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HEALTH AND SAFETY CODE - HSC

DIVISION 13. HOUSING [17000 - 19997] (*Division 13 enacted by Stats. 1939, Ch. 60.*)

PART 2.5. STATE BUILDING STANDARDS [18901 - 18949.31] (*Part 2.5 repealed and added by Stats. 1979, Ch. 1152.*)

CHAPTER 4.5. Guidelines for Straw-Bale Structures [18944.30 - 18944.41] (*Chapter 4.5 added by Stats. 1995, Ch. 941, Sec. 1.*)

ARTICLE 3. Construction Guidelines [18944.40 - 18944.41] (*Article 3 added by Stats. 1995, Ch. 941, Sec. 1.*)

18944.40. (a) Straw-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.

(b) Minimum bale wall thickness shall be 13 inches.

(c) Buildings with loadbearing bale walls shall not exceed one story in height without substantiating calculations and design by a civil engineer or architect licensed by the state, and the bale portion of the loadbearing walls shall not exceed a height-to-width ratio of 5.6:1 (for example, the maximum height for a wall that is 23 inches thick would be 10 feet 8 inches).

(d) The ratio of unsupported wall length to thickness, for loadbearing walls, shall not exceed 15.7:1 (for example, for a wall that is 23 inches thick, the maximum unsupported length allowed is 30 feet).

(e) The allowable vertical load (live and dead load) on top of loadbearing bale walls plastered with cement or lime cement plaster on both sides shall not exceed 800 pounds per linear foot, and the resultant load shall act at the center of the wall. Straw-bale structures shall be designed to withstand all vertical and horizontal loads, and the resulting overturning and base shear, as specified in the latest edition of the California Building Standards Code. Straw-bale walls plastered with cement or lime cement plaster on both sides shall be capable of resisting in-plane lateral forces from wind or earthquake of 360 pounds per linear foot.

(f) Foundations shall be designed in accordance with the California Building Standards Code to accommodate the load created by the bale wall plus superimposed live and dead loads. Supports for bale walls shall extend to an elevation of at least six inches above adjacent ground at all points, and at least one inch above floor surfaces.

(g) (1) Bale walls shall be anchored to supports to resist lateral forces, as approved by the civil engineer or architect. This may be accomplished with one-half inch reinforcing bars embedded in the foundation and penetrating the bales by at least 12 inches, located along the center line of the bale wall, spaced not more than two feet apart. Other methods as determined by the engineer or architect may also be used.

(2) Nonbale walls abutting bale walls shall be attached by means of one or more of the following methods or by means of an acceptable equivalent:

(A) Wooden dowels of $\frac{5}{8}$ inch minimum diameter and of sufficient length to provide 12 inches of penetration into the bale, driven through holes bored in the abutting wall stud, and spaced to provide one dowel connection per bale.

(B) Pointed wooden stakes, a minimum of 12 inches in length and $1\frac{1}{2}$ inches by $3\frac{1}{2}$ inches at the exposed end, fully driven into each course of bales, as anchorage points.

(C) 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 $\frac{3}{16}$ of an inch for steel and $\frac{1}{2}$ inch for plywood, in a minimum of three locations.

(3) (A) Bale walls and roof bearing assemblies shall be anchored to the foundation where necessary, as determined by the civil engineer or architect, by means of methods that are adequate to resist uplift forces resulting from the design wind 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.

(B) With loadbearing bale walls, the dead load of the roof and ceiling systems will produce vertical compression of the walls. Regardless of the anchoring system used to attach the roof bearing assembly to the foundation, prior to installation of wall finish materials, the nuts, straps, or cables shall be retightened to compensate for this compression.

(h) (1) 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 so as to come into contact with the bottom course of bales. This barrier shall consist of one of the following:

(A) Cementitious waterproof coating.

(B) Type 30 asphalt felt over an asphalt emulsion.

(C) Sheet metal flashing, sealed at joints.

(D) Another building moisture barrier, as approved by the building official.

(2) All penetrations through the moisture barrier, as well as all joints in the barrier, shall be sealed with asphalt, caulking, or an approved sealant.

(3) There shall also be a drainage plane between the straw and the top of the foundation, such as a one inch layer of pea gravel.

(i) (1) For nonloadbearing walls, bales may be laid either flat or on edge. Bales in loadbearing bale walls shall be laid flat and be stacked in a running bond, where possible, with each bale overlapping the two bales beneath it. Overlaps shall be a minimum of 12 inches. Gaps between the ends of bales which are less than 6 inches in width may be filled by an untied flake inserted snugly into the gap.

