Chapter

8

Blanket Insulation: Batts and Rolls

Blanket insulations are flexible, bound products made from mineral (glass, rock, and slag) or cotton fibers. They are available in widths suited to standard spacings of wall studs and attic or floor joists. They come in rolls or batts in standard widths, usually to fit between framing on 16 or 24" centers. Continuous rolls can be hand-cut and trimmed to fit. Batts are available in a variety of precut lengths. Available with or without vapor retarder facings, the thickness and density of the insulation varies depending on the R-value desired. Batts with a special flame-resistant facing are also available in various widths for applications such as basement walls where the insulation will be left exposed. Newer products on the market include plastic-wrapped batts and fiberglass batts encapsulated in nonwoven fabric.

Fiberglass Batts and Rolls

As discussed in Chap. 7, fiberglass is one of a group of glassy, noncrystalline materials historically referred to as man-made mineral fibers (MMMFs) or man-made vitreous fibers (MMVFs). The current terminology is synthetic vitreous fibers (SVFs). The synthetic fiber is made from molten sand, glass, or other inorganic materials under highly controlled conditions. After the glass is melted in high-temperature gas or electric furnaces, the material is spun or blown into fibers that are then processed into the final product. Batt insulation is glass that is spun into threads, coated with a binding agent, and collected into a thick matte of fibers of varying thicknesses. Perhaps the most common of all residential insulation materials, it is estimated that since the development of fiberglass insulation in the 1910s, it has been used in approximately 90 percent of homes in the United States (that contain insulation).[1]

Product description

Fiberglass blanket insulation is made from sand (SiO_2), limestone ($CaCO_3$), and sodium carbonate (Na_2CO_3) and is usually the least expensive insulation on the market for the insulating value achieved.[2] Because it is inorganic, it will not rot or absorb moisture, is noncombustible, and does not support the growth of mildew, mold, or fungus. The North American Insulation Manufacturers Association (NAIMA) recommends the use of fiberglass insulation that meets the requirements of the current edition of American Society for Testing and Materials (ASTM) C665 Standard, "Specification for Mineral Fiber Blanket Thermal Insulation."

Each type comes either in continuous rolls or in packages of precut lengths called *batts* (Fig. 8.1). Relatively easy to install, both types are roughly equal in price per square foot. The decision to purchase batts or rolls depends on the specific application and/or preference of the installer. This is covered in more detail later in this chapter.

Batts and rolls are manufactured for standard joist and stud spacings. Lengths of batts available include 47, 48, 90, 93, 94, and 96 in. Rolls are available in lengths of 39 ft 2 in, 40 ft, and 70 ft 6 in. Widths of rolls and batts can be found in the following sizes: 11, 15, 15¼, 16, 23, 23¼ and 24 in.

Nominal Dimensions Available

	Batts	Rolls
Lengths	47″ (1194 mm), 48″ (1219 mm)	39′2″ (11.94 M)
	90″ (2286 mm), 93″ (2362 mm)	40′ (12.19 M)
	94″ (2388 mm), 96″ (2438 mm)	70′6″ (21.49 M)
Widths	11″ (279 mm), 15″ (381 mm)	11″ (279 mm)
	15¼″ (387 mm), 16″ (406 mm)	15″ (381 mm)
	23″ (584 mm), 23¼″ (590 mm)	23″ (584 mm)
	24″ (610 mm)	

Figure 8.1 Typical sizes of batts and rolls. (*NAIMA*)

Fiberglass does not take up water within the glass fibers, but water vapor passes freely between the fibers. Therefore, fiberglass insulation must be used in conjunction with a vapor barrier placed on the appropriate side. Batt and roll insulation is available unfaced or with a facing already attached. Unfaced blankets are used in conjunction with a polyethylene vapor barrier where applicable. The most common facings available for blanket products are kraft paper and foil (Figs. 8.2 through 8.5).

All manufacturers of fiberglass insulation products provide performance and installation information such as R-value, number of

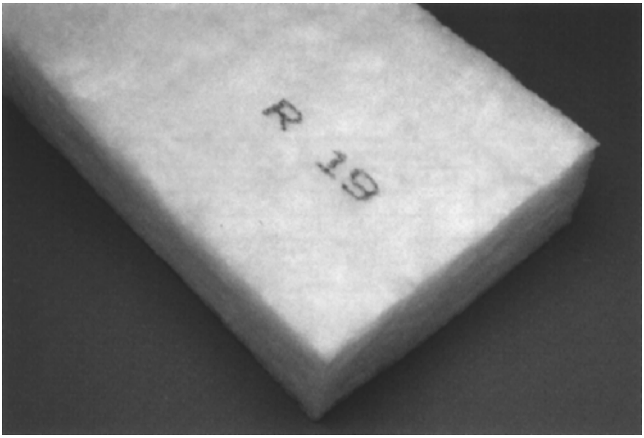

Figure 8.2 Unfaced batt. (*CertainTeed*)

Figure 8.3 Kraft paper–faced batt. (*CertainTeed*)

Figure 8.4 Foil-faced batt. (*CertainTeed*)

Batt Insulation Characteristics		
Thickness (inches)	R-value	Cost (¢/sq.ft.)
3½	11	12-16
3⅝	13	15-20
3½	15 (high density)	34-40
6 to 6¼	19	27-34
5¼	21 (high density)	33-39
8 to 8½	25	37-45
8	30 (high density)	45-49
9½	30 (standard)	39-43
12	38	55-60
This chart is for comparison only. Determine actual thickness, R-value, and cost from manufacturer or local building supply.		

Figure 8.5 Typical cost.

pieces per package, coverage per bag, size, and type either on preprinted bags or on labels attached to generic bags.

R-value

Although the typical R-value is 3.2 per inch, R-values can range from 3.04 to 4.3 for fiberglass blanket insulation. In addition to bag labeling, R-values are also printed on the facings of batts and rolls. Unfaced insulation is coded with stripes or ink-jet-printed to identify the R-value. The most common R-values in standard sizes for fiberglass insulation are R-11, R-13, and R-15 for $3^1/_2$"-thick products; R-19, R-21, and R-22 for $5^1/_2$"-thick products; and R-25, R-30, and R-38. One manufacturer's table of standard sizes and R-values for batt insulation is shown in Fig. 8.6.

