Basis for Prescriptive Use of Plastered Strawbale Walls as Braced Wall Panels in the IRC

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Introduction

The 2015 International Residential Code (IRC) contains a new chapter on strawbale construction, Appendix S. This chapter provides for strawbale walls to be used as braced wall panels for resisting wind and seismic loads. The wind table, AS106.13(2) was based on the "basic wind speed" of previous editions of the IRC. Because the 2015 IRC was revised to use an "ultimate design wind speed" a proposal was submitted in early 2016 to revise the wind table to be based on the "ultimate design wind speed."

Described herein is the basis for the determination of tabulated lengths of strawbale braced wall panels—the values proposed for the revised wind table (Table AS106.13(2) for the 2018 IRC and the values approved for use in the seismic table (Table AS106.13(3) in the 2015 IRC (for which no changes are proposed).

Reference is made to the previous version of this document, dated April 28, 2013, which provides the basis for the lengths of strawbale braced wall panels that appear in the 2015 IRC.

Summary

The strawbale braced wall panel types are described in Section AS106.13, and are referred to in Table AS106.13(1) below. The proposed braced wall length table for wind, Table AS106.13(2), is shown below, with changes tracked relative to the version of this table that appears in the 2015 IRC. Proposed new text is shown underlined and text proposed for deletion is shown with ~~strikethrough~~. The braced wall length table for seismic, Table AS106.13(3) of the 2015 IRC, is also provided.

TABLE AS106.13(1)
PLASTERED STRAWBALE BRACED WALL PANEL TYPES

WALL DESIGNATION	PLASTER[a] (both sides)		SILL PLATES[b] (nominal size in inches)	ANCHOR BOLT[c] SPACING (on center)	MESH[d]	STAPLE SPACING[e] (on center)
	TYPE	THICK-NESS (minimum, each side)				
A1	Clay	1.5"	2 x 4	32"	None	None
A2	Clay	1.5"	2 x 4	32"	2" x 2" high-	2"

					density polypropylene	
A3	Clay	1.5”	2 x 4	32”	2” x 2” x 14ga[i]	4”
B	Soil-cement	1”	4 x 4	24”	2” x 2” x 14ga[i]	2”
C1	Lime	7/8”	2 x 4	32”	17 ga woven wire	3”
C2	Lime	7/8”	4 x 4	24”	2” x 2” x 14ga[i]	2”
D1	Cement-lime	7/8”	4 x 4	32”	17 ga woven wire	2”
D2	Cement-lime	7/8”	4 x 4	24”	2” x 2” x 14ga[i]	2”
E1	Cement	7/8”	4 x 4	32”	2” x 2” x 14ga[i]	2”
E2	Cement	1.5”	4 x 4	24”	2 “ x 2” x 14ga[i]	2”

SI: 1 inch=25.4 mm

a. Plasters shall conform with Sections AR104.4.3 through AR104.4.8, AR106.7, AR106.8, and AR106.12.

b. Sill plates shall be Douglas fir-larch or southern pine and shall be *preservative-treated* where required by the *International Residential Code*.

c. Anchor bolts shall be in accordance with Section AR106.13.3 at the spacing shown in this table.

d. Installed in accordance with Section AR106.9.

e. Staples shall be in accordance with Section AR106.9.2 at the spacing shown in this table.

