Two-core concrete blocks + insulated cores + stucco

Description

- Concrete
  - Thermal conductivity – 9.1 Btu-in/h-ft^2-F
  - Density – 140 lb/ft^3
  - Specific Heat – 0.20 Btu/lb-F
- Mortar
  - Thermal conductivity – 5.0 Btu-in/h-ft^2-F
  - Density – 110 lb/ft^3
  - Specific Heat – 0.20 Btu/lb-F
- Foam inserts
  - Thermal conductivity – 0.24 Btu-in/h-ft^2-F
  - Density – 1.5 lb/ft^3
  - Specific Heat – 0.29 Btu/lb-F

Total thickness 11.625-in

COMPUTATION RESULTS

Three-dimensional model

Table 20.1
Resistance, transmittance and capacitance of the wall

	IP		*SI*	
R-value	2.29137	ft^2 °F h/Btu	0.40328	m^2 K/W
R^{-1}	0.43642	Btu/h ft^2 °F	2.47966	W/m^2 K
Capacitance	14.37337	Btu/ft^2 °F	293.70255	kJ/m^2 K

Table 20.2
Dimensionless 3D z-transfer function coefficients

n	b_n	c_n	d_n
0	0.04707	9.72126	1.00000
1	0.13063	-16.99955	-0.98904
2	0.01402	8.85120	0.23027
3	0.03217	-1.39633	-0.01356
4	0.00389	0.05121	0.00012

$\Sigma\, c_n = 0.22779$, $E_1 = 0.00000$

Table 20.3
3D response factors calculated with the help of the finite difference computer code HEATING 7.2 [Btu/h ft^2 °F]

n	X_n	Y_n
0	4.2425575E+00	2.0542305E-02
1	-3.2228838E+00	7.7328808E-02
2	-3.0166168E-01	7.7885015E-02
3	-1.0807977E-01	7.3543811E-02
4	-5.9281572E-02	5.7545132E-02
5	-3.7456527E-02	4.1026125E-02
6	-2.4822014E-02	2.8302765E-02
7	-1.6715279E-02	1.9313432E-02
8	-1.1317462E-02	1.3133046E-02
9	-7.6772945E-03	8.9209297E-03
10	-5.2117148E-03	6.0581984E-03
11	-3.5391289E-03	4.1141544E-03
12	-2.4037924E-03	2.7941991E-03
13	-1.6329080E-03	1.8979485E-03
14	-1.1093875E-03	1.2893319E-03
15	-7.5380719E-04	8.7599251E-04
16	-5.1225996E-04	5.9523732E-04
17	-3.4815438E-04	4.0451303E-04
18	-2.3664810E-04	2.7493244E-04
19	-1.6087271E-04	1.8688267E-04
20	-1.0937260E-04	1.2704578E-04
21	-7.4366979E-05	8.6377005E-05
22	-5.0570336E-05	5.8732896E-05
23	-3.4391758E-05	3.9940063E-05
24	-2.3391309E-05	2.7163070E-05
25	-1.5910913E-05	1.8475258E-05
26	-1.0823680E-05	1.2567316E-05
27	-7.3636475E-06	8.5493639E-06
28	-5.0101202E-06	5.8165194E-06
29	-3.4090972E-06	3.9575792E-06
30	-2.3198810E-06	2.6929735E-06
31	-1.5787965E-06	1.8326080E-06
32	-1.0745331E-06	1.2472144E-06
33	-7.3138454E-07	8.4887908E-07
34	-4.9785533E-07	5.7780696E-07
35	-3.3891528E-07	3.9332458E-07

Table 20.4
3D response factors ratio, dimensionless 3D response factors and transfer functions of the first order

n	X_n/X_{n-1}	Y_n/Y_{n-1}	$R*X_n$	$R*Y_n$	$R*X'_n$	$R*Y'_n$
0			9.72126	0.04707	9.72126	0.04707
1	-0.75966	3.76437	-7.38481	0.17719	-14.00241	0.14515
2	0.09360	1.00719	-0.69122	0.17846	4.33588	0.05784
3	0.35828	0.94426	-0.24765	0.16852	0.22289	0.04703
4	0.54850	0.78246	-0.13584	0.13186	0.03275	0.01714
5	0.63184	0.71294	-0.08583	0.09401	0.00664	0.00425
6	0.66269	0.68987	-0.05688	0.06485	0.00155	0.00086
7	0.67341	0.68239	-0.03830	0.04425	0.00042	0.00011
8	0.67707	0.68000	-0.02593	0.03009	0.00014	-0.00003
9	0.67836	0.67927	-0.01759	0.02044	0.00006	-0.00004
10	0.67885	0.67910	-0.01194	0.01388	0.00003	-0.00003
11	0.67907	0.67911	-0.00811	0.00943	0.00002	-0.00002
12	0.67920	0.67917	-0.00551	0.00640	0.00001	-0.00001
13	0.67930	0.67925	-0.00374	0.00435	0.00001	-0.00001
14	0.67939	0.67933	-0.00254	0.00295	0.00001	-0.00001
15	0.67948	0.67942	-0.00173	0.00201		
16	0.67956	0.67950	-0.00117	0.00136		
17	0.67964	0.67958	-0.00080	0.00093		
18	0.67972	0.67966	-0.00054	0.00063		
19	0.67980	0.67974	-0.00037	0.00043		
20	0.67987	0.67982	-0.00025	0.00029		
21	0.67994	0.67989	-0.00017	0.00020		
22	0.68001	0.67996	-0.00012	0.00013		
23	0.68008	0.68003	-0.00008	0.00009		
24	0.68014	0.68010	-0.00005	0.00006		
25	0.68021	0.68016	-0.00004	0.00004		
26	0.68027	0.68022	-0.00002	0.00003		
27	0.68033	0.68029	-0.00002	0.00002		
28	0.68039	0.68035	-0.00001	0.00001		
29	0.68044	0.68040	-0.00001	0.00001		
30	0.68050	0.68046	-0.00001	0.00001		
31	0.68055	0.68051				
32	0.68060	0.68057				
33	0.68065	0.68062				
34	0.68070	0.68067				
35	0.68075	0.68072				