If greater R-values are desired, it is possible to install multiple layers of blanket insulation where there is adequate space. Since R-values can be added, thermal calculations are simple. For example, if a ceiling requires R-38 insulation, then two layers of R-19 batts or rolls can be used. Only one layer should have a vapor retarder, facing the correct side of the wall depending on the climate, while additional layers normally should be unfaced. It is

R-Value		Thickness		Width	
R	RSI	in.	(mm)	in.	(mm)
UNFACED					
8	1.4	2½	(64)	16 & 24	(406 & 610)
11	1.9	3½	(89)	11¼, 15, 15¼, 19, 23, 23¼, 44, 48 & 84	(286, 381, 387, 483, 584, 591, 1118, 1219 & 2134)
13	2.3	3½	(89)	15¼, 16, 23¼ & 24	(387, 406, 591 & 610)
15	2.6	3½	(89)	15¼ & 23¼	(387 & 591)
19	3.3	6¼	(159)	11, 11¼, 15, 15¼, 16, 19, 23, 23¼, 24 & 48	(279, 286, 381, 387, 406, 483, 584, 591, 610 & 1219)
21	3.7	5½	(140)	15, 15¼ & 23¼	(381, 387 & 591)
25	4.4	8	(203)	15, 16, 19, 23, 24, 32 & 46½	(381, 406, 483, 584, 610, 813 & 1181)
30	5.3	10	(254)	16, 19 & 24	(406, 483 & 610)
30C*	5.3	8¼	(210)	15¼ & 23¼	(387 & 591)
38	6.7	12	(305)	16 & 24	(406 & 610)
38C*	6.7	10	(254)	15¼ & 23¼	(387 & 591)
KRAFT-FACED					
11	1.9	3½	(89)	11, 15, 16, 23 & 24	(279, 381, 406, 584 & 610)
13	2.3	3½	(89)	11, 15, 16, 19, 23 & 24	(279, 381, 406, 483, 584 & 610)
15	2.6	3½	(89)	15 & 23	(381 & 584)
19	3.3	6¼	(159)	11, 15, 16, 19, 23 & 24	(279, 381, 406, 483, 584 & 610)
21	3.7	5½	(140)	15 & 23	(381 & 584)
22	3.9	8	(203)	15, 19 & 23	(381, 483 & 584)
25	4.4	8	(203)	15 & 23	(381 & 584)
26	4.6	8	(203)	16 & 24	(406 & 610)
30	5.3	10	(254)	11, 15, 16, 19, 19¼, & 24	(279, 381, 406, 483, 489 & 610)
30C*	5.3	8¼	(210)	15 & 23	(381 & 584)
38	6.7	12	(305)	16 & 24	(406 & 610)
38C*	6.7	10	(254)	15 & 23	(381 & 584)

**Cathedral Ceiling Batts*

Figure 8.6 Batt insulation specifications. (*CertainTeed*) important not to compress the blankets to a less than normal thickness during installation because the rated R-value will be reduced.

The popularity of cathedral ceilings over the last 10 years has created the demand for a modified type of blanket insulation. R-30 and R-38 fiberglass insulation batts are 10 and 12", respectively. These sizes are too thick when placed between nominal 2 × 10 or 2 × 12 framing members, and still maintain the 1" continuous airspace required by most building codes for roof-ceiling ventilation requirements. Known as high-performance or high-density batts, the modified R-30 and R-38 insulations typically are designated with a “C” suffix. The R-30 superbatts are $8^1/_4$ to $8^1/_2$" thick, as opposed to standard R-30 fiberglass batts of $9^1/_2$ to 10". (Thickness may vary by manufacturer.) R-38 superbatts are 10 to $10^1/_4$" thick, as opposed to standard. Since these batts achieve the same R-value as the thicker types, they do not need to be compressed to fit the angles and spaces typically found in cathedral ceilings. Because they contain more fiberglass, these higher-density batts are more expensive than low-density batts. Similarly, medium-density batt insulation is also becoming increasingly popular. Measuring the same thickness as R-11, a $3^1/_2$"-thick batt can now achieve R-values of 13 or 15.

Sidewalls

Fiberglass blanket insulation products are manufactured to fit in both 2 × 4 and 2 × 6 wood frame construction. Standard sidewall widths of both 15 and 23 in are available. If steel stud framing is used, 16- and 24" widths are available for steel stud construction. R-11, R-13, and R-15 are used in nominal 4" walls, whereas R-19 and R-21 are used for nominal 6" walls (Fig. 8.7).

It is important to note that proper installation is necessary in order to guarantee that the actual R-value achieved is the R-value intended. For example, homes built with 2 × 6 construction typically use a standard R-19 batt that measures 6 to $6^3/_4$" thick to fill a $5^1/_2$" wall cavity. Compressing the insulation causes it to lose some of its thermal effectiveness, reducing its R-value to approximately R-18. Using an R-21 high-density batt that measures $5^1/_2$" thick guarantees that there is no compromise to the R-value during installation.

Attics and ceilings

The most common blanket products for attics and flat ceilings are R-30 and R-38 batts. As mentioned earlier, high-performance batts

Figure 8.7 Installing batt insulation. (*CertainTeed*)

are also available as R-30C or R-38C. Because the high-performance batts achieve the recommended R-values in less space, they allow room for ventilation between the insulation and the roof deck without the need for roof baffles or the installation of larger roof joists (Fig. 8.8).

In order to achieve R-values of 38 and higher, two layers can be used and their R-values combined. For example, an R-19 batt added to an R-30 will yield an R-49. When installing a second layer, always use unfaced insulation, because using a second vapor retarder will trap moisture between the two layers. It is also recommended that the second layer be applied across the joists in open attic spaces (Fig. 8.9).

A combination of blankets and blown-in insulation also can be used. A batt or roll can be installed during the initial construction process, and a layer of blown insulation can be added at a later time.

Floors and crawl spaces

R-11, R-13, R-15, R-19, R-21, R-25, and R-30 roll or batt insulation can be used under floors and in crawl spaces, as determined by the locally adopted building code and/or International Energy Conservation Code (IECC). When insulating floors over unheated basements or crawl spaces, faced products should be used.

Another strategy is to insulate the walls in well-sealed crawled spaces as an effective alternative to underfloor insulation. This

Figure 8.8 High-performance fiber glass batt. (*CertainTeed*)

Figure 8.9 Encapsulated fiber glass insulation. (*CertainTeed*)

method usually requires less insulation, minimizes temperature swing in piping and ductwork, and may even help cool the house in summer because some heat can escape through the uninsulated floor. It is critical that the space not have air leakage to the exterior, because this would allow heat to escape during the winter months.[3]

For insulating foundation walls of heated crawl spaces, use either unfaced insulation where the building code does not require a vapor retarder, or insulation with a special facing recommended for exposed applications. The insulation should be fastened to the sill plate and draped down the wall. The recommended R-value for this application varies by geographic area.

Basements

For finished basements, standard or high-performance batts can be used depending on the R-value required. It is important to verify if there are any moisture penetrations in the basement walls prior to insulation installation. As in sidewall construction, vapor retarders should be installed either as facing on the insulation or as polyethylene sheeting.

For unfinished basements that contain furnaces, water heaters, ducts, etc., manufacturers offer special basement wall insulation that is available in 4- or 6-ft widths in 50-ft rolls. It typically comes with a white or aluminum, flame-resistant polypropylene protective facing and is intended for use in applications where the insulation will be left exposed. It can be applied either full or half wall height (Fig. 8.10).

Limitations

Unlike loose-fill insulation products, fiberglass blanket insulation can be difficult to work with in tight or irregular spaces. Special attention to wall obstructions or areas where compression may occur is necessary so as not to compromise the overall effectiveness of the installation. This is also true if heavier insulations, such as cellulose or slag wool loose-fill insulation, are installed over (and compress) fiberglass blanket insulation.

