Clark County Department of Building & Fire Prevention

4701 West Russell Road, Las Vegas, NV 89118 ~ (702) 455-3000

Load Bearing & Non-Load Bearing Straw Bale Construction Building Permit Guide

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Part I. General Information

This guideline establishes minimum prescriptive standards of safety for the construction of structures which use baled straw as load bearing or non-load bearing material. The Clark County Building Administrative Code, Section 22.02.140, contains provisions for alternate materials and methods of construction. Pursuant to these provisions, this guideline shall be used as a reference during plan review and inspection of straw bale construction. This guideline is based on the Pima County, Arizona prescriptive code for straw bale construction which they have been using for several years. The Clark County Department of Building has used the Pima County code successfully for a number of years to facilitate the construction of straw bale single family residences.

Part II. Scope

The provisions of this guideline shall apply to all structures utilizing straw bales in the construction of wall systems. Load bearing structures shall be limited to Occupancy Group R, Division 3 and U.

Part III. Definition

For the purpose of this guideline, certain terms are defined as follows:

- **STRAW** is the dry stems of cereal grains left after the seed heads have been removed.
- **BALES** are rectangular compressed blocks of straw, bound by string or wire.
- **FLAKES** are slabs of straw removed from an untied bale. Flakes are used to fill small gaps between the ends of stacked bales.
- **LAID FLAT** refers to stacking bales so that the sides with the largest cross-sectional area are horizontal and the longest dimension of this area is parallel with the wall plane.
- **LAID ON EDGE** refers to stacking bales so that the sides with the largest cross-sectional area are vertical and the longest dimension of this area is horizontal and parallel with the wall plane.

Part IV. Materials

Specifications for Bales:

- **Type of Straw:** Bales of various types of straw, including, but not limited to, wheat, rice, rye, barley, oats and similar plants, shall be acceptable if they meet the minimum requirements for density, shape, moisture content, and ties.
- **Shape:** Bales shall be rectangular in shape.
- **Dimensions:** Bales used within a continuous wall shall be consistent height and width to ensure even distribution of loads within wall systems.

- **Ties:** Bales shall be bound with ties of either polypropylene string or bailing wire. Bales with broken or loose ties shall not be used unless the broken or loose ties are replaced with ties which restore the original degree of compaction of the bale.

- Moisture Content: Moisture content of bales, at time of installation, shall not exceed 20 percent of the total weight of the bale. Moisture content of bales shall be determined by the following:
  - Laboratory Method: A total of 5 samples, taken from the center of each of 5 bales randomly selected from the bales to be used, shall be tested for moisture content by a Clark County approved testing laboratory.
  - Density: Bales in load-bearing structures shall have a minimum calculated dry density of 7.0 pounds per cubic foot. The calculated dry density shall be determined after reducing the actual bale weight by the weight of the moisture content, as determined in section titled Moisture Content. The calculated dry density shall be determined by dividing the calculated dry weight of the bale by the volume of the bale.

- **Custom:** Size Bales. Where custom-made partial bales are used, they shall be of the same density, same string or wire tension, and where possible, use the same number of ties as the standard size bales

Part V. Construction & General Requirements

- **General:** Bale walls, when covered with plaster, drywall or stucco shall be deemed to have the equivalent fire resistive rating as wood frame construction with the same wall-finishing system.

- **Wall Thickness:** Nominal minimum bale wall thickness shall be 14 inches.

- **Wall Height:** Bale walls shall not exceed one story in height and the bale portion shall not exceed a height to width ration of 5.6:1 (for example, the maximum height for the bale portion of a 23 inch thick wall would be 10 feet – 8 inches), unless the structure is designed by a state of Nevada licensed engineer or registered architect.

- **Exception:** In the non-load bearing exterior end walls of structures with gable or shed roofs, an approved continuous assembly shall be required at the roof bearing assembly level.

- **Unsupported Wall Length:** The ratio of unsupported wall length to thickness, for bale walls, shall not exceed 13:1 (for a 23 inch thick wall, the maximum unsupported length allowed is 25 feet), unless the structure is designed by a licensed engineer or registered architect by the state of Nevada.