TABLE AS106.13(2)
BRACING REQUIREMENTS FOR STRAWBALE BRACED WALL PANELS BASED ON WIND SPEED

• EXPOSURE CATEGORY B[d] • 25-FOOT MEAN ROOF HEIGHT • 10-FOOT EAVE-TO-RIDGE HEIGHT[d] • 10-FOOT WALL HEIGHT[d] • 2 BRACED WALL LINES[d]			MINIMUM TOTAL LENGTH (FEET) OF STRAWBALE BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE[a, b, c, d]		
~~Basic~~ Ultimate Design Wind Speed (mph)	**Story Location**	**Braced Wall Line Spacing (feet)**	**Strawbale Braced Wall Panel[e] A2, A3**	**Strawbale Braced Wall Panel[e] C1, C2, D1**	**Strawbale Braced Wall Panel[e] B, D2, E1, E2**
≤ ~~85~~110	One-story building	10	6.4	3.8	3.0
		20	8.5	5.1	4.0
		30	10.2	6.1	4.8
		40	13.3	6.9	5.5
		50	16.3	7.7	6.1
		60	19.4	8.3	6.6
≤ ~~90~~115	One-story building	10	6.4	3.8	3.0
		20	~~9.0~~8.5	~~5.4~~5.1	~~4.3~~4.0
		30	11.2	6.4	5.1
		40	~~15.3~~14.3	7.47.2	~~5.9~~5.7
		50	18.4	8.1	6.5
		60	21.4	8.8	7.0
≤ 120	One-story building	10	7.1	4.3	3.4
		20	9.0	5.4	4.3
		30	12.2	6.6	5.3
		40	16.3	7.7	6.1
		50	19.4	8.3	6.6
		60	23.5	9.2	7.3
≤ ~~100~~130	One-story building	10	7.1	4.3	3.4
		20	10.2	6.1	4.8
		30	14.3	7.2	5.7
		40	18.4	8.1	6.5
		50	22.4	9.0	7.1
		60	26.5	9.8	7.8

≤ ~~110~~140	One-story building	10	7.8	4.7	3.7
		20	~~12.2~~11.2	~~6.6~~6.4	~~5.3~~5.1
		30	~~17.3~~16.3	~~7.9~~7.7	~~6.3~~6.1
		40	~~22.4~~21.4	~~9.0~~8.8	~~7.1~~7.0
		50	26.5	9.8	7.8
		60	~~31.6~~30.6	~~11.4~~11.0	~~8.5~~8.3

For SI: 1 inch = 25.4 mm, 1 foot = 305 mm, 1 mile per hour = 0.447 m/s.

a. Linear interpolation shall be permitted.
b. All braced wall panels shall be without openings and shall have an aspect ratio (H:L) ≤ 2:1.
c. Tabulated minimum total lengths are for braced wall lines using single braced wall panels with an aspect ratio (H:L) ≤ 2:1, or using multiple braced wall panels with aspect ratios (H:L) ≤ 1:1. For braced wall lines using two or more braced wall panels with an aspect ratio (H:L) > 1:1, the minimum total length shall be multiplied by the largest aspect ratio (H:L) of braced wall panels in that line.
d. Subject to applicable wind adjustment factors associated with “All methods” in Table R602.10.3(2)
e. Strawbale braced panel types indicated shall comply with AR106.13.1 through AR106.13.3 and with Table AR106.13(1)

TABLE AS106.13(3)
BRACING REQUIREMENTS FOR STRAWBALE BRACED WALL PANELS BASED ON SEISMIC DESIGN CATEGORY

• **SOIL CLASS D**[d] • **WALL HEIGHT = 10 FEET**[d] • **15 PSF ROOF/CEILING DEAD LOAD**[d] • **BRACED WALL LINE SPACING ≤ 25 FEET**[d]			**MINIMUM TOTAL LENGTH (FEET) OF STRAWBALE BRACED WALL PANELS REQUIRED ALONG EACH BRACED WALL LINE**[a, b, c, d]	
Seismic Design Category	**Story Location**	**Braced Wall Line Length (feet)**	**Strawbale Braced Wall Panel**[e] **A2, C1, C2, D1**	**Strawbale Braced Wall Panel**[e] **B, D2, E1, E2**
C	One-story building	10	5.7	4.6
		20	8.0	6.5
		30	9.8	7.9
		40	12.9	9.1
		50	16.1	10.4
D_0	One-story building	10	6.0	4.8
		20	8.5	6.8
		30	10.9	8.4
		40	14.5	9.7
		50	18.1	11.7
D_1	One-story building	10	6.3	5.1
		20	9.0	7.2
		30	12.1	8.8
		40	16.1	10.4
		50	20.1	13.0
D_2	One-story building	10	7.1	5.7
		20	10.1	8.1
		30	15.1	9.9
		40	20.1	13.0
		50	25.1	16.3

