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APPENDIX D
DERIVATION OF FOUNDATION DESIGN

D-100. CONDITIONS AFFECTING DESIGN. Values for the Foundation Design Load Tables have been derived based on major foundation design factors, foundation design criteria, and design assumptions.

D-100.1 MAJOR FOUNDATION DESIGN FACTORS determine the appropriateness of foundations for manufactured homes:

A. Soil and site conditions.

1. Soil types
2. Bearing capacities
3. Drainage
4. Slopes

B. Load Conditions and Combinations. Various combinations of (1) through (5) with appropriate factors:

1. Dead loads
2. Occupancy live loads
3. Wind loads
4. Snow loads / Minimum roof live loads
5. Seismic loads

C. Foundation Design and Capacity.

1. Footing depth
2. Footing size
3. Reinforcing
4. Materials

D. Connection Compatibility with Manufactured Home. Adequate capacity plus a safety factor is required to transfer forces from the manufactured house to the foundation without failure.

D-100.2 CRITERIA FOR FOUNDATION DESIGN for manufactured homes must meet the following:

A. Assumptions made in foundation system design must be compatible with the design of the housing unit and actual site conditions.

B. Stress Limitations. The design must sustain all loads within stress limitations of connection systems.

C. Acceptable Foundation Design must provide for the Permanent Foundation criteria as specified in Section 100-1.C.

D-100.3 DESIGN ASSUMPTIONS

A. Values Included In Appendix B & C. The foundation tables in Appendices B & C are based on a number of design assumptions:

1. Building width is discussed in terms of minimum chassis beam spacing in Chapter 1: 100-1.A.5 and again in Chapter 6: 600-2.A.1. for comparison of nominal and range of actual width, and then is illustrated in Figure 6-1. It is clear that many actual widths are possible. The following actual widths and projections (dc) were used in the Tables of Appendix B:

Wt (nominal)	Wt (actual)	dc
12’	11’-8”(11.67’)	32.25”(2.69’)

14’	13’-8”(13.67’)	41”(3.42’)
16’	15’-6”(15.5’)	45.25”(3.77’)

2. The Overturning (Av) and Sliding (Ah) Tables in Appendix B assume hn=8.0 feet and assume a chassis beam depth of 10” (0.833 ft).

3. The manufactured home is located on a flat, open site with no protection from the wind.

4. Wind force on the manufactured home, instead of seismic force, is the controlling factor for the foundation overturning anchorage design in the transverse direction. Seismic forces or wind force may control sliding anchorage in the transverse or longitudinal direction.

5. Uplift, overturning, and sliding caused by wind or seismic forces acting on the manufactured home are transferred to the foundation by the structural integrity of the manufactured home.

Marriage Wall Connection Options

*Figure D - SEQ Figure_D_- * ARABIC*

6. The manufactured home unit, single or multi-width, is assumed to be a box with flexible floor and roof diaphragms. End walls and selected interior shear walls were assumed to transfer lateral forces based on tributary area methodology. The unit’s shear wall locations must closely coincide with the foundation shear walls or vertical X-bracing planes. A structural engineer shall design the system if deviations from these assumptions exist.

7. Multi-section units are assumed to be connected at the marriage wall to act as a single box for overturning consideration, and do not act separately as illustrated in Figure D-1. This is particularly necessary in high seismic locations.

B. List of Variables. These variables are used throughout Appendix D.

<u>Aa</u> Seismic coefficient representing effective peak acceleration

Ah Required horizontal anchorage (lbs. or lbs./LF)

Av Required vertical anchorage (lbs. or lbs./LF)

<u>Av</u> Seismic coefficient representing effective peak velocity related acceleration

Ce Exposure factor (See ASCE 7-93)

Ct Thermal factor (See ASCE 7-93)

Cp External wall or roof pressure coefficient (See ASCE 7-93)

Cs Roof slope factor (See ASCE 7-93)

Cs Seismic design coefficient (See ASCE 7-93)

dc Distance from perimeter of structure to chassis beam line.

DL Total dead load of structure for each foot of length

Fr Force resisting sliding

Fsl Sliding force (lbs.)