- **Allowable Loads:** The allowable vertical load (live and dead load) on the top of load bearing bale walls shall not exceed 360 pounds per square foot (psf) and the resultant load shall act at a center of the wall. Bale structures shall be designed to withstand all vertical and horizontal loads as specified in IBC Chapter 16.

- **Foundations:** Foundations shall be sized to accommodate the thickness of the bale wall and the load created by the wall and roof live and dead loads. Foundation (stem) walls which support bale walls shall extend to an elevation of not less than 6 inches above adjacent ground at all points. The minimum width of the footing shall be located along the centerline of the bale wall. A vertical bar shall also be located within 1 foot of any opening or corner, except at locations occupied by anchor

bolts.

- **Intersecting Walls:** Walls of other materials intersecting bale walls shall be attached to the bale wall by means of one or more of the following methods or an acceptable equivalent:
  - Wooden dowels at least 5/8 inch in diameter of sufficient length to provide 12 inches of penetration into the bale, driven through holes bored in the abutting stud, and spaced to provide one dowel connection per bale.
  - Pointed wooden stakes, at least 12 inches in length and 1 – ½ inch by 3 – ½ inches at the exposed end, fully driven into each course of bales, as anchorage points.
  - Bolted or threaded rod connection of the abutting wall, through the bale wall, to a steel nut and steel or plywood plate washer, a minimum of 6 inches square and a minimum thickness of 3/16 inch for steel and ½ inch for plywood, in at least three locations.

- **Anchor Bolts:** Load bearing bale walls shall be anchored to the foundation by ½ inch diameter steel anchor bolts embedded at least 7 inches in the foundation at intervals of 6 feet or less. A minimum of two anchor bolts per wall shall be provided, with one bolt located within 36 inches of each end of each wall section, consisting of ½ inch diameter threaded rod to be connected to the anchor bolts, and to each other, by means of threaded coupling nuts, and shall extend through the roof bearing assembly and be fastened with a steel washer and nut. Bale walls and roof bearing assemblies may be anchored to the foundation by means of other methods which are adequate to resist uplift forces resulting from the controlling design wind or seismic load. There shall be a minimum of two points of anchorage per wall, spaced not more than 6 feet apart, with one located within 36 inches of each end of each wall.

  The dead load of the roof and ceiling systems will produce vertical compression of the bales. Regardless of the anchoring system used to attach the roof bearing assembly to the foundation, prior to installation of wall finish materials, bolts or straps shall be re-tightened to compensate for this compression.

- **Moisture Barrier:** A moisture barrier shall be used between the top of the foundation and the bottom of the bale wall to prevent moisture from migrating through the foundation into the bottom course of bales. This barrier shall consist of one of the following:
  - 30# felt asphalt felt over an asphalt emulsion.
  - An approved corrosion-resistant flashing (sealed at joints with a waterproof compound).
  - Other approved building moisture barrier. All penetrations through the moisture barrier, as well as all joints in the barrier, must be sealed with asphalt, caulking or an approved sealant.

- **Stacking and Pinning:** Bales in load-bearing walls shall be laid flat and stacked in running bond where possible, with each bale overlapping the two bales beneath it. Bales in non-load bearing walls may be laid either flat or on edge and stacked in running bond where possible. Overlaps shall be a minimum of 12 inches. Gaps between the ends of bales which are less than 6 inches in width can be filled by an untied flake inserted snugly into the gap.

  The first course of bales shall be laid by impaling the bales on the vertical bars or threaded rods, if any, extending from the foundation. When the fourth course has been laid, #4 rebar pins, or an acceptable equivalent, long enough to extend through all four courses, shall be driven down through the bales, two in each bale, located so that they do not pass within six inches of, or through the space between the ends of any two bales. The layout of these pins shall approximate the layout of the vertical bars extending from the foundation. As each subsequent course is laid, two such pins, long enough to extend through the course being laid and three courses immediately

below it shall be driven down through each bale. This pinning method shall be continued to the top of the wall. In walls seven or eight courses high, pinning at the fifth course may be eliminated. Only full length bales shall be used at corners of load bearing walls, unless exceptions are designed by a licensed engineer or registered architect by the state of Nevada. Vertical #4 rebar pins or an acceptable alternative shall be located within 1 foot of all corners or door openings. Staples, made of #3 or larger rebar formed into a "U" shape, at least 18 inches long with two 6 inch legs, shall be used at all corners of every course, driven with one leg into the top of each abutting corner bale. In lieu of staples, corner bales may be tied together by an approved method.

