



November 6, 2020

Adam Hicks, Chief Building Official  
Coconino County Community Development  
Building Division  
2500 N. Fort Valley Rd.  
Flagstaff, AZ 86001

RE: 2009 New Mexico Earthen Building Materials Code

Dear Mr. Hicks,

This letter is to encourage the adoption of the content of the 2009 New Mexico Earthen Building Materials Code, with specific guidance and recommendations for some items following, as an amendment to Ordinance 2019-10 for Coconino County.

The Alternative Technology Advisory Group was created for the purpose of reviewing alternative building methodologies and technologies that don't meet prescriptive building code requirements and to make recommendations to the Coconino County Building Division regarding those alternatives.

Interest in sustainable building with local materials, such as earthen ones, has increased in recent years in Coconino County due to growing interest in sustainability and affordability. Coconino County encourages sustainable building as a way to conserve resources, reduce energy use and shrink carbon footprint. Sustainable building approaches are often difficult to evaluate against building code requirements. Coconino County Community Development has established the Alternative Technology Advisory Group, made up of experts in sustainable technologies, building code and alternative construction techniques, to help the Building Division evaluate new technologies.

We support adoption of the content of the 2009 New Mexico Earthen Building Materials Code because it:

- Has been in place in New Mexico in some form for almost 20 years.
- Is based on empirical data from the numerous earthen structures in that state.
- Was developed to address design criteria required across New Mexico, some of which mimic those in Coconino County.
- Will provide a clear path to permitting earthen structures in the County.

We have the following clarifications/recommendations to the 2009 New Mexico Earthen Building Materials Code for the amendment to the Ordinance:

#### **14.7.4.8 Earthen Building Materials**

##### **Add C. Number of Stories (from IBC adobe section but applied to all earthen building methods)**

Earthen building construction shall be limited to buildings not exceeding one story, except that two-story construction is allowed when designed by a registered design professional.

#### **14.7.4.11 Properties, Sampling and Testing**

**E. Mortar.** All mortars must meet the compressive strength requirement of 300 psi as determined through an unconfined compression test of a set cylinder of the mortar.

##### **L. Wood Lintels**

The wood lintel schedule was spot-checked and the configurations were adequate. We recommend the table's inclusion in the amendment. We also recommend identifying a common wood type (pressure-treated Southern Yellow Pine #2) that meets the required fiber stress of 850 psi.

##### **M. Concrete Lintels**

All configurations listed in Table 3 were checked and we recommend its inclusion in the amendment with the exception that for the Maximum Span of less than 6' the reinforcing be changed from 2 - # 4 rebar to 2 - #5 rebar.

**O. Plastering.** All listed plasters in this section are acceptable as we recommend requiring a drain plane between the earthen material and insulation, addressing concerns with moisture and condensation.

##### **P. Wall Insulation**

1) Wall insulation meeting the IECC requirements shall be installed, with a minimum R-value of 13. We recommend greater insulation of R-24 or more and will include this recommendation in an educational guide to earthen structures.

2) A continuous vertical moisture drain plane to the outside of the foundation wall shall be installed between the earthen wall and the exterior insulation (to prevent condensate forming against the wall). The drain plane must allow significant contact between the insulation and the air barrier (Tyvek DrainWrap is one example that will allow both drainage and contact with insulation). A sectional, scaled drawing of the exterior wall detailing the attachment of the IECC-required insulation, including the attachment mechanism and spacing, must be submitted for review by the building official. The attachment mechanism and spacing must adequately support the insulation and any exterior siding or stucco. Screws or serrated nails with a 2.5-inch minimum penetration are recommended for adequate pull-out resistance & support.

#### **Q. Parapets.**

Parapets are not recommended due to excessive ongoing required maintenance to prevent moisture and structural damage. If incorporated into the design, a sectional, scaled drawing of the parapet wall detailing the structure, IECC required insulation (on both sides and top) continuous water penetration barrier and maintenance requirements must be submitted for review by the building official. Parapets must also be designed by a structural engineer.

#### **14.7.4.12 Rammed Earth Construction**

##### **E. Lateral Support**

All methods of lateral support that are listed are adequate. For the steel or wood frame intersecting wall, proper cross-bracing will be determined using IRC table 602.10.3

##### **F. Openings**

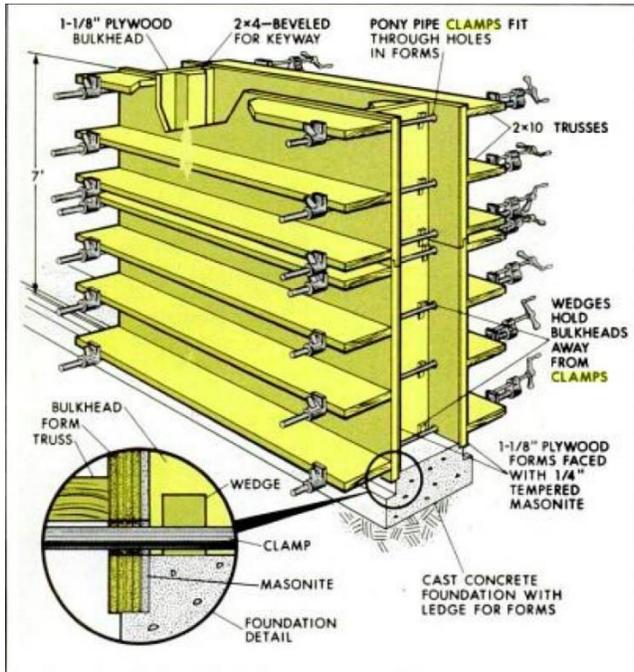
The inclusion of these requirements is important for the structural integrity of the corners of rammed earth buildings; we recommend it be included for adobe and compressed earth block building corners as well.

##### **G. Piers.**

We recommend this paragraph be retained with the understanding that the term “pier” is not descriptive of what they are defined to be in Figure 9-A and 9-B, which is small walls between openings.

#### **14.7.4.13 Foundations**

**B.** Rammed earth walls may not overhang the load bearing surface, though the wall insulation may. See following figure showing notched stem wall to support the rammed earth form.



**14.7.4.14 Rammed Earth Soil Specifications**

**B. Soil compressive strength.** Cylindrical test units of rammed earth shall be tested by a certified laboratory at random intervals selected by the building inspector during the construction of the building. The frequency shall be 1 test for every 100' of wall. Projects achieving a higher compressive strength on test units shall be allowed to reduce the testing frequency by a factor of  $300 \text{ psi} \div \text{actual compressive strength}$ . A minimum of 1 test shall be conducted for each project.

It is further recommended that a soil analysis for prepared soil for the construction is done before amendment is added to ensure it is the recommended mix. Silt and clay can be mistaken for one another and it is best to have this more inexpensive test done first before doing the required compressive strength test. We will include this recommendation in our educational guide.

Cylindrical test units can be made using a 3-hole porous block (available from Western Technologies):



#### **14.7.4.16 Attachments and Connections**

**H. Attachment of concrete bond beam to a rammed earth wall.** We recommend the inclusion of this paragraph as well as the corresponding Figure 16 in the amendment as is. The connection of the roof to the concrete bond beam addresses uplift forces through the weight of the bond beam. The purpose of the rebar between the rammed earth wall and the bond beam is to act as a dowel to hold the bond beam to the rammed earth wall to resist out-of-plane forces. We recommend that the rebar is set after the earth is partially tamped rather than after it is completely compacted because hammering the rebar into the compacted wall may crack it.

**I. Attachment of wood bond beam to a rammed earth wall.** We recommend the inclusion of this paragraph instead of the IBC table if the bolts aren't rammed into the structure and are instead attached after the wall is built. We are concerned with cracking.

#### **14.7.4.17 Bond Beams**

**A. General.** We recommend the inclusion of the Exception. This is common practice in earthen construction as it allows for an earthen façade covering the bond beam so the wall appears to be constructed completely of earthen material.

#### **14.7.4.18 Lintels Over Openings**

We recommend inclusion of Figure 15, which accurately depicts the requirement of the minimum bearing length of the lintel on the wall. Lintel spans in the table correspond with the opening dimension and do not include the length of lintel bearing on the adjacent walls.

## COMMUNITY DEVELOPMENT

Table 4 was spot-checked and was found to be more than adequate. It is recommended that the Grade 40 steel reinforcement minimum be changed to Grade 60.

### 4.7.4.22 Electrical

**A. Electrical System Installation.** Electrical wiring within a channel/raceway or conduit shall be covered a minimum of 2.5" for protection of the wiring and structural integrity of the wall.

### 14.7.4.23 Compressed Earth Block Construction

We recommend that the Compressed Earth Block Construction section be included in the amendment to the Ordinance.

### 14.7.4.24 Mortar

**A. General.** All mortars must meet the compressive strength requirement of 300 psi as determined through an unconfined compression test of a set cylinder of the mortar. Mortar shall be fully bedded on entire surface of the block.

**B. Slip mortars.** Omit statement that water may be substituted for slip mortar.

**C. Stacking.** Compressed earth blocks may be stacked without mortar. Underlying blocks must be swept clean of any debris larger than 1/16" and sufficient water applied to the surface of the head and bed joints to create adequate cohesion. The wall must be stuccoed with a cementitious material on the exterior and plastered on the interior.

All other parts of the CEB code mimic the Adobe portion of the code and are acceptable.

### 14.7.4.40 Figure 10- Wood Bond Beam Construction

This figure shows only a flat roof, which would have less up-lift forces than a pitched roof. Jim Hands, the structural engineer who helped develop the NM code said that any type of roof can be used, but the maximum overhang is 24".

With these recommendations, we are in full support of the adoption of the New Mexico Earthen Materials Code into Coconino County Ordinance 2019-10.

Sincerely,

*Nina Schmidt*

Nina Schmidt

Chair of the Alternative Technology Advisory Group