

CODE CHANGE PROPOSAL FORM

(Must be submitted electronically)

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Model Code: 2024 IRC

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Code or Rule Section: Appendix BJ

Firm/Association affiliation, if any:

MN House of Representatives
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Topic of proposal: Strawbale Construction

Code or rule section to be changed: Appendices

Intended for Technical Advisory Group ("TAG"):

General Information

Yes **No**

- | | | |
|--|-------------------------------------|-------------------------------------|
| A. Is the proposed change unique to the State of Minnesota? | ☐ | ☒ |
| B. Is the proposed change required due to climatic conditions of Minnesota? | ☐ | ☒ |
| C. Will the proposed change encourage more uniform enforcement? | ☒ | ☐ |
| D. Will the proposed change remedy a problem? | ☒ | ☐ |
| E. Does the proposal delete a current Minnesota Rule, chapter amendment? | ☐ | ☒ |
| F. Would this proposed change be appropriate through the ICC code development process? | ☐ | ☒ |

Proposed Language

1. The proposed code change is meant to:

☐ change language contained the model code book? If so, list section(s).

☐ change language contained in an existing amendment in Minnesota Rule? If so, list Rule part(s).

☐ delete language contained in the model code book? If so, list section(s).

☐ delete language contained in an existing amendment in Minnesota Rule? If so, list Rule part(s).

☒ add new language that is not found in the model code book or in Minnesota Rule.

2. Is this proposed code change required by Minnesota Statute? If so, please provide the citation.

No.

3. Provide *specific* language you would like to see changed. Indicate proposed new words with underlining and ~~strikethrough~~ words proposed for deletion. Include the entire code (sub) section or rule subpart that contains your proposed changes.

Adoption of the 2024 IRC Appendix BJ Strawbale Construction, as amended by this proposal
Code reference: <https://codes.iccsafe.org/content/IRC2024P1/appendix-bj-strawbale-construction>
Appendix BJ: Strawbale Construction Code with Commentary is provided in Addendum 1 as part of this application.

Proposed amendments for the Minnesota code are as follows:

BJ105.6.6 Separation of bales and earth. Bales shall be separated from earth by not less than 8 12 inches (203 305 mm) in accordance with Figure BJ105.1(1).

BJ105.6.7 Separation of exterior plaster and earth. Exterior plaster applied to straw bales shall be located not less than 6 8 inches (152 203mm) above earth or 3 inches (76 152 mm) above paved areas in accordance with Figures BJ105.1(1) and BJ105.1(2).

(Note: This provides more separation of strawbale walls above grade and paving than required for conventional wood-framed walls in the code. Revised Figures BJ105.1(1) and (2) will be submitted if the code changes as amended is approved.)

BJ105.6.10 Roof overhangs. Strawbale walls with direct-applied exterior plaster shall be provided with roof overhangs as follows:

1. 20" horizontal projection for one-story buildings

2. 30" horizontal projection for two-story buildings

Exception: Exterior strawbale walls with ventilated cladding in accordance with BJ104.1.1.

(Note: This provides more weather protection for strawbale walls than conventional wood-framed walls which have no roof overhang requirement in the code, and increases by 25% the recommended minimums of 16" and 24" respectively, provided by building science expert and strawbale researcher John Straube at University of Waterloo in Ontario, Canada.)

BJ105.6.1.1 Exterior plaster and silicate mineral paint. An approved silicate mineral paint shall be applied to exterior plasters that are direct-applied over strawbale walls.

(Note: This is common practice in Ontario, and standard minimum practice for the leading strawbale building practitioners working in climate zones 6A and 7A when using direct-applied exterior plaster. Silicate mineral paints chemically bond with the mineral substrate they are applied to, creating a durable, water-repellent and vapor-permeable surface without sacrificing vapor permeability. This

reduces water absorption by and saturation of the plaster, preventing or reducing the formation of cracks.)

4. Will this proposed code change impact other sections of a model code book or an amendment in Minnesota Rule? If so, please list the affected sections or rule parts.

No.