For SI: 1 inch = 25.4 mm, 1 foot = 305 mm, 1 pound per square foot = 0.0479 kPa.

a. Linear interpolation shall be permitted.
b. All braced wall panels shall be without openings and shall have an *aspect ratio* (H:L) ≤ 2:1.
c. Tabulated minimum total lengths are for braced wall lines using single braced wall panels with an *aspect ratio* (H:L) ≤ 2:1, or using multiple braced wall panels with *aspect ratios* (H:L) ≤ 1:1. For braced wall lines using two or more braced wall panels with an *aspect ratio* (H:L) > 1:1, the minimum total length shall be multiplied by the largest *aspect ratio* (H:L) of braced wall panels in that line.
d. Subject to applicable seismic adjustment factors associated with “All methods” in Table R602.10.3(4), except “Wall dead load”.

e. Strawbale braced wall panel types indicated shall comply with Sections AR106.13.1 through AR106.13.3 and with Table AR106.13(1)

Note that the wind and seismic adjustment factors for the required length of wall bracing in the IRC are referred to and qualified in footnote d of the wind and seismic tables for strawbale braced wall panels.

Basis

The derivation of braced wall panel equivalencies considers the relatively greater mass in strawbale construction, seismic performance expressed in terms of displacement capacity relative to displacement demand, and the basis used to establish existing braced wall panel requirements, as detailed in the following.

1. Mass Considerations: The greater dead weight of strawbale walls relative to conventional light-frame braced wall panels is accounted for in developing these equivalencies. To do so, a representative one-story building was considered. Figure 1 shows a sketch of the representative building, which is based on Figure 2308.9.3 (Basic Components of the Lateral Bracing System) of the 2012 International Building Code. The interior wall of Figure 1 is considered to be of light frame construction while the exterior walls may be of light frame or straw bale construction. Openings shown on the exterior walls are repeated on opposite faces.

