

Town of Marana

Amendments to the: 2006 International Residential Code

R101.1 Title. Add: “Town of Marana” as name of adopting jurisdiction.

Table R301.2(1) Climatic and geographic design criteria. INSERT as follows:

Ground Snow Load	Less than 4000 ft 0 psf
Wind Speed	90 mph
Seismic Design	Category B
Weathering	Negligible
Frost Line Depth	none
Termite	Moderate to Heavy
Decay	None to Slight
Winter Design Temperature	33 deg
Flood Hazards	Per Engineering Dept Standards.

Section R301.2.2.2.2 Irregular buildings. REVISE section by ADDING “B,” in front of “C” in the first paragraph.

Table 301.5 Minimum Uniformly Distributed Live Loads. REVISE Table 301.5 in part as follows:

TABLE R301.5

MINIMUM UNIFORMLY DISTRIBUTED LIVE LOADS

(In pounds per square foot)

USE	LIVE LOAD
Attics with limited storage ^{b, g, h}	20 40
Sleeping rooms	30 40

(other sections and uses in table to remain unchanged)
(footnotes a through f to remain unchanged)

G. For attics with ~~limited storage and constructed with trusses~~ **TRUSSED SYSTEMS**, this live load... (balance of footnote g, and footnotes h, and i, to remain unchanged)

Section R303.3 Bathrooms. REPLACE the section and exception with:

Section R303.3 Bathrooms and Kitchens. Bathrooms, water closet compartments, Kitchens and other similar rooms shall be provided with mechanical exhaust systems. The minimum ventilation rates for bathrooms, kitchens, and similar spaces shall be per Table M1507.3

Section R308.4 Hazardous locations. REVISE section by DELETING items 5 and REPLACING with the following:

5. Glazing in any room containing a hot tub, whirlpool, sauna, steam room, bathtub, and shower where the bottom exposed edge of the **glazing** is less than 60 inches above a standing surface (ARS §36-1631).

Section R309.1 Opening protection. REVISE section by ADDING the following to the end of the paragraph:

Such doors shall be self-closing and self-latching.

Section R311.4.3 Landings at doors. REPLACE section with:

R411.4.3 Landings at doors. There shall be a floor or landing on each side of each exterior door. The floor or landing at an exterior door shall be flush with the interior finish floor elevation, or a minimum of 4 inches (52 MM) lower than the top of the threshold. When located lower than the threshold, the door, other than an exterior storm or screen door, shall not swing over the landing. The landing shall be permitted to have a slope not to exceed 0.25 units vertical in 12 units horizontal (2 percent).

Section R312.3 Paths of travel. ADD new section by inserting:

Section R312.3 Path of Travel is any sidewalk, stair or path leading from the home to a pool, spa, ramada, or other habitable structure. Changes in elevation, stairs, handrails and guards shall conform to the Residential Building Code. Paths adjacent on elevated areas must be provided with guards when within two feet of the drop or slope exceeding 1 in 2. Stairs or steps leading to the pool area or leading to raised areas around pools and spas shall be provided with a handrail when there is more than one riser unless the tread is more than 24 inches between risers. Stairs and handrails must meet the provisions of the Residential Building Code. Hand rails in this section are in addition to those required for exiting the pool. Walking surfaces shall be non skid in pool areas.

Section R313.2 Location. REVISE section by adding:

4. Where the ceiling height of a room open to the hallway serving sleeping areas exceeds that of the hallway by 24 inches (610 MM) or more, smoke alarms shall be located in the hallway and in the adjacent room.

Figure R403.1.7.1 Foundation Clearances from Slopes. DELETE figure and REPLACE with 2006 International Building Code **Figure 1805.3.1 Foundation Clearances from Slopes.**

Section R403.1 General. REVISE section by INSERTING the following at the end of the paragraph: Footings and monolithic foundation slab turndowns shall have minimum reinforcement consisting of one No. 4 bar located a minimum of 3 inches (76mm) clear from the top of the footing. Masonry and concrete stemwalls shall have minimum reinforcement in accordance with Section R606.1.1 and with vertical reinforcement installed in the footing with a standard hook.

Section 602.10.3 Braced wall panel construction methods. REVISE by DELETING subsection #1. Delete all references to this method in all related tables and sections.

Section R802.11.1 Uplift resistance. REVISE section by DELETING both paragraphs and ADDING the following:

All rafters and trusses shall be tied down to their supporting member by a metal connector with a minimum design Uplift resistance of at least 400 pounds. Load paths will be constructed to be continuous to the foundation.

Section R1305.1.1 REVISE to read:

Section R1305.1.1 Furnaces and Air Handlers. Furnaces and Air Handlers within ...(remaining portion unchanged).

ADD new section M1307.6 to read:

Section M1307.6 Liquefied Petroleum Appliances. LPG appliances shall not be installed in an attic, pit or other location that would cause a ponding or retention of gas.

Section M1403.2 Foundations and supports. DELETE the words “heat pump” and “ground” and INSERT the words “mechanical system” and “finish grade”.

Section M1411.3.2 Drain pipe materials and sizes REVISE section by ADDING the following at the end of the paragraph:

Condensate disposal shall be allowed to terminate as follows:

1. Into an approved fixture tailpiece, funnel drain, waste air gap fitting, floor sink, slop sink and laundry tray.
2. At or below grade outside the building in an area capable of absorbing the condensate flow without surface drainage.
3. Over roof drains that connect to drainage pipes, provided they terminate at or above grade in an area capable of absorbing the condensate flow without surface drainage.

Equipment Capacity	Minimum Condensate Pipe Diameter
Up to 10 tons of refrigeration	¾ inch
11 to 20 tons	1 inch
21 to 40 tons	1 ¼ inch
41 to 100 tons	1 ½ inch
Over 100 tons	2 inch

When two or more units are tied together, the minimum drain size shall be 1”.

ADD the following after “uniform slope”, “not less than 307.1”

Section 1503.3 Kitchen exhaust rates. DELETE the section wording and INSERT: Domestic kitchen cooking appliances are required to be equipped with ducted range hoods or down draft exhaust systems. The fans shall be sized in accordance with Section M1507.3

Section 1703.2 Two opening or ducts. INSERT after the second sentence the words: For LPG appliances, any duct serving the lower opening shall be at the floor level and slope to the outdoors without traps or pockets.

Section G2415.9 Minimum burial depth. REVISE section by DELETING section text and subsection and REPLACING with the following:

Underground piping systems shall be installed a minimum depth of 12 inches (304.8 mm) below grade for metal piping and 18 inches (457 mm) for plastic piping with caution tape placed 6 inches (152.5 mm) above plastic pipes.

Section P2503.6 Water-supply system testing. REVISE section by DELETING the phrase fragment “other than plastic,” from the first sentence.

Section P2603.6.1 Sewer depth. INSERT [number] as “12” in both locations.

ADD new section P2803.6.2 to read:

Section P2803.6.2 Replacement water heaters. Replacement water heaters shall comply with the following when it is not feasible to run the Temperature and Pressure relief valve line to the exterior of the residence:

1. A drain pan shall be installed under the water heater.
2. The temperature relief valve shall be set to a maximum of 210 degrees and the pressure relief valve to 150psi with a line draining into the pan.
3. A pressure relief valve set at no greater than 125psi shall be installed at the main water supply connection outside the dwelling.