Need and Reason

1. Why is the proposed code change needed? Please provide a general explanation as well as a specific explanation for any changes to numerical values (heights, area, etc.)

Strawbale construction has grown in popularity and use in the US and worldwide over the past three decades. Currently, a variety of inconsistent approval pathways in Minnesota are adding significant cost, complexity, and time delays to the design, permitting, construction and inspection processes. In some cases, builders or owners may construct unpermitted strawbale buildings to avoid these delays. By adopting IRC Appendix BJ: Strawbale Construction as amended by this proposal, design professionals, builders, and code officials will have a minimum construction standard by which to design, construct, plan check and inspect strawbale buildings that ensures their durability and safe use.

2. Why is the proposed code change a reasonable solution?

IRC Appendix BJ has been approved through ICC's national model code development process to establish minimum construction standards for strawbale building. Appendix BJ (originally Appendix S) was first approved for the 2015 IRC and like conventional wood-framed construction has since been through three code development cycle updates. The Strawbale appendix has been adopted and used statewide in California, Maryland, New Jersey, New Mexico, Oregon, and in Denver and 6 counties in CO, and in Tucson / Pima County, AZ. These state and local jurisdictions include dry, wet, hot, and cold climates. It has been used extensively in Washington, Oregon, and New England states with no reported problems related to moisture management, structure, fires, or other code-related performance concerns.

3. What other factors should the TAG consider?

"Strawbale construction" encompasses two wall system types and approved variations. The first is (A) LOAD BEARING, composed of load-bearing plastered stacked straw bales that also serve as insulation, as illustrated in Figure BJ101.2A, and with structural requirements and limitations described in Sections BJ106.2 through BJ106.12. The second is (B) POST-AND-BEAM WITH STRAWBALE INFILL composed of a load-bearing framing system, nonbearing strawbale insulation, and plaster or other compatible cladding as illustrated in Figure BJ101.2B, and with structural requirements and limitations described in Sections BJ106.2 through BJ106.11 and BJ106.15. Either system can use reinforced plaster cladding to provide lateral-force resistance as a braced wall panel with structural requirements and limitations described in Sections BJ106.2 through BJ106.11 and BJ106.13, but can also use conventional braced wall panels such as plywood, as specified in the IRC and Appendix BJ.

Figures BJ105.1(1) through (4) further illustrate requirements and components of the top and bottom of the two wall systems, and reference the Appendix BJ or IRC sections that govern them.

Common acceptable variations from the wall systems or components illustrated in Appendix BJ include different bale orientations, finish systems, locations of structural elements, or placement of windows

relative to wall thickness. The materials and methods outlined in Appendix BJ provide minimum requirements for safe and durable strawbale construction based on testing, research, successful practices and modern building science. Components and materials in strawbale walls provide equivalent or better quality, strength, effectiveness, fire resistance, durability, and safety compared with similar components in conventional wood-framed walls. The Commentary version of Appendix BJ includes extensive additional guidance for interpreting the code provisions and additional information about best and/or acceptable alternative practices.

Concerns from the TAG in response to the first Application for the adoption of Appendix BJ with amendments are addressed as follows:

TAG Concern: Bale density and moisture content

- Bale density and moisture content need periodic special inspections, which are not indicated in Appendix BJ. The building official can't be expected to be on-site during construction to periodically test 5% of the bales.

The Appendix intentionally provides the building official both flexibility and authority to verify bale moisture content and density, with extensive guidance given in the commentary version of the IRC (See **2024 IRC Commentary version of Appendix BJ** provided in supporting materials). Building departments typically have and use the Commentary versions of the codes for guidance about how to interpret the provisions in the code, especially for anything that they may not be familiar with. Long and widespread experience demonstrates that the first time or two that a building department permits a strawbale project, they create a process that satisfies the building official that the bales meet or exceed the requirements in the appendix. It is not the responsibility of the building department to provide the moisture meter or scale to weigh bales, though departments where strawbale building is more common can or have done so.

There is no need or requirement for periodic special inspections, only that “the moisture content of the bales at the time of application of the first coat of plaster or the installation of another finish shall not exceed 20 percent . . .” This is the critical time to ensure the bales are of an acceptable moisture content, and it is usually demonstrated to the building official by the builder or owner. The required bale density is also typically demonstrated by the builder or owner, and can be done any time prior to or during stacking bales in the walls. Typically, inspectors combine the bale requirement inspections with the regular inspections that occur for any construction project.

TAG Concern: Use of plaster exterior finish

- Exterior plaster cracking is a concern with extreme temperature swings. The concern is bulk water intrusion with only slow drying through the plaster finishes to the interior or exterior.
- RAIN SCREEN: This type of construction in our extreme cold/hot humid environment would be better suited to have a rain-screen exterior application.
- MEMBRANE LAYERS: There is an exception when a water resistive barrier with a means of draining moisture to the exterior is detailed in the wall system. A number of house-wraps have a wrinkled texture which can provide this drainage system cost effectively and eliminate the need for special inspections.

Appendix BJ provides for a range of reliable finishes, including several plaster and nonplaster types, for designers and owners to choose an appropriate finish for their project, needs, and other conditions. Section **BJ104.1 General** provides requirements for all exterior finishes including their minimum vapor permeability.

Concerns about plaster cracking and potential wetting and drying issues are addressed in Section **BJ104.4 Plaster**, including the number of coats, mix design, and mesh. Section **BJ105.6.1 Water-resistive barriers and vapor permeance ratings** states that “plastered bale walls shall be constructed without any membrane barrier between straw and plaster to facilitate transpiration of moisture from the bales, and to secure a structural bond between straw and plaster, except as permitted or required elsewhere in this appendix.”

Though counter to the WRB requirement over conventional wood-frame construction, the application of plaster directly to strawbale walls has proven successful for over three decades on thousands of buildings in every climate in the U.S., and in over 50 countries worldwide. Plastered strawbale buildings in Nebraska that have remained in service for 80 to 110 years provide further evidence. This performance is attributed to a) minimal through-cracking of multi-coat plasters, and b) where modest water intrusion does occur, straw bales' ability to manage significant amounts of water, storing and releasing it over time (drying) without harm.

In Appendix BJ exterior plasters must be applied in two or three coats to minimize through-cracking, with the exception of single-coat soil-cement plaster, which requires mesh to resist cracking. Mesh can be used in any plaster, and is required in plasters on structural strawbale walls.

Civil engineering professor, building science expert and strawbale researcher John Straube at University of Waterloo in Ontario, Canada provides in-depth technical analysis of the moisture performance of exterior direct-applied plaster moisture performance on strawbale walls in the following research paper:

<https://ecobuildnetwork.org/wp-content/uploads/2024/12/Moisture-Properties-of-plaster-and-Stucco-for-Strawbale-Buildings-Straube-2003.pdf>

Proposed amendment BJ105.10 requires a roof overhang for walls with direct-applied exterior plaster to provide extra protection for these walls, which would be prudent for any building system with plaster finishes in Minnesota's climate.

A rain screen can be a very effective finish system in many climates, including Minnesota's, and is mentioned in the Commentary for Section BJ105.6.1. Appendix BJ allows the use of rain screens.

TAG Concern: Moisture and height above grade

- Provide sufficient height and flashing of the stem wall of strawbale walls to ensure durability of the bales relative to Minnesota snow accumulation and safe discharge of any water that enters the wall system.

Although Appendix BJ was developed with considerations for all climate zones covered by the IRC, in response to concerns about Minnesota's challenging mixed climate, we are proposing revisions to increase separation above grade to sections **BJ105.6.6 Separation of bales and earth**, and **BJ105.6.7 Separation of exterior plaster and earth** (if the proposal is accepted as amended, we will provide revised versions of Figure BJ105.1(1) and Figure BJ105.1(2) to match the proposed changes). We are also proposing a new section, **BJ05.6.10 Roof overhangs**, for walls with direct applied plaster finishes to provide the additional protection we think appropriate for any wall system with plaster exterior finishes. Walls with ventilated cladding finishes in accordance with Section BJ104.1.1 would be exempted from the overhang requirement.

