BCC Ruling No. 99-56-712

BUILDING CODE COMMISSION DECISION ON B.C.C. #99-56-712

IN THE MATTER OF Subsection 24 (1) of the Building Code Act, 1992.

AND IN THE MATTER OF Sentence 9.25.2.1.(1), (2) and (4), Sentence 9.25.2.3.(1), Article 9.25.3.1., Article 9.25.4.1., Sentence 9.25.4.2.(5) and Articles 9.28.4.2. and 9.28.4.3. of Regulation 403, as amended by O. Reg. 22/98, 102/98, 122/98, 152/99 and 278/99 (the "Ontario Building Code").

AND IN THE MATTER OF an application by Ms. Beth Northrup et al., property owner, Mississauga, Ontario for the resolution of a dispute with Mr. Agris Robeznieks, Chief Building Official, City of Mississauga, Ontario to determine whether the proposed insