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

Description

2x6 steel stud wall + 1-in. EPS + ¾-in. stucco

- 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
- ¾-in concrete stucco
  - Thermal conductivity – 9.0 Btu-in/h-ft^2-F
  - Density – 140 lb/ft^3
  - Specific Heat – 0.20 Btu/lb-F

COMPUTATION RESULTS

Three-dimensional model

Table 17.1
Resistance, transmittance and capacitance of the wall

	IP		*SI*	
R-value	15.15703	ft^2 °F h/Btu	2.66764	m^2 K/W
R^{-1}	0.06598	Btu/h ft^2 °F	0.37486	W/m^2 K
Capacitance	2.94890	Btu/ft^2 °F	60.25728	kJ/m^2 K

Table 17.2
Dimensionless 3D z-transfer function coefficients

n	b_n	c_n	d_n
0	0.10508	8.12097	1.0000
1	0.34909	-11.41045	-0.57984
2	0.01933	4.10657	0.05862
3		-0.33939	
4		0.00108	

$\Sigma\, c_n = 0.47878$, $E_1 = 0.01103$

Table 17.3
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	5.3578866E-01	6.9326573E-03
1	-4.4214330E-01	2.7051529E-02
2	-1.6845501E-02	1.6554407E-02
3	-6.2408997E-03	8.0131694E-03
4	-2.5600723E-03	3.8488624E-03
5	-1.1065362E-03	1.8499743E-03
6	-4.9406328E-04	8.9112201E-04
7	-2.2537779E-04	4.3024371E-04
8	-1.0436181E-04	2.0816392E-04
9	-4.8858443E-05	1.0089676E-04
10	-2.3065815E-05	4.8977908E-05
11	-1.0960790E-05	2.3804728E-05
12	-5.2356972E-06	1.1581495E-05
13	-2.5114486E-06	5.6392547E-06
14	-1.2087870E-06	2.7477080E-06
15	-5.8343489E-07	1.3395888E-06
16	-2.8231214E-07	6.5354384E-07
17	-1.3685604E-07	3.1895693E-07
18	-6.6449037E-08	1.5572260E-07
19	-3.2304156E-08	7.6047390E-08
20	-1.5720315E-08	3.7144677E-08

Table 17.4
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			8.12097	0.10508	8.12097	0.10508
1	-0.82522	3.90204	-6.70158	0.41002	-10.66086	0.35879
2	0.03810	0.61196	-0.25533	0.25092	3.01195	0.05101
3	0.37048	0.48405	-0.09459	0.12146	0.02989	-0.00088
4	0.41021	0.48032	-0.03880	0.05834	0.00731	-0.00088
5	0.43223	0.48065	-0.01677	0.02804	0.00215	-0.00040
6	0.44650	0.48169	-0.00749	0.01351	0.00069	-0.00016
7	0.45617	0.48281	-0.00342	0.00652	0.00023	-0.00006
8	0.46305	0.48383	-0.00158	0.00316	0.00008	-0.00002
9	0.46816	0.48470	-0.00074	0.00153	0.00003	-0.00001
10	0.47209	0.48543	-0.00035	0.00074	0.00001	
11	0.47520	0.48603	-0.00017	0.00036		
12	0.47768	0.48652	-0.00008	0.00018		
13	0.47968	0.48692	-0.00004	0.00009		
14	0.48131	0.48725	-0.00002	0.00004		
15	0.48266	0.48753	-0.00001	0.00002		
16	0.48388	0.48787		0.00001		
17	0.48477	0.48804				
18	0.48554	0.48822				
19	0.48615	0.48835				
20	0.48663	0.48844				

$\alpha = 0.48754$, $\tau_1 = 1.39201$

Equivalent wall model: 3 layers plane wall

Table 17.5
Structure factors and time constants

Structure factors		*Time constants [h]*	
φ_{ii}	0.17519	$R \cdot C \cdot \varphi_{ii}$	7.831
φ_{ie}	0.04097	$R \cdot C \cdot \varphi_{ie}$	1.831
φ_{ee}	0.74286	$R \cdot C \cdot \varphi_{ee}$	33.203
		$R \cdot C$	44.697

Table 17.6a
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	0.72493	0.37500	0.75	1.035	25	0.24
2	14.12191	0.51478	5	0.354	5.37	0.23
3	0.31019	2.05912	2.5	8.060	49.42	0.20

Table 17.6b
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	0.12759	7.66267	0.019	0.149	400	1.006
2	2.48546	10.51892	0.127	0.051	85.95	0.964
3	0.05459	42.07569	0.064	1.163	790.70	0.838

Table 17.7
Dimensionless z-transfer function coefficients and first time constants for the equivalent wall

n	b_n	c_n	d_n	τ_n
0	0.03050	8.09338	1.00000	
1	0.39018	-9.43437	-0.35233	0.869
2	0.22796	2.05695	0.01151	0.283
3	0.01045	-0.05707	-0.00006	0.199
4	0.00003	0.00024		0.113

$\Sigma\, c_n = 0.65912$, $\alpha = 0.31658$

Table 17.8
Response factors for the equivalent wall [Btu/h ft^2 °F]

n	X_n	Y_n
0	5.339686E-01	2.012217E-03
1	-4.343080E-01	2.645128E-02
2	-2.345955E-02	2.433641E-02
3	-6.996925E-03	8.959815E-03
4	-2.206407E-03	2.880127E-03
5	-6.982797E-04	9.131097E-04
6	-2.210562E-04	2.891124E-04
7	-6.998220E-05	9.152885E-05
8	-2.215509E-05	2.897641E-05
9	-7.013900E-06	9.173406E-06
10	-2.220474E-06	2.904135E-06
11	-7.029618E-07	9.193963E-07
12	-2.225449E-07	2.910642E-07
13	-7.045370E-08	9.214566E-08
14	-2.230437E-08	2.917164E-08
15	-7.061157E-09	9.235213E-09
16	-2.235435E-09	2.923702E-09
17	-7.076980E-10	9.255908E-10
18	-2.240444E-10	2.930253E-10
19	-7.092840E-11	9.276650E-11
20	-2.245464E-11	2.936819E-11

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

Table 17.9a
3-D model

	Transmittance		*Admittance*	
period	amplitude	phase angle	amplitude	phase angle
48	0.98	-14°	1.49	43°
24	0.93	-27°	2.40	56°
12	0.79	-50°	4.33	59°
6	0.51	-83°	7.79	50°

Table 17.9b
Equivalent wall

	Transmittance		*Admittance*	
period	amplitude	phase angle	amplitude	phase angle
48	0.99	-14°	1.46	44°
24	0.97	-27°	2.34	60°
12	0.89	-53°	4.21	67°
6	0.69	-99°	7.57	68°