- **Alternate Pinning Method:** When the third course has been laid, vertical #4 rebar pins or an acceptable equivalent long enough to extend through all three courses, shall be driven down through the bales, two in each bale, located so that they do not pass within 6 inches of or through the space between the ends of any two bales. The layout of these rebar pins shall approximate the layout of the rebar pins extending from the foundation. As each subsequent course is laid, two such pins, long enough to extend through that course and the two courses immediately below it shall be driven down through each bale. This pinning method shall be continued to the top of the wall.

- **Roof Bearing Assembly:** Load bearing bale walls shall have a roof bearing assembly at the top of the wall to bear the roof load and to provide a means of connecting the roof structure to the foundation. The roof bearing assembly shall be continuous along the tops of structural walls. An acceptable roof bearing assembly option consists of two double 2" by 6" or larger horizontal top plates, one located at the inner edge of the wall and the other at the outer edge. Connecting the two double top plates and located horizontally and perpendicular to the length of the wall shall be 2" by 6" cross members spaces not more than 72 inches center to center, and as required to align with the threaded rods extending from the anchor bolts in the foundation. The double 2" by 6" top plates shall be face nailed with 16d nails staggered at 16 inches on center, with laps and intersections face nailed with four 16d nails. The cross members shall be face nailed to the plates with four, 16d nails at each end. Corner connections shall include overlaps nailed as above or an acceptable equivalent such as plywood gussets or metal plates. Alternatives to this roof bearing assembly option must provide equal or greater vertical rigidity and provide horizontal rigidity equivalent to a continuous double 2" by 4" inch plate. The connection of roof framing members to the roof bearing assembly shall comply with the section 2304.9.1of the IBC.

- **Openings and Lintels:** All openings in load bearing bale walls shall be a minimum of one full bale length from any outside corner, unless exceptions are designed by a licensed engineer or registered architect by the state of Nevada.
  - **Openings:** Openings in exterior bale walls shall not exceed 50 percent of the total wall area, based on interior dimensions, where the wall is providing resistance to lateral loads, unless the structure is designed by a state of Nevada licensed engineer or registered architect.
  - **Lintels:** Wall and/or roof load present above any opening shall be carried, or transferred to the bales below by one of the following:
    - An approved structural frame.
    - A lintel (such as an angle-iron cradle, wooden beam, wooden box beam). Lintels shall be at least twice as long as the opening is wide and extend at least 24" beyond either side of the opening. Lintels shall be centered over openings and shall be specified to comply with the previous section titled, "Allowable Loads."

- **Moisture Protection:** All weather-exposed bale walls shall be protected from water damage. An approved building moisture barrier shall be used to protect at least the bottom course of bales, but

not more than the lower one-third of the vertical exterior wall surface, in order to allow natural transpiration of moisture from the bales. The moisture barrier shall have its upper edge inserted at least 6 inches into the horizontal joint between two courses of bales, and shall extend at least 3 inches below the top of the foundation. Bale walls shall have special moisture protection provided at all window sills. Unless protected by a roof, the tops of walls shall be protected. This moisture protection shall consist of a waterproof membrane, such as asphalt-impregnated felt paper, polyethylene sheeting, or other acceptable moisture barrier, installed in such manner as to prevent water from entering the wall system at window sills or at the top of walls. The asphalt-impregnated paper shall comply with ASTM D 226 or six a mil polyethylene may be used as an option.

- **Wall Finishes:** Interior and exterior surfaces of bale walls shall be protected from mechanical damage, flame, animals and prolonged exposure to water. Bale walls adjacent to bath and shower enclosures shall be protected by an approved moisture barrier.
  Cement stucco shall be reinforced with galvanized woven wire stucco netting or an acceptable equivalent. Such reinforcement shall be secured by attachment through the wall at a maximum spacing of 24 inches horizontally and 16 inches vertically.