Health considerations

As discussed in Chap. 7, debates have been intensifying since the mid-1980s as to the safety of using fiberglass insulation. The concern has been that the fibers that comprise fiberglass may replicate the affects of the fibers found in another silicon dioxide material, asbestos. The structure and size of these glass fibers vary. The smaller fibers, which cannot be seen by the naked eye, can enter the lungs, whereas larger, visible fiberglass particles can be irritating to the skin, eyes, nose, and throat. According to a recent

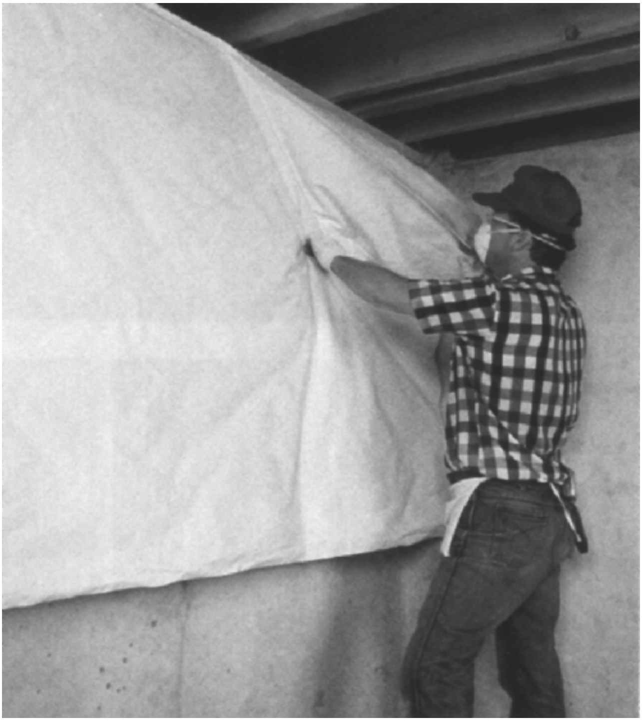

Figure 8.10 Polypropylene-faced fiber glass roll. (*CertainTeed*)

report, the larger size of fiberglass fibers is a critical physical property difference from asbestos. "Since large-diameter fibers fall out of suspension in the air faster than small-diameter fibers, work with SVFs is less likely to generate high concentrations of airborne fibers than work with asbestos."[4]

Fiberglass is listed by the International Agency for Research on Cancer (IARC) as a possible carcinogen and by the National Toxicology Program (NTP) as "reasonably anticipated to be a carcinogen."[1] Although occupational and residential exposures to fiberglass fibers are low when compared with past asbestos exposures, all fiberglass insulation is required to have a cancer warning label as mandated by the Occupational Safety and Health Administration's (OSHA) hazard communication standard.[1] Full hazard disclosure is also found in the product's Manufacturer's Safety Data Sheet (MSDS).

The Consumer Product Safety Commission (CPSC) also has found (1992) that "fibrous glass is carcinogenic in animals only when surgically implanted into the lung or abdomen. In tests where animals were exposed by inhalation, the expected route of human exposure, the animals did not develop tumors. Therefore, the animal implantation studies do not establish a hazard to humans."[5]

A common complaint about fiberglass has been the use of formaldehyde in its manufacturing process, and the danger the chemical may present to humans. Conventional fiberglass insulation is made with 5 to 7 percent phenol formaldehyde resin.[6] Industry officials report that formaldehyde is found in the final product in only trace amounts. After being sprayed on as part of the manufacturing process, it goes through an oven curing process where the majority of the formaldehyde is cured and the excess collected by precipitators to ensure that harmful amounts are not released into the atmosphere.[1]

The greatest concern with fiberglass, however, is not necessarily aimed at the home occupants surrounded by the insulation but at the installers of the insulation. Workers in fiberglass manufacturing plants, as well as people working with or using materials that contain fiberglass, may develop a skin irritation. This mechanical irritation is a physical reaction of the skin to the ends of fibers that have rubbed against or become embedded in the skin's outer layer. Any skin irritation caused by fiberglass is temporary. Washing the exposed skin gently with warm water and mild soap can relieve it. The vast majority of workers and consumers, however, can control skin irritation by following recommended work practices when handling the material. Fiberglass is also the catalyst for eye irritation if deposited in the eye by the user's fingers or through fibers in the air. If this should happen, the eyes should not be rubbed but rinsed thoroughly with warm water, and a doctor consulted if irritation persists.[7]

Fiberglass released into the air during its manufacture or handling also may create temporary upper respiratory tract irritation. Like skin irritation, upper respiratory tract irritation is a mechanical reaction to the fibers. It is not an allergic reaction, and the irritation generally does not persist. Such exposures to high concentrations of airborne fiberglass may result in temporary coughing or wheezing. These effects will subside after the worker is removed from exposure.[7]

In response to these health concerns, several manufacturers have developed new products that attempt to reduce the amount of airborne glass fibers. Generically called *encapsulated batts,* these blanket products seal the fiberglass in a polyethylene covering that minimizes contact and also serves as a vapor barrier. Reportedly easier to install, there is no itching, and the price is only about 5 to 30 percent higher than traditional batts depending on the manufacturer.

One product is produced by fusing together two different types of glass, which gives the fiber a curving or twisted configuration and eliminates the need for binders to hold the fibers together. The fibers are more resilient, stronger, and less prone to breakage, so fewer fiber particles will get into the air or into the installer's skin. Since the fiber is twisted, a binder (typically formaldehyde) is not required to hold batts together.[6]

Another formaldehyde-free fiberglass insulation product uses an acrylic binder to hold the fibers together. Unlike the phenol-formaldehyde resin used in conventional fiberglass, it does not off-gas formaldehyde during either manufacture or use. The acrylic binder is a thermosetting resin. Although heat is used to cure the binder, as with phenol-formaldehyde, this binder releases very few volatiles.[8]

As will be discussed later in this chapter, proper clothing and handling and the use of approved respiratory protection can effectively control exposure to airborne fibers and therefore reduce the likelihood of skin or upper respiratory tract irritation.

Environmental considerations

Fiberglass uses two resources, sand and recycled glass. Sand does not have an impact on nonrenewable natural resources. Recycled plate and bottle glass is considered a secondary raw material, so, when used as raw material, recycled glass is changed into a product that can save energy and reduce pollution.[1]

All fiberglass companies use at least 20 percent recycled glass cullet in their insulation products to comply with the U.S. Environmental Protection Agency (EPA) recycled-content procurement guidelines. Johns Manville's fiberglass is certified by Scientific Certification Systems (SCS) to contain 25 percent recycled glass (18 percent postconsumer bottles and 7 percent postindustrial cullet). Johns Manville's manufacturing equipment readily handles colored glass, making it easier for the company to use postconsumer recycled cullet. CertainTeed and Owens Corning rely primarily on postindustrial cullet from flat glass manufacturers.[9]

Fire resistance

Fiberglass is naturally fire resistant, but faced insulations will contribute to flame spread unless flame-resistant materials are used.

Vapor retarder

Batts and rolls are available with facings of asphalt-coated kraft paper, aluminum foil, or plastic film already attached. The facings extend over the sides of the insulation to provide strengthened flanges that can be stapled to wood framing to hold the insulation in place where recommended by the manufacturer. (Some faced products may be pressure-fit between framing without stapling.)

