

TABLE 6. SOLAR ABSORPTION COEFFICIENTS FOR DIFFERENT BUILDING MATERIALS

SURFACE MATERIAL	ABSORPTION COEFFICIENT (a)
Very Light Colored Surfaces..... White stone Very light colored cement White or light cream-colored paint	0.4
Medium Dark Surfaces..... Asbestos shingles Unpainted wood Brown stone Brick and red tile Dark-colored cement Stucco Red, green or gray paint	0.7
Very Dark Colored Surfaces..... Slate roofing Tar roofing materials Very dark paints	0.9

The calculation of heat transmission through walls and roofs does not take into consideration the heat capacity of the structure nor the consequent time lag in the transmission of heat. In the case of massive walls the time lag may amount to several hours⁴. Thus in many cases the wall transmission cannot be added directly to the cooling load from other sources because the peak of the wall transmission load may not coincide with the peak of the total cooling load and may even occur after the cooling system has been shut down for the day. The data in Table 7 were taken from A.S.H.V.E. research papers and whereas they result from a study of experimental slabs, they give an approximate idea of the time lag to be expected in various structures.

Solar Radiation Transmitted Through Glass

Windows present a problem somewhat different from that of opaque walls, because they permit a large percentage of the solar energy to pass through, a small amount is reflected and the balance is absorbed by the glass. The amount absorbed depends upon the character and thickness of the glass and the angle between it and the sun's rays. The temperature of the glass is raised by the absorbed heat and this heat is then delivered to the air on each side in proportion to the difference between the glass and air temperatures.⁵

TABLE 7. TIME LAG IN TRANSMISSION OF SOLAR RADIATION THROUGH WALLS AND ROOFS

TYPE AND THICKNESS OF WALL OR ROOF	TIME LAG, HOURS
2-in. pine.....	1½
6-in. concrete.....	3
4-in. gypsum.....	2½
3-in. concrete and 1-in. cork.....	2
2-in. iron and cork (equivalent to ¾-in. concrete and 2.15-in. cork).....	2½
4-in. iron and cork (equivalent to 5½-in. concrete and 1.94-in. cork).....	7¼
8-in. iron and cork (equivalent to 16-in. concrete and 1.53-in. cork).....	19
22-in. brick and tile wall.....	10

⁴Loc. Cit. Notes 1 and 2.

⁵Heat Absorbing Glass Windows, by W. W. Shaver (A.S.H.V.E. TRANSACTIONS, Vol. 41, 1935, p. 287).

The A.S.H.V.E. tests⁶ indicate that a single pane of double strength glass 0.127 in. thick absorbs approximately 11 per cent of the solar radiation passing through it when the impingement is normal. For smaller angles of impingement, the glass retards percentages of the total radiant energy approximately in proportion to the sine of the angle.

The amount of solar radiation delivered to an unshaded glass surface may be obtained from Tables 2, 3, 4 or 5. These values must be used only for the net glass area on which the sun shines and not the entire glass area. Tests at the A.S.H.V.E. Research Laboratory⁷ have determined the percentage of heat from solar radiation actually delivered to a room with various types of outdoor and indoor shading. The data in Table 8 are taken from these tests.

The percentage values in this table were obtained by dividing the total amount of heat actually entering through the shaded window by the total amount of heat calculated to enter through a bare window (solar radiation plus glass transmission, based on observed outside glass temperature). For bare windows on which the sun shines, the transmission of heat from outside air to glass may be small or negative as the glass temperature is raised by the solar radiation absorbed.

In calculating the total heat gain through windows on the sunny side of buildings, it is sufficiently accurate to proceed as follows:

Consider the total heat gain as that resulting from solar radiation and neglect the heat transmission through the glass caused by the difference between the temperatures of the inside and outside air. This method should be used except at times when the calculated heat gain per square foot due to normal transmission exceeds the solar intensity. At such times, solar radiation may be neglected and the total heat gain considered as resulting from normal transmission.

The solar heat transmission through windows or skylights may be expressed by the formula:

$$H_c = A_c f I \quad (3)$$

where

H_c = solar radiation transmitted through a window, Btu per hour.

A_c = net area of glass exposed to sun's rays, square feet.

f = percentage of solar radiation (expressed as a decimal) transmitted to the inside (Table 8). For bare windows, $f = 1$.

I = intensity of solar radiation striking surface, Btu per hour per square foot (Tables 2, 3, 4 and 5).

In Equation 3, $f = 1$ for bare windows because the tests from which Table 8 was obtained showed that approximately all of the solar radiation impinging on a bare window became a part of the heat load in the room. This was because almost all of the heat absorbed by the glass flowed into the room by conduction. Other tests⁸ have indicated that in the case of

⁶A.S.H.V.E. RESEARCH REPORT No. 974—Radiation of Energy Through Glass, by J. L. Blackshaw and F. C. Houghten (A.S.H.V.E. TRANSACTIONS, Vol. 40, 1934, p. 93). A.S.H.V.E. RESEARCH REPORT No. 975—Studies of Solar Radiation Through Bare and Shaded Windows by F. C. Houghten, Carl Gutberlet, and J. L. Blackshaw (A.S.H.V.E. TRANSACTIONS, Vol. 40, 1934, p. 101).

⁷Loc. Cit. Note 6.

⁸A.S.H.V.E. RESEARCH REPORT No. 1002—Cooling Requirements of Single Rooms in a Modern Office Building, by F. C. Houghten, Carl Gutberlet, and Albert J. Wahl (A.S.H.V.E. TRANSACTIONS, Vol. 41, 1935, p. 53).