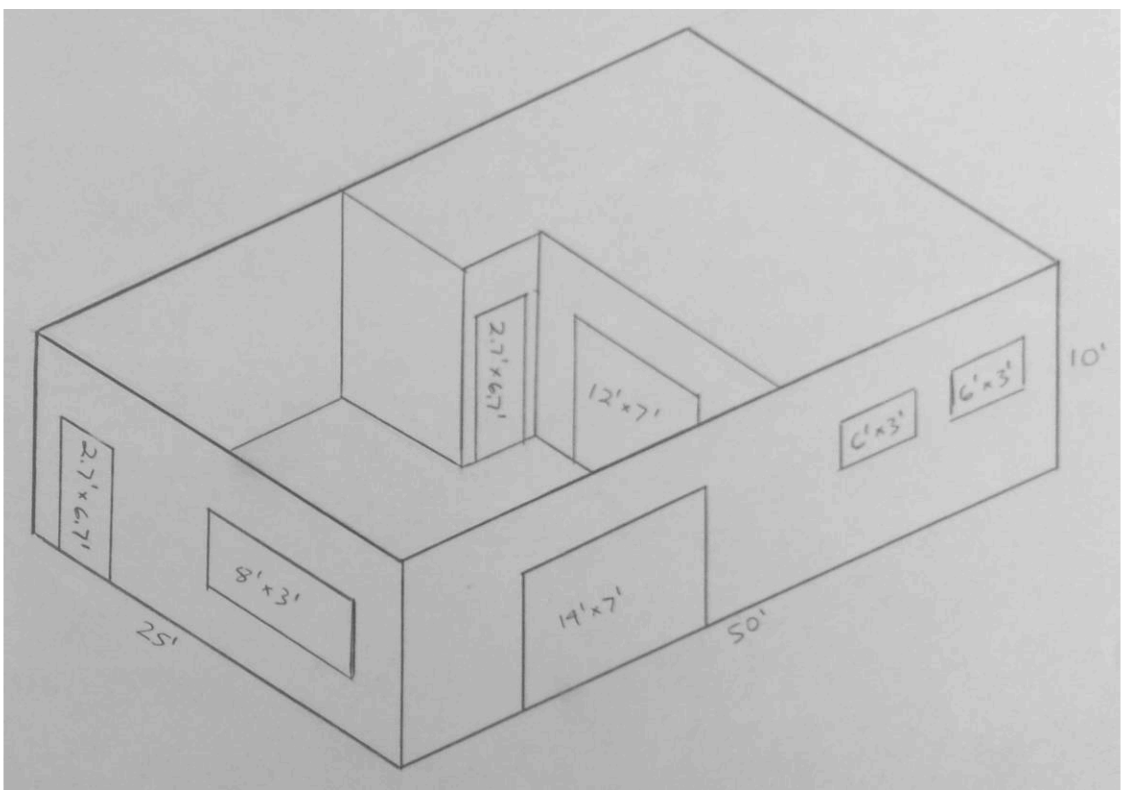

Figure 1: Representative one-story building used for establishing influence of seismic weight of strawbale walls, based on Figure 2308.9.3 of the 2012 IBC.

The representative ceiling and roof dead load was taken as 15 psf, and the roof was assumed to overhang by 2 ft on all sides, for a total weight of 23,490 pounds. The upper half of each wall was taken tributary to the roof level. Thus, the light-framed interior walls, assumed to be 15 psf, with openings as shown, contributed 1746 pounds to the seismic weight. Exterior walls were considered to be composed of conventional light framing or plastered strawbale, as follows:

- Conventional light-framed exterior walls were taken as 15 psf, with openings as shown, contributing 9372 pounds to the seismic weight.
- Strawbale walls were assumed to be composed of 24-inch wide bales, plastered on both sides with plaster having average thickness ¼ inch greater than the minimum thicknesses specified in the proposed Appendix for the IRC. Values of bale and plaster unit weights were estimated at the high end of what would be expected at equilibrium moisture content: 8.5 pcf for straw bales, 110 pcf for clay plaster, 130 pcf for soil cement and lime plasters, 138 pcf for cement-lime plaster, and 142 pcf for cement plaster.

Based on the foregoing, component weights were determined as given in Table 1.

Table 1: Seismic Weights (lbs) Tributary to Roof for Representative One-Story Building

	Conventional Light-Frame	Strawbale					
		A Clay (1-1/2”)	B Soil Cement (1”)	C Lime (7/8”)	D Cement -Lime (7/8”)	E1 Cement (7/8”)	E2 Cement (1-1/2”)
Roof	23490	23490	23490	23490	23490	23490	23490
Interior Wall	1746	1746	1746	1746	1746	1746	1746
Exterior 50 ft Walls	6120	20026	17986	16881	17493	17799	23834
Exterior 25 ft Walls	3252	10642	9558	8971	9296	9459	12666
Total Seismic Weight	34608	55904	52780	51088	52025	52494	61736
Ratio Relative to Light-Frame	1.00	1.62	1.53	1.48	1.50	1.52	1.78

Seismic forces for short-period structures are proportional to the seismic weight and are independent of period of vibration. The foregoing results indicate that strawbale walls must therefore resist proportionately greater seismic loads (as indicated by the ratios given in Table 1).

2. Seismic Performance Considerations: Figure 2 illustrates the lateral force-displacement response of an idealized building. To allow for differences in the inherent ductility capacities of different lateral force-resisting systems, allowable shears are derived to maintain a constant ratio of displacement demand and displacement capacity.