Appendix BJ addresses flashing at the bottom of the wall in Section **BJ105.3.1 Exterior sill plate flashing**. Rising moisture at the top of the foundation is addressed in Section **BJ105.6.5 Separation of bales and concrete**. Existing provisions have proven adequate in preventing the intrusion of moisture as well as insects and rodents. Strawbale walls are no more or less vulnerable to these problems than wood frame walls with conventional insulation and finishes.

The proposed revisions are the result of extended discussions with building science experts, designers, builders, and others intimately familiar with Minnesota's climate and buildings. It was concluded that requiring a stem wall to raise the bottom of the strawbales above an anticipated snow depth is unnecessary, adding considerable expense, and would be excessive as a minimum requirement for all strawbale buildings.

Moisture damage from snow against strawbale has not proven to be a problem. When it's cold enough for the snow to remain frozen it can't wet the wall. Heat emanating from the wall typically melts the snow in contact with it, creating a gap allowing the water to drain straight down, only minimally wetting the wall. The wetting that does occur is not sufficient to cause a long-term problem. Deterioration of straw requires

moisture content above 30% by weight, at a temperature above about 60 degrees F for an extended period of time.

More than 30 years of experience with thousands of strawbale buildings throughout the U.S. and Canada in all climates, including hundreds located in cold wet regions in Minnesota and the Upper Midwest, in New England, Washington, Oregon and Northern California, and hundreds in Ontario, Quebec, Nova Scotia, and British Columbia, and elsewhere in Canada, demonstrates that raised stem walls or similar requirements are not necessary. After a decade of the Strawbale Appendix being in the IRC, the authors of the appendix have received no negative feedback from ICC or others and no code change proposals have been submitted seeking to address this as a problem.

TAG Concern: Post-and-beam structure

- The residential building code does not include post-and-beam construction, thus requires professional engineering. Post-and-beam is commonly used for strawbale construction and the appendix does not address this.
- In Minnesota, the snow load is greater than the load of another floor.

Appendix BJ Section **BJ106.15 Post-and-beam with strawbale infill** addresses this issue. It uses IRC Table R602.7(1) that is typically used for girder and header spans, along with its required number of jack studs, as a prescriptive 'post-and-beam' design for strawbale walls. BJ106.15 Items 1 through 7 include other requirements, such as connections at discontinuous beam ends and other connections, to create a complete 'post-and-beam' system. Use of Table R602.7(1) for this purpose is limited to one-story strawbale buildings because Appendix BJ Sections BJ105.2 and BJ106.2 require "an *approved* engineered design" for two-story buildings.

Table R602.7(1) includes ground snow loads up to 70 psf, which exceeds the largest design ground snow load in Minnesota. In addition, BJ106.15 gives the option of "an *approved* engineered design" for more conventional post-and-beam designs or those exceeding the limitations of Table R602.7(1). The commentary for BJ106.15 further explains the use of this section.

TAG Concern: Fire

- Intact bale walls are very fire resistant, but if fire moves into the wall there is no fire blocking to stop fire from migrating in the wall.
- Once started, how does the fire department not destroy the entire house trying to completely extinguish the fire?
- Is there a risk of spontaneous combustion?

Fire blocking is only required 10ft vertically in walls. That said, like some conventional insulations, stacked straw bales function as continuous fire blocking. The bales greatly restrict air movement, and the requirements in Section **BJ105.8 Voids and stuffing** ensure the walls contain no voids between bales or framing.

A fire department can effectively deal with any smoldering fire in a bale wall. Our direct experience shows that the thermal imaging cameras every fire department has today, reliably detect the heat in the walls where a smoldering fire is occurring, thus preventing unnecessary and wholesale destruction of a strawbale house or a house using any other wall system.

Spontaneous combustion is absolutely not an issue with straw, only with hay (specifically wet hay stored in large piles.) Section **BJ103.7 Types of straw** prohibits the use of hay.