Section E3306.3: Minimum size of conductors. REVISE section by DELETING the words “and No 12 aluminum” from the first sentence and REPLACING these with “No 6 aluminum”.

Section 3603.1: Branch circuits for heating. REVISE section by ADDING a sentence to the end of the paragraph to read:

Evaporative cooler fan and pump motors shall be permitted to be connected to the same branch circuit as central heating.

ADD new section E3603.7 to read:

Section E3603.7 Dishwasher and Garbage Disposer Branch Circuits – Dwelling Units. In residential occupancies, dishwasher and garbage disposer may be on the same 20-ampere branch circuit.

ADD new section E3702.7 to read:

Section E3702.7 Earthen material wiring method. Type UF Cable shall be permitted to be used in mortar joints of adobe construction in occupancies where the use of Nonmetallic Sheathed Cable is permitted by this code.

Table E3701.4 Allowable Applications for Wiring Methods. Revise as Follows:

Allowable Applications (application allowed where marked with an 'A')	AC	EMT	ENT	FMC	IMC RMC RNC	LFC^a	MC	NM	SR	SE	UF	USE
Services		A	A ^h	A ⁱ	A	A ⁱ	A			A		A
Feeders	A	A	A	A	A	A	A	A		A ^b	A	A ^b
Branch circuits	A	A	A	A	A	A	A	A	A	A ^c	A	
Inside a building	A	A	A	A	A	A	A	A	A	A	A	
Wet locations exposed to sunlight		A	A ^h	A ^d	A	A	A			A	A ^e	A ^e
Damp locations		A	A	A ^d	A	A	A			A	A	A
Embedded in noncinder concrete in dry location		A	A		A							
In noncinder concrete in contact with grade		A	A ^f		A ^f							
Embedded in plaster not exposed to dampness	A	A	A	A	A	A	A			A	A	
Embedded in masonry		A	A		A ^f	A	A				A ^j	
In masonry voids and cells exposed to dampness or below grade line		A ^f	A	A ^d	A ^f	A	A			A	A	
Fished in masonry voids	A			A		A	A	A		A	A	
In masonry voids and cells not exposed to dampness	A	A	A	A	A	A	A	A		A	A	
Run exposed	A	A	A	A	A	A	A	A	A	A	A	A
Run exposed and subject to physical damage					A							
For direct burial		A			A ^g	A	A				A	A
Embedded in earthen material wall systems with full head and bed joints		A ^f	A	A	A ^f	A	A ^f				A	
Embedded in Straw Bale walls		A ^f	A	A	A ^f	A	A ^f	A			A	

For SI: 1 foot = 304.8 mm

- a. Liquid-tight flexible nonmetallic conduit without integral reinforcement within the conduit wall shall not exceed 6 feet in length.
- b. The grounded conductor shall be insulated except where used to supply other buildings on the same premises. Type USE cable shall not be used inside buildings.
- c. The grounded conductor shall be insulated.
- d. Conductors shall be a type approved for wet locations and the installation shall prevent water from entering other raceways.
- e. Shall be listed as "Sunlight Resistant".
- f. Metal raceways shall be protected from corrosion and approved for the application.
- g. RNC shall be Schedule 80 when exposed outside or when exposed to physical damage inside.
- h. Shall be listed as "Sunlight Resistant" where exposed to the direct rays of the sun.
- i. Conduit shall not exceed 6 feet in length.
- j. Type UF cable shall be permitted to be used in mortar joints of adobe construction in occupancies where the use of nonmetallic cable is permitted by this code.

Section E3808.8.1 Flexible metal conduit. REVISE section by DELETING all text and REPLACING it with the following:

Flexible metal conduit shall not be permitted as a grounding means. An equipment grounding conductor, sized in accordance with Table E3808.12, shall be installed in all flexible metal conduits. Where an equipment bonding jumper is required around flexible metal conduit, it shall be installed in accordance with Section E3808.20.

Exception: Listed and labeled factory assembled (pre-wired) fixtures and equipment with flexible metal conduit will not require the addition of the grounding conductor in the pre-wired raceway.

Section E3808.8.2 Liquid-tight flexible metal conduit. REVISE section by DELETING all text and REPLACING it with the following:

Liquid-tight flexible metal conduit shall not be permitted as a grounding means. An equipment grounding conductor, sized in accordance with Table E3808.12, shall be installed in all liquid-tight flexible metal conduits. Where an equipment bonding jumper is required around liquid-tight flexible metal conduit, it shall be installed in accordance with Section E3808.20.

Exception: Listed and labeled factory assembled (pre-wired) fixtures and equipment with liquid-tight flexible metal conduit will not require the addition of the grounding conductor in the pre-wired raceway.

ADD new section E4202.3 and subsections to read:

Section E4202.3 Location of power supplies and transformers.

1. Accessibility: Class 1, Class 2, and Class 3 power supplies and transformers shall be accessible.
2. Prohibited locations:
 - a) In any closet or space within 6 inches of the front of the shelf.

All Appendix Requirements are adopted with the following exceptions:

Appendix E Manufactured Housing used as Dwellings is hereby DELETED in its entirety and REPLACED with the following:

See State Office of Manufactured Housing Regulations

Appendix F Radon Control Methods is hereby DELETED in its entirety.

Appendix G Swimming Pools, Spas and Hot Tubs. Is DELETED in its entirety.

Appendix I Private Sewage Disposal. REVISE this section by DELETING all text and REPLACING it with the following:

See State Department of Environmental Quality Regulations

Appendix J Existing Buildings and Structures is hereby DELETED in its entirety.

Appendix L Existing Buildings and Structures is hereby DELETED in its entirety.

APPENDIX O is adopted as a reference only. DEQ regulations apply to all installations.

Appendix M is hereby DELETED in its entirety and REPLACED with the following:

Appendix AM: Straw-Bale Structures.

Section AM101 Purpose. The purpose of this appendix chapter is to establish minimum prescriptive standards of safety for the construction of structures which use baled straw as a load bearing or non-load bearing material.

Section AM102 - Scope. The provisions of this chapter shall apply to all structures utilizing straw-bales in the construction of wall systems. Load bearing structures shall be limited to Occupancy Groups R, Division 3 and U.

Section AM103 - Definitions. For the purpose of this chapter, 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 strings 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.

LAI D 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.

LAI D 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.

Section AM104 - MATERIALS

Section AM104.1 Specifications for Bales.

Section AM104.1.1 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.

Section AM104.1.2 Shape. Bales shall be rectangular in shape.

Section AM104.1.3 Dimensions. Bales used within a continuous wall shall be of consistent height and width to ensure even distribution of loads within wall systems.

Section AM104.1.4 Ties. Bales shall be bound with ties of either polypropylene string or baling 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.

Section AM104.1.5 Moisture Content. Moisture content of bales, at time of installation, shall not exceed 20% of the total weight of the bale. Moisture content of bales shall be determined by one of the following:

Section AM104.1.5.1 Field Method. A suitable moisture meter, designed for use with baled straw or hay, and equipped with a probe of sufficient length to reach the center of the bale, shall be used to determine the average moisture content of 5 bales randomly selected from the bales to be used.

Section AM104.1.5.2 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 recognized testing lab.

Section AM104.1.6 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 7204.1.5. The calculated dry density shall be determined by dividing the calculated dry weight of the bale by the volume of the bale.

