- 2x6 steel stud wall + R-19 insulation + 1-in. EPS + brick (clear wall)

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
- 5.5-in. R-19 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
- 2x6 steel studs
  - Thermal conductivity – 314 Btu-in/h-ft^2-F
  - Density – 490 lb/ft^3
  - Specific Heat – 0.12 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
- 1-in EPS foam sheathing
  - Thermal conductivity – 0.26 Btu-in/h-ft^2-F
  - Density – 1.5 lb/ft^3
  - Specific Heat – 0.29 Btu/lb-F
- 3 ¼-in brick
  - Thermal conductivity – 6.0 Btu-in/h-ft^2-F
  - Density – 120 lb/ft^3
  - Specific Heat – 0.19 Btu/lb-F

COMPUTATION RESULTS

Three-dimensional model

Table 18.1
Resistance, transmittance and capacitance of the wall

	IP		*SI*	
R-value	15.46532	ft^2 °F h/Btu	2.72190	m^2 K/W
R^{-1}	0.06466	Btu/h ft^2 °F	0.36739	W/m^2 K
Capacitance	8.9465034	Btu/ft^2 °F	182.81099	kJ/m^2 K

Table 18.2
Dimensionless 3D z-transfer function coefficients

n	b_n	c_n	d_n
0	0.00820	8.28614	1.00000
1	0.14244	-14.88340	-0.97089
2	0.12483	8.59382	0.26764
3	0.00222	-1.82738	-0.01836
4		0.10926	
5		-0.00005	

$\Sigma\, c_n = 0.27839$, $E_1 = -0.00252$

Table 18.3
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	5.3578826E-01	5.2990783E-04
1	-4.4218234E-01	9.7245130E-03
2	-1.7022372E-02	1.7371260E-02
3	-6.5045367E-03	1.4416258E-02
4	-2.8142001E-03	9.5259634E-03
5	-1.3069845E-03	5.7319992E-03
6	-6.3558430E-04	3.2908692E-03
7	-3.1867970E-04	1.8412712E-03
8	-1.6314275E-04	1.0151197E-03
9	-8.4738372E-05	5.5488065E-04
10	-4.4472408E-05	3.0181470E-04
11	-2.3517095E-05	1.6371275E-04
12	-1.2505799E-05	8.8672219E-05
13	-6.6784210E-06	4.7994322E-05
14	-3.5779892E-06	2.5970855E-05
15	-1.9217510E-06	1.4053846E-05
16	-1.0343253E-06	7.6071312E-06
17	-5.5756021E-07	4.1185681E-06
18	-3.0091598E-07	2.2302986E-06
19	-1.6255746E-07	1.2079979E-06
20	-8.7880486E-08	6.5440779E-07
21	-4.7539454E-08	3.5458373E-07
22	-2.5730920E-08	1.9216880E-07
23	-1.3932198E-08	1.0415902E-07

Table 18.4
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			8.28614	0.00820	8.28614	0.00820
1	-0.82529	18.35133	-6.83849	0.15039	-11.32740	0.14595
2	0.03850	1.78634	-0.26326	0.26865	3.44141	0.18718
3	0.38212	0.82989	-0.10059	0.22295	0.04202	0.07741
4	0.43265	0.66078	-0.04352	0.14732	0.01097	0.02654
5	0.46442	0.60172	-0.02021	0.08865	0.00336	0.00884
6	0.48630	0.57412	-0.00983	0.05089	0.00112	0.00287
7	0.50140	0.55951	-0.00493	0.02848	0.00040	0.00090
8	0.51193	0.55131	-0.00252	0.01570	0.00015	0.00027
9	0.51941	0.54662	-0.00131	0.00858	0.00006	0.00008
10	0.52482	0.54393	-0.00069	0.00467	0.00002	0.00002
11	0.52880	0.54243	-0.00036	0.00253	0.00001	
12	0.53177	0.54163	-0.00019	0.00137		
13	0.53403	0.54126	-0.00010	0.00074		
14	0.53575	0.54112	-0.00006	0.00040		
15	0.53710	0.54114	-0.00003	0.00022		
16	0.53822	0.54128	-0.00002	0.00012		
17	0.53906	0.54141	-0.00001	0.00006		
18	0.53970	0.54152		0.00003		
19	0.54021	0.54163		0.00002		
20	0.54061	0.54173		0.00001		
21	0.54096	0.54184		0.00001		
22	0.54125	0.54196				
23	0.54146	0.54202				

