

ICF wall: Polysteel 03 with finish

Description

- ¾-in concrete stucco
 - Thermal conductivity – 9.0 Btu-in/h-ft²-F
 - Density – 140 lb/ft³
 - Specific Heat – 0.20 Btu/lb-F
- Foam shells
 - Thermal conductivity – 0.26 Btu-in/h-ft²-F
 - Density – 1.5 lb/ft³
 - Specific Heat – 0.29 Btu/lb-F
- Concrete core
 - Thermal conductivity – 12.5 Btu-in/h-ft²-F
 - Density – 140 lb/ft³
 - Specific Heat – 0.20 Btu/lb-F
- Steel connectors
 - Thermal conductivity – 314 Btu-in/h-ft²-F
 - Density – 490 lb/ft³
 - Specific Heat – 0.12 Btu/lb-F

Total thickness 10 ¾-in

COMPUTATION RESULTS

Three-dimensional model

Table 7.1
Resistance, transmittance and capacitance of the wall

	<i>IP</i>		<i>SI</i>	
R-value	11.23044	ft ² °F h/Btu	1.97768	m ² K/W
R ⁻¹	0.08904	Btu/h ft ² °F	0.50564	W/m ² K
Capacitance	15.17577	Btu/ft ² °F	310.09846	kJ/m ² K

Table 7.2
Dimensionless 3D z-transfer function coefficients

<i>n</i>	<i>b_n</i>	<i>c_n</i>	<i>d_n</i>
0	0.00333	12.44518	1.0000
1	0.01647	-24.90756	-1.16082
2	0.00388	14.40928	0.18473
3	0.00022	-1.92311	
4		0.00012	

$$\Sigma c_n = 0.02391, E_1 = 0.00000$$

Table 7.3
3D response factors calculated with the help of the finite difference computer code
HEATING 7.2 [Btu/h ft² °F]

n	X_n	Y_n
0	1.1082968E+00	2.9661970E-04
1	-9.3157481E-01	1.8108235E-03
2	-3.0740358E-03	2.5078731E-03
3	-2.7195180E-03	2.5965690E-03
4	-2.5786520E-03	2.5508817E-03
5	-2.4847592E-03	2.4781231E-03
6	-2.4035890E-03	2.4016944E-03
7	-2.3273471E-03	2.3265318E-03
8	-2.2541361E-03	2.2535769E-03
9	-2.1834230E-03	2.1829337E-03
10	-2.1150070E-03	2.1145449E-03
11	-2.0487753E-03	2.0483305E-03
12	-1.9846430E-03	1.9842129E-03
13	-1.9225360E-03	1.9221195E-03
14	-1.8623858E-03	1.8619824E-03
15	-1.8041278E-03	1.8037371E-03
16	-1.7477004E-03	1.7473220E-03
17	-1.6930445E-03	1.6926779E-03
18	-1.6401031E-03	1.6397481E-03
19	-1.5888217E-03	1.5884777E-03
20	-1.5391472E-03	1.5388140E-03
21	-1.4910287E-03	1.4907059E-03
22	-1.4444169E-03	1.4441042E-03
23	-1.3992642E-03	1.3989613E-03
24	-1.3555246E-03	1.3552312E-03
25	-1.3131536E-03	1.3128693E-03
26	-1.2721080E-03	1.2718327E-03
27	-1.2323464E-03	1.2320796E-03
28	-1.1938282E-03	1.1935698E-03
29	-1.1565146E-03	1.1562643E-03
30	-1.1203677E-03	1.1201252E-03
31	-1.0853510E-03	1.0851161E-03
32	-1.0514291E-03	1.0512015E-03
33	-1.0185676E-03	1.0183471E-03
34	-9.8673337E-04	9.8651981E-04
35	-9.5589429E-04	9.5568741E-04
36	-9.2601919E-04	9.2581878E-04
37	-8.9707792E-04	8.9688377E-04
38	-8.6904126E-04	8.6885318E-04
39	-8.4188092E-04	8.4169871E-04
40	-8.1556949E-04	8.1539298E-04

Table 7.4
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			12.44666	0.00333	12.44666	0.00333
1	-0.84055	6.10487	-10.46199	0.02034	-22.51965	0.01711
2	0.00330	1.38494	-0.03452	0.02816	10.10050	0.00846
3	0.88467	1.03537	-0.03054	0.02916	0.00290	0.00188
4	0.94820	0.98240	-0.02896	0.02865	0.00063	0.00040
5	0.96359	0.97148	-0.02790	0.02783	0.00015	0.00008
6	0.96733	0.96916	-0.02699	0.02697	0.00004	0.00001
7	0.96828	0.96870	-0.02614	0.02613	0.00001	
8	0.96854	0.96864	-0.02531	0.02531	0.00001	
9	0.96863	0.96865	-0.02452	0.02452		
10	0.96867	0.96867	-0.02375	0.02375		
11	0.96868	0.96869	-0.02301	0.02300		
12	0.96870	0.96870	-0.02229	0.02228		
13	0.96871	0.96871	-0.02159	0.02159		
14	0.96871	0.96871	-0.02092	0.02091		
15	0.96872	0.96872	-0.02026	0.02026		
16	0.96872	0.96872	-0.01963	0.01962		
17	0.96873	0.96873	-0.01901	0.01901		
18	0.96873	0.96873	-0.01842	0.01842		
19	0.96873	0.96873	-0.01784	0.01784		
20	0.96874	0.96874	-0.01729	0.01728		
21	0.96874	0.96874	-0.01674	0.01674		
22	0.96874	0.96874	-0.01622	0.01622		
23	0.96874	0.96874	-0.01571	0.01571		
24	0.96874	0.96874	-0.01522	0.01522		
25	0.96874	0.96874	-0.01475	0.01474		
26	0.96874	0.96874	-0.01429	0.01428		
27	0.96874	0.96874	-0.01384	0.01384		
28	0.96874	0.96874	-0.01341	0.01340		
29	0.96874	0.96874	-0.01299	0.01299		
30	0.96874	0.96874	-0.01258	0.01258		
31	0.96875	0.96875	-0.01219	0.01219		
32	0.96875	0.96875	-0.01181	0.01181		
33	0.96875	0.96875	-0.01144	0.01144		
34	0.96875	0.96875	-0.01108	0.01108		
35	0.96875	0.96875	-0.01074	0.01073		
36	0.96875	0.96875	-0.01040	0.01040		
37	0.96875	0.96875	-0.01007	0.01007		
38	0.96875	0.96875	-0.00976	0.00976		
39	0.96875	0.96875	-0.00945	0.00945		
40	0.96875	0.96875	-0.00916	0.00916		

