COCONINO COUNTY ARIZONA
COMMUNITY DEVELOPMENT

COCONINO COUNTY
Sustainable Building Program

SUPPLEMENTAL GUIDELINES FOR RESIDENTIAL STRAWBALE CONSTRUCTION

In a substantive policy, Coconino County has accepted the 2015 International Residential Code **Appendix S** for Strawbale Construction and corresponding code sections as its building code for residential strawbale construction. The following guidelines are supplemental to Appendix S, offering some important aspects of strawbale code requirements but are not inclusive of all. Also, specific County requirements and interpretations are included. Users of Appendix S are also encouraged to read its Commentary (published by the International Code Council) which is available at the Coconino Building Department and as a free download at http://strawbuilding.org/

General:

- Appendix S is not intended to limit other methods of strawbale construction provided the proposed method is approved by the Building Official. Designs stamped by a professional engineer are also acceptable.

- Appendix S contains sections "AS105 Strawbale Wall- General" and "AS106 Strawbale Wall-Structural". The General section applies to **all** stawbale walls. "Structural wall" is defined by the Appendix as "a wall that meets the definition for a load-bearing or shear wall;" The "Strawbale Wall-Structural" section applies to both walls that are loadbearing and those that are not loadbearing but are shear walls.

- Appendix S does not specifically address the post and beam construction method. Braced wall requirements for post and beam structures can be addressed through meeting the structural wall requirements of Section AS106 or through other methods approved in IRC Chapter 6 (these will need to be increased by 60% to accommodate the extra weight of strawbale walls per AS105.2).

Strawbale Wall- General:

- Straw from wheat, rice, rye, barley or oat are acceptable bale materials. Verification can be done through a receipt for the material or a letter from the supplier. Straw from other cereal grains must be approved by the Building Official.

- Dry density of the bales shall not be less than 6.5 pounds per cubic ft. The dry density can be tested by measuring bale moisture with a grain moisture meter, weighing the bale, taking the bale measurements and completing the "Straw Bale Density Worksheet". Density will be verified by an inspector on not less than 2% of the project bales and not less than five bales. This inspection will be done at the same time as the moisture content inspection. If equipment is not available, the builder may elect to use a

third party to perform the testing. If the owner/contractor has the proper listed tools to perform the test, it is the responsibility of the owner/contactor to have the test ready for the inspectors to inspect.

- Appendix S is prescriptive code for strawbale homes that are **1 story in height**. The maximum building height is 25' and the maximum wall height is 12'. Buildings of two or more stories will require engineering.

- Strawbale walls can be non-loadbearing or loadbearing.

- Two sill plates are required, one at each strawbale face, and they must be preservative-treated or naturally durable wood. 2 X 4 is the minimum size, the maximum is 4 X 4. Anchor bolts are required per 2015 IRC Appendix S. On monolithic foundation pours, 3" of coverage on anchor bolts must be maintained.

- Braced wall lines that include non-structural strawbale must be increased by 60%.

- All strawbale walls must employ a method of out-of-plane resistance per Table AS105.4. This can be done using pins made out of steel, wood or bamboo installed externally or internally per AS105.4.2, or through mesh-reinforced plastering of the walls. With the Coconino County Wind Design Speed of 90 mph (3 second gust) and its Seismic Design Category 'C', all methods of out-of-plane resistance in Table AS105.4 are allowed, though maximum wall height will be dictated by the method chosen and 2012 IRC Tables R602.3 (5) and R602.3.1.

- Strawbale walls must be finished. Clay, soil-cement, gypsum, lime, cement-lime and cement plasters are all allowed and all have different requirements. Other wall finishing or cladding systems are also allowed per Section AS104.1. Different plasters are assigned different load bearing capacities in Table AS106.2. Reinforcing mesh is not required with clay plaster, but not using it will limit wall height. Finishes cannot have a perm rating less than 3, meaning they must be somewhat permeable to water vapor.

- At the time the first coat of plaster is applied, the moisture content of the bale wall shall not exceed 20% by weight. Use a grain moisture meter to verify this. An inspector will field verify this in not less than 5% of the total bales and not less than 10 bales.

- Intersecting interior partitions can be attached to an exterior strawbale wall at the top and bottom plates as specified in the IRC for "light-framed" walls, or to alternating straw bale courses with steel, wood, or bamboo dowel per AS105.5.

Strawbale Wall - Structural:

- A default wall dead load of 60 psf per face area will be used for vertical load calculations.

- For braced wall panels, sill plates must be Douglas fir-larch or southern pine and be preservative-treated when required in the IRC.

- Bales in structural walls must be laid in a running bond (head joints in successive courses are offset not less than one-quarter of the bale length.)

- Allowable Bearing Capacities of walls with different plasters are listed in Table AS106.12. The maximum bearing capacity is 800 psf. Clay plaster has a bearing capacity of 400 plf. The following table shows the maximum roof truss spans for corresponding Total Loads (snow loads + dead load) at maximum and minimum bearing capacities. This assumes there is a continuous box beam header at the top of the wall distributing the load to both skins.

  Maximum Roof Span for Specific Total Loads with Minimum and Maximum Plaster Bearing Capacities

		Total Load (psf)= Snow load + Dead Load			
		30	**40**	**50**	**60**
Bearing Capacity (plf)	**800**	*49'-0"*	*36'-0"*	*28'-0"*	*22'-6"*
	400	*23'-0"*	*16'-0"*	*12'-0"*	*9'-0"*

- Load-bearing walls must be pre-compressed by a uniform load of not less than 100 plf prior to application of plaster. This can be done with the roof if the roof load is determined to be ≥100 plf and is uniformly loaded across the top plates. Other methods are discussed in the commentary. This will be inspected.

- The plaster skin of a structural strawbale wall must be supported by the foundation (or other means per Section AS106.10). Therefore, the foundation (and/or concrete slab) must be wide enough to extend at least to the edge of the plaster on both the interior and exterior of the wall.

- Table AS106.13(1) gives plaster type, mesh type and staple spacings (of mesh to top and bottom plates) for different braced wall panel types. These braced wall panel types can then be used in Tables AS106.13(2) and AS106.13(3) to determine minimum total lengths of braced wall panels for wind speed and seismic design categories respectively. The table yielding the greater wall length is used. Clay plaster without mesh and soil-cement plaster cannot be used for braced wall panels because they are not listed in one or both of these tables.

- Strawbale walls must be plastered on both sides. Different plasters can be used on each side, but the plaster with the lowest structural capacity shall be used in determining braced wall panel lengths.

- For strawbale walls that resist wind uplift forces the maximum resistance possible in a plastered strawbale wall is 200 plf for each plaster skin (400 plf resistance for both sides). This is given for plasters with reinforcing mesh stapled at a spacing of 2" on center. Resistance to wind uplift forces over this amount will need to be designed to transfer the load beyond 200 plf per skin to the foundation independently of the plaster skin.

Thank you to Martin Hammer, Architect, lead author of Appendix S for his valuable contribution to these guidelines!

2500 N. FORT VALLEY ROAD, BUILDING 1 ● FLAGSTAFF, ARIZONA 86001-9331
(928) 679-8850 ● FAX (928) 679-8851