The kraft paper or standard foil vapor retarder facings on many blanket insulation products are combustible and should not be left exposed. Gypsum board is one such covering material. Special care must be taken to keep open flame and other sources of heat away from the facing. In addition to the home's habitable rooms, garages, storage rooms, utility rooms, and laundries are areas where faced insulation also should be covered. If in doubt, always consult individual manufacturers' installation instructions. It is also important to repair damaged vapor retarders by covering the damaged area with scrap vapor retarder material and taping it in place or, in the case of small rips, by using duct tape or polyvinyl tape.

The National Institute of Standards and Technology (NIST) recently published a study that demonstrated that the permeance of the asphalt-impregnated kraft facing used as a vapor retarder on batt insulation can rise dramatically under very humid conditions. These results suggest that in very moist areas such as shower rooms, kraft paper alone may not be sufficient to keep moisture out of the walls. A better strategy is to install a continuous polyethylene vapor retarder.[10]

Some blanket products are available without these facings. If unfaced fiberglass insulation is used, a separate vapor retarder should be applied after the insulation is installed.

Special low-flame-spread vapor-retarder facings are available that can be left exposed. (Flame-resistant facings are labeled FS25, or flame spread index 25.) Sometimes, the flame-resistant cover can be purchased separately from the insulation. Fiberglass blanket products also are available for basement walls that can be left exposed. These blankets have a flame-resistant facing and are labeled to show that they comply with ASTM C665, type II, class A.

Installation standards and practices

As mentioned in Chap. 7, general work practices applicable to all work involving SVFs such as fiberglass (rock wool and slag wool) have been established by U.S. Occupational Safety and Health Administration (OSHA). Excerpts of the guidelines are as follows[11]:

1. Minimize dust generation.
   - Keep the material in its packaging as long as practicable and if possible.
   - Tools that generate the least amount of dust should be used. If power tools are to be used, they should be equipped with appropriate dust-collection systems as necessary.
   - Keep work areas clean and free of scrap SVF material.
   - Do not use compressed air for cleanup unless there is no other effective method. If compressed air must be used, proper procedures and control measures must be implemented. Other workers in the immediate area must be removed or similarly protected.
   - Where repair or maintenance of equipment that is either insulated with SVF or covered with settled SVF dust is necessary, clean the equipment first with a HEPA vacuum or equivalent (where possible), or wipe the surface clean with a wet rag to remove excess dust and loose fibers. If compressed air must be used, proper procedures and control measures must be implemented. Other workers in the immediate area must be removed or similarly protected.
   - Avoid unnecessary handling of scrap materials by placing them in waste disposal containers and by keeping equipment as close to working areas as possible that prevents release of fibers.
2. Ventilation
   - Unless other proper procedures and control measures have been implemented, dust-collection systems should be used in manufacturing and fabrication settings where appropriate and feasible.
   - Exhausted air containing SVFs should be filtered prior to recirculation into interior workspaces.
   - If ventilation systems are used to capture SVFs, they should be checked and maintained regularly.
3. Wear appropriate clothing.
   - Loose-fitting, long-sleeved and long-legged clothing is recommended to prevent irritation. A head cover is also recommend-

ed, especially when working with material overhead. Gloves are also recommended. Skin irritation cannot occur if there is no contact with the skin. Do not tape sleeves or pants at wrists or ankles.
- Remove SVF dust from the work clothes before leaving work to reduce potential for skin irritation.

4. Wear appropriate personal protective equipment.
   - To minimize upper respiratory tract irritation, measures should be taken to control the exposure. Such measures will be dictated by the work environment and may include appropriate respiratory protective equipment. See OSHA's respiratory protection standard.
   - When appropriate, eye protection should be worn whenever SVF products are being handled.
   - Personal protective equipment should be fitted properly and worn when required.

5. Removal of fibers from the skin and eyes.
   - If fibers accumulate on the skin, do not rub or scratch. Never remove fibers from the skin by blowing with compressed air.
   - If fibers are seen penetrating the skin, they may be removed by applying and then removing adhesive tape so that the fibers adhere to the tape and are pulled out of the skin.
   - SVFs may be deposited in the eye. If this should happen, do not rub the eyes. Flush them with water or eyewash solution (if available). Consult a physician if the irritation persists.

Insulation should be installed just before the interior finish is applied. In addition to the removal of all construction debris from the spaces to be insulated, the following checklist should be completed. (If any part of this work is done following the installation of the insulation, the vapor retarder may be damaged, and gaps may be made in the insulation.)

1. Sidewalls, floors, roofs, and ceilings have been framed.
2. Roofing is finished and doors, windows, subflooring, and sheathing are in place.
3. Plumbing, heating, ventilating, and air-conditioning work has been completely roughed in.
4. Cabling and wiring (including telephone and other low-voltage wiring) have been completely roughed in.

Stapling methods. There are three commonly accepted methods of installing faced insulation in wood framing members. These are referred to as *inset stapling*, *face stapling*, and *pressure fit*. (Faced blanket insulations typically provide a stapling flange for attaching the insulation to the framing members; Fig. 8.11.)

It is important to note that wherever batts or rolls of any type are too short to fill a stud cavity, a piece should be cut to size to fill the gap. When insulation is too long, it should be cut to fit properly, not doubled over or compressed. For standard wall heights, use precut batts rather than continuous rolls. This will tend to expedite the installation process. Rolls should be used where length requirements permit. If cutting is necessary, the best knife has been found to be one with a serrated blade. Utility knifes are more common.

It is easiest to cut kraft-faced batts with the paper face down. Cutting from the paper side can rip the paper and ruin its efficiency as a vapor barrier. To cut insulation properly, lay the blanket on a board with the kraft or foil facing down. Place a straight edge or 2×4-in piece of lumber over the area of insulation to be cut. Press the straight edge down hard, and cut with the knife. Blades should be replaced periodically because they tend to dull during use.

Inset stapling. When using the inset stapling method, place the insulation in the cavity, and check to be sure that it completely fills the cavity, top to bottom. It is recommended that a single batt be used in sidewalls. However, when insulating with 47- or 48-in batts, make sure the two pieces are butted snugly together. Gently press the insulation at the sides into the framing cavity, usually about $^3/_4$

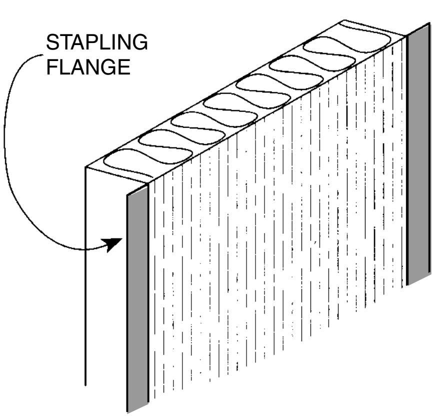

Figure 8.11 Stapling flange. (*NAIMA*)

in, until the outside edge of the flange is flush with the face of the framing. When inset stapling insulation between inclined or vertical framing members, as in cathedral ceilings or walls, start stapling at the top and work down. Use enough staples to hold the insulation firmly in place, and avoid gaps and "fishmouths" between flanges and framing[12] (Fig. 8.12).