$\alpha = 0.54174$, $\tau_1 = 1.63139$

Equivalent wall model: 3 layers plane wall

Table 18.5
Structure factors and time constants

Structure factors		*Time constants [h]*	
φ_{ii}	0.05843	$R \cdot C \cdot \varphi_{ii}$	8.084
φ_{ie}	0.02320	$R \cdot C \cdot \varphi_{ie}$	3.211
φ_{ee}	0.89517	$R \cdot C \cdot \varphi_{ee}$	123.856
		$R \cdot C$	138.361

Table 18.6a
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	0.71865	0.35938	0.75	1.044	25	0.23
2	14.36364	0.57248	6.5	0.453	4.60	0.23
3	0.38302	8.01465	3.5	9.138	119.47	0.23

Table 18.6b
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	0.12648	7.34339	0.019	0.151	400	0.964
2	2.52800	11.69784	0.165	0.065	73.52	0.964
3	0.06741	163.7698	0.089	1.318	1911.57	0.964

Table 18.7
Dimensionless z-transfer function coefficients and first time constants for the equivalent wall

n	b_n	c_n	d_n	τ_n
0	0.00180	8.14548	1.00000	
1	0.10472	-13.13315	-0.80824	1.363
2	0.20211	6.23314	0.16289	0.856
3	0.04256	-0.90428	-0.00259	0.243
4	0.00088	0.01088		0.140
5		0.00001		0.119

$\Sigma\, c_n = 0.35207$, $\alpha = 0.48023$

Table 18.8
Response factors for the equivalent wall [Btu/h ft^2 °F]

n	X_n	Y_n
0	5.266936E-01	1.162516E-04
1	-4.235048E-01	6.865054E-03
2	-2.504850E-02	1.859844E-02
3	-8.369247E-03	1.666608E-02
4	-3.076634E-03	1.051528E-02
5	-1.187640E-03	5.832233E-03
6	-4.803097E-04	3.044022E-03
7	-2.026802E-04	1.537416E-03
8	-8.863788E-05	7.618029E-04
9	-3.986423E-05	3.731409E-04
10	-1.830417E-05	1.814621E-04
11	-8.529211E-06	8.784857E-05
12	-4.014867E-06	4.240665E-05
13	-1.902850E-06	2.043303E-05
14	-9.059712E-07	9.833711E-06
15	-4.326396E-07	4.729018E-06
16	-2.070097E-07	2.273059E-06
17	-9.917706E-08	1.092226E-06
18	-4.755470E-08	5.247167E-07
19	-2.281446E-08	2.520459E-07
20	-1.094913E-08	1.21059E-07
21	-5.255901E-09	5.814205E-08
22	-2.523359E-09	2.792339E-08
23	-1.211580E-09	1.341021E-08

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

Table 18.9a
3-D model

	Transmittance		*Admittance*	
period	amplitude	phase angle	amplitude	phase angle
48	0.97	-24°	1.52	44°
24	0.89	-47°	2.46	56°
12	0.66	-86°	4.43	59°
6	0.32	-143°	7.95	50°

Table 18.9b
Equivalent wall

	Transmittance		*Admittance*	
period	amplitude	phase angle	amplitude	phase angle
48	0.98	-24°	1.49	45°
24	0.92	-47°	2.40	60°
12	0.73	-89°	4.29	66°
6	0.40	-156°	7.60	67°