Section AM104.1.7 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.

Section AM105 - Construction and General Requirements

Section AM105.1 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.

Section AM105.2 Wall Thickness. Nominal minimum bale wall thickness shall be 14 inches.

Section AM105.3 Wall Height. Bale walls shall not exceed one story in height and the bale portion shall not exceed a height to width ratio 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 an engineer or architect licensed by the State to practice as such, and approved by the Building Official.

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.

Section AM105.4 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 an engineer or architect licensed by the State to practice as such, and approved by the Building Official.

Section AM105.5 Allowable Loads. The allowable vertical load (live and dead load) on the top of bale walls shall not exceed 360 pounds per square foot (psf) and the resultant load shall act at the center of the wall. Bale structures shall be designed to withstand all vertical and horizontal loads as specified in Chapter 16.

Section AM105.6 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 the width of the bale it supports, except that the bales may overhang the exterior edge of the foundation by not more than 3 inches to accommodate rigid perimeter insulation. Footings shall extend a minimum of 12 inches below natural, undisturbed soil, or to frost line, whichever is lower.

Section AM105.7 Wall and Roof Bearing Assembly Anchorage

Section AM105.7.1 General. Vertical reinforcing bars with a minimum diameter of 1/2", shall be embedded in the foundation a minimum depth of 6 inches, and shall extend above foundation a minimum of 12 inches. These vertical bars shall be located along the centerline of the bale wall, spaced not more than 2 feet apart. A vertical bar shall also be located within 1 foot of any opening or corner, except at locations occupied by anchor bolts.

Section AM105.7.2 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:

1. Wooden dowels at least 5/8" 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.
2. Pointed wooden stakes, at least 12 inches in length and 1-1/2" by 3-1/2" at the exposed end, fully driven into each course of bales, as anchorage points.
3. 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" for steel and 1/2" for plywood, in at least three locations.

Section AM105.7.3 Anchor Bolts. Load bearing bale walls shall be anchored to the foundation by 1/2" 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. Sections of 1/2" diameter threaded rod shall 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 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.

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.

Section AM105.7.4 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:

1. cementitious waterproof coating;
2. type 30 asphalt felt over an asphalt emulsion;
3. sheet metal flashing, sealed at joints;
4. 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.

Section AM105.7.5 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. For non-load bearing walls, bales may be laid either flat or on-edge. Bales in load bearing walls shall be laid flat and 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 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 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.

Only full-length bales shall be used at corners of load bearing walls, unless exceptions are designed by an engineer or architect licensed by the State to practice as such, and approved by the Building Official.

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 a method approved by the building official.

Section AM105.7.5.1 Alternative 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.

Section AM105.7.6 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” X 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 doubled top plates and located horizontally and perpendicular to the length of the wall shall be 2” X 6” 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” X 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 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 must provide equal or greater vertical rigidity and provide horizontal rigidity equivalent to a continuous double 2 by 4 top plate.

The connection of roof framing members to the roof bearing assembly shall comply with the appropriate sections of the UBC.

Section AM105.7.7 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 an engineer or architect licensed by the State to practice as such, and approved by the Building Official.

Section AM105.7.7.1 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 an engineer or architect licensed by the State to practice as such, and approved by the Building Official.

Section AM105.7.7.2 Lintels. Wall and/or roof load present above any opening shall be carried, or transferred to the bales below by one of the following:

1. A structural frame,
2. 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 not exceed the load limitations of Section 7205.5 by more than 25 percent.

Section AM105.7.8 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 also 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 tops of walls.

Section AM105.7.9 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 a 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, using a method approved by the Building Official.

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.

Section AM105.7.10 Electrical. All wiring within or on bale walls shall meet all provisions of the National Electrical Code adopted by this jurisdiction. Type UF cable may be used, or wiring may be run in metallic or nonmetallic conduit systems.

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

Section AM105.7.11 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.

Section AM106 - Privacy/Landscape Walls

Section AM106.1 General. This section covers freestanding 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. Alternate methods, other than those listed in this section, may be approved by the building official.

Section AM106.2 Foundations. The minimum foundation shall consist of an 8 inch thick reinforced concrete stem wall, over an approved footing. Minimum width of the stem wall shall be equal to the width of the bottom bale. Stem walls shall have continuous horizontal reinforcement consisting of two #4 bars with 24 inches minimum lap at splices.

Section AM106.2.1 Reinforcement. Vertical reinforcing bars, a minimum 3/8" in diameter, shall be placed in the center of the stem wall, two per bale, and extend up a minimum of 24 inches, and be embedded a minimum of 4 inches into the concrete stem wall. Bales shall be pinned, using two 3/8" diameter bars per bale, and use pins long enough to provide at least one vertical bar from stem wall to top of wall, with a minimum of one full bale overlap where not continuous.

For the purpose of attaching stucco mesh to the wall, 12d or larger galvanized common double-headed nails shall be embedded in the concrete a minimum of 1 inch below the top of the stem wall, with the heads embedded a minimum of 2 inches into the concrete, and the points extending a minimum of 3/4" from the face of the stem wall, and spaced a minimum of 6" on center on both sides of the wall.

Section AM106.2.2 Moisture Barrier. A moisture barrier shall be used between the top of the stem wall and the first course of bales. A moisture barrier shall also be used to protect the tops of bales at the top of walls, and shall extend 6 inches down on either side of the wall.

Section AM106.2.3 Stucco Mesh. Stucco mesh, 20 gauge or heavier, shall be attached by means of clinching the embedded nails on one side of the wall, stretching a continuous piece of netting tightly over the top of the wall, and fastening the netting in the same manner on the opposite side of the wall.

Section AM106.2.4 Wall Finish. Walls shall be finished with cement stucco, or stabilized mud plaster, with a minimum thickness of 7/8".

ADD new Appendix RA:

Section RA1 - Earthen Wall Structures

Section RA1.1 General. Earthen wall structures in Seismic Design Category A, B or C with basic wind speed of 90 mph or less with wind exposure category of A, B, or C may be designed and constructed in accordance with the provisions of this Section R614.

This Section shall supersede the limitations of Section R301.2.2 and structures complying with the provisions of Section RA1.1.2 shall have complied with the seismic requirements of this code.

Exception: Structures with any site conditions may be designed with accepted engineering practice for earthen wall structures and the provisions of the IBC Section 2114 as amended.

Section RA1.1.1 Earthen materials. This section shall establish minimum standards for safety for construction of earthen materials structures, collectively known as adobe, rammed earth, and hydraulic pressed unit construction.

Section RA1.1.2 Professional registration not required. When the empirical design provisions of this section are used to design wall systems, project drawings, typical details and specifications are not required to bear the seal of an architect or engineer, unless otherwise required by the state law of the jurisdiction having authority or as required by Section R614.1.3.

Section RA1.1.3 Professional registration required. When the earthen structure is over 12 feet (3638 mm) in height, as measured by Table RA1.2.1, or is over 1 story, or has open walls over 50% of any wall line the plans and specifications shall be prepared by a registered professional architect or engineer licensed in the state for which the project is to be constructed. All such projects shall be designed in accordance with accepted engineering practice for earthen wall structures and in accordance the International Building Code Section 2114 as amended.

Section RA1.2 Dimensions of earth walls. The actual measured thickness of earthen walls shall conform to the requirements of Section R614.