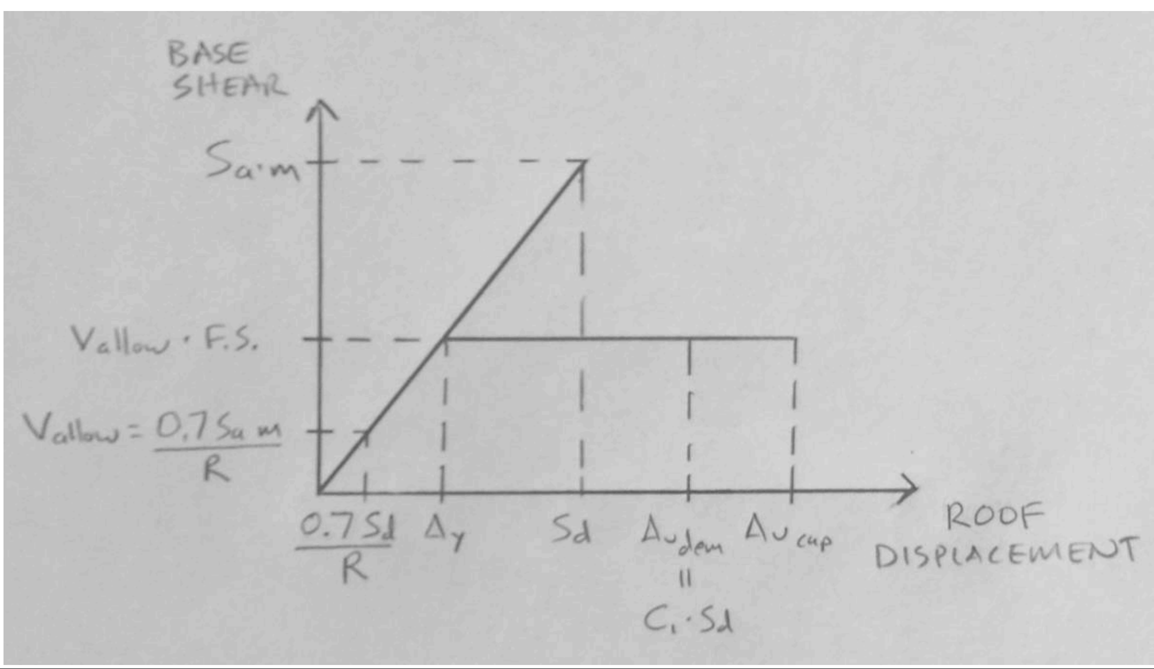

Figure 2: Idealized lateral force-displacement response

Following the work of Miranda and others, displacement demand is estimated as

$$\Delta_{u,demand} = C_1 \cdot S_d \tag{1}$$

where C_1= displacement amplification factor (>1 for short period systems) and S_d= spectral displacement associated with the natural (elastic) period of vibration of the system.

Displacement capacity can be stated in terms of design parameters as

$$\Delta_{u,capacity} = \left(\frac{0.7 \cdot S_d}{R}\right)(FS)\left(\mu_{capacity}\right) \tag{2}$$

where R= the R factor used for seismic design, FS= the factor of safety, given by the ratio of ultimate strength and allowable design strength, and $\mu_{capacity}$ is the yield-point referenced ductility capacity.

Taking the ratio of (1) and (2) allows the ratio of displacement capacity and demand to be determined as

$$\frac{\Delta_{u,capacity}}{\Delta_{u,demand}} = \left(\frac{0.7}{C_1 \cdot R}\right)(FS)\left(\mu_{capacity}\right) \tag{3}$$

The working report entitled "Seismic Design Factors and Allowable Shears for Strawbale Wall Assemblies" (Jalali, et al. 2013) tabulates adjusted ultimate shear strengths (repeated in Column (b) of Table 2A) and ductility capacities evaluated for both strawbale and wood structural panel walls. The ductility capacities reported by Jalali et al. are referenced to an allowable design shear, given as the ultimate strength divided by 2.5 (Column (d) of Table 2A). The ductility capacities required in Equation (3) can be approximated as the Jalali et al. values divided by 2.5 (Column (e) of Table 2A).

For wood structural panels, Equation (3) is evaluated as

$$\frac{\Delta_{u,capacity}}{\Delta_{u,demand}} = \left(\frac{0.7}{C_1 \cdot 5.5}\right)(3)(11.2/2.5) = \frac{1.71}{C_{1,WSP}} \quad \text{(Wood Structural Panels)}$$

where 11.2 is ductility value reported by Jalali et al. referenced to the ultimate strength divided by 2.5.