Additionally, straw bales are well below the surface burning characteristic limits required for insulation, as established by an ASTM E84 test, meeting the Class A Rating for insulation with a flame spread index of 10 (Class A requires under 25), and a smoke developed index of 350 (Class A requires under 450).

Cost/Benefit Analysis

1. Will the proposed code change increase or decrease costs? Please explain and provide estimates if possible.

Same or decrease. The adoption of Appendix BJ as amended will only impact costs of construction for owners who choose to build with strawbale. The provisions in Appendix BJ are not applicable unless pursuing strawbale construction, and do not contradict any other building code sections. Adoption of Appendix BJ as amended, for anyone wishing to build with strawbale, will likely result in reduced costs due to streamlining the review process with applicable AHJ. Not including Appendix BJ in the Minnesota code considerably increases the cost for anyone wishing to build a strawbale house, who then must go through the alternative materials and methods process, which not only increases costs for the applicant but also time and expense for the jurisdiction.

2. If there is an increased cost, will this cost be offset by a safety or other benefit? Please explain. If the benefit is quantifiable (for example energy savings), provide an estimate if possible.

See response to Cost/Benefit Analysis question 1.

3. If there is a cost increase, who will bear the costs? This can include government units, businesses, and individuals.

See response to Cost/Benefit Analysis question 1.

4. Are there any enforcement or compliance cost increases or decreases with the proposed code change? Please explain.

No. The responsibility and cost for demonstrating compliance with requirements in Appendix BJ, including bale density and maximum moisture content, and compressive strength for plaster, are borne by the owner.

5. Will the cost of complying with the proposed code change in the first year after the rule takes effect exceed \$25,000 for any one small business or small city ([Minn. Stat. § 14.127](#))? A small business is any business that has less than 50 full-time employees. A small city is any statutory or home rule charter city that has less than ten full-time employees. Please explain.

No. The owner or contractor will need to supply a report recording compliance with requirements particular to Appendix BJ, including bale density and maximum moisture content, and compressive strength for plaster. The submission process will be similar to required blower door testing results, which cost considerably less than \$25,000 and are typically emailed to the inspector and filed with the building permit.

Regulatory Analysis

1. What parties or segments of industry are affected by this proposed code change?

The adoption of Appendix BJ as amended will only impact parties who choose to build with strawbale. The provisions contained in Appendix BJ are not applicable unless pursuing strawbale construction, and do not contradict any other building code sections.

2. Can you think of other means or methods to achieve the purpose of the proposed code change? What might someone opposed to this code change suggest instead? Please explain what the

alternatives are and why your proposed change is the preferred method or means to achieve the desired result.

Adoption of Appendix BJ as amended is the best way to systematize consistent compliance with code standards. The only viable alternative for someone wishing to build a strawbale house in the State now is to go through the Alternative materials and methods process in the current code. As explained elsewhere this is costly and time-consuming for both the applicant and jurisdiction. Adding Appendix BJ as amended to the State code is the most straightforward, efficient and effective way to allow people to build the house they want.

3. What are the probable costs or consequences of not adopting the code change, including those costs or consequences borne by identifiable categories of affected parties, such as separate classes of government units, businesses, or individuals?

Strawbale construction is growing in popularity. Without adoption of Appendix BJ as amended, a patchwork of code enforcement methods are adding significant cost and complexity, including but not limited to longer permitting processes, delays in construction, and construction that does not comply with the minimum health, safety and welfare standards created by Appendix BJ.

4. Are you aware of any federal or state regulation or requirement related to this proposed code change? If so, please list the federal or state regulation or requirement and your assessment of any differences between the proposed code change and the federal regulation or requirement.

No

***Note: The information you provide in this code change proposal form is considered Public Data and used by the TAG to consider your proposed modification to the code. Any code change proposal form submitted to DLI may be reviewed at public TAG meetings and used by department staff and the Office of Administrative Hearings to justify the need and reasonableness of any proposed rule draft subject to administrative review and is available to the public.

****Note: Incomplete forms will be returned to the submitter with instruction to complete the form. Only completed forms will be accepted and considered by the TAG. The submitter may be asked to provide additional information in support of the proposed code change.