  Where bales abut other materials, the plaster/stucco shall be reinforced with galvanized expanded metal lath, or an acceptable equivalent, extending a minimum of 6 inches onto the bales. Earthen and lime-based plasters may be applied directly onto the exterior and interior surface of bale walls without reinforcement, except where applied over materials other than straw.

  Weather-exposed earthen plasters shall be stabilized using a method approved by the Building Official.

  Lime-based plasters may be applied directly onto the exterior surface of bale walls without reinforcement, except where applied over materials other than straw.

- **Electrical:** All wiring within or on bale walls shall meet all provisions of the National Electrical Code adopted by this jurisdiction. Type NM or UF cable may be used, or wiring may be run in metallic or non-metallic conduit systems. Electrical boxes shall be securely attached to wooden stakes driven a minimum of 12 inches into the bales, or an acceptable equivalent.

- **Plumbing:** Water or gas pipes within bale walls shall be encased in a continuous pipe sleeve to prevent leakage within the wall. Where pipes are mounted on bale walls, they shall be isolated from the bales by a moisture barrier.

Part VI. Privacy/Landscape Walls

(This section is based on calculations verifying the design is a 6-foot free-standing "gravity wall" with no need for sub grade foundation for 90 MPH design wind load.) Refer to ASCE 7-05 for requirements.

General: This section covers free-standing or attached bale privacy or landscape walls, not exceeding 6 feet in height, from final grade to top of wall. Bales may be stacked either flat or on edge.

Department Of Building & Fire Prevention Locations & Services

MAIN OFFICE 4701 W. Russell Road Las Vegas, NV 89118 (702)455-3000	On-Site Plan Submittals All "Walk-Through" Plan Review / Permitting Functions Residential Tract Submittal / Permitting All Sub-Trade (Electrical, Plumbing & Mechanical) Permitting Building Inspection Scheduling Functions Fire Prevention Inspection Services Records	Temporary Certificate of Occupancy Submittals Building Inspections Building Inspector Inquiries Amusement / Transportation Systems Operation Certificates Approved Fabricators Quality Assurance Agency Listing
LAUGHLIN OFFICE Regional Government Center 101 Civic Way Laughlin, NV 89029 (702)298-2436	Building Inspection Services Fire Prevention Inspection Services	
OVERTON OFFICE 320 North Moapa Valley Blvd. Overton, NV 89040 (702)397-8089	Building Inspection Services Fire Prevention Inspection Services	

Automated Phone System (702) 455-3000

Option 1: For all Inspection services or to report a building code violation.
Option 2: For information regarding on-site permits or new plan submittals.
Option 3: For the Building Plans Examination division or QAA information.
Option 4: For the Zoning Plans Examination division.
Option 5: For information or copies regarding land development, construction documents, plans or permits.
Option 6: To speak with Management staff.
Option #: For hours of operation, Office location and website information.

Other Clark County Departments/Divisions/Districts

Air Quality & Environmental Management	500 S. Grand Central Parkway, Las Vegas NV	(702) 455-5942
Public Works, Development Review Services	500 S. Grand Central Parkway, Las Vegas NV	(702) 455-6000
Comprehensive Planning	500 S. Grand Central Parkway, Las Vegas NV	(702) 455-4314
Fire Department	575 E. Flamingo Road, Las Vegas NV	(702) 455-7316
Las Vegas Valley Water District	1001 S. Valley View Boulevard, Las Vegas NV	(702) 870-2011
Southern Nevada Health District	625 Shadow Lane, Las Vegas NV	(702) 759-1000
Water Reclamation District	5857 E. Flamingo Road, Las Vegas NV	(702) 668-8888

State of Nevada

Division of Water Resources	400 Shadow Lane, Suite 201, Las Vegas NV	(702) 486-2770
Nevada State Contractors Board	2310 Corporate Circle, Suite 200, Henderson NV	(702) 486-1100

Utilities

Nevada Power	6226 W. Sahara Avenue, Las Vegas NV	(702) 402-5555
Southwest Gas	5241 Spring Mountain Road, Las Vegas NV	(877) 860-6020

www.clarkcountynv.gov/building