Allowable shears for strawbale walls can be obtained by applying a Factor of Safety (FS_{SBW}) to the ultimate strengths. The value of the FS_{SBW} to be used is determined to obtain a value of $\Delta_{u,capacity}/\Delta_{u,demand}$ equivalent to that determined above for wood structural panels. Thus, allowable shears can be determined by applying

$$FS_{SBW} = 1.71\left(\frac{C_{1,SBW}}{C_{1,WSP}}\right)\left(\frac{R_{SBW}}{0.7 \cdot \mu_{capacity,SBW}}\right) \tag{4}$$

to the ultimate strengths of the strawbale walls.

Because strawbale shearwalls tend to resist greater mass while having stiffness similar to wood structural panels (see Jalali, et al, 2013), the strawbale wall system will tend to have larger period. Because the displacement amplification factor, C_1, increases above 1 as the period of vibration reduces, $C_{1,WSP}$ will tend to be greater than $C_{1,SBW}$. Thus, for deriving strawbale allowable shears, it is conservative to take $C_{1,SBW}/C_{1,WSP} = 1$ in Equation (4). Thus, values of FS_{SBW} determined using Equation (4) applied to experimental data assuming $C_{1,SBW}/C_{1,WSP} = 1$ are provided in Column (g). Corresponding baseline allowable shears (Column (h)) are obtained by applying the FS_{SBW} values to the Adjusted Ultimate Strengths of Column (b) and dividing by the wall lengths of Column (c). Absent considerations described in the following, these allowable shears would be appropriate to use with R=3.5 to obtain values of $\Delta_{u,capacity}/\Delta_{u,demand}$ comparable to those obtained with engineered wood structural panel shear walls.

3. Adjustments for Strawbale Performance Characteristics: In this section, additional adjustments specific to the characteristics of strawbale wall systems are made.

The reversed cyclic load tests of full scale walls reported by C. Ash et al. demonstrated that the reinforced plaster is the first line of defense for resisting lateral loads; as damage to the plaster skins develops at larger displacements, the wall transitions to rocking behavior, with the bales providing a stable core capable of maintaining gravity load support. In each reversed cyclic test, the walls were tested through two complete cycles of drift to ± 7% of the wall height, the largest drift that could be accommodated by the test equipment. Tension cracks opened between the bale courses, but the cracks closed upon displacement reversal and the bales remained in alignment. In short, the bales provided a soft, ductile core capable of maintaining gravity load support. This inherent "backup" system provides strawbale wall systems with a degree of toughness and resistance to loss of gravity load support not available in many if not all other conventional seismic force-resisting systems. This system effect is substantial and merits recognition. Similar robustness was apparent in shake table testing of a weaker strawbale wall system tested at the University of Nevada, Reno in 2009. A video of this test can be viewed at https://www.youtube.com/watch?v=fTSy2JvkCF4. The final test report is available at http://ecobuildnetwork.org/projects/straw-bale-code-supporting-documents. At this time we are recognizing this system performance benefit with a modest factor of 1.3, indicating that strawbale building systems have an inherent stability, toughness, and resilience allowing them to maintain gravity load support through lateral displacements 30% larger than would be determined based on ductility capacity of isolated walls. This factor is listed in Column (i) of Table 2B.

Allowable shears reported by Jalali et al. (2013) were reduced by 10% or 25% depending on the type of reinforced plaster to account for the limited amount of reversed cyclic test data. For consistency, these reductions are applied here, as indicated in Column (j) of Table 2B.

To address the higher mass of strawbale construction, as compared with conventional light-framed construction, allowable shears derived in Table 2B are reduced in proportion to the mass of the strawbale system relative to that of a conventional system. The ratios provided in Column (k) are the inverses of the corresponding ratios determined in Table 1.

Thus, adjusted allowable shears for seismic loading are determined for strawbale walls having aspect ratios of 1:1 or lower in Column (l), obtained as the product of the factors in Columns (i), (j), and (k) applied to the baseline shears of Column (h).