$\alpha = 0.68074$, $\tau_1 = 2.60023$

Equivalent wall model: 3 layers plane wall

Table 20.5
Structure factors and time constants

Structure factors		*Time constants [h]*	
φ_{ii}	0.36160	$R \cdot C \cdot \varphi_{ii}$	11.909
φ_{ie}	0.11190	$R \cdot C \cdot \varphi_{ie}$	3.685
φ_{ee}	0.41461	$R \cdot C \cdot \varphi_{ee}$	13.655
		$R \cdot C$	32.935

Table 20.6a
Thermophysical properties of the equivalent wall - IP units

Layer n	R_n ft^2-°F-h/Btu	C_n Btu/ft^2-°F	l_n in	k_n Btu-in/h-ft^2-°F	ρ_n lb/ft^3	c_{pn} Btu/lb-°F
1	0.51232	5.77719	3.125	6.100	110.922	0.2
2	1.26007	1.80524	5	3.968	21.663	0.2
3	0.51898	6.79094	3.5	6.744	116.416	0.2

Table 20.6b
Thermophysical properties of the equivalent wall - SI units

Layer n	R_n m^2 K/W	C_n kJ/m^2 K	l_n m	k_n W/m K	ρ_n kg/m^3	c_{pn} kJ/kg K
1	0.09017	118.05	0.079	0.880	1774.75	0.838
2	0.22177	36.888	0.127	0.572	346.61	0.838
3	0.09134	138.765	0.089	0.973	1862.66	0.838

Table 20.7
Dimensionless z-transfer function coefficients and first time constants for the equivalent wall

n	b_n	c_n	d_n	τ_n
0	0.00130	8.63153	1.00000	
1	0.07879	-13.44316	-0.92170	1.773
2	0.16352	5.73563	0.20928	0.894
3	0.038154	-0.65277	-0.00490	0.269
4	0.00092	0.01148	0.00001	0.156
5		0.00002		0.119

$\Sigma\, c_n = 0.28269$, $\alpha = 0.56893$

Table 20.8
Response factors for the equivalent wall [Btu/h ft2 °F]

n	X_n	Y_n
0	3.766979E+00	5.653207E-04
1	-2.39484E+00	3.490873E-02
2	-4.925511E-01	1.034227E-01
3	-2.192224E-01	1.046731E-01
4	-1.057215E-01	7.540651E-02
5	-5.396266E-02	4.810279E-02
6	-2.868096E-02	2.906677E-02
7	-1.565761E-02	1.709211E-02
8	-8.692526E-03	9.905542E-03
9	-4.875022E-03	5.694775E-03
10	-2.750537E-03	3.259265E-03
11	-1.557345E-03	1.860607E-03
12	-8.835629E-04	1.060615E-03
13	-5.018813E-04	6.040871E-04
14	-2.852724E-04	3.439020E-04
15	-1.622137E-04	1.957273E-04
16	-9.225994E-05	1.113781E-04
17	-5.248005E-05	6.337374E-05
18	-2.985437E-05	3.605755E-05
19	-1.698399E-05	2.051495E-05
20	-9.662336E-06	1.167178E-05
21	-5.497065E-06	6.640485E-06
22	-3.127397E-06	3.777981E-06
23	-1.779250E-06	2.149407E-06
24	-1.012261E-06	1.222859E-06
25	-5.759016E-07	6.957191E-07
26	-3.276459E-07	3.95814E-07
27	-1.864065E-07	2.251894E-07
28	-1.060517E-07	1.281166E-07
29	-6.033573E-08	7.288900E-08
30	-3.432665E-08	4.146855E-08
31	-1.952937E-08	2.359259E-08
32	-1.111079E-08	1.342247E-08
33	-6.321231E-09	7.636414E-09
34	-3.596322E-09	4.344563E-09
35	-2.046046E-09	2.471743E-09

Frequency response for the three-dimensional model and equivalent wall; dimensionless amplitude and phase angle

Table 20.9a
3-D model

	Transmittance		*Admittance*	
period	amplitude	phase angle	amplitude	phase angle
48	0.94	-27°	1.94	51°
24	0.79	-50°	3.29	57°
12	0.50	-84°	5.63	55°
6	0.18	-118°	9.51	46°

Table 20.9b
Equivalent wall

	Transmittance		*Admittance*	
period	amplitude	phase angle	amplitude	phase angle
48	0.97	-27°	1.94	51°
24	0.88	-53°	3.33	58°
12	0.65	-98°	5.60	55°
6	0.32	-165°	8.38	48°