GCpi Internal wall or ceiling pressure coefficient (See ASCE 7-93)

Gh Gust response factor (See ASCE 7-93)

hn Height of the exterior wall acted on by lateral wind pressure

I Importance factor (See ASCE 7-93)

Kz Velocity pressure exposure coefficient (See ASCE 7-93)

LL Live load

Mo Overturning moment of structure

Mr Moment resisting overturning

p Design wind pressure

Pf Design roof snow load (See ASCE 7-93)

Pg Ground snow load (See ASCE 7-93)

Sp or Spacing: Spacing of foundation elements in the longitudinal direction.

V Basic wind speed (See ASCE 7-93)

Wt Width of structure (or 1/2 the total width of a multi-section unit)

D-200. LOAD CONDITIONS INCLUDED IN FOUNDATION DESIGN. The following load conditions have been used as assumptions in design of the foundation systems in this handbook. This information is important for engineers who may be designing connection details or modifying foundations designs. All Design Loads are based on ASCE 7-93, except as noted otherwise.

D-200.1 DEAD LOAD DESIGN FACTORS. Dead loads consist of the material weight of the manufactured home without furnishings or occupants. Dead load includes the weight of the roof, floor, walls, and chassis, and may include permanent attachments such as cabinets and attached appliances.

A. Dead Load Categories. Dead loads were grouped into two categories: heavy and light. The heaviest combinations of dead loads were used for the computation of footing areas, and the determination of inertia forces for the computation of sliding and overturning due to seismic activity. Heavier loads generate the largest inertia forces and produce the largest footings. The lightest combinations of dead loads were used for the computation of horizontal and vertical anchorage due to wind. Lighter loads offer less resistance to overturning and sliding and thus require greater anchorage. The following dead loads in Table D-1 have been included in the calculations for the

Foundation Design Load Tables on the next page.

B. Dead Load Equations for use in computing the required vertical and horizontal anchorage to resist overturning and sliding are listed below by type. The equations are for the total Dead Load per foot of Manufactured Home length. Figure D-2 illustrates the individual component loads and the total dead load situated at the geometric centroid of the unit.

$DL = (34.5)2 + (26.25)2 +$

$2(6 + 8.6)Wt + 9 \times 4$

(ext. walls) + (marriage wall) + (floor + roof) + (chassis beams)

$\boxed{DL = 157.5 + (29.2)Wt}$

Heaviest combination of loads:

SINGLE-SECTION TYPES C, E, & I

$DL = (44.25)2 + (13 + 9.7)Wt + 9 \times 2$

(walls) + (floor + roof) + (chassis beams)

Dead Load Components and Total

Lightest combination of loads:

SINGLE-SECTION TYPES C, E, & I

$DL = (34.5)2 + (6 + 8.6)Wt + 9 \times 2$

(walls)+(floor+roof)+(chassis beams)

$\boxed{DL = 87 + (14.6)Wt}$

MULTI-SECTION TYPES C, E, & I

$\boxed{DL = 106.5 + (22.7)Wt}$

MULTI-SECTION TYPES C, E, & I

$DL = (44.25)2 + (26.25)2 +$

$2(13 + 9.7)Wt + 9 \times 4$

(ext. walls) + (marriage wall) + (floor + roof) + (chassis beams)

$\boxed{DL = 177 + (45.4)Wt}$

*Figure D - SEQ Figure_D_- * ARABIC*

TABLE D-1
DEAD LOAD ON FOUNDATION

LOCATION	ITEM	HEAVY (psf)	LIGHT (psf)	HEAVY (plf of length)	LIGHT (plf of length)
EXTERIOR	7/16" siding	1.4			
WALL	.019 aluminum		0.1		
	2 x 4 studs @ 16"o.c.	1.5	1.5		
	3 1/2" fiberglass insulation	1.0	1.0		
	1/2" gypsum	2.0	2.0		
	SUM =	**5.9**	**4.6**		
TOTAL	**7'-6" WALL**			**44.25**	**34.5**
FLOOR	carpet & pad	1.0			
	1/16" vinyl		0.7		
	5/8" plywood	1.7	1.7		
	2 x 10 joist @ 16"o.c.	2.6			
	2 x 6 joist @ 16"o.c.		1.4		
	11" fiberglass insulation	2.2			
	5 1/2" fiberglass insulation		1.2		
	mechanical	2.0	1.0		
	misc. partitions	3.5	0.0		
	SUM =	**13.0 ***	**6.0 ***	**13 × Wt + 9**	**6 × Wt + 9**
	* plus 9 plf for each manufactured home beam				
ROOF	asphalt shingles with felt	2.5			
	3/8" plywood	1.1			
	20 ga. steel		2.5		
	2 x 3 truss	1.5	1.5		
	9 1/2" fiberglass insulation	2.6	2.6		
	1/2" gypsum ceiling	2.0	2.0		
	SUM =	**9.7**	**8.6**	**9.7 × Wt**	**8.6 × Wt**
MARRIAGE	2x4 studs @ 16"	1.5	1.5		
WALL	1/2" gypsum (one side)	2.0	2.0		

