Two-core concrete blocks + empty cores + stucco

Description

12-in. two-core concrete block wall

- 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

Total thickness 11.625-in

COMPUTATION RESULTS

Three-dimensional model

Table 19.1
Resistance, transmittance and capacitance of the wall

	IP		*SI*	
R-value	1.35549	ft^2 °F h/Btu	0.23857	m^2 K/W
R^{-1}	0.73774	Btu/h ft^2 °F	4.19170	W/m^2 K
Capacitance	14.33041	Btu/ft^2 °F	292.82468	kJ/m^2 K

Table 19.2
Dimensionless 3D z-transfer function coefficients

n	b_n	c_n	d_n
0	0.19225	5.98628	1.00000
1	0.15877	-9.65447	-0.91110
2	-0.15272	4.39335	0.15573
3	0.03684	-0.48275	-0.00234

$\Sigma\, c_n = 0.24241$, $E_1 = -0.03000$

Table 19.3
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	4.4785061E+00	1.4186645E-01
1	-3.1608281E+00	2.4642917E-01
2	-2.6985386E-01	8.9590204E-02
3	-1.0921202E-01	7.0838145E-02
4	-6.4683766E-02	5.5665974E-02
5	-4.2571370E-02	4.0429260E-02
6	-2.8967610E-02	2.8452566E-02
7	-1.9933197E-02	1.9805490E-02
8	-1.3769648E-02	1.3735411E-02
9	-9.5250305E-03	9.5141659E-03
10	-6.5922935E-03	6.5878173E-03
11	-4.5635852E-03	4.5612097E-03
12	-3.1595880E-03	3.1581156E-03
13	-2.1877292E-03	2.1867509E-03
14	-1.5149212E-03	1.5142538E-03
15	-1.0491064E-03	1.0486468E-03
16	-7.2657558E-04	7.2625796E-04
17	-5.0323741E-04	5.0301766E-04
18	-3.4857418E-04	3.4842207E-04
19	-2.4146104E-04	2.4135573E-04
20	-1.6727379E-04	1.6720087E-04
21	-1.1588764E-04	1.1583714E-04
22	-8.0292360E-05	8.0257386E-05
23	-5.5633791E-05	5.5609568E-05
24	-3.8550491E-05	3.8533713E-05
25	-2.6714528E-05	2.6702906E-05
26	-1.8513604E-05	1.8505552E-05
27	-1.2830980E-05	1.2825401E-05
28	-8.8931087E-06	8.8892438E-06
29	-6.1641314E-06	6.1614533E-06
30	-4.2728165E-06	4.2709607E-06
31	-2.9619672E-06	2.9606812E-06
32	-2.0533808E-06	2.0524895E-06
33	-1.4235791E-06	1.4229614E-06
34	-9.8699781E-07	9.8656961E-07
35	-6.8434148E-07	6.8404465E-07

Table 19.8
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			6.07059	0.19230	6.07059	0.19230
1	-0.70578	1.73705	-4.28448	0.33403	-8.49130	0.20077
2	0.08537	0.36355	-0.36579	0.12144	2.60329	-0.11004
3	0.40471	0.79069	-0.14804	0.09602	0.10545	0.01187
4	0.59228	0.78582	-0.08768	0.07545	0.01491	0.00891
5	0.65815	0.72628	-0.05771	0.05480	0.00305	0.00251
6	0.68045	0.70376	-0.03927	0.03857	0.00072	0.00059
7	0.68812	0.69609	-0.02702	0.02685	0.00019	0.00012
8	0.69079	0.69352	-0.01866	0.01862	0.00006	0.00001
9	0.69174	0.69267	-0.01291	0.01290	0.00002	-0.00001
10	0.69210	0.69242	-0.00894	0.00893	0.00001	-0.00001
11	0.69226	0.69237	-0.00619	0.00618	0.00001	-0.00001
12	0.69235	0.69239	-0.00428	0.00428		
13	0.69241	0.69242	-0.00297	0.00296		
14	0.69246	0.69247	-0.00205	0.00205		
15	0.69252	0.69252	-0.00142	0.00142		
16	0.69257	0.69257	-0.00098	0.00098		
17	0.69262	0.69262	-0.00068	0.00068		
18	0.69266	0.69266	-0.00047	0.00047		
19	0.69271	0.69271	-0.00033	0.00033		
20	0.69276	0.69276	-0.00023	0.00023		
21	0.69280	0.69280	-0.00016	0.00016		
22	0.69285	0.69285	-0.00011	0.00011		
23	0.69289	0.69289	-0.00008	0.00008		
24	0.69293	0.69293	-0.00005	0.00005		
25	0.69298	0.69298	-0.00004	0.00004		
26	0.69302	0.69302	-0.00003	0.00003		
27	0.69306	0.69306	-0.00002	0.00002		
28	0.69310	0.69310	-0.00001	0.00001		
29	0.69314	0.69314	-0.00001	0.00001		
30	0.69317	0.69317	-0.00001	0.00001		
31	0.69321	0.69321				
32	0.69325	0.69325				
33	0.69329	0.69329				
34	0.69332	0.69332				
35	0.69336	0.69336				