$\mathbf{a} = 0.96875$, $\mathbf{t}_1 = 31.49413$

Equivalent wall model: 3 layers plane wall

Table 7.5
Structure factors and time constants

Structure factors		Time constants [h]	
ϕ_{ii}	0.25109	R·C· ϕ_{ii}	42.793
ϕ_{ie}	0.18967	R·C· ϕ_{ie}	32.326
ϕ_{ee}	0.36957	R·C· ϕ_{ee}	62.986
		R·C	170.430

Table 7.6a
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	\mathbf{r}_n lb/ft ³	c_{pn} Btu/lb-°F
1	6.37766	5.05859	3.5	0.549	69.38	0.25
2	1.07764	6.32324	3.725	3.457	97	0.21
3	3.77514	3.79394	3.5	0.927	52.03	0.25

Table 7.6b
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	\mathbf{r}_n kg/m ³	c_{pn} kJ/kg K
1	1.12247	103.366	0.089	0.079	1110	1.048
2	0.18966	129.208	0.095	0.499	1552.01	0.880
3	0.66442	77.525	0.089	0.134	832.50	1.048

Table 7.7
Dimensionless z-transfer function coefficients and first time constants for the equivalent wall

n	b_n	c_n	d_n	t_n
0	0.00000	11.28589	1.00000	
1	0.00000	-39.41437	-2.90657	23.175
2	0.00000	54.99039	3.26624	3.333
3	0.00019	-39.35908	-1.80440	1.619
4	0.00075	15.49559	0.51760	0.916
5	0.00098	-3.36101	-0.07562	0.613
6	0.00036	0.38622	0.00526	0.385
7	0.00007	-0.02184	-0.00016	0.326

$$\Sigma c_n = 0.00179, \mathbf{a} = 0..=95777$$

Table 7.8
Response factors for the equivalent wall [Btu/h ft² °F]

n	X_n	Y_n
0	1.004937E+00	1.425692E-07
1	-5.886787E-01	1.971057E-07
2	-9.685069E-02	2.858019E-07
3	-5.010632E-02	1.716555E-05
4	-3.188904E-02	1.161155E-04
5	-2.236258E-02	3.687183E-04
6	-1.653618E-02	7.552091E-04
7	-1.264007E-02	1.197900E-03
8	-9.900400E-03	1.620366E-03
9	-7.916180E-03	1.978560E-03
10	-6.452702E-03	2.255751E-03
11	-5.357883E-03	2.452718E-03
12	-4.529425E-03	2.58035E-03
13	-3.895812E-03	2.649954E-03
14	-3.405427E-03	2.675024E-03
15	-3.021316E-03	2.665500E-03
16	-2.716093E-03	2.630963E-03
17	-2.470060E-03	2.578303E-03
18	-2.268635E-03	2.513024E-03
19	-2.101109E-03	2.439543E-03
20	-1.959090E-03	2.360736E-03
21	-1.837019E-03	2.279017E-03
22	-1.730310E-03	2.196046E-03
23	-1.635616E-03	2.113245E-03
24	-1.550532E-03	2.031554E-03
25	-1.473262E-03	1.950928E-03
26	-1.402164E-03	1.872669E-03
27	-1.336585E-03	1.796677E-03
28	-1.275223E-03	1.722917E-03
29	-1.217856E-03	1.651867E-03
30	-1.163739E-03	1.583287E-03
31	-1.112704E-03	1.517311E-03
32	-1.064183E-03	1.453916E-03
33	-1.018197E-03	1.392996E-03
34	-9.743906E-04	1.334546E-03
35	-9.326787E-04	1.278485E-03
36	-8.928181E-04	1.224664E-03
37	-8.548512E-04	1.173106E-03
38	-8.184446E-04	1.123647E-03
39	-7.837215E-04	1.076299E-03
40	-7.504839E-04	1.030894E-03

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

**Table 7.9a
3-D model**

period	<i>Transmittance</i>		<i>Admittance</i>	
	amplitude	phase angle	amplitude	phase angle
48	0.21	-99°	2.64	37°
24	0.14	-107°	3.72	50°
12	0.06	-96°	6.30	57°
6	0.03	-146°	11.61	51°

**Table 7.9b
Equivalent wall**

period	<i>Transmittance</i>		<i>Admittance</i>	
	amplitude	phase angle	amplitude	phase angle
48	0.28	-148°	3.14	34°
24	0.10	-222°	4.04	38°
12	0.02	-328°	5.50	42°
6	0.00	-120°	7.90	45°