	SUM =	**3.5**	**3.5**		
TOTAL	**7'-6" WALL**			**26.25**	**26.25**

D-200.2 LIVE LOAD DESIGN FACTORS

A. Description. Design live loads consist of the weight of all moving and variable loads (from use and occupancy) that may act on the manufactured home including loads on floors, operational loads on roofs and ceilings, or snow loads, but do not include wind, earthquake or dead loads. All live loads are assumed to be uniformly distributed and roof live loads are horizontally projected on sloped surfaces. The design live loads specified herein for the floor and attic are the minimums recommended by the ASCE standard. The design live loads specified herein for the roof are the minimum recommended by the *Minimum Property Standard*, HUD Handbook 4910.1, 1994 Edition. The roof live load used for the design of the foundation system should be the greater of the appropriate value indicated in the Data Plate shown here or as obtained from the ASCE 7-93 for snow load.

Minimum Uniformly Distributed Live Loads (used for Foundation Design Load Tables)	
Location	Live Load
	(psf)
Roof (slope 3/12 or less, ≤14°)	20*
Roof (slope over 3/12, >14°) (Over the entire width of the unit. Compare with snow load value. Use the larger value.)	15*
Dwelling rooms	40
(Floor design live loads over the entire area of the unit.)	
Attics	10
(uninhabitable, without storage)	
* Due to snow load factors, the 30 psf ground snow load used on the Foundation Design Load Tables is equivalent to a 20 psf roof live load. The 20 psf ground snow load is equivalent to a 15 psf roof live load.	

Snow Load Distribution

*Figure D - SEQ Figure_D_- * ARABIC*

B. Design Assumptions. The following values for live loads were used in the engineering calculations and are included in the tables. They are provided here as background information only. The field inspector will not need to calculate live loads under normal circumstances. See box of live loads.

D-200.3 SNOW LOAD DESIGN FACTORS

A. Ground Snow Load. The ground snow load values (Pg) to be used in the design of the manufactured home are found in Appendix H. The ground snow load is converted to a roof snow load to account for wind and thermal factors (see Figure D-3). The value (Pg) modified by snow load design factors has been included in the derived values for the Foundation Design Load Tables. The following assumptions were made to find Pf, the horizontally projected uniformly distributed design roof snow load:

B. Design Assumptions.

Basic Snow Load Equation:

$$Pf = 0.7 \times Ce \times Ct \times I \times Pg$$

Where:

1. Ground snow load (Pg) from the Ground Snow Load maps on pages H-11, H-12 and H-13.

2. Importance factor I = 1.0 (residential buildings)

3. Exposure factor Ce = 1.0 (locations where snow removal cannot be relied on to reduce snow loads)

4. Thermal factor Ct = 1.0 (heated structures)

5. Slope factor Cs = 1.0 (4/12 slope or less)

6. Flat roof factor = 0.7 (contiguous U.S.; Use 0.6 in Alaska.)

Therefore, the Required Effective Footing Area Tables are based on:

$$Pf = 0.7 \times Pg \text{ (Roof snow load)}$$

C. Drifted Snow. At locations where the manufactured home is adjacent to a higher structure, drifted snow loads MUST be calculated in accordance with ASCE 7-93. An average value including the drifted load may be used with the Foundation Design Load Tables.

D-200.4 WIND LOAD DESIGN FACTORS.

A. Model for Analysis. The methodology for resistance of the box to uplift, overturning and sliding utilizes equations for Main Wind-Force Resisting Systems as defined in ASCE 7-93.

B. Basic Wind Speed. The basic wind speed map is found on page H-14. Wind factors have been included in the derived values for the Foundation Design Load Tables of Appendix B.