Section RA1.2.1 Thickness and Height. The minimum thickness and maximum height of earthen walls and parapets shall be in accordance with Tables RA1.2.1 (1 to 6) based upon the Sds value for the site of the project. Wall thickness shall be measured from face to face of walls with concave joints. Walls with rake joints shall be measured surface of joint to surface of joint. The thickness of wall sections shall not be combined without full cross bonding of the masonry units throughout the wall.

Exception: Walls supported only at ground level and only supported at the base of the wall shall be limited to a height of 1/2 that allowed by Tables RA1.2.1 (1 to 6).

Table RA1.2.1 (1)

Seismic Sites with Sds

0.00 TO 0.25

Assuming zero tension out-of-plane

			Actual Wall thickness (in)							
--	--	--	----------------------------	--	--	--	--	--	--	--

	10	11	12	13	14	15	16	18	20	22	24
				Maximum Wall Heights (inches)							
EXTERIOR	NP	83	99	116	135	144	144	144	144	144	144
INTERIOR	127	140	144	144	144	144	144	144	144	144	144
PARAPET	NP	22	24	26	28	30	32	36	40	44	48
				Bond Beam Size and Steel Requirements							
				All Bond Beams 8" Minimum Height							
EXTERIOR WALL											
NO PARAPET											
TYPE "A"	2 - #4	2 - #4	2 - #5	2 - #5	2 - #5	2 - #5	2 - #4	2 - #4	2 - #4	2 - #4	2 - #4
TYPE "B"	2 - #5	2 - #5	2 - #5	4 - #4	4 - #4	4 - #4	2 - #5	2 - #4	2 - #4	2 - #4	2 - #4
TYPE "C"	NP	NP	NP	NP	NP	4 - #5	4 - #4	2 - #4	2 - #4	2 - #4	2 - #4
EXTERIOR WALL											
with FULL PARAPET											
TYPE "A"	2 - #4	2 - #4	2 - #5	2 - #5	2 - #5	2 - #5	2 - #4	2 - #4	2 - #4	2 - #4	2 - #4
TYPE "B"	2 - #5	2 - #5	2 - #5	4 - #4	4 - #4	4 - #4	2 - #5	2 - #4	2 - #4	2 - #4	2 - #4
TYPE "C"	NP	NP	NP	NP	NP	4 - #5	4 - #4	2 - #4	2 - #4	2 - #4	2 - #4
INTERIOR WALL											
with infill between beams											
TYPE "A"	2 - #4	2 - #4	2 - #5	2 - #5	2 - #5	2 - #5	2 - #4	2 - #4	2 - #4	2 - #4	2 - #4
TYPE "B"	2 - #5	2 - #5	2 - #5	4 - #4	4 - #4	4 - #4	2 - #5	2 - #4	2 - #4	2 - #4	2 - #4
TYPE "C"	NP	NP	NP	NP	NP	4 - #5	4 - #4	2 - #4	2 - #4	2 - #4	2 - #4

NP = This wall not permitted.

Table RA1.2.1 (2)

Seismic Sites with Sds

0.25 TO 0.30

Assuming zero tension out-of-plane

	10	11	12	Actual Wall thickness (in) 13	14	15	16	18	20	22	24
				Maximum Wall Heights (inches)							
EXTERIOR	NP	83	99	116	135	144	144	144	144	144	144
INTERIOR	106	116	127	137	144	144	144	144	144	144	144
PARAPET	NP	22	24	26	28	30	32	36	40	44	48
				Bond Beam Size and Steel Requirements							
				All Bond Beams 8" Minimum Height							
EXTERIOR WALL											
NO PARAPET											
TYPE "A"	2 - #4	2 - #5	2 - #5	2 - #5	4 - #4	4 - #4	2 - #5	2 - #4	2 - #4	2 - #4	2 - #4
TYPE "B"	2 - #5	4 - #4	4 - #4	4 - #5	4 - #5	4 - #5	4 - #4	2 - #5	2 - #4	2 - #4	2 - #4
TYPE "C"	NP	NP	NP	NP	NP	4 - #5	4 - #5	2 - #5	2 - #4	2 - #4	2 - #4
EXTERIOR WALL											
with FULL PARAPET											
TYPE "A"	2 - #4	2 - #5	2 - #5	2 - #5	4 - #4	4 - #4	2 - #5	2 - #4	2 - #4	2 - #4	2 - #4
TYPE "B"	2 - #5	4 - #4	4 - #4	4 - #5	4 - #5	4 - #5	4 - #4	2 - #5	2 - #4	2 - #4	2 - #4
TYPE "C"	NP	NP	NP	NP	NP	4 - #5	4 - #5	2 - #5	2 - #4	2 - #4	2 - #4
INTERIOR WALL											
with infill between beams											
TYPE "A"	2 - #4	2 - #5	2 - #5	2 - #5	4 - #4	4 - #4	2 - #5	2 - #4	2 - #4	2 - #4	2 - #4
TYPE "B"	2 - #5	4 - #4	4 - #4	4 - #5	4 - #5	4 - #5	4 - #4	2 - #5	2 - #4	2 - #4	2 - #4
TYPE "C"	NP	NP	NP	NP	NP	4 - #5	4 - #5	2 - #5	2 - #4	2 - #4	2 - #4

NP = This wall not permitted.

BOND BEAM LOAD	46	61	79	100	125	125	108	80	42	0	0
BOND BEAM LOAD	81	103	130	160	194	204	198	194	183	171	203
BOND BEAM LOAD	84	100	118	137	150	151	152	155	158	161	164

Table RA1.2.1 (3)

Seismic Sites with Sds

0.30 TO 0.35

Assuming zero tension out-of-plane

	10	11	12	Actual Wall thickness (in) 13	14	15	16	18	20	22	24
				Maximum Wall Heights (inches)							
EXTERIOR	NP	83	99	116	127	136	144	144	144	144	144
INTERIOR	91	100	109	118	127	136	144	144	144	144	144
PARAPET	NP	22	24	26	28	30	32	36	40	44	48
				Bond Beam Size and Steel Requirements All Bond Beams 8" Minimum Height							
EXTERIOR WALL NO PARAPET											
TYPE "A"	2 - #5	2 - #5	2 - #5	4 - #4	4 - #4	4 - #5	4 - #5	4 - #4	2 - #5	2 - #4	2 - #4
TYPE "B"	4 - #4	4 - #4	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #4	2 - #5	2 - #4	2 - #4
TYPE "C"	NP	NP	NP	NP	NP	4 - #6	4 - #6	4 - #5	4 - #4	2 - #5	2 - #4
EXTERIOR WALL with FULL PARAPET											
TYPE "A"	2 - #5	2 - #5	2 - #5	4 - #4	4 - #4	4 - #5	4 - #5	4 - #4	2 - #5	2 - #4	2 - #4
TYPE "B"	4 - #4	4 - #4	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #4	2 - #5	2 - #4	2 - #4
TYPE "C"	NP	NP	NP	NP	NP	4 - #6	4 - #6	4 - #5	4 - #4	2 - #5	2 - #4
INTERIOR WALL with infill between beams											
TYPE "A"	2 - #5	2 - #5	2 - #5	4 - #4	4 - #4	4 - #5	4 - #5	4 - #4	2 - #5	2 - #4	2 - #4
TYPE "B"	4 - #4	4 - #4	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #4	2 - #5	2 - #4	2 - #4
TYPE "C"	NP	NP	NP	NP	NP	4 - #6	4 - #6	4 - #5	4 - #4	2 - #5	2 - #4

NP = This wall not permitted.