4. Determination of Braced Wall Length Requirements for Seismic Design: Required lengths of strawbale wall panels were determined to provide resistance equivalent to that provided by wood structural panels in the IRC. Based on Crandell (2007) and Ehrlich (personal communication, 2013), we understand that braced wall lengths for wood structural panels (Method WSP) in the IRC were determined on the basis of an allowable shear of 317 plf (the nominal unit shear value of 634 plf divided by an Allowable Stress Design factor of safety of 2.0) and R factor of 5.5. We determined the required shear resistance along braced wall lines by multiplying the minimum lengths provided in the Table R602.10.3(3) of the 2012 IRC by the allowable shear of 317 plf. Since this required strength is based on R=5.5, the required strengths were increased by multiplying these values by the ratio of 5.5/3.5= 1.571 to obtain the required strengths at an R=3.5 level.

For purposes of seismic bracing, strawbale wall types were grouped into two categories: $V_{allow} \geq 383$ plf (Strawbale Methods B, D2, E1, and E2) and $V_{allow} \geq 284$ plf (Strawbale Methods A2, C1, C2, and D1).

The required strengths (at the R=3.5 level) were divided by the allowable shears of Column (l) of Table 2B to obtain the required lengths of strawbale panel along each braced wall line.

As described above, the allowable shears of Column (l) were adjusted to account for the greater mass characteristic of straw bale construction, and are applicable for wall panel segments having aspect ratios (height over plan length) not exceeding 1.0. Where the required wall length along a braced wall line was determined to be less than 10 ft, corresponding to an aspect ratio greater than 1.0, the total required wall length was increased to account for the reduction in allowable shear associated with more slender walls.[1] Thus, the tabulated required braced wall lengths can be satisfied using any number of wall segments, each having aspect ratio not exceeding 1.0, or where the required panel length is less than 10 feet, using a single panel of the tabulated length (having an aspect ratio greater than 1.0). Where the required total braced wall length along a braced wall line is provided using multiple wall segments where one or more segments has an aspect ratio exceeding 1.0, the total braced wall length along that braced wall line should be determined as the product of the tabulated length and the largest of the wall segment aspect ratios.

The IRC does not require wall bracing for Seismic Design Categories A and B, or for detached construction in Seismic Design Category C. Due to the greater seismic mass of strawbale buildings (typically not exceeding 50% according to Table 1), strawbale buildings of any type (detached or townhouses) in Seismic Design Category C should be provided with lateral bracing equivalent to that required for townhouses of conventional construction.

[1] The allowable shear (per unit length) is reduced in proportion to the aspect ratio.

5. Determination of Braced Wall Length Requirements for Wind Design: We maintained consistency with the approach used to establish required braced wall lengths for conventional materials, reported by Crandell and Martin (2009). The required shear resistance along a braced wall line was determined as the product of the required length in Table R602.10.3(1) of the 2015 IRC and the allowable shear for Method WSP (350 plf, anchored by a value of 700 plf divided by a factor of safety of 2.0).

Allowable shears for the strawbale braced panels are developed in Table 3. Column (b) tabulates adjusted ultimate strengths reported by Jalali et al. (2013), also provided in Column (b) of Table 2A. These adjusted ultimate strengths are derived from reversed cyclic test data and thus underestimate the strengths that would be determined in monotonic testing. As for conventional braced panels, a factor of safety of 2.0 is used to establish allowable shears (Column (d)). Allowable shears reported by Jalali et al. (2013) were reduced by 10% or 25% depending on the type of reinforced plaster to account for the limited amount of reversed cyclic test data. For consistency, these reductions are applied here, as indicated in Column (e) of Table 3. Allowable shears for strawbale braced panels having aspect ratios not exceeding 1.0 are shown in Column (f) of Table 3, determined as Columns (b) divided by Columns (c) and (d) and multiplied by Column (e).

For purposes of wind bracing, strawbale wall types were grouped into three categories: $V_{allow} \geq 753$ plf (Strawbale Methods B, D2, E1, and E2), $V_{allow} \geq 477$ plf (Strawbale Methods C1, C2, and D1), and $V_{allow} \geq 172$ plf (Strawbale Methods A2 and A3).