C. Design Assumptions.

1. To convert mile per hour (MPH) wind speed to a basic wind velocity pressure (q) in pounds per square feet (psf) use the following equation from ASCE 7-93:

$$q = 0.00256 \times Kz \times (V \text{ x } I)^2$$

where:

a. Mean roof height is assumed to be less than or equal to 15 feet from grade.

b. Basic Wind Speed (V) is from the isobar map on page H-14 for the unit's geographic location.

c. Velocity Pressure Coefficient (Kz) is based on Exposure C: open terrain with scattered obstructions having heights generally less than 30 feet. This Category includes flat open country and grasslands. For these conditions, including item (a) above, Kz = 0.8.

d. Importance Category I (residential) for inland sites, sets I = 1.0, while for coastal sites (hurricane oceanline) I = 1.05. Linear interpolation can be utilized for sites between the oceanline and 100 miles inland; however, this was not done for the tables of Appendix B. Thus, only the above two values have been included.

2. Velocity pressure (q) is applied to surfaces, i.e. walls and roof planes, to generate design wind pressures (p) for Main Wind-Force Resisting Systems. Design wind pressures (p) are based on external and internal effects utilizing the following equation from ASCE 7-93:

$$p = q \times Gh \times Cp - q \times (\pm GCpi)$$

(external) - (internal)

where:

Exterior (Cp) Coeffic

a. The Gust Response Factor (Gh) is assumed to be based on Exposure C (see section D-200.4.C.1.c). The Minimum Property Standard (MPS) permits use of Exposure C regardless of whether the site is inland or coastal. Thus, for units of assumed mean height less than or equal to 15 feet, Gh = 1.32.

b. External Roof and Wall Pressure Coefficients (Cp) vary on the windward roof surface based on the structural issue being

*Figure D - SEQ Figure_D_- * ARABIC*

analyzed. Figure D-4 illustrates the various (Cp) values for the transverse and longitudinal directions. A roof slope of 10 to 15 degrees (2 in 12 to 3 in 12) produces 2 possible situations: (+0.2) pressure and (-0.9) suction. The value (-0.9) was selected to produce maximum suction for uplift and overturning while (+0.2) was selected to maximize sliding. Note that (+) means pressure on the external surface, while (-) means suction on the external surface. For the leeward wall in the longitudinal direction the proportions of the unit (L/Wt) are important to establishing the proper exterior (Cp) value. Single-section units, regardless of the combination of width or length, has a ratio L/Wt $\geq$ 4.0; therefore, Cp = -0.2. For multi-section units An average proportion of unit (28' x 70', or 32' x 80') was assumed. Thus, the L/Wt ratio was 2.5 and by interpolation Cp = -0.275. Single or multi-section units have a Wt/L ratio, which is $\leq$ 1.0 for all proportions of units. Thus, the leeward value for Cp = -0.5 in the transverse direction.

c. Internal Roof and Wall Pressure Coefficients assume a uniform distribution of openings on all surfaces, thus GCpi = ±0.25. Figure D-5 illustrates the pressures and suctions used for various structural considerations. Note that the walls receive offsetting values that cancel any internal effect; therefore, only the roof (GCpi) values are utilized for the calculation of overturning and sliding in the transverse direction. Internal roof

Pressures are not utilized in the longitudinal direction.

Interior (GCpi) Coefficients

*Figure D - SEQ Figure_D_- * ARABIC*

d. Wind pressures and suctions are typically treated as uniformly distributed and typically applied perpendicular to the orientation of any planar surface. This usually requires the calculation of horizontal and vertical components when wind is applied to sloping surfaces, in this case only roof planes. Figure D-6 illustrates that by the use of trigonometry the resultant force (P) on any sloping surface has components (P_V) and (P_H), which can be arrived at as shown. Note that for the vertical components (P_V) it is possible to merely multiply the pressure (p) by the horizontal length of the slope (Wt/2) for single section units or by (Wt) for multi-section units. This approach simplifies the sample calculations provided in section D-300 for uplift, overturning and sliding in the transverse direction.

D-200.5 SEISMIC LOAD FACTORS.

A. Seismic Versus Wind Forces. It has been stated in Chapters 4 and 6 that seismic forces did not control over wind forces in the computations for consideration of overturning in the transverse direction; however, seismic forces did sometimes control over wind for certain situations of sliding in the transverse and longitudinal direction. This is particularly true in the longitudinal direction because only the end wall elevations are exposed to the wind, producing small applied horizontal forces. Seismic inertia forces are a function of mass that is the same in both directions, which may be larger than the wind forces in particular when the geographic region is also a high snow region.