Face stapling. Place the insulation between the framing members, and check to be sure that the blanket fits the cavity at both ends. With facing material flush with the face of the framing, the flanges will overlap the framing. Staple the flanges to the face of the framing using enough staples to hold the insulation firmly in place, and avoid gaps and fishmouths. The flange of the faced insulation placed in the next cavity will overlap the previously stapled flange[12] (Fig. 8.13).

Both methods are used widely and can provide acceptable performance. Inset stapling is usually preferred by the wall finish trades because it allows adhesive application of wall board. Another problem occurs when stapling over the face of the framing; the layers of paper can get bunched up. This makes it harder for the gypsum wallboard crew to find places to nail, and often results in more nail pops.

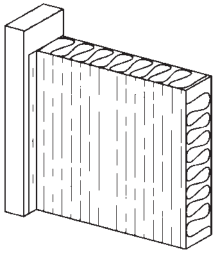

Figure 8.12 Inset stapling. (*NAIMA*)

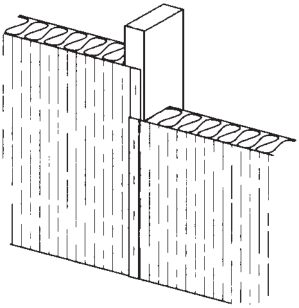

Figure 8.13 Face stapling. (*NAIMA*)

Pressure fit. To install faced products by pressure fit, gently place the insulation into the cavity space between the framing members. The insulation facing must be flush with the face of the stud and fit snugly at the sides and ends.[12]

Unfaced insulation. Many insulation subcontractors prefer unfaced batts for most applications because they are faster to install. Similar to the pressure-fit technique, gently place the insulation into the cavity space between framing members. It is important that insulation be correctly sized for the cavity, and fit snugly at the sides and ends.

Sidewalls. First of all, verify with the local building code all requirements regarding insulation materials, ventilation clearances, and firestops. Make sure that any openings between floors are fire-stopped with fireproof caulk, unfaced fiberglass, or rock wool. Plumbing and wiring chases, flue chases, hearths, and chimneys all need fire stops.

Measure the ceilings and walls to determine the square footage, and divide by the number of square feet in a package. The coverage of each package of insulation varies according to manufacturer, R-value, and width. Some installers prefer the 16"-wide batts rather than the typical 15"-wide batts. These wider batts are made for walls framed with metal studs, but when used with wood framing, the extra inch of width makes a good, snug fit between studs.

In order to avoid incidental compression during packaging, it is wise to fluff up the batts, making sure that each is expanded to its full thickness. Running a thin putty knife between the fiberglass and the stud also fluffs and aligns the batt after it is in place. Full-length batts, which are typically cut to 93" for an 8-ft wall, can be used in empty stud bays where there are no electrical or plumbing obstacles.

An all-too-common practice by installers when encountering obstacles within the stud cavity is to omit the insulation, or incorrectly compress the batt. This may be marginally sufficient when the electrical wiring is located close to the inside wall surface. When the wiring is in the center of the cavity, either a shallow cut in the insulation may be used to allow the wiring to pass through the insulation or it may be split lengthwise and the wiring sandwiched within (Figs. 8.14 and 8.15).

The splitting technique also works for insulating behind vertical runs of plumbing, and not only insulates copper pipes but also

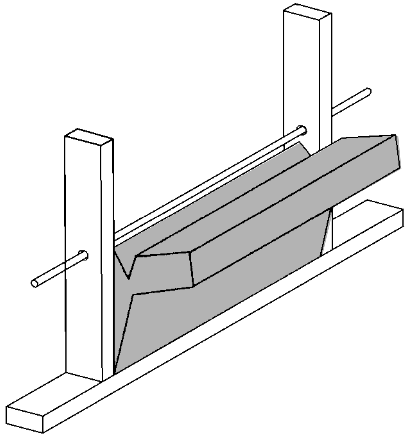

Figure 8.14 Splitting technique. (*NAIMA*)

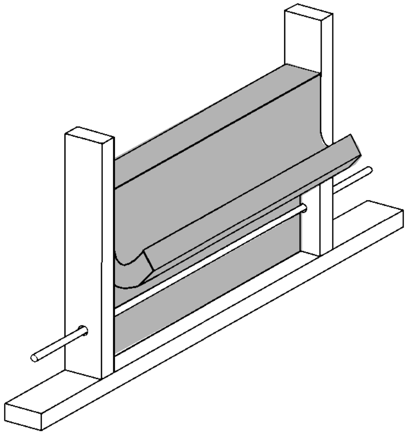

Figure 8.15 Splitting technique. (*NAIMA*)

helps to reduce noise from PVC waste stacks. To guard against pipes freezing, insulation should never be placed between piping and the warm side of the wall.

Junction boxes for wall switches and convenience outlets at outside walls should be insulated between the rear of the box and the sheathing. Place insulation behind the junction box, and if necessary, cut insulation to fit snugly around it. If installing kraft-faced batt insulation, use the outside of the box as a guide to slice the paper carefully, which lessens the chance of ripping it.

Some installers prefer using 4-ft batt lengths because they are easier to maneuver around wiring and plumbing in the bays. If batts are stacked in a bay, make sure that the butt joint between the batts is tight. The batts should fit snugly in the bay and should fill the width of the stud from the sheathing inward.

Special cutting of insulation may be required for less than standard width or length cavities or for insulating around window and door framing, stud corners, and band joists and between chimneys and framing.

Ceiling joists below an attic. When ceiling insulation is installed at the same time as wall insulation, it can be installed from below. Batts or rolls, faced or unfaced, are installed between ceiling joists and butted together. Faced batts should be stapled to joists unless the manufacturer recommends pressure-fit applications.

It is particularly important that clearance for air movement from vent openings be maintained. This should be a minimum of 1 in of unblocked free airspace between the roof sheathing and the insulation. (Verify the amount of airspace required with all applicable building codes.) The insulation should extend far enough to cover the tops of the exterior walls but should not block the flow of air from the eave vents. To make sure that the eave vents (also referred to as *soffit vents*) are not blocked, attic vents or baffles should be installed to provide unrestricted airflow from the soffit to the attic if prohibited by insulation placement. It is important also for the insulation to cover the top plate. Use baffles if necessary to keep the insulation from blocking the passage of air (Fig. 8.16).