$\alpha = 0.69298$, $\tau_1 = 2.72666$

Equivalent wall model: 3 layers plane wall

Table 19.5
Structure factors and time constants

Structure factors		*Time constants [h]*	
φ_{ii}	0.36786	$R \cdot C \cdot \varphi_{ii}$	7.146
φ_{ie}	0.12772	$R \cdot C \cdot \varphi_{ie}$	2.481
φ_{ee}	0.37670	$R \cdot C \cdot \varphi_{ee}$	7.317
		$R \cdot C$	19.423

Table 19.6a
Thermophysical properties of the equivalent wall - IP units

Layer	R_n	C_n	l_n	k_n	ρ_n	c_{pn}
n	ft^2-°F-h/Btu	Btu/ft^2-°F	in	Btu-in/h-ft^2-°F	lb/ft^3	Btu/lb-°F
1	0.32713	5.63623	3.125	9.553	108.22	0.2
2	0.67704	2.68637	5	7.385	64.47	0.1
3	0.35132	6.00782	3.5	9.962	102.99	0.2

Table 19.6b
Thermophysical properties of the equivalent wall - SI units

Layer	R_n	C_n	l_n	k_n	ρ_n	c_{pn}
N	m^2 K/W	kJ/m^2 K	m	W/m K	kg/m^3	kJ/kg K
1	0.05757	115.170	0.079	1.378	1731.45	0.838
2	0.11916	54.893	0.127	1.065	1031.57	0.419
3	0.06183	122.763	0.089	1.437	1647.86	0.838

Table 19.7
Dimensionless z-transfer function coefficients and first time constants for the equivalent wall

n	b_n	c_n	d_n	τ_n
0	0.01309	6.23165	1.00000	
1	0.23401	-7.91305	-0.61174	1.261
2	0.19904	2.27364	0.07290	0.534
3	0.01459	-0.13199	-0.00038	0.192
4	0.00005	0.00052		0.101

$\Sigma\, c_n = 0.46078$, $\alpha = 0.45251$

Table 19.8
Response factors for the equivalent wall [Btu/h ft^2 °F]

n	X_n	Y_n
0	4.597326E+00	9.656719E-03
1	-3.025393E+00	1.785478E-01
2	-5.085630E-01	2.553567E-01
3	-1.861483E-01	1.539633E-01
4	-7.757489E-02	7.567500E-02
5	-3.408017E-02	3.516702E-02
6	-1.526424E-02	1.605524E-02
7	-6.882978E-03	7.286900E-03
8	-3.110868E-03	3.300715E-03
9	-1.407113E-03	1.494105E-03
10	-6.366377E-04	6.761696E-04
11	-2.880684E-04	3.059823E-04
12	-1.303503E-04	1.384604E-04
13	-5.898388E-05	6.265433E-05
14	-2.669044E-05	2.835146E-05
15	-1.207756E-05	1.282918E-05
16	-5.465153E-06	5.805272E-06
17	-2.473011E-06	2.626914E-06
18	-1.119049E-06	1.188693E-06
19	-5.063756E-07	5.378893E-07
20	-2.291375E-07	2.433977E-07
21	-1.036859E-07	1.101387E-07
22	-4.691840E-08	4.983832E-08
23	-2.123081E-08	2.255209E-08
24	-9.607050E-09	1.020493E-08
25	-4.347239E-09	4.617784E-09
26	-1.967148E-09	2.089571E-09
27	-8.901442E-10	9.455414E-10
28	-4.027948E-10	4.278624E-10
29	-1.822667E-10	1.936098E-10
30	-8.247659E-11	8.760945E-11
31	-3.732109E-11	3.964371E-11
32	-1.688798E-11	1.793899E-11
33	-7.641897E-12	8.117480E-12
34	-3.457997E-12	3.673201E-12
35	-1.564761E-12	1.662142E-12

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

Table 19.9a
3-D model

	Transmittance		*Admittance*	
period	amplitude	phase angle	amplitude	phase angle
48	0.94	-18°	1.46	38°
24	0.81	-32°	2.21	47°
12	0.58	-46°	3.54	49°
6	0.38	-54°	5.78	43°

Table 19.9b
Equivalent wall

	Transmittance		*Admittance*	
period	amplitude	phase angle	amplitude	phase angle
48	0.98	-19°	1.43	40°
24	0.94	-37°	2.23	53°
12	0.80	-70°	3.77	55°
6	0.51	-123°	5.95	51°