Wood stud 3.5 24oc

Description

- ½-in. gypsum board
  - Thermal conductivity – 1.11 Btu-in/h-ft^2-F
  - Density – 50 lb/ft^3
  - Specific Heat – 0.26 Btu/lb-F
- 3.5-in. R-11 fiberglass batts
  - Thermal conductivity – 0.32 Btu-in/h-ft^2-F
  - Density – 5.3 lb/ft^3
  - Specific Heat – 0.23 Btu/lb-F
- 2x4 wood studs
  - Thermal conductivity – 1.0 Btu-in/h-ft^2-F
  - Density – 36 lb/ft^3
  - Specific Heat – 0.39 Btu/lb-F
- ½-in. plywood
  - Thermal conductivity – 0.8 Btu-in/h-ft^2-F
  - Density – 34 lb/ft^3
  - Specific Heat – 0.29 Btu/lb-F
- ½-in wood siding
  - Thermal conductivity – 0.5 Btu-in/h-ft^2-F
  - Density – 34 lb/ft^3
  - Specific Heat – 0.30 Btu/lb-F

COMPUTATION RESULTS

Three-dimensional model

Table 1.1
Resistance, transmittance and capacitance of the wall

	IP		*SI*	
R-value	11.39127	ft^2 °F h/Btu	2.00486	m^2 K/W
R^{-1}	0.08779	Btu/h ft^2 °F	0.49879	W/m^2 K
Capacitance	1.79330	Btu/ft^2 °F	36.64396	kJ/m^2 K

Table 1.2
Dimensionless 3D z-transfer function coefficients

n	b_n	c_n	d_n
0	0.19337	7.64880	1.00000
1	0.24476	-12.33863	-0.91447
2	-0.15501	5.81307	0.23694
3	0.01954	-0.84437	-0.01887
4	0.00097	0.02478	0.00004

$\Sigma\, c_n = 0.30364$, $E_1 = -0.00002$

Table 1.3
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	6.7146162E-01	1.6975601E-02
1	-4.6913515E-01	3.7010346E-02
2	-7.7794338E-02	1.6215108E-02
3	-2.1441836E-02	8.0947201E-03
4	-7.8795553E-03	4.3433504E-03
5	-3.5727479E-03	2.3582245E-03
6	-1.8013726E-03	1.2798800E-03
7	-9.4869935E-04	6.9348185E-04
8	-5.0793822E-04	3.7534109E-04
9	-2.7362013E-04	2.0303676E-04
10	-1.4773288E-04	1.0980310E-04
11	-7.9833819E-05	5.9376410E-05
12	-4.3156510E-05	3.2107040E-05
13	-2.3332883E-05	1.7361448E-05
14	-1.2616021E-05	9.3881222E-06
15	-6.8219021E-06	5.0768088E-06
16	-3.6890344E-06	2.7455106E-06
17	-1.9949965E-06	1.4848278E-06
18	-1.0789292E-06	8.0306334E-07
19	-5.8353223E-07	4.3435450E-07
20	-3.1561503E-07	2.3494144E-07

Table 1.4
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			7.64880	0.19337	7.64880	0.19337
1	-0.69868	2.18021	-5.34405	0.42159	-9.48116	0.31700
2	0.16583	0.43812	-0.88618	0.18471	2.00433	-0.04332
3	0.27562	0.49921	-0.24425	0.09221	0.23507	-0.00770
4	0.36749	0.53657	-0.08976	0.04948	0.04235	-0.00040
5	0.45342	0.54295	-0.04070	0.02686	0.00785	0.00010
6	0.50420	0.54273	-0.02052	0.01458	0.00149	0.00005
7	0.52665	0.54183	-0.01081	0.00790	0.00029	0.00001
8	0.53540	0.54124	-0.00579	0.00428	0.00006	
9	0.53869	0.54094	-0.00312	0.00231	0.00001	
10	0.53992	0.54080	-0.00168	0.00125		
11	0.54039	0.54075	-0.00091	0.00068		
12	0.54058	0.54074	-0.00049	0.00037		
13	0.54066	0.54074	-0.00027	0.00020		
14	0.54070	0.54075	-0.00014	0.00011		
15	0.54073	0.54077	-0.00008	0.00006		
16	0.54076	0.54079	-0.00004	0.00003		
17	0.54079	0.54082	-0.00002	0.00002		
18	0.54082	0.54085	-0.00001	0.00001		
19	0.54084	0.54087	-0.00001			
20	0.54087	0.54090				

$\alpha = 0.54088$, $\tau_1 = 1.62721$

Equivalent wall model: 3 layers plane wall

Table 1.5
Structure factors and time constants

Structure factors		*Time constants [h]*	
φ_{ii}	0.41451	$R \cdot C \cdot \varphi_{ii}$	8.468
φ_{ie}	0.07970	$R \cdot C \cdot \varphi_{ie}$	1.628
φ_{ee}	0.41346	$R \cdot C \cdot \varphi_{ee}$	8.446
		$R \cdot C$	20.428

Table 1.6a
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	0.58189	0.62500	0.75	1.289	40	0.25
2	9.64545	0.50626	3.25	0.337	7.48	0.25
3	1.16393	0.66204	1	0.859	31.78	0.25

Table 1.6b
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	0.10241	12.771	0.019	0.186	640	1.048
2	1.69760	10.345	0.083	0.049	119.63	1.048
3	0.20485	13.528	0.025	0.124	508.45	1.048

Table 1.7
Dimensionless z-transfer function coefficients and first time constants for the equivalent wall

n	b_n	c_n	d_n	τ_n
0	0.05080	9.12250	1.00000	
1	0.45323	-10.47223	-0.30686	0.769
2	0.19302	2.10285	0.00942	0.291
3	0.00547	-0.05063	-0.00002	0.163
4	0.00001	0.00005		0.100

$\Sigma\, c_n = 0.70254$, $\alpha = 0.27257$

Table 1.8
Response factors for the equivalent wall [Btu/h ft^2 °F]

n	X_n	Y_n
0	8.008323E-01	4.459567E-03
1	-6.735756E-01	4.115655E-02
2	-2.963588E-02	2.953197E-02
3	-7.178884E-03	9.155234E-03
4	-1.932449E-03	2.532557E-03
5	-5.259544E-04	6.914873E-04
6	-1.433335E-04	1.885153E-04
7	-3.906729E-05	5.138440E-05
8	-1.064845E-05	1.400577E-05
9	-2.902423E-06	3.817519E-06
10	-7.911066E-07	1.040532E-06
11	-2.156300E-07	2.836154E-07
12	-5.877376E-08	7.730438E-08
13	-1.601983E-08	2.107067E-08
14	-4.366485E-09	5.743183E-09
15	-1.190163E-09	1.565406E-09
16	-3.243998E-10	4.266789E-10
17	-8.842090E-11	1.162989E-10
18	-2.410067E-11	3.169931E-11
19	-6.569063E-12	8.640205E-12
20	-1.790514E-12	2.355040E-12

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

Table 1.9a
3-D model

	Transmittance		*Admittance*	
period	amplitude	phase angle	amplitude	phase angle
48	0.98	-12°	1.60	45°
24	0.92	-23°	2.63	55°
12	0.77	-41°	4.63	55°
6	0.52	-65°	7.76	43°

Table 1.9b
Equivalent wall

	Transmittance		*Admittance*	
period	amplitude	phase angle	amplitude	phase angle
48	0.99	-12°	1.54	48°
24	0.98	-24°	2.54	63°
12	0.91	-48°	4.68	70°
6	0.73	-90°	8.64	69°