BOND BEAM LOAD	53	71	92	117	137	157	176	156	127	88	40
BOND BEAM LOAD	94	121	151	186	218	250	281	289	291	287	277
BOND BEAM LOAD	86	103	120	140	160	182	203	206	210	213	216

Table RA1.2.1 (4)

Seismic Sites with Sds

0.35 TO 0.40

Assuming zero tension out-of-plane

	10	11	12	Actual Wall thickness (in) 13	14	15	16	18	20	22	24
				Maximum Wall Heights (inches)							
EXTERIOR	NP	83	95	103	111	119	127	143	144	144	144
INTERIOR	79	87	95	103	111	119	127	143	144	144	144
PARAPET	NP	22	24	26	28	30	32	36	40	44	48
				Bond Beam Size and Steel Requirements All Bond Beams 8" Minimum Height							
EXTERIOR WALL NO PARAPET											
TYPE "A"	2 - #5	2 - #5	4 - #4	4 - #4	4 - #4	4 - #5	4 - #5	4 - #5	4 - #4	2 - #5	2 - #5
TYPE "B"	4 - #4	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #4	2 - #5
TYPE "C"	NP	NP	NP	NP	NP	4 - #6	4 - #6	4 - #6	4 - #5	4 - #5	2 - #5
EXTERIOR WALL with FULL PARAPET											
TYPE "A"	2 - #5	2 - #5	4 - #4	4 - #4	4 - #4	4 - #5	4 - #5	4 - #5	4 - #4	2 - #5	2 - #5
TYPE "B"	4 - #4	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #4	2 - #5
TYPE "C"	NP	NP	NP	NP	NP	4 - #6	4 - #6	4 - #6	4 - #5	4 - #5	2 - #5
INTERIOR WALL with infill between beams											
TYPE "A"	2 - #5	2 - #5	4 - #4	4 - #4	4 - #4	4 - #5	4 - #5	4 - #5	4 - #4	2 - #5	2 - #5
TYPE "B"	4 - #4	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #4	2 - #5
TYPE "C"	NP	NP	NP	NP	NP	4 - #6	4 - #6	4 - #6	4 - #5	4 - #5	2 - #5

NP = This wall not permitted.

BOND BEAM LOAD	61	81	101	118	137	157	179	227	211	181	142
BOND BEAM LOAD	108	138	168	198	229	263	299	379	399	409	412
BOND BEAM LOAD	89	105	123	143	163	186	209	260	268	272	276

Table RA1.2.1 (5)

Seismic Sites with Sds

0.40 TO 0.45

Assuming zero tension out-of-plane

	10	11	12	Actual Wall thickness (in) 13	14	15	16	18	20	22	24
				Maximum Wall Heights (inches)							
EXTERIOR	NP	78	85	92	99	106	113	127	141	144	144
INTERIOR	70	78	85	92	99	106	113	127	141	144	144
PARAPET	NP	22	24	26	28	30	32	36	40	44	48
				Bond Beam Size and Steel Requirements All Bond Beams 8" Minimum Height							
EXTERIOR WALL NO PARAPET											
TYPE "A"	2 - #5	2 - #5	4 - #4	4 - #4	4 - #4	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #4
TYPE "B"	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #6	4 - #5	4 - #5
TYPE "C"	NP	NP	NP	NP	NP	4 - #6	4 - #6	4 - #6	4 - #6	4 - #6	4 - #5
EXTERIOR WALL with FULL PARAPET											
TYPE "A"	2 - #5	2 - #5	4 - #4	4 - #4	4 - #4	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #4
TYPE "B"	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #6	4 - #5	4 - #5
TYPE "C"	NP	NP	NP	NP	NP	4 - #6	4 - #6	4 - #6	4 - #6	4 - #6	4 - #5
INTERIOR WALL with infill between beams											
TYPE "A"	2 - #5	2 - #5	4 - #4	4 - #4	4 - #4	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #4
TYPE "B"	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #6	4 - #5	4 - #5
TYPE "C"	NP	NP	NP	NP	NP	4 - #6	4 - #6	4 - #6	4 - #6	4 - #6	4 - #5

NP = This wall not permitted.

BOND BEAM LOAD	68	85	101	118	137	157	179	227	280	274	243
BOND BEAM LOAD	121	149	177	208	241	276	314	398	491	530	548
BOND BEAM LOAD	91	108	126	146	167	189	213	265	322	339	343

Table RA1.2.1 (6)

Seismic Sites with Sds

0.45 TO 0.50

Assuming zero tension out-of-plane

	10	11	12	Actual Wall thickness (in) 13	14	15	16	18	20	22	24
				Maximum Wall Heights (inches)							
EXTERIOR	NP	70	76	82	89	95	101	114	127	140	144
INTERIOR	63	70	76	82	89	95	101	114	127	140	144
PARAPET	NP	22	24	26	28	30	32	36	40	44	48
				Bond Beam Size and Steel Requirements All Bond Beams 8" Minimum Height							
EXTERIOR WALL NO PARAPET											
TYPE "A"	2 - #5	2 - #5	4 - #4	4 - #4	4 - #4	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5
TYPE "B"	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #6	4 - #6	4 - #5
TYPE "C"	NP	NP	NP	NP	NP	4 - #6	4 - #6	4 - #6	4 - #6	4 - #6	4 - #6
EXTERIOR WALL with FULL PARAPET											
TYPE "A"	2 - #5	2 - #5	4 - #4	4 - #4	4 - #4	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5
TYPE "B"	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #6	4 - #6	4 - #5
TYPE "C"	NP	NP	NP	NP	NP	4 - #6	4 - #6	4 - #6	4 - #6	4 - #6	4 - #6
INTERIOR WALL with infill between beams											
TYPE "A"	2 - #5	2 - #5	4 - #4	4 - #4	4 - #4	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5
TYPE "B"	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #5	4 - #6	4 - #6	4 - #5
TYPE "C"	NP	NP	NP	NP	NP	4 - #6	4 - #6	4 - #6	4 - #6	4 - #6	4 - #6

NP = This wall not permitted.

BOND BEAM LOAD	70	85	101	118	137	157	179	227	280	338	345
BOND BEAM LOAD	129	156	185	218	252	290	330	417	515	623	683
BOND BEAM LOAD	93	110	129	149	170	193	217	269	327	390	417

Section RA1.2.2 Maximum length. The maximum length of any earthen wall laterally braced by Bond Beams per Section R614.5.2 shall be 20 feet (6,096 mm) between perpendicular bracing walls. Any wall in excess of 20 feet (6,096 mm) shall be designed in accordance with the amended IBC as noted in Section RA1.1 above, (See Section R614.7 for required lengths of solid shear panels in walls.), or braced by a roof diaphragm roof system as required by Section RA1.5.2.3.

Section RA1.3 Support conditions. Earthen walls shall be supported on a solid concrete, solid masonry foundation system the width of which shall be not be less than 1/2 inch narrower than the earthen wall which it supports. Earthen structures shall not be less than 6 inches above adjacent grade.

Section RA1.3.1 Moisture barrier. A moisture barrier equal to 30 lb. asphalt impregnated building paper, or equivalent moisture resistant barrier, shall be installed between the supporting foundation and the earthen wall material.