(2) Bale wall assemblies shall be held securely together by rebar pins driven through bale centers as described in this chapter, or equivalent methods as approved by the civil engineer or architect.

(3) The first course of bales shall be laid by impaling the bales on the rebar verticals and threaded rods, if any, extending from the foundation. When the fourth course has been laid, vertical #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 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 pins, long enough to extend through that course and the 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.

(4) Alternative pinning method to the method described in paragraph (3): 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 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 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.

(5) Only full-length bales shall be used at corners of loadbearing bale walls.

(6) Vertical #4 rebar pins, or an acceptable alternative, shall be located within one foot of all corners or door openings.

(7) Staples, made of #3 or larger rebar formed into a "U" shape, a minimum of 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.

(j) (1) All loadbearing bale walls shall have a roof bearing assembly at the top of the walls to bear the roof load and to provide the means of connecting the roof structure to the foundation. The roof bearing assembly shall be continuous along the tops of loadbearing bale walls.

(2) An acceptable roof bearing assembly option shall consist of two double 2-inch by 6-inch, or larger, horizontal top plates, one located at the inner edge of the wall and the other at the outer edge. Connecting the two doubled top plates, and located horizontally and perpendicular to the length of the wall, shall be 2-inch by 6-inch cross members, spaced no 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-inch by 6-inch top plates shall be face-nailed with 16d nails staggered at 16-inch o.c., with laps and intersections face-nailed with four 16d nails. The crossmembers shall be face-nailed to the top 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 shall provide equal or greater vertical rigidity and provide horizontal rigidity equivalent to a continuous double 2 by 4 top plate.

(3) The connection of roof framing members to the roof plate shall comply with the appropriate sections of the California Building Standards Code.

(k) All openings in loadbearing bale walls shall be a minimum of one full bale length from any outside corner, unless exceptions are approved by an engineer or architect licensed by the state to practice. Wall or roof load present above any opening shall be carried, or transferred, to the bales below by one of the following:

(1) A frame, such as a structural window or door frame.

(2) A lintel, such as an angle-iron cradle, wooden beam, or wooden box beam. Lintels shall be at least twice as long as the opening is wide and extend a minimum of 24 inches beyond either side of the opening. Lintels shall be centered over openings.

(3) A roof bearing assembly designed to act as a rigid beam over the opening.

(l) (1) All weather-exposed bale walls shall be protected from water damage. No vapor impermeable barrier may be used on bale walls, and the civil engineer or architect may design the bale walls without any membrane barriers between straw and plaster, except as specified in this section, in order to allow natural transpiration of moisture from the bales and to secure a structural bond between plaster and straw.

(2) Bale walls shall have special moisture protection provided at all horizontal surfaces exposed to the weather. This moisture protection shall be installed in a manner that will prevent water from entering the wall system.

(m) (1) 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 a moisture barrier.

(2) Cement stucco shall be reinforced with galvanized woven wire stucco netting or an equivalent, as approved by the building official. The reinforcement shall be secured by attachment through the wall at a maximum spacing of 24 inches horizontally and 16 inches vertically, unless substantiated otherwise by a civil engineer or architect.

(3) Where bales abut other materials, the plaster or stucco shall be reinforced with galvanized expanded metal lath, or an acceptable equivalent, extending a minimum of 6 inches onto the bales.

(4) Earthen and lime-based plasters may be applied directly onto bale walls without reinforcement, except where applied over materials other than straw.

(n) (1) All wiring within or on bale walls shall meet all provisions of the California Electrical Code. Type "NM" or "UF" cable may be used, or wiring may be run in metallic or nonmetallic conduit systems.

(2) Electrical boxes shall be securely attached to wooden stakes driven a minimum of 12 inches into the bales, or an acceptable equivalent.

(o) 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.

(p) Bales shall be protected from rain and other moisture infiltration at all times until protected by the roof of the structure.

(Amended by Stats. 2002, Ch. 31, Sec. 5. Effective April 26, 2002. Inoperative on date prescribed in Section 18944.41.)

18944.41. Sections 18944.30, 18944.31, 18944.33, 18944.35, and 18944.40 shall become inoperative when building standards become effective after approval by the California Building Standards Commission pursuant to Chapter 4 (commencing with Section 18935) that permit the construction of structures that use baled straw as a loadbearing or nonloadbearing material and that are safe to the public.

(Added by Stats. 2002, Ch. 31, Sec. 6. Effective April 26, 2002.)