Seismic Dead Load Dist

B. Dead Loads. The model assumes use of the “heavy” dead load values for roof, floor and wall components from Table D-1. It is assumed that the weight of the exterior walls and the weight of the marriage wall (for multi-section units only) are distributed half to the roof plane and half to the floor plane. The marriage wall was assumed continuous, without any large openings to maximize the dead load. This distribution of the dead load is illustrated in Figure D-7 to arrive at inertia forces (Fxr) and (Fxf). The weight of the end walls was included in the total mass of the unit and distributed to the roof and floor as shown in Figure D-7 and defined by the equations below:

1. Areas at each end of a Single-Section unit:

$$A_r = \frac{Wt'a}{2} + \frac{hn}{2}'Wt$$

$$A_f = Wt'\frac{hn}{2}$$

Roof Plane - Wind Components - Transverse Direction

*Figure D - SEQ Figure_D_- * ARABIC*

2. Areas at each end of a Multi-Section unit:

$$A_r = Wt'a + 2'Wt'\frac{hn}{2}$$

$$A_f = 2'Wt'\frac{hn}{2}$$

3. These areas are multiplied by the heavy wall weight of 5.9 psf resulting in total roof and floor load additions respectively for Single or Multi-Section units as follows:

$$W_{endroof} = 2'5.9'A_r$$

$$W_{endfloor} = 2'5.9'A_f$$

The above loads are in pounds and are smeared into the unit's dead load for overturning by using an average length of 60 feet, while for sliding they are smeared into the unit's dead load by dividing by "L". See Section D-200.5.E.7.a for further clarification.

C. Snow Loads. When the flat roof snow load (Pf) is less than 30 psf, the snow load to be attributed to the mass at the roof plane shall be zero. Where siting and snow duration and conditions warrant, and roof snow load is equal to or exceeds 30 psf , the snow load shall be added to the mass of the roof plane. The local authority may permit a reduction in snow load by as much as 80%. See Figure D-7. Note that roof snow load (Pf) has been previously defined as 70% of the ground snow load (Pg) in section D-200.3B.

D. Miscellaneous Loads. No consideration of partial occupancy live load was included in the mass of the floor plane; however, mechanical and partition load was included in the floor plane.

E. Seismic Analysis Method. The Equivalent Lateral Force Procedure (ELF) was assumed for manufactured housing units, as defined by ASCE 7-93. No plan or elevation irregularities were assumed, Thus, the manufactured home superstructure was assumed to be a simple rectangular box with proportions of length to width not exceeding 5 to 1.

1. The Fundamental Period (T): the manufactured home is assumed to have the same period in either direction, transverse or longitudinal, determined from the following equation:

   $T = Ct \times h^{3/4}$

where:

   a. Ct = 0.02 for the category of: all other buildings.

   b. the height from bottom of footing to the mean roof height (h) has been assumed as 13.5 feet.

   c. Thus: T = 0.14 seconds.

2. Site Coefficient (S): the site has been selected for the most significant soil classification, thus S = 2.0.

3. The Response Modification Coefficient (R): the structure has been selected as a bearing wall system with light frame walls with shear panels. Thus, R = 6.5.

4. Effective peak velocity-related acceleration coefficient (Av): is selected for the geographic location

based on the map H-16 in Appendix H.

5. The Seismic Design Coefficient (Cs) is determined by the following equation:

$$\underline{Cs} = \frac{1.2´Av´S}{R´T^{2/3}}$$

Insertion of all the above values in the equation for (Cs) leads to the results tabulated below:

Av	Cs
0.15	0.204
0.2	0.273
0.3	0.409
0.4	0.546

6. But (Cs) need not exceed the following equation:

$$\underline{Cs} = \frac{2.5´Aa}{R}$$

where:

a. Effective peak acceleration coefficient (Aa): selected for the geographic location based on map H-15 in Appendix H.

b. The results are tabulated below:

Aa	Cs
0.15	0.058
0.2	0.077
0.3	0.115
0.4	0.154

c. The values for (Cs) are definitely smaller in item (6.b) above rather than in item (5.a), thus Cs is based on the equation in item (6). Thus, for this Manual assuming Aa = Av:

$$\underline{Cs} = \frac{2.5´Aa}{R}$$

7. The basic equation for base shear (V_B), using the (ELF) method, is:

$$V_B = \underline{Cs} \times W$$

where:

a. The total weight (W) is the summation of the roof plane mass and the floor plane mass, including snow as applicable, as a function of unit length. It is advantageous to keep the roof and floor loads separated for calculation ease and kept in units of lbs/ft of unit length as follows:

For a Single-Section Unit:

$$w_{roof} = 9.7´Wt + 44.25 + \frac{W_{endroof}}{L} + \%P_f´Wt$$

$$w_{floor} = 13.0´Wt + 44.25 + 18 + \frac{W_{endfloor}}{L}$$

For a Multi-Section Unit:

$$Wt + 44.25 + 26.25 + \frac{W_{endroof}}{L} + 2´\%P_f´Wt$$

$$w_{floor} = 26.0´Wt + 36 + 44.25 + 26.25 + \frac{W_{endfloor}}{L}$$

Note: For overturning calculations, where (L) does not enter the equations, use L=60 ft as an average length to smear the end wall load. For Sliding

(L) is always required and the end wall weight is smearing over the real length (L).

Where for either the Single or Multi-Section unit, the total dead load per foot of length of the unit becomes:

$$W = w_{roof} + w_{floor}$$

b. The seismic coefficient (<u>Cs</u>) is based on equation in item (6.b).

8. The base shear (V_B) is then distributed vertically as inertia forces (F_{xr} and F_{xf}) to the floor and roof levels according to the mass that exists at each level (see Figure D-7), based on the following generic equation:

$$F_x = C_{vx} \times V_B$$

where also generically:

$$C_{vx} = \frac{w_x{}' h_x}{\sum_{i=1}^{n} \left(w_i{}' h_i\right)}$$

a. The weight and height at each respective level is subscripted with an (x) while the sum of the product of each level's weight and height are generically subscripted with an (I). The uppermost level of the building (n) is in this case the roof. For a one story manufactured home, there will only be two levels, w_{roof} and w_{floor} reducing to two expressions substituting Single or Multi-Section unit values as follows:

$$C_{roof} = \frac{w_{roof}{}' h_r}{w_{roof}{}' h_r + w_{floor}{}' h_f}$$

$$C_{floor} = \frac{w_{floor}{}' h_f}{w_{roof}{}' h_r + w_{floor}{}' h_f}$$

Thus, the inertia forces in lbs/ft of unit length at the two respective levels becomes:

$$F_{xr} = C_{roof}{}' V_B \qquad \text{and,}$$

$$F_{xf} = C_{floor}{}' V_B$$

b. Sample spreadsheet output for two cases (snow Pg = 0 psf and snow Pg = 100 psf) indicates the range of (F_{xr}) and (F_{xf}) values at the roof and floor levels respectively for a single section unit. These examples include the 12, 14 and 16 nominal width units and are labeled as Tables D-2 and D-3. Note: nominal , rather than actual unit width (Wt) were used in the dead load calculations for conservatism.

9. The forces (F_{xr} and F_{xf}) were applied to the manufactured home unit as illustrated in Figure D-7 and used for transverse and longitudinal overturning and sliding calculations for comparison to the wind forces. The forces that produced the largest required resistance values were used in the Foundation Design Load Tables - Appendix B. Values that are grayed in the Tables of Appendix B are controlled by seismic inertia forces.

D-300. SAMPLE EQUATIONS USED FOR FOUNDATION DESIGN LOAD TABLE VALUES.

D-300.1 REQUIRED EFFECTIVE FOOTING AREA. Refer to Figures D-8(A&B) and D-9(A&B) for the free-body diagrams illustrating the applied gravity loads on the superstructure and on the foundation for a Type **C** and Type **E** or **I** single-section unit, and a Type **C** multi-section unit with consideration of a continuous marriage wall and a marriage wall with a large opening. Note that the "heavy" dead loads are used from Table D-1. For allowable stress design methodology, the load combination from ASCE 7-93 is: DL(heavy) + LL(occupancy) + LL(attic) + SL(or min. roof LL).