Vapor retarders are not a standard recommendation for attics. Exceptions may include very cold climates or isolated cases where there is high humidity in the house during the winter. An attic vapor barrier is not required by building codes, as long as the attic is sufficiently ventilated. If used, proper orientation of the vapor retarder is consistent with other locations in the home. For example, if the vapor retarder faces the inside of the room in sidewall installation, it also will face the inside of the room from the ceiling. Penetration of the vapor retarder by recessed lights, attic openings, and vents can provide paths for conditioned air and moisture to escape into the attic.[12]

Bridging or cross-bracing of ceiling or floor joists is insulated by splitting a batt vertically at the center and packing one half into the lower opening and the other half into the upper opening. Another method is to butt the insulation to the bridging and then fill the bridging space with scrap or loose insulation.[12]

After the ceiling gypsum wallboard has been installed, temporary flooring should be laid across the joists to provide some foot-

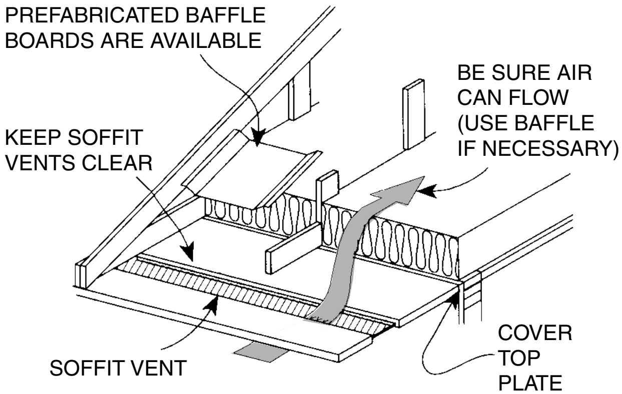

Figure 8.16 Baffle placement. (*NAIMA*)

ing. It is easiest to place the insulation blanket at the outer edge of the attic space and work toward the center. This allows for more headroom in the center of the space, where cutting and fitting can be performed. Stapling is not required if insulation is laid in over finished ceilings.

If the joist cavities are completely filled and the required R-value has not been achieved, insulation in long runs perpendicular to the direction of the joists should then be placed. Leftover pieces can be used for small spaces.

Insulation should be kept 3 in away from recessed lighting fixtures unless the fixture has an IC rating. (The IC label, for *insulation contact,* can be found on the inside of the fixture.) A type IC insulated ceiling fixture is designed for direct contact with insulation. If insulation is placed over an unrated fixture, it may cause the fixture to overheat and perhaps start a fire. Insulation always should be installed at least 3 in away from the recessed fixture's wiring compartment or ballast or any metal chimneys, gas water heater flues, or other heat-producing devices.

Attic rooms. Attics that are used as living spaces are to be insulated as other habitable rooms are. Attic framing can be a little difficult to work with, so rafters and collar beams should be insulated with separate pieces of fiberglass insulation. Trying to fit a continuous length of insulation where collar beams and rafters meet may result in gaps or compression of the insulation.

When selecting and installing insulation for the rafter portion, 1 in of ventilation space should be provided between the insulation and the roof sheathing. Eave vents and baffles that run along the entire ceiling cavity will ensure proper airflow.

The framing member size of the rafter will determine the batt selection. For example, 2" × 10" joists will require R-30C high-density insulation that measures $8^{1}/_{4}$", and will automatically provide the required ventilation space when installed properly.

Verify that the exterior thermal envelope is insulated. This will require insulation in knee walls, end walls, dormers, and any other surface that encompasses the conditioned space. As soon as the insulation has been installed, finish the walls and ceiling with an approved interior finish, such as gypsum wallboard.[12] See Fig. 8.17 for proper attic insulation locations.

Cathedral ceilings. The "rules" for cathedral ceilings are similar to those applied to attic rooms. A ventilation baffle should be installed at the eave of every joist to make sure that the ventilation space is not blocked by insulation. Baffles used in cathedral ceilings to maintain an air passage to the ridge should not extend farther than the wall plate and should not block soffit vents, because any obstructions in the soffit will disrupt airflow. As mentioned earlier, fixture ratings, vapor retarder orientation, and proper placement must be respected.

Floors. Floor insulation limits all three modes of heat loss. A warmer floor reduces the temperature difference that drives convection. Floor insulation also directly impedes conduction and radiation to the colder air below the floor. Like walls, floor cavities should be completely filled with insulation without gaps or voids.

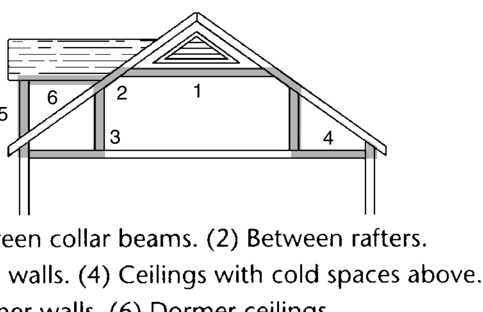

Figure 8.17 Attic rooms. (*NAIMA*)

The most efficient use of floor insulation requires contact with the subfloor and both joists.

Given the deeper joist members commonly used in the longer spans of engineered wood systems, the amount of floor insulation required by some codes can be less than the space available. For example, an R-19 batt is $6^1/_4$" thick. A floor framed with 2 × 8s is about $7^1/_2$" deep, whereas a 2 × 10 floor is $9^1/_2$". To avoid a gap in this situation, the batt must be pushed up into the cavity. This is easily achieved with the proper intermittent supports.

The easiest and most effective method of holding insulation in place is to use straight, rigid wire insulation hangers (preferably galvanized) with pointed ends. The hangers are made for joist spacings of 12, 16, 18, 20, and 24", and may be used against wood, metal, or concrete. The hangers, which are slightly longer than the joist spacing, are placed by hand between the joists and bowed upward into the insulation, causing the insulation to press gently against the subflooring. Spacing of hangers is as required to prevent sagging of the insulation, preferably 12" apart and not more than 6" from ends of batts and rolls (Fig. 8.18).

When insulating floors where the insulation is less than the thickness of the joists and the method of installation does not hold the insulation up against the subflooring, it will be necessary to insulate the headers or band joists at outside walls. This is so because there will be an airspace between the top of the insulation and the subfloor that will allow heat to be lost at outside walls. Therefore, it is recommended that the insulation be pushed up to the subfloor.

Although floor framing is typically 16 or 24" on-center bays, historical home designs may vary. Therefore, a number of insulation hanger systems are available:

1. Metal rods, or spring rods, or "tiger claws" are available through insulation distributors. They are easy to use, but compress the insulation in the middle.
2. Wood lath provides a sturdy support for insulation.

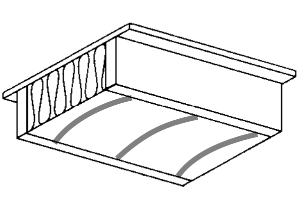

Figure 8.18 Insulation hangers. (*NAIMA*)

3. Plastic mesh should be attached to the bottom of the framing. Draping the mesh over the joists leads to compression that reduces insulating value.
4. Polypropylene twine resists rot, mildew, rodents, and other dangers. The twine needs to be stapled every 12 to 18".
5. Plastic straps are typically a thin strap made of recycled plastic. The ends are wider for easy stapling. The strap can attach to the joist bottom or lift a batt up into the cavity without compressing it.
6. Galvanized wire, nylon mesh, or galvanized screen (chicken wire is also suitable) will hold the insulation in place. After the insulation has been pushed into place, the mesh or screen is stapled or nailed to the joist faces.
7. Galvanized, malleable wire may be laced around nails protruding from the faces of the joists, or the wire may be stapled to the joists. Wire and nail spacings are as required to prevent sagging of the insulation.