Required braced wall lengths for wind loading were determined as the required shear resistance along a braced wall line divided by the allowable shear of Column (f). As for the seismic braced wall lengths, where the required wall length along a braced wall line was determined to be less than 10 ft, corresponding to an aspect ratio greater than 1.0, the total required wall length was increased to account for the reduction in allowable shear associated with more slender walls.[2] Thus, the tabulated required braced wall lengths can be satisfied using any number of wall segments, each having aspect ratio not exceeding 1.0, or where the required panel length is less than 10 feet, using a single panel of the tabulated length (having an aspect ratio greater than 1.0). Where the required total braced wall length along a braced wall line is provided using multiple wall segments where one or more segments has an aspect ratio exceeding 1.0, the total braced wall length along that braced wall line should be determined as the product of the tabulated length and the largest of the wall segment aspect ratios.

We note that the minimum braced wall panel lengths (Table AS106.13 in the 2015 IRC and modified for inclusion in the 2018 IRC) are for strawbale buildings that are limited elsewhere in Appendix S to a 25-ft mean roof height. These braced wall panel lengths were derived to provide resistance corresponding to Method WSP in Table R602.10.3(1) which is based on a 30-ft mean roof height. Because the strawbale braced panel wall lengths were not adjusted for mean roof height, the tabulated lengths are conservative for use in strawbale buildings that are limited to a 25-ft mean roof height.

[2] The allowable shear (per unit length) is reduced in proportion to the aspect ratio.

Table 2A: Baseline allowable shears for Strawbale Braced Panels under seismic loading

Strawbale Panel Type	Adjusted V_{ult}, kips	Wall length, ft	Ductility Capacity Relative to Allowable Design Level	Ductility Capacity	R for Strawbale	FS for Equivalent $\frac{\Delta_{u,capacity}}{\Delta_{u,demand}}$	V_{allow}, baseline, plf
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
A2	3.05	8.0	22.6	9.04	3.5	0.95	403
A3	4.10	8.0	11.7	4.68	3.5	1.83	281
B	16.26	8.0	6.3	2.52	3.5	3.39	599
C1	10.18	8.0	6.3	2.52	3.5	3.39	375
C2	13.97	8.0	6.3	2.52	3.5	3.39	515
D1	11.71	8.0	6.3	2.52	3.5	3.39	431
D2	16.07	8.0	6.3	2.52	3.5	3.39	592
E1	16.70	8.0	6.3	2.52	3.5	3.39	615
E2	17.45	8.0	6.3	2.52	3.5	3.39	643

Table 2B: Adjusted allowable shears for Strawbale Braced Panels under seismic loading

Strawbale Panel Type	System capacity factor	Additional Reduction	Mass Adjustment (light frame / strawbale)	V_{allow}, 1:1 aspect ratio
(a)	(i)	(j)	(k)	(l)
A2	1.3	0.90	0.619	292
A3	1.3	0.90	0.619	203
B	1.3	0.75	0.656	383
C1	1.3	0.75	0.677	248
C2	1.3	0.75	0.677	340
D1	1.3	0.75	0.665	280
D2	1.3	0.75	0.665	384
E1	1.3	0.75	0.659	395
E2	1.3	0.90	0.561	422

Table 3: Adjusted allowable shears for Strawbale Braced Panels under wind loading

Strawbale Panel Type	Adjusted V_{ult}, kips	Wall length, ft	Factor of Safety (Ultimate/Allowable)	Additional Reduction	V_{allow}, 1:1 aspect ratio
(a)	(b)	(c)	(d)	(e)	(f)
A2	3.05	8	2	0.90	172
A3	4.10	8	2	0.90	231
B	16.26	8	2	0.75	762
C1	10.18	8	2	0.75	477
C2	13.97	8	2	0.75	655
D1	11.71	8	2	0.75	549
D2	16.07	8	2	0.75	753
E1	16.70	8	2	0.75	783
E2	17.45	8	2	0.90	982

References

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