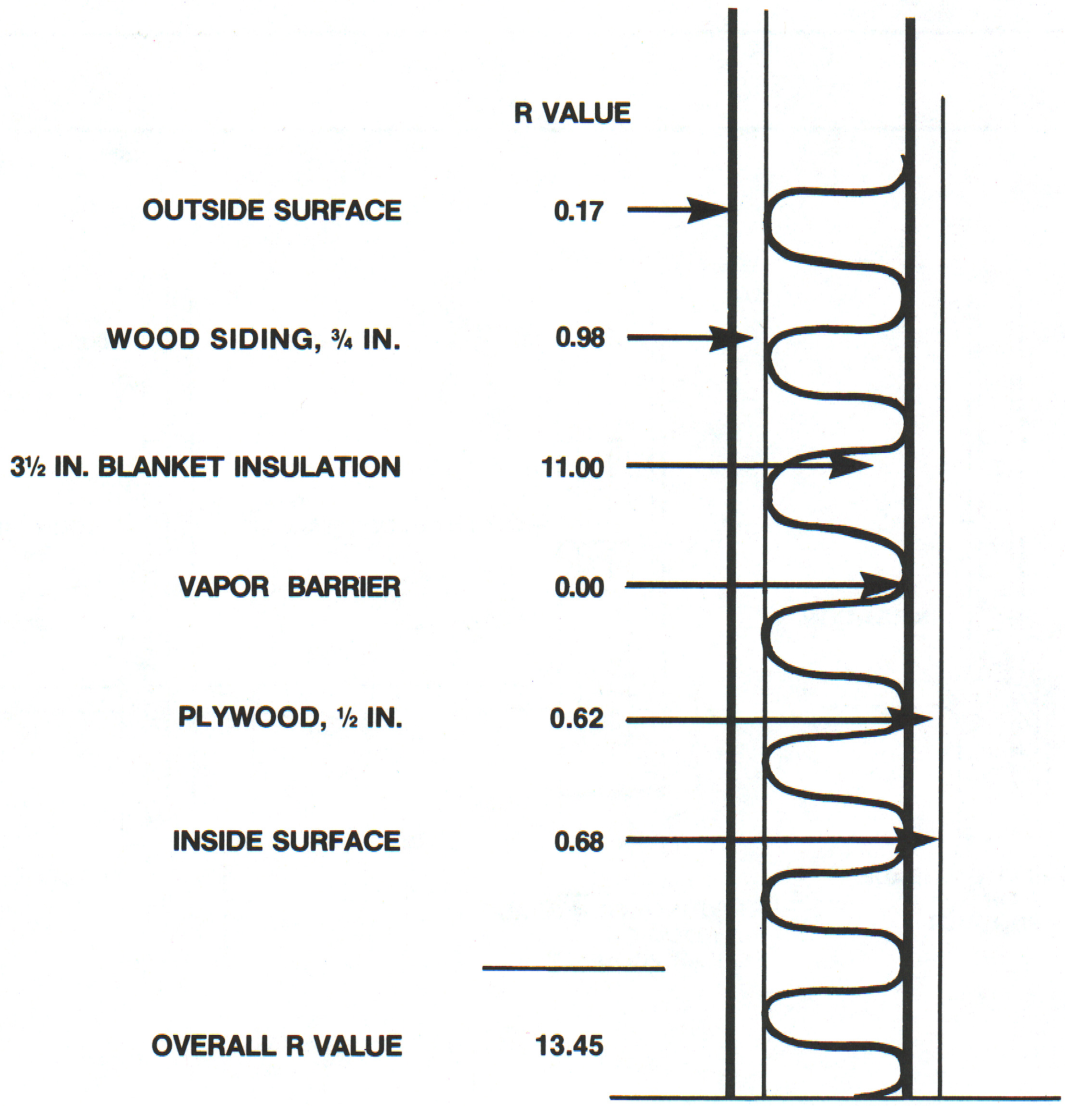


Figure 4. How to determine the resistance of a wall.