Buying a thicker batt may be a better option than trying to lift a thinner batt into the proper position. Material costs will climb slightly, but labor should be the same. Attaching the insulation support to the bottom of the floor joist will be easier. It also could lead to a higher-quality job, because there is less chance for compression or gaps.

If insulating over an unheated area, the vapor retarder should be in substantial contact with the subfloor. Where the header is parallel with the floor joists, it may be necessary to adhere insulation to the header or fill the joist area with insulation. If you insulate above an unheated crawl space or basement, you also will need to insulate any ducts or pipes running through this space. Otherwise, pipes could freeze and burst during cold weather in northern climates.

Cantilevered overhang areas must not be overlooked. If the underside of the cantilever has been closed, insulation must be installed by sliding batts into place from the room below (Fig. 8.19).

For homes where the underside of the floor is exposed and readily accessible, such as homes on pilings or certain garage areas, the insulation should be covered with a suitable exterior material to protect it from high winds and physical abuse.

Heated crawl space. More common in northern climates, heated crawl spaces help protect water pipes from freezing while also elim-

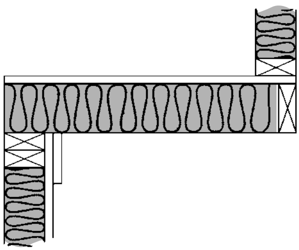

Figure 8.19 Cantilevered overhang. (*NAIMA*)

inating the need for under-floor insulation. The first step is to measure and cut small pieces of insulation and fit them snugly into the band joist between the floor joists. (Before installing the insulation, check for any air leakage at the foundation sill joint, and caulk or seal this joint as needed.) Use R-13 blanket insulation as a minimum on structures with 2 × 4" sill plates, and R-19 with 6"-wide sill plates. If the fiberglass has a facing or vapor retarder, be sure that the insulation is installed with the vapor retarder toward the heated space (only in cold climates). The insulation can be stapled by the paper or foil facing or fastened with wire fasteners. (Verify with local practice and building codes for proper vapor retarder placement.)

On the two sides where the floor joists are perpendicular to the band joist, cut the insulation material to a snug fit, and gently push it into place between the floor joists. Be sure that it fits snugly against the band joist without being compressed. On the sides where the floor joists are parallel to the band joist, cut longer pieces of insulation (sections of 4 ft or less are easiest to work with). The insulation can be held in place with staples (if faced), tiger claws, thin wire, or fishing line criss-crossed around tacks or nails at 1-ft intervals.

Insulation for the crawl space walls should be cut long enough to cascade down the walls and extend 2 ft along the ground on the crawl space floor. Furring strips should then be installed to hold the insulation in place by nailing it to the sill. By not driving the nails completely through the furring strips the insulation is compressed as little as possible. After the insulation has been installed, a 6-mil polyethylene vapor retarder should be spread across the entire floor. The vapor retarder should be placed under the crawl-space wall insulation (Fig. 8.20). Rocks or bricks can be set on top of the crawl-space wall insulation that extends out on the floor in order to hold it in place.

Basement walls. If fiberglass blanket insulation is to be used for masonry or concrete basement walls, there are two methods that

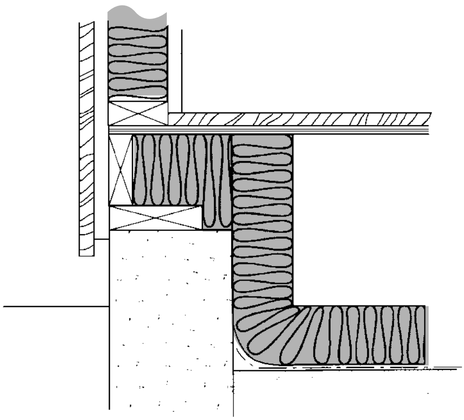

Figure 8.20 Heated crawl space walls. (*NAIMA*)

can be adopted. Installing furring strips directly to the masonry wall will allow the use of R-3 or R-6 batt insulation applied directly to the wall (Fig. 8.21). A separate frame wall also could be built, usually of 2 × 4" or 2 × 6" wood framing. The top plate is nailed to the underside of the joists or to blocking between joists. Batt insulation is then installed as in typical sidewall applications.

The framed wall can be very advantageous for installing thicker insulation or if additional electrical wiring is to be run, as is common in most basement renovation projects. It is important to note that the band joists need to be insulated separately. Insulation is then installed as described earlier under "Sidewalls."

It is important to note that the sealing of a basement may pose a threat of radon gas. If the home is in an area that is known to have soils containing radon, testing measures must be implemented. Venting measures and proper concrete slab construction will be mandatory if a significant concentration (greater than 4.0 pCi/liter) is discovered.

Slag Wool and Rock Wool

As discussed in Chap. 7, *mineral wool* refers to three types of insulation made from raw materials that are spun into loose-fill or batt products:

1. Glass wool, or fiberglass, made from recycled glass or silicates
2. Rock wool, made from virgin basalt, an igneous rock
3. Slag wool, made from steel-mill slag

Rock and slag wool fall within a group of materials referred to as *man-made vitreous fibers* (MMVFs), reflecting the glassy, noncrys-

Figure 8.21 R-3 masonry wall insulation between furring strips. (*CertainTeed*)

talline nature of these materials. The mineral wool form of MMVFs was developed initially in the late 1800s by melting slag and spinning it into insulation for use in homes and industry. Over the past century, mineral wool manufacturing has evolved into a large and diversified industry as more and more products have been developed.

Rock wool and slag wool each use different raw materials in their manufacture. Rock wool is made from natural minerals, primarily natural rock such as basalt or diabase. Slag wool is made primarily from iron ore blast furnace slag. Slag wool accounts for roughly 80 percent of the mineral wool industry, compared with 20 percent for rock wool.[9] Rock wool is predominantly used in blanket insulation products.

Rock and slag wool insulations are produced by a centrifugal wheel process. Natural rocks or iron ore blast furnace slag are melted, and the hot, viscous material is spun into fiber by pouring a stream of molten material onto one or several rapidly spinning wheels. As droplets of the molten material are thrown from the wheel(s), fibers are generated. As the material fiberizes, its surface generally is coated with a binder and/or dedusting agent (e.g., mineral oil) to suppress dust and maintain shape. The fiber is then collected and formed into batts or blankets or baled for use in other products, such as acoustical ceiling tile and spray-applied fireproofing, insulating, and acoustical materials.[13]

Product description

The mechanics of rock wool blanket insulation are similar to those of fiberglass blanket insulation. The batt insulation has an R-value of 3.6 per inch and is manufactured for standard joist and stud spacings. Unfaced batts are a good material for insulating around chimneys because the material does not support combustion. Small amounts of moisture have little effect on R-value.

Health considerations

An extensive discussion of the health effects of mineral wool insulation was presented in Chap. 7. In review, injection/implantation studies have determined the carcinogenic hazard of this fibrous material. Although not generally accepted for human health hazard assessment, the International Agency for Research on Cancer (IARC) has classified both rock and slag wool as a "2B, possibly carcinogenic to humans."

Mineral wool is a form of insulation that in the past has been shown to contain lead particles. The lead health hazard during installation came from lead particulate released into the air. Exposure levels were found to be higher than acceptable standards, especially with blown-in applications.[14]

Rock and slag wool fibers are a catalyst for skin irritation. This irritation is a mechanical reaction of the skin to the ends of rock and slag wool fibers that have rubbed against or become embedded in the skin's outer layer. Workers in contact with mineral wool during manufacturing processes or installation are susceptible to this temporary nuisance. It can be relieved by gently rinsing the exposed skin with warm water and then washing with mild soap.

Eye irritation occurs when rock wool fibers or slag wool are deposited in the eye by the user's fingers or through airborne mineral wool fibers. If this occurs, the eyes should not be rubbed but rinsed thoroughly with warm water. A doctor should be consulted if the irritation persists.

If sufficient amounts of rock and slag wool are released into the air during manufacture or handling, some workers may experience temporary upper respiratory tract irritation. Such exposures to high concentrations of airborne rock and slag wool fibers may result in temporary coughing or wheezing, a mechanical reaction. These effects will subside after the worker is removed from exposure. The use of approved respiratory protection can effectively control upper respiratory tract irritation by limiting exposure to airborne fibers.

Environmental considerations

Given the relative use of these two materials, mineral wool has, on average, 75 percent postindustrial recycled content. (*Postindustrial recycling* refers to the use of industrial by-products, as distinguished from material that has been in consumer use.)[16] According to the North American Insulation Manufacturers Association (NAIMA), over 938 million lb (425 million kg) of blast furnace slag was used in 1992 to produce slag wool.[9]

Fire resistance

Rock and slag wools have good fire resistance because of their physical and chemical properties. The fibers are noncombustible and have melting temperatures in excess of 2000°F, supplying fire protection as well as sound control and attenuation.[9] Mineral wool is also a good material for insulating around chimneys because it does not support combustion.

Availability

Mineral wool insulation products also appear to be extremely popular outside the United States. For example, a softer mineral wool batt product is now available from a Canadian manufacturer. In contrast to the stiff and brittle rock wool batts, this new product is highly compressible, which allows easier insertion between framing members and a friction-fit installation. At the present time, the soft mineral wool batt insulation is more fragile than fiberglass insulation and is about 15 percent higher in cost.[16]

Installation standards and practices

General work practices, applicable to all work involving synthetic vitreous fibers (SVFs) such as rock and slag wool, have been established by OSHA. These are listed in the fiberglass section of this chapter.

In all cases, however, manufacturers' specific recommendations as outlined in their Material Safety Data Sheets (MSDSs) should be consulted. The installation methods for rock wool batt insulation are similar to those for fiberglass batt insulation. Please refer to the preceding section for general installation guidelines and procedures.

Plastic Fiber Insulation

The recycled content and clean manufacturing process of plastic fiber insulation are expected to make this product quite popular when it enters the marketplace in the near future. Plastic fiber batts are made from recycled polyethylene terephthalate (PET), commonly used to make milk containers. Although the batts are difficult to cut with standard tools, the insulation does not cause skin irritation. The batt insulation is extremely soft yet looks like high-density fiberglass.

R-values vary depending on the density of the product. R-values range from 3.8 to 4.3 per inch. The material does not burn when exposed to an open flame, but it melts at a low temperature. Major U.S. insulation manufacturers are expected to produce plastic fiber insulation products within the next few years.[15]

Cotton

Cotton insulation, also known as *agricultural fiber,* is available in blanket form and is installed in the same manner as fiberglass batts. This material has been produced for years, but developmental and marketing strategy changes have not allowed this product to gain a significant foothold in the residential market. Cotton insulation was developed originally as Insulcot by a small West Texas company using virgin cotton. Promoted initially as a nonirritating alternative to fiberglass, early market research revealed a consumer interest in the use of recycled fiber, and the company switched to mill scraps from denim and T-shirt mills. The developer eventually licensed production of the insulation to Greenwood Mills, a large textile manufacturer.[9] This was discontinued in late 1997 due to the excessive cost of production.[17] Inno-Therm Products, LLC, has now purchased the equipment and technology for manufacturing batt insulation out of recycled cotton fabric from Greenwood Cotton Insulation Products. Inno-Therm expects to begin commercial production of the insulation in 2000. The company is planning to pursue both automotive and building insulation markets, focusing initially on commercial building applications.[18]

Product description

Cotton insulation is a batt insulation with kraft paper facing made from polyester fibers and ground-up denim scrap from blue jean and T-shirt factories. Cotton thermal insulation is 75 percent cotton and 25 percent polyester and is treated with a flame retardant and insect/rodent repellents. The polyester improves tear strength and recoil characteristics. It meets the same class I standards for fire resistance as fiberglass insulation. The batts come in widths of 15, 16, 23, and 24". R-values include R-11, R-13, R-19, and R-30.[19]

Cotton insulation does not irritate the skin during installation and is composed of approximately 95 percent postindustrial recycled fiber. According to one installer, the fibers are a lot tougher than glass fibers, making cutting with a knife a little difficult.[19]

Fire resistance

Although treated with borates as a fire retardant, a Habitat for Humanity environmental home insulated with Insulcot in Austin, Texas, burned in March 1994 when a plumber's torch ignited some exposed insulation. Fire retardants for cellulose insulation were reportedly used in Insulcot, but different chemicals were used in a later composition.[9]

Availability

New production of cotton insulation is scheduled to start in 2000.

Appendix

The Energy Efficiency and Renewable Energy Clearinghouse (EREC)
P.O. Box 3048
Merrifield, VA 22116
800-DOE-EREC
Fax: 703-893-0400

Cellulose Insulation Manufacturers Association (CIMA)
136 South Keowee Street
Dayton, OH 45402
937-222-2462
http://www.cellulose.org/

CertainTeed Corporation
750 E. Swedesford Road
Valley Forge, PA 19482
800-233-8990
800-782-8777
http://www.certainteed.com/pro/insulation/
http://www.cphome.com/

Johns Manville
P.O. Box 5108
Denver, CO 80217
800-654-3103
303-978-2000
http://www.jm.com/

Knauf Fiber Glass
Glenn Brower
One Knauf Dr.
Shelbyville, IN 46176
800-825-4434
317-398-4434
Fax: 317-398-3675
Email: *gab2@knauffiberglass.com*

North American Insulation Manufacturers Association (NAIMA)
Catherine L. Imus
44 Canal Center Plaza, Suite 310
Alexandria, VA 22314
703-684-0084
Fax: 703-684-0427
E-mail: *insulation@naima.org*
Website: *http://www.naima.org*

Owens Corning
Bill Edmunds
Fiberglas Tower
Toledo, OH 43659
800-438-7465
614-321-7731
Fax: 614-321-5606
http://www.owenscorning.com

Southface Energy Institute
241 Pine Street
Atlanta, Georgia 30308
404-872-3549
Fax: 404-872-5009
http://www.southface.org

Thermafiber Mineral Wool
James Shriver
3711 W. Mill Street
Wabash, IN 46992
219-563-2111
Fax: 219-563-8979
E-mail: *jshriver@thermafiber.com*

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