TABLE 20. APPROXIMATE SOLAR DECLINATIONS IN DEGREES

DATE	DECLINATION	DATE	DECLINATION	DATE	DECLINATION
April 1	4.5	June 1	22.0	Aug. 1	18.0
April 15	10.0	June 15	23.5	Aug. 15	14.0
May 1	15.0	July 1	23.0	Sept. 1	8.5
May 15	19.0	July 15	21.5	Sept. 15	3.0

exposure walls. (Steady-state calculations as suggested there take no account of the time lag present with periodic cycles of air temperature.)

The results of experimental observations[13] on heat gains through glass-block sections are given in Table 21. Tabulated heat-gain rates are based upon a constant indoor-air temperature of 78 F and a maximum outdoor-air temperature of 95 F for the design day chosen. The values given are approximate, and intended for estimates only; they are *averages* for *four* representative glass block designs, two with smooth exterior faces and two with ribbed exterior faces.

Shading of Glass Areas—Design Tables

The effects and possibilities of shading should be carefully investigated whenever the heat gain from glass is a large portion of the cooling load.

Vertical glass which is not mounted in the plane of the building surface is partially shaded by the *setback*. If a vertical window of height l and width w be set back from the plane of the building a distance s, the fraction of the total area of the window which receives *direct* solar radiation is:

$$G_t = 1 - r_1 \tan \beta - r_2 \tan \gamma + r_1 r_2 \tan \beta \tan \gamma \qquad (11)$$

where

$r_1 = s/l$, $r_2 = s/w$, β = solar altitude, and γ is the difference between the azimuth angles of the wall in question and of the horizontal projection of the sun's rays. (γ is always equal to or less than 90 deg.)

Solar altitudes are given in Table 18 for various latitudes and an August

TABLE 21. TOTAL INSTANTANEOUS RATES OF HEAT GAIN FOR GLASS BLOCKS[12] ON DESIGN DAY OF AUGUST 1

(Values tabulated include solar and sky radiation, convection, and conduction averaged for four types of blocks)

MEAN SUN TIME	TOTAL INSTANTANEOUS RATE OF HEAT GAIN, BTU PER HOUR FOR EACH SQUARE FOOT OF SUNLIT GLASS BLOCK					
	Vertical Surface Facing					
	East	West	South			
North Latitude, Deg	30 to 45	30 to 45	30	35	40	45
7 a.m.	61	----	−4.5	−2.0	−0.5	1.0
8	78	----	0.0	2.0	4.0	5.0
9	74	5.0	5.0	7.0	10	12
10	58	6.5	11	15	18	21
11	45	7.5	17	22	26	32
12 noon	37	11	22	28	34	41
1 p.m.	30	22	25	32	39	46
2	24	35	26	32	39	47
3	20	55	24	30	37	45
4	16	77	20	26	32	41
5	13	86	15	20	25	34
6	11	65	9.5	14	18	26
7	8	19	3.5	7.0	11	18

TABLE 22. VALUES OF THE AZIMUTH-DIFFERENCE ANGLE, γ, DEGREES, FOR WINDOW-REVEAL SHADING CALCULATIONS (SEE EQUATION 11)

Computed for solar declination of 18 deg—August 1

N. LATITUDE DEGREES	MEAN SUN TIME	WINDOW ORIENTATION						
		NE	E	SE	S	SW	W	NW
30	6 a. m.	61	74	29	Shade	Shade	Shade	Shade
	7	54	81	36	----	----	----	----
	8	47	88	43	----	----	----	----
	9	39	84	51	6	----	----	----
	10	28	73	62	17	----	----	----
	11	7	52	83	38	----	----	----
	12 N	Shade	0	45	90	45	0	----
	1 p. m.	----	Shade	Shade	38	83	52	7
	2	----	----	----	17	62	73	28
	3	----	----	----	6	51	84	39
	4	----	----	----	Shade	43	88	47
	5	----	----	----	----	36	81	54
	6	----	----	----	----	29	74	61
40	6 a. m.	59	76	31	Shade	Shade	Shade	Shade
	7	50	85	40	----	----	----	----
	8	40	85	50	5	----	----	----
	9	27	74	61	16	----	----	----
	10	14	59	76	31	----	----	----
	11	Shade	35	80	55	----	----	----
	12 N	----	0	45	90	45	0	----
	1 p. m.	----	Shade	10	55	80	35	----
	2	----	----	Shade	31	76	59	14
	3	----	----	----	16	61	74	27
	4	----	----	----	5	50	85	40
	5	----	----	----	Shade	40	85	50
	6	----	----	----	----	31	76	59
50	6 a. m.	57	78	33	Shade	Shade	Shade	Shade
	7	45	90	45	0	----	----	----
	8	33	78	57	12	----	----	----
	9	20	65	70	25	----	----	----
	10	3	48	87	42	----	----	----
	11	Shade	26	71	65	19	----	----
	12 N	----	0	45	90	45	0	----
	1 p. m.	----	Shade	19	65	71	26	----
	2	----	----	Shade	42	87	48	3
	3	----	----	----	25	70	65	20
	4	----	----	----	12	57	78	33
	5	----	----	----	0	45	90	45
	6	----	----	----	Shade	33	78	57

1 design day. Values of the angle γ are given in Table 22 for the August 1 design day. Special cases not covered by the tabulated data may be solved analytically[14]; however, the design conditions chosen will yield a satisfactory approximation if used without correction for estimates at any time during the summer period.

Example 9. Estimate the instantaneous rate of sky and solar radiation heat gain from a west window 3 ft wide by 5 ft high with a setback of 6 in. for August 1 and a north latitude of 40 deg at 3 p. m. (sun time).

From Table 18, the instantaneous rate of sky and solar radiation heat gain per square foot of sunlit glass is 172 Btu per hour. From the same table, the solar altitude is 45.5 deg. From Table 22, the angle γ is 16 deg, from Equation 11, the fraction of the total window area that is receiving direct solar radiation is:

$$G_t = 1 - 0.1 \tan 45.5 - 0.167 \tan 16 + 0.0167 \tan 45.5 \tan 16$$
$$= 1 - 0.102 - 0.048 + 0.005 = 0.855.$$

Although the *sky* radiation is not reduced in proportion to the shaded portion, since the sky radiation is small this fact may be neglected, and hence instantaneous sky- and solar-radiation heat gain for this window is:

$$q = 3 \times 5 \times 0.855(172) = 2206 \text{ Btu per hour.}$$

A window such as the one in Example 9 above would customarily be provided with an additional shading means for use particularly when directly