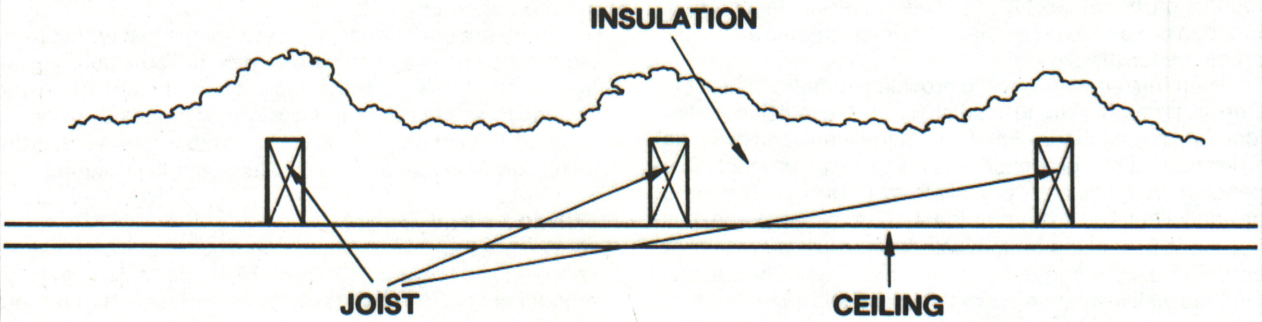


Figure 5. In northern climates, it is advisable to cover ceiling joists.

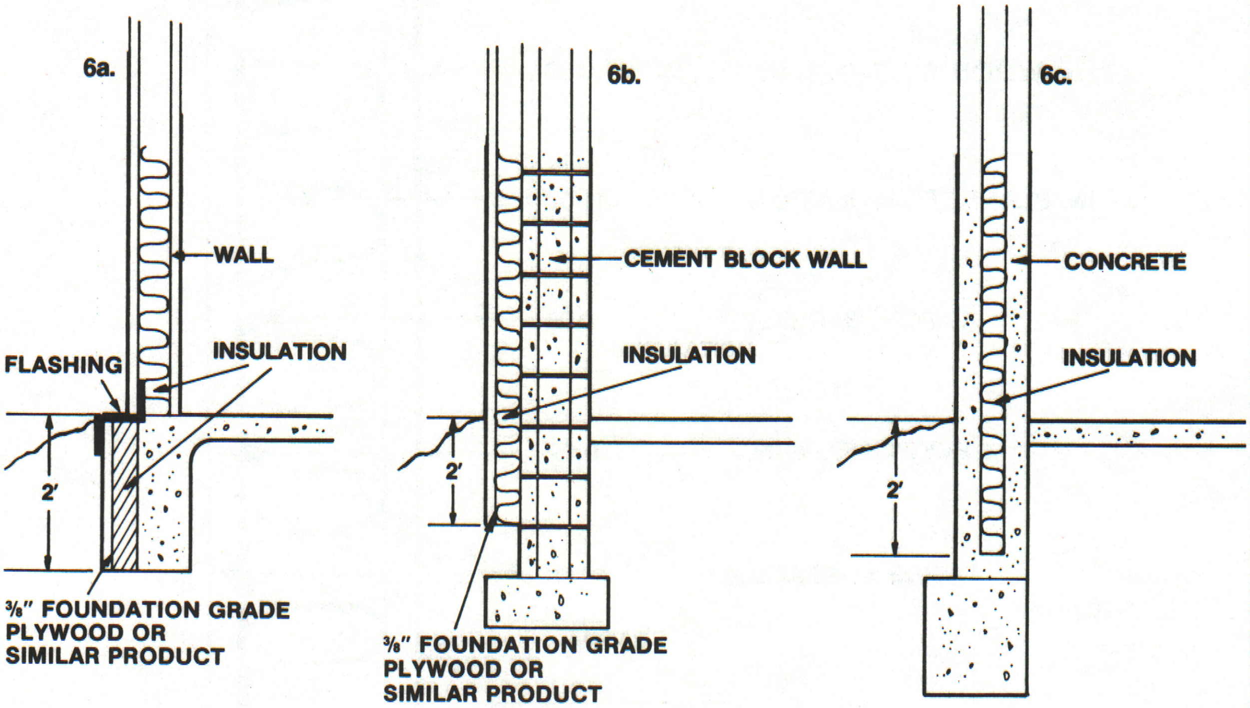


Figure 6. Insulation should be installed around housing foundations. (6a) Insulation in a frame wall. (6b) Insulation in a concrete block wall. (6c) Insulation in a pre-cast concrete wall.