Seismic

Smax=	2		R=	6.5			hn=	11.0 ft
Exposure Group I				Ct=	0.02			
Seismic Performance A to D					Assume no plan or elevation irregularities			
Equivalent Lateral Force Procedure								
Period:	Ta=Ct(hn)^3/4=			0.120802				
	Tmax=Ta*Ca			Ca=	1.5	(1.5 max for Av=.15)		
			Tmax=	0.181203				
Cs max=2.5*Aa/R			Aa	Cs max				
		0.15	0.057692					
		0.20	0.076923					
		0.30	0.115385					

Gravity Loads

Figure D -8A

		0.40	0.153846					
Snow Load: Pg=			0 psf		Pf=	0 psf		
		Wt						
DL	12.0	14.0	16.0					
roof	160.65	180.05	199.45					
floor	218.25	244.25	270.25					
total	378.90	424.30	469.70					

Width 12 ft

				Vbase=	21.86	29.15	43.72	58.29
					Fx=Cvx*Vbase			
					Aa			
	w	h	w*h	Cvx	0.15	0.2	0.3	0.4
roof	160.65	11.0	1767.15	0.729654	15.95	21.27	31.90	42.53
floor	218.25	3.0	654.75	0.270346	5.91	7.88	11.82	15.76
sum	378.90		2421.90	1.0	21.86	29.15	43.72	58.29

Width 14 ft

				Vbase=	24.48	32.64	48.96	65.28
					Fx=Cvx*Vbase			
					Aa			
	w	h	w*h	Cvx	0.15	0.2	0.3	0.4
roof	180.05	11.0	1980.55	0.729941	17.87	23.82	35.74	47.65
floor	244.25	3.0	732.75	0.270059	6.61	8.81	13.22	17.63
sum	424.30		2713.30	1.0	24.48	32.64	48.96	65.28

Width 16 ft

				Vbase=	27.10	36.13	54.20	72.26
					Fx=Cvx*Vbase			
					Aa			
	w	h	w*h	Cvx	0.15	0.2	0.3	0.4
roof	199.45	11.0	2193.95	0.730173	19.79	26.38	39.57	52.76
floor	270.25	3.0	810.75	0.269827	7.31	9.75	14.62	19.50
sum	469.70		3004.70	1.0	27.10	36.13	54.20	72.26

Seismic Forces - Ground Snow < 30 psf

Table D - 2

Seismic

Smax=	2	R=	6.5		hn=	11.0 ft
Exposure Group I			Ct=	0.02		
Seismic Performance A to D				Assume no plan or elevation irregularities		
Equivalent Lateral Force Procedure						
Period:	Ta=Ct(hn)^3/4=		0.120802			
	Tmax=Ta*Ca		Ca=	1.5	(1.5 max for Av=.15)	
		Tmax=	0.181203			

Cs max=2.5*Aa/R

Aa	Cs max
0.15	0.057692
0.20	0.076923
0.30	0.115385
0.40	0.153846

Snow Load: Pg= 100 psf   Pf= 70 psf

	Wt		
DL	12.0	14.0	16.0
roof	1000.65	1160.05	1319.45
floor	218.25	244.25	270.25
total	1218.90	1404.30	1589.70

Width 12 ft

				Vbase=	70.32	93.76	140.64	187.52
					Fx=Cvx*Vbase			
					Aa			
	w	h	w*h	Cvx	0.15	0.2	0.3	0.4
roof	1000.65	11.0	11007.15	0.943856	66.37	88.50	132.75	176.99
floor	218.25	3.0	654.75	0.056144	3.95	5.26	7.90	10.53
sum	1218.90		11661.90	1.0	70.32	93.76	140.64	187.52

Width 14 ft

				Vbase=	81.02	108.02	162.03	216.05
					Fx=Cvx*Vbase			
					Aa			
	w	h	w*h	Cvx	0.15	0.2	0.3	0.4
roof	1160.05	11.0	12760.55	0.945695	76.62	102.16	153.24	204.31
floor	244.25	3.0	732.75	0.054305	4.40	5.87	8.80	11.73
sum	1404.30		13493.30	1.0	81.02	108.02	162.03	216.05

Width 16 ft

				Vbase=	91.71	122.28	183.43	244.57
					Fx=Cvx*Vbase			
					Aa			
	w	h	w*h	Cvx	0.15	0.2	0.3	0.4
roof	1319.45	11.0	14513.95	0.947095	86.86	115.82	173.72	231.63
floor	270.25	3.0	810.75	0.052905	4.85	6.47	9.70	12.94
sum	1589.70		15324.70	1.0	91.71	122.28	183.43	244.57

Seismic Forces - Ground Snow 100 psf

Table D - 3