Example 11. A one-story office building, Fig. 7 is located in an eastern state near 40 deg latitude. The adjoining buildings on the north and west are not conditioned and the air temperature within them is known to be substantially equal to the outdoor air temperature at any time of the day.

South wall construction: 8 in. concrete block, 4 in. brick veneer, ½ in. plaster on walls. (Table 8, Chapter 6, No. 92B, $U = 0.41$.)

East wall and outside north wall construction: 8 in. concrete block, ½ in. plaster on walls. (Table 7, Chapter 6, No. 82B, $U = 0.52$.)

West wall and adjoining north party wall construction: 13 in. solid brick, no plaster:

$$\frac{1}{U} = \frac{1}{1.65} + \frac{13}{5} + \frac{1}{1.65} \text{ or, } U = 0.263. \text{ Use } U = 0.26.$$

Roof construction: 2½ in. flat roof deck of 2 in. gypsum fiber concrete on gypsum board surfaced with built-up roofing. (Table 14, Chapter 6, No. 6A, $U = 0.38$.)

Floor construction: 4 in. concrete on ground.

Window: 3 ft x 5 ft, non-opening type, with Venetian blinds for those on south wall. Approximately 4 in. reveal on all windows.

Front doors: Two 2 ft-6 in. x 7 ft (glass panels).

Side doors: Two 2 ft-6 in. x 7 ft (½ glass panels).

Rear doors: Two 2 ft-6 in. x 7 ft (glass panels).

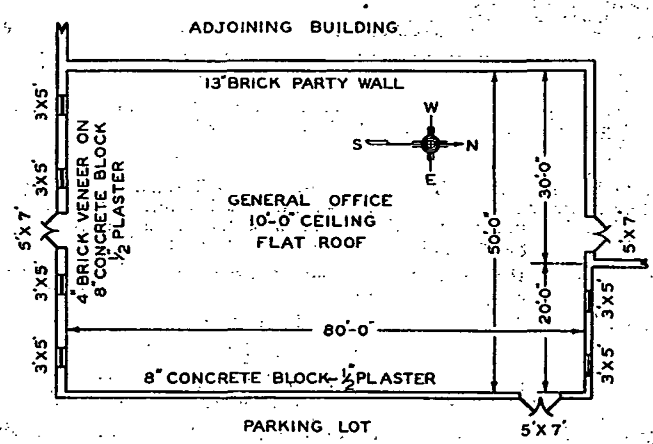

Fig. 7. Plan of One-Story Office Building

Outside design conditions: Sol-air temperature cycle corresponding to New York City, Table 10, this chapter; maximum dry-bulb 95 F, wet-bulb 78 F; $W_o = 0.0169$ lbs vapor per lb dry air; $h_o = 41.38$ Btu per lb dry air.

Indoor design conditions: Dry-bulb 80 F, wet-bulb 65 F; $W_i = 0.0098$ lbs vapor per lb dry air; $h_i = 29.95$ Btu per lb dry air.

Occupancy: 85 office workers.

Lights: 12,000 watts fluorescent, 4,000 watts tungsten.

Fan motor: 7½ hp.

Conditioning equipment to be located in adjoining structure to north.

Required: Total, sensible, and latent maximum cooling loads and required air quantity through conditioning equipment.

Solution. From Table 4 the recommended ventilation rate is 15 cfm per person.

Total necessary = 85 × 15 = 1275 cfm or 76,500 cu ft per hr.

Check: Room volume is 40,000 cu ft = 1.91 air changes per hr.

Estimated Time of Maximum Cooling Load.

For this job, judgment indicates that the greatest single contribution to the cooling load will be from the roof. Hence, the time of the maximum cooling load will be the time of the maximum heat gain through the roof. In some cases, there would be no clear-cut evidence of this nature and consequently it would be necessary to estimate the load for several successive times and then to select the maximum.

From Table 12, estimate the roof time lag as 2 hours. From Table 13, take the time of the maximum rate of heat entry as 1:00 p. m. The estimated time of maximum interior heat gain follows as 3:00 p. m. (This may be slightly different than 3:00 p. m. civil time.)

Heat Gain Through Outer Wall and Roof Areas.

The first step is to determine values of t_p using Tables 10 and 12 and Fig. 4 as follows:

t_m (24 hr average) is read directly from Table 10.

The time lag is approximated from Table 12 for exterior walls.

South wall: Estimate 4 in. common brick as 2.3 hr, 8 in. concrete block and ½ in. plaster (equivalent to 6 in. of solid concrete) as 3.8 hr, plus 1 hr for heavy construction = approximately 7 hrs.

East wall and exposed North wall: Estimate 8 in. concrete block and ½ in. plaster as 3.8, plus 1 hr = approximately 5 hrs.

The time of maximum rate of heat entry is entered in the next column as the time earlier than 3:00 p. m. by the amount of the time lag. t_e* is read from Table 10. Factor λ is read from Fig. 4, and t_p is calculated from Equation 10.

The tabulation of the values obtained is given in the following table.

Section	t_m F[a]	Time Lag Hr	Time of Max. Heat Entry	t_e* F	Factor λ	t_p F
Roof (light const.)	106.4	2	1 p. m.	154	0.91	150
South wall	90.7	7	8 a. m.	86	0.30	89
East wall	92.3	5	10 a. m.	114	0.35	100
Exposed north wall	88.5	5	10 a. m.	92	0.50	90

[a]For $(b/f_o) = 0.25$.

Next, for an indoor temperature $t_i = 80$ F, the rates of heat gain may be calculated and tabulated.

Section	Net Area Sq Ft	U Btu/(Hr) (Sq Ft) (F Deg)	$(t_p - t_i)$ F Deg	q Btu Per Hr
Roof	4000	0.38	70	106,400
South wall	405[a]	0.41	9	1,490
East wall	765[a]	0.52	20	7,950
Exposed north wall	170[a]	0.52	10	880
			Total	116,720

[a]Calculated from gross wall area less windows and doors.

Determine Heat Gain Through Party Wall and Inside Door Areas.

For the door, estimate $U = 0.59$, from Chapter 6, Table 9, No. 5A. Space temperature at 3:00 p. m. is, from Table 10, 94 deg F. Neglect the time lag for the door and take $(t_p - t_i) = 94 - 80 = 14$ F deg.

The party wall will be treated as if it were an outside wall in the shade, which corresponds to $(b/f_o) = 0$ in Table 10. From Table 12, time lag = 9.5 hr, λ = 0.23.

$$t_p = 84.8 + 0.23\,(76 - 84.8) = 82.8 \text{ F.}$$