Section RA1.4 Allowable stresses. Allowable compressive, tensile and shear stresses in earthen walls shall not exceed the values prescribed in Table RA1.4. In determining the stresses in masonry, the effects of all loads and conditions of loading and the influence of all forces affecting the design and strength of the several parts shall be taken into account. Bolts in shear shall be limited to those values in IBC Table 2114.6.B.

Section RA1.4.1 Combined units. In walls composed of different kinds or grades of units, materials or mortars, the maximum stress shall not exceed the allowable stress for the weakest of the combination of units, materials and mortars of which the wall is composed. The net thickness of any facing unit of earthen materials used to resist stress shall not be less than 3 inches (76.2 mm).

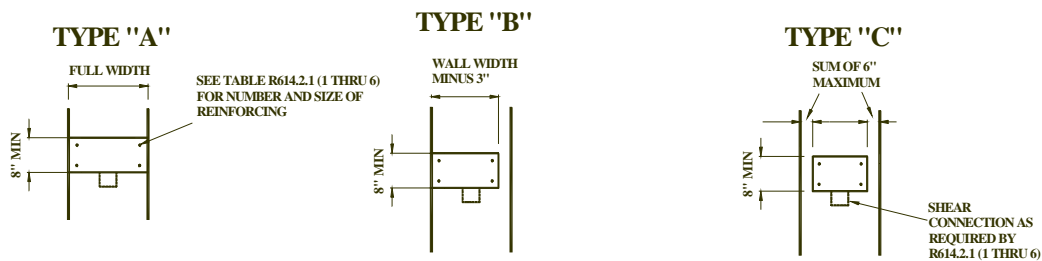
When dissimilar materials, (e.g. concrete masonry or steel) are used to support earth wall construction, such elements shall be structurally isolated from other earth wall elements. The design shall recognize, with specific detailing, the effects shrinkage of the earth wall construction may have on the structural integrity of the structure.

TABLE R614.4				
ALLOWABLE STRESSES FOR EMPIRICAL DESIGN OF EARTHEN WALL STRUCTURES				
		ALLOWABLE STRESSES		
STRENGTH OF UNIT, GROSS AREA		GROSS CROSS-SECTIONAL AREA	NOTE 1	
Compression	300 psi	Normal Loading	30 psi	
		Concentrated Loading	30 psi	
Modulus of rupture	55 psi	Allowable tension without tensile reinforcing	0 psi	
Shear	n.a.	With special inspection	8 psi	
		Without special inspection	4 psi	
Modulus of Elasticity	60,000 psi	Allowable deflection	Less than 1/2%	
For SI: 1 pound per square inch = 6.895 kPa.				
Notes:				
1.	Gross cross-sectional area shall be calculated on the actual rather than the nominal dimensions.			

Section RA1.5 Lateral support. Earthen walls constructed of earthen units shall be bonded and tied to intersecting earthen walls and laterally supported in the vertical direction in accordance with one of the methods in Section RA1.5.1 or Section RA1.5.2.

Section RA1.5.1 Bond Beams. A continuous concrete bond beam system embedded in the earthen walls, designed to provide lateral support for the walls without the aid of additional bracing elements such as roof diaphragm. Bond beams shall be not less than the width of the wall minus 6 inches (152.4 mm) and a height of not less than 8 inches. Bond beams shall be reinforced as required by Tables RA1.5.2.1 (1 to 6). Bars shall be placed not more than 1 ½” from the inside face of the form or veneer block as indicated in Figure RA1.5.2.1.

Figure RA1.5.2.1



Section RA1.5.2.2.1 Bond beam anchorage. Bond beams shall be anchored to earthen walls at intervals of not over 48 inches (1219 mm) by a connection with shear strength of not less than 200 lbs. per lineal foot plus an additional 25 lbs. per lineal foot for every inch of thickness in excess of 16” thick.

Section RA1.5.3 Roof diaphragm. A roof diaphragm complying with other provisions of this code adequate to provide not less than 200 lbs. per lineal foot of lateral support may be used to brace earthen walls. Earthen walls shall be anchored to roof diaphragms with connections to resist loads of not less than 200 lbs. per lineal foot plus an additional 25 lbs. per lineal foot for every inch of thickness in excess of 16” thick. This anchorage shall be tie beams as specified in Section RA1.5.3.2 or other anchorage methods of equal strength.

Section RA1.5.3.1 Tie beams. A tie beam is a concrete or masonry, beam built into the earthen wall for the purpose of anchoring the roof diaphragm and transferring the lateral perpendicular and parallel forces. Tie beams shall be provided for all earthen walls laterally braced by a roof diaphragm. Tie beams shall be anchored to the roof diaphragm system as required by other provisions in this code at intervals not exceeding 4 feet (1219 mm).

Tie beams shall be not less than ½ the width of the earthen wall, a minimum of 8 inches (203.2 mm) high and reinforced with 2 - #4 reinforcing bars.

Section RA1.5.3.2 Tie beam anchorage. Tie beams shall be anchored to earthen walls at intervals of not over 48 inches (1219 mm) by a connection with shear strength of not less than 200 lbs. per lineal foot plus an additional 25 lbs. per lineal foot for every inch of thickness in excess of 16" thick.

Section RA1.6 Lintels. Earthen walls over openings shall be supported by steel lintels, reinforced concrete or masonry lintels or earthen arches designed to support load imposed. Lintels shall not be supported by rigid structural columns, frames or posts with rigidities greater than the earthen wall unless the design allows for the potential for differential settlements.

Small openings less than 12" may be constructed without structural lintels.

Section RA1.7 Shear walls. earthen walls subject to in-plane loads shall be designed with at least one earthen wall shear panel, at least 4 feet long, free of openings, with a length as computed by formula RA1.7-1.

$$L = (\text{Sqrt PL} \times \text{Sds} \times 4) \quad \text{Equation RA1.7-1}$$

Where:

L = Length of shear panel

PL = Sum of overall length of walls perpendicular to the panel.

Sds = Sds factor as determined by Section 1615 of the International Building Code.

Section RA1.8 Jambs at openings. Portions of walls between openings or corner shall be constructed with lengths of not less than 1 ½ times the thickness of the wall in which they occur.

Section RA1.9 Piers. The thickness of isolated earthen piers shall be not less than 1 ½ times those wall thickness values indicated in Table RA1.1.2.1A1(1 to 6). When structural posts or columns are provided within the pier ties or attachments shall be provided to the earthen wall system to laterally secure it as required by Section R614.11.

Section RA1.9.1 Pier Cap. A solid concrete cap shall be provided at the top of load bearing piers under all concentrated loads. The cap shall cover not less than 50% of the top of the pier.

Section RA1.10 Chases. Chases and recesses in earthen walls shall not be deeper than one-half the thickness of the wall thickness. The maximum length of a horizontal chase or horizontal projection shall not exceed 4 feet (1219 mm), and shall have at least 8 inches (203.2 mm) of masonry in back of the chases and recesses and between adjacent chases or recesses and the jambs of openings.

Chases and recesses in earthen walls shall be designed and constructed so as not to reduce the required strength or required fire resistance of the wall and in no case shall a chase or recess be permitted within the required area of a pier. Masonry directly above chases or recesses wider than 12 inches (304.8 mm) shall be supported on noncombustible lintels.

Section RA1.11 Stack bond. When the earthen wall is constructed of units, (e.g. adobe brick), units shall not be laid in stack bond. Units shall, in all locations throughout the wall system, overlap the courses below by not less than one-third the dimension of the units.

Section RA1.12 Metal reinforcement. In addition to bonding earthen walls shall be anchored at their intersections, all walls shall be reinforced with joint reinforcement at vertical intervals of not more than

16 inches (406.4 mm). Horizontal reinforcement shall be continuous at the intersections. Reinforcement shall be not more than 4 inches narrower than the wall thickness.

Section RA1.13 Veneer. All veneers using earthen materials shall be installed in accordance with this section. Such veneers shall be installed with a noncombustible foundation, over concrete masonry, a backing of wood or cold-formed steel and shall be limited to the first story above grade and be not less than 4 inches (101.6 mm) or greater than 8 inches (203.2 mm) in thickness. Veneers shall not exceed a height of over 20 times their thickness without structural vertical support.

Section RA1.13.1 Anchorage. Earth units shall be anchored to the supporting wall with a corrosion-resistant veneer tie system mechanically attached to continuous horizontal joint reinforcement continuously installed in the veneer bed joint not less than 16 inches (406.4 mm) on center vertically. When earth mortar systems are used the tie system shall prevent the accumulation of mortar at the base of the veneer. Conventional brick ties shall not be used to anchor earth units.

Section RA1.13.2 Air space. The veneer shall be separated from the sheathing by an air space of a minimum of 1 inch (25.4 mm) but not more than 2 inches (50.8 mm). A moisture-resistant barrier or 15 lb. asphalt-saturated felt as required by Section R703.2 shall be provided except when veneer is applied over concrete masonry or concrete backing.

Section RA1.13.3 Flashing. Approved corrosion-resistive flashing shall be provided in the exterior wall envelop in such a manner as to prevent entry of water into the wall cavity or penetration of water into the building structural framing components. The flashing shall extend to the surface of the exterior wall finish and shall be installed to prevent water from reentering the exterior wall envelope. Flashing shall be located beneath the first course of veneer, and at other points of support, including structural floors, shelf angles and lintels. Approved corrosion-resisting flashing shall be installed at all of the following locations:

1. At top of all exterior window and door openings in such a manner as to be leak proof.
2. At the intersection of chimneys or other masonry construction with frame or stucco walls, with projecting lips on both sides under stucco copings.
3. Under and at the ends of masonry, wood or metal copings and sills.
4. Where exterior porches, decks or stairs attach to a wall or floor assembly of wood-frame construction.
5. At wall and roof intersections.

Section RA1.13.4 Weep holes. Weep holes shall be provided in the outside with of masonry walls at a maximum spacing of 33 inches (838.2 mm) on center. Weep holes shall not be less than 3/16 inches (4.76 mm) in diameter. Weep holes shall be located immediately above the flashing.

Section RA1.13.5 Plaster veneer. Both interior and exterior faces of earthen walls which are to be plastered with cement plaster shall be lathed and plastered in accordance the Section R703.6.1.

Section RA1.14 Buttresses. Earthen walls used as buttresses shall not extend beyond an average length perpendicular to the wall to be braced a distance of 6 feet (1829 mm) without consideration to out-of-plane bending of the buttress.

Section RA1.15 Gable end walls. Gable end walls shall be constructed using veneer construction as required by Section RA1.13 or shall be provided with lateral bracing to prevent overturn designed in accordance with the IBC as modified.

Section RA1.16 Ledgers. Ledgers shall not be used to support vertical live and dead loads in excess of 75 lbs. per lineal foot.

Section RA1.17 Construction documents. In addition to the provisions of Section R106 all plans for earthen structures shall include the following:

1. The Sds number of the site.
2. The wind speed and site exposure coefficient of the site.
3. The material standard to which the earthen materials will comply.
4. The foundation supporting system and moisture barrier material.
5. The length, height and thickness in the actual dimensions of all earthen walls and parapets.
6. The bond beam or tie beam construction and attachment method to the earthen wall.
7. Lintel design, construction and end bearing area.
8. Veneer dimensions, attachment methods, moisture barrier and supporting structure.
9. Flashing materials and installation.
10. Metal reinforcement type and location.

Section RA1.18 Corbeled wall elements. The maximum corbeled projection beyond the face of the wall shall not be more than one fourth of the wall thickness.

Section RA1.19 Material standards. The materials used in earthen wall structures shall comply with the following material standards. For each of the tests prescribed in these standards, five full size sample units shall be selected at random from each lot of units of fraction thereof produced. Mass wall systems such as rammed earth shall provide a five tests for each required standard test series.

Section RA1.19.1 Manufacturers of earthen materials. Established manufacturers of earthen materials shall certify compliance with these standards. Copies of their periodic testing shall be supplied to the building official when requested. Literature, advertising and other information supplied by the manufacturer to designers and users of earthen materials shall include the actual dimensions of units, not nominal dimensions.

Section RA1.19.2 Onsite earthen materials. Earthen units, mortar, rammed earth wall materials mined, mixed, formulated, and or molded on site shall be tested for compliance with these standards. For individual structures, a set of tests shall be provided for the first 2500 square feet of wall and an additional test for each additional 2500 square feet or portion thereof in the structure. At least one set of tests shall be made for each structure and for each 2500 square feet of patio wall. The fabricator of the materials used in the project shall certify in writing to the building official compliance with these standards. The certification shall include the number of units site molded, size of the units, volume of material used as mortar, dates of fabrication, and results of testing of the material. If materials from established manufacturers and onsite materials are used in the project, copies of records including sources, quantities, and location of use within the structure shall be provided to the building official upon request.

Section RA1.19.3 Categories of earthen materials. Type I, II, III, and IV earthen materials are approved for use in construction of projects designed in accordance with Section 2114.

Exception: Type I adobe shall only be used for repairs and small additions in which new walls do not exceed 10% of the surface area of existing walls of Type I construction and for structures constructed of a similar material system and for projects requiring this class of materials to meet historic guidelines.

Section RA1.19.3.1 Required plaster veneer. Adobe of Type I and II shall be protected on the exterior with exterior plaster meeting the requirements of IBC Section 2512 applied over wire lath. Type I and II adobe shall not be used within 4 inches (101.6 mm) of the floor or at the top of parapet walls or near potential sources of water which may affect the stability of the earth wall system. Other Types of adobe may be left unplastered and may be used without separation from the floor.

Section RA1.19.3.2 Adobe units and mortar. Moisture resistant stabilized adobe units and mortar shall meet the following testing standards as indicated in Table. Type S Portland cement mortar may be used for Type II, III, and IV adobe in lieu of earth mortar.

Table RA1.19.3.2

<i>Material Type</i>	Dry Compression R614.19.3.2.1	Wet Compression R614.19.3.2.2	Modulus of Rupture R614.19.3.1.3	Absorption <2.5% R614.19.3.2.4	Absorption <5.0% R614.19.3.2.5	Moisture Content R614.19.3.2.6
I	X		X			X
II	X		X		X	X
III	X		X	X		X
IV		X	X			X

X Indicates that material must pass the test standards prescribed in this Section.

Section RA1.19.3.2.1 Dry compression strength. Determine the compressive strength of the required number of samples as required by Section R614.19. in accordance with the following procedures.

