important, since houses with cold floors are not successfully heated. In this connection, it should be remembered that a well insulated floor does not assure comfort if down-drafts from windows or exposed walls create pools of chilly air over considerable areas of the floor. For this reason a floor of type (a) should not be used in a severe climate, except with a ceiling panel heating system or other system capable of warming the floor uniformly by radiation.

Data are meager, but the results of some experiments[7] indicate that the heat loss from a concrete slab floor on grade is more nearly proportional to

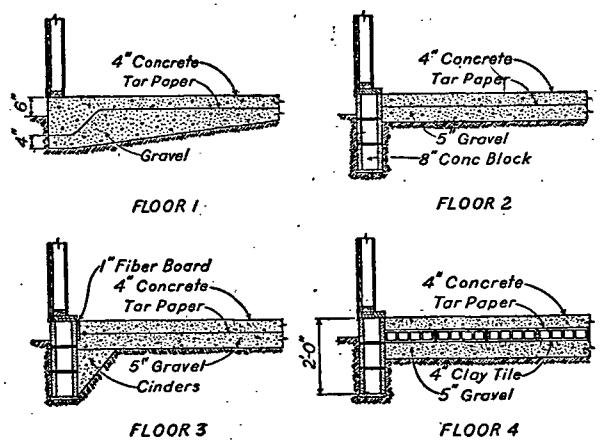


FIG. 2. VALUES OF F FOR VARIOUS FLOORS.

Floor	1	2	3	4
F	0.81	0.69	0.55	0.75

the perimeter than to the area of the floor, and that the heat loss can be estimated by means of the formula:

$$H_F = FP\,(t - t_o) \qquad (3)$$

where

H_F = heat loss of the floor, Btu per hour.
P = perimeter or exposed edge of the floor, linear feet.
F = heat loss coefficient, Btu per (hour) (linear foot of exposed edge) (degree difference in temperature between the inside air and the outside air). (See Fig 2.)
t = inside air temperature, Fahrenheit.
t_o = outside air temperature, Fahrenheit.

Values of coefficient F were determined[8] for four types of floors and are shown in Fig. 2.

Floors of type (b), consisting of concrete slabs placed on the ground, and containing heating pipes or ducts, are now in use in many small dwelling houses. The heat loss downward or through the ground from such floors is called the *reverse loss*. Authoritative data for computing or estimating

the magnitude of reverse losses are lacking; it is customary for designers to allow a percentage (often in the range from 10 to 20 per cent) of the house heat loss to cover the reverse heat loss from such a floor. The desirability of edge insulation is apparent, but standards of practice have not been established. An inch of fibrous waterproof material is the minimum thickness of edge insulation that is recommended, and greater thicknesses sometimes may be worthwhile.[8] Such a floor usually is placed above a cinder or gravel fill four or more inches thick, both to insulate the floor from the earth and to retard the rise of ground water by capillarity. Obviously, it is important that such floors be laid several inches above grade, and that effective sub-soil drainage be provided to avoid water soaked slabs from rain or melting snow, and consequent excessive heat loss.

TRANSMISSION HEAT LOSS

The basic formula for the loss of heat by transmission through any surface is given in Equation 4:

$$H_t = AU\,(t - t_o) \qquad (4)$$

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 surface, square feet.
U = coefficient of transmission, air to air, Btu per (hour) (square foot) (Fahrenheit degree temperature difference) (Chapter 9).
t = inside temperature near surface involved (this 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 9, Table 7). The area (A) is 150 sq ft. Substituting in Equation 4:

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

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 4 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 9, 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 9 or calculate the combined roof and ceiling coefficient by means of Equation 5, Chapter 9, where this formula is applicable as explained in Chapter 9.

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 4, the value of t_a thus obtained, together with the ceiling area (A) and the ceiling coefficient