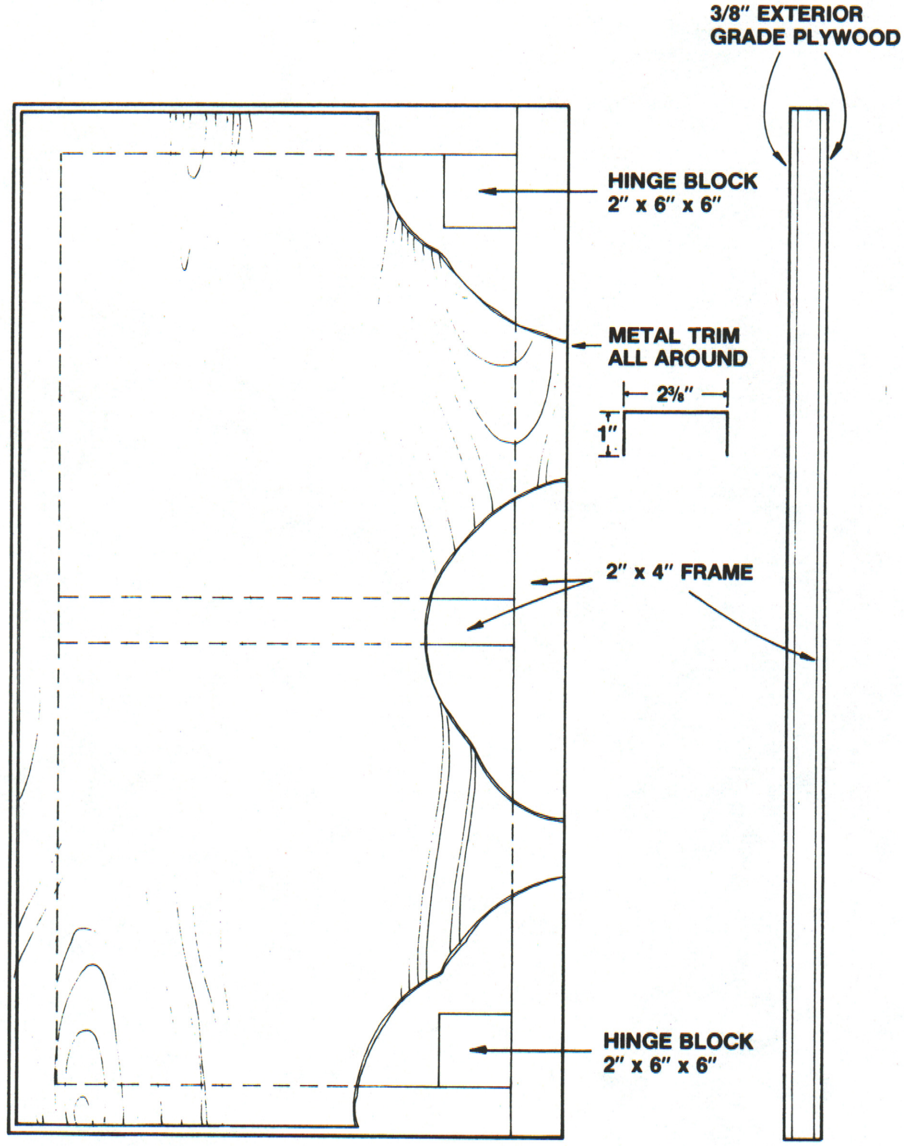


Figure 7. Insulated door in a housing facility.

If the building does have windows, consider constructing insulated panels that can be installed in the window frame during the heating season and removed when heat is no longer needed. One or two windows may be kept uncovered to provide the operator a view to the outside, but the hogs don't need sunlight. The insulation value of windows can be improved by adding a sheet of clear plastic to the inside and outside of the window frame.

Doors should be insulated and weather-stripped to reduce heat loss. You can purchase manufactured insulated doors or you can construct them using 2-in. framing lumber and plywood (see Figure 7).

In these energy-conscious days, insulation of swine housing is a recommended practice. With the proper use of insulation materials, fuel requirements are lowered, air temperatures inside the housing remain more constant, and pig and human comfort within the facilities is improved.

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