Section RA1.19.3.2.1.1 Dry the Specimen. Dry the specimen at a temperature of 85° F.+ -15° F. (29° C. +- 9°) in an atmosphere having relative humidity of not more than 50 percent. Weigh the specimen at one-day intervals until constant weight is attained.

Section RA1.19.3.2.1.2 Cap the Specimen. The specimen may be suitably capped with calcined gypsum mortar or the bearing surfaces may be rubbed smooth and true. Then calcined gypsum is used for capping, conduct the test after the capping has set and the specimen has been dried to constant weight in accordance with Item 1 of this section.

Section RA1.19.3.2.1.3 Test the Specimen. Test the specimens in the position in which the earthen unit is designed to be used. And bed on and cap with a felt pad not less than 1/8 inch (3.2mm) or more than 1/4 inch (6.4 mm) in thickness.

Section RA1.19.3.2.1.4 Testing Equipment. The loading head shall completely cover the bearing area of the specimen and the applied load shall be transmitted through a spherical bearing block of proper design. The speed of the moving head of the testing machine shall not be more than 0.05 inch (1.27 mm) per minute.

Section RA1.19.3.1.5 Reporting Results. Calculate the average compressive strength of the specimens tested and report this as the compressive strength of the block. Units shall have an average dry compressive strength of 300 psi (2068 kPa) and no individual unit may have a strength of less than 250 psi. (1724 kPa).

Section RA1.19.3.2.2 Wet compression strength. Determine the compressive strength of the required number of specimen as required by Section RA1.19.3.2.1 in accordance with the following procedures.

Section RA1.19.3.2.2.1 Cap the Specimen. The specimens may be suitably capped with a capping material compatible with water saturation or the bearing surfaces may be rubbed smooth and true.

Section RA1.19.3.2.2.2 Wetting the Specimen. Submerge the specimen under water for not less than 8 hours or longer as required until fully saturated.

Section RA1.19.3.2.2.3 Test the Specimen. Immediately test the specimen in the position in which the earthen unit is designed to be used. And bed on and cap with a felt pad not less than 1/8 inch (3.2 mm) or more than 1/4 inch (6.4 mm) in thickness.

Section RA1.19.3.2.2.4 Testing Equipment. The loading head shall completely cover the bearing area of the specimen and the applied load shall be transmitted through a spherical bearing block of proper design. The speed of the moving head of the testing machine shall not be more than 0.05 inch (1.27 mm) per minute.

Section RA1.19.3.2.2.5. Reporting Results. Calculate the average compressive strength of the specimens tested and report this as the compressive strength of the block. Adobe units shall have an average wet compressive strength of 300 psi (2068 kPa). Five samples shall be tested and no individual unit may have a wet compressive strength of less than 250 psi. (1724 kPa).

Section RA1.19.3.2.3 Modulus of rupture. Adobe units shall have an average modulus of rupture of 50 psi (345 kPa) when tested in accordance with the following procedure. Five samples shall be tested and no individual unit shall have a modulus of rupture of less than 35 psi (241 kPa).

Section RA1.19.3.2.3.1 Support conditions. A cured unit shall be simply supported by 2-inch-diameter (50.8 mm) cylindrical supports located 2 inches (50.8 mm) in from each end and extending the full width of the unit.

Section RA1.19.3.2.3.2 Loading conditions. A 2-inch-diameter (50.8 mm) cylinder shall be placed at mid-span parallel to the supports.

Section RA1.19.3.2.3.3 Testing procedure. A vertical load shall be applied to the cylinder at the rate of 500 pounds per minute (37 N/s) until failure occurs.

Section RA1.19.3.2.3.4 Modulus of rupture determination. The modulus of rupture shall be determined by the formula:

$$Fr = 3WLs/2bt^2 \quad (\text{Equation 2116.3.2.3.4-1})$$

Where, for the purposes of this section only:

b = Width of the test specimen measured parallel to the loading cylinder, inches (mm).
fr = Modulus of rupture, psi (Mpa).
Ls = Distance between supports, inches (mm).
T = Thickness of the text specimen measured parallel to the direction of load, inches (mm).
W = The applied load at failure, pounds (N).

Section RA1.19.3.2.4 Absorption less than 2.5%. A 4-inch (101.6 mm) cube, cut from an adobe unit fired to a constant weight in a ventilated oven at 212 degrees F to 239 degrees F , shall not absorb more than 2 ½ percent moisture by weight when placed upon a constantly water-saturated, porous surface for 7 days. A minimum of five specimens shall be tested and each specimen shall be cut from a separate unit.

Section RA1.19.3.2.5 Absorption less than 5.0%. A 4-inch (101.6 mm) cube, cut from an adobe unit fired to a constant weight in a ventilated oven at 212 degrees F to 239 degrees F , shall not absorb more than 2 ½ percent moisture by weight when placed upon a constantly water-saturated, porous surface for 7 days. A minimum of five specimens shall be tested and each specimen shall be cut from a separate unit.

Section RA1.19.3.2.6 Additional Requirements. All earthen units shall meet the following requirements.

Section RA1.19.3.2.6.1 Moisture content requirements. Earthen units shall have a moisture content not exceeding 4 percent by weight at the time of use.

Section RA1.19.3.2.6.2 Shrinkage cracks. All earthen units shall not contain more than three shrinkage cracks and any single shrinkage crack shall not exceed 3 inches (76.2 mm) in length or 1/8 inch (3.2 mm) in width.

Section RA1.19.3.2.6.3 Soil requirements. Soil used for moisture resisting adobe units and mortar shall be chemically compatible with the stabilizing material. The soil shall contain sufficient clay to bind the particles together without the aid of stabilizers. The soil shall contain not more than 0.2 percent of water-soluble salts.

Section RA1.19.3.3 Cement Stabilized Rammed Earth. Cement stabilized Rammed Earth shall meet the following standards. The installer of the wall system shall comply with the requirements of Section 2114.14.2 for frequency of testing.

Section RA1.19.3.3.1 Testing before Construction. The installer of cement stabilized Rammed Earth shall provide the following testing before issuance of a building permit.

Section RA1.19.3.3.2 Materials from a Licensed Sand and Gravel Producer. A copy of Proctor ASTM D 698 shall be provided for each soil type and source or combination of sources. Periodic testing as provided by the supplier may be supplied to meet this requirement. The soil contain not more than 0.2 percent of water-soluble salts.

Section RA1.19.3.3.3 Material Mined and Mixed on Site. A copy of ASTM D 698, ASTM C 117, ASTM C 136, and ASTM D 4318 shall be provide for each soil type and source or combination of

sources. Such tests shall be repeated as required to assure that all materials to be used have been tested and are represented by the tests. The soil shall contain not more than 0.2 percent of water-soluble salts.

Section RA1.19.3.3.4 Testing required during Construction. The installer of cement stabilized Rammed Earth shall provide the following tests made during the construction process. A certified testing laboratory shall provide field density tests for comparison to the pre-construction Proctor ASTM D 698, percent moisture ASTM D 2216, dry density ASTM D 698, and percent moisture ASTM D 1556. Cement Stabilized Rammed Earth walls shall meet or exceed 95% maximum dry density (ASTM D 698). Samples taken from the wall shall exceed 300 psi compression (ASTM D 1633) 14 days after placement.