Temperatures Under Basement Floors

The temperature under basement floors [6] is influenced by the heat from the basement or protected from the influence of atmospheric conditions by the basement. In computing losses through basement floors the ground temperatures may be assumed the same as the approximate water temperature at depths of 30 to 60 ft given in Fig. 3, Chapter 37. Test results indicate that the heat losses through basement floors are frequently over-estimated [7].

BASEMENT TEMPERATURES AND HEAT LOSS

The allowance to be made for basement heat loss depends on whether the basement is to be heated or not.

If the basement is *heated* and a specified temperature is to be maintained, the heat loss should be estimated in the usual manner, based on the proper wall and floor coefficients (see Chapter 6) and the outside air and ground temperatures. Heat loss through windows and walls above grade should be based on outside temperatures and the proper air-to-air coefficients. Heat loss through basement walls below grade should be based on the floor and wall coefficients for surfaces in contact with the soil and on the proper ground temperature.

If a basement is completely below grade and is *not heated*, the temperature in the basement will normally range between that in the rooms above and the ground temperature. Basement windows will of course lower the basement temperature when it is colder outside and any heat given off by the heating plant will increase the basement temperature. In any case, the exact basement temperature is likely to be a somewhat indeterminate quantity, if the basement is not heated. Since the basement temperature will generally be lower than that of the rooms above, an allowance should theoretically be made for the loss from the rooms above through the floor over the basement.

The temperature in crawl spaces below floors will vary greatly depending on the number and size of wall vents, the quantity of heating pipes, and the type of insulation. It is therefore necessary to analyze the conditions and select an appropriate temperature by judgment.

TRANSMISSION HEAT LOSS

The basic formula for the loss of heat by transmission through any surface is given in Equation 3.

$$H_t = A\,U\,(t - t_o) \tag{3}$$

where

H_t = heat loss transmitted through the wall, roof, ceiling, floor, or glass, Btu per hour.

A = area of wall, glass, roof, ceiling, floor, or other exposed surfaces, square feet.

U = coefficient of transmission, air to air, Btu per (hour) (square foot) (Fahrenheit degree temperature difference) (Chapter 6).

t = inside temperature near surface involved which may not necessarily be the so-called breathing line temperature, Fahrenheit degrees.

t_o = outside temperature, or temperature of adjacent unheated space or of the ground, Fahrenheit degrees.

Example 3. Calculate the transmission loss through an 8 in. brick wall having an area of 150 sq ft if the inside temperature (t) is 70 F and the outside temperature (t_o) is −10 F.

Solution. The coefficient of transmission (U) of a plain 8 in. brick wall is 0.50 (Chapter 6, Table 7). The area (A) is 150 sq ft. Substituting in Equation 3:

$$H_t = 150 \times 0.50 \times [70 - (-10)] = 6000 \text{ Btu per hour.}$$

Transmission Loss Through Ceilings and Roofs

The transmission heat loss through top floor ceilings, attics, and roofs may be estimated by either of two methods:

1. By substituting in Equation 3 the ceiling area (A), the inside-outside temperature difference ($t - t_o$) and the proper value of (U):

   a. *Flat roofs.* Select the coefficient of transmission of the ceiling and roof from Tables 14 or 15, Chapter 6, or use appropriate coefficients in Equation 1 if side walls extend appreciably above the ceiling of the floor below.

   b. *Pitched roofs.* Select the combined roof and ceiling coefficient from Table 17, Chapter 6 or calculate the combined roof and ceiling coefficient by means of Equation 5, Chapter 6, where this formula is applicable as explained in Chapter 6.

2. By estimating the attic temperature (based on the inside and outside design temperatures) by means of Equation 1, and substituting for t_o in Equation 3, the value of t_a thus obtained, together with the ceiling area (A) and the ceiling coefficient (U). This applies to *pitched roofs*. In the case of *flat roofs* it is not necessary to calculate the attic temperatures as the ceiling-roof heat loss can be determined as per paragraph 1a.

INFILTRATION HEAT LOSS

The infiltration heat loss includes (1) the *sensible heat loss* or the heat required to warm the outside air entering by infiltration and (2) the *latent heat loss* or the heat equivalent of any moisture which must be added.

Sensible Heat Loss

The formula for the heat required to warm the outside air which enters a room by infiltration to the temperature of the room, is given in Equation 4.

$$H_s = 0.240\,Q\,d\,(t - t_o) \tag{4}$$

where

H_s = heat required to raise temperature of air leaking into building from t_o to t, Btu per hour.

0.240 = specific heat of air.

Q = volume of outside air entering building, cubic feet per hour (see Chapter 8).

d = density of air at temperature t_o, pounds per cubic foot.

It is sufficiently accurate to use $d = 0.075$ in which case Equation 4 reduces to

$$H_s = 0.018\,Q\,(t - t_o) \tag{4a}$$

The volume of outside air entering per hour (Q) depends on the wind velocity and direction, the width of crack or size of openings, the type of openings and other factors, as explained in Chapter 8. Where the crack method is used for estimating leakage, it is more convenient to express the air leakage heat loss in terms of the crack length:

$$H_s = B\,L\,(t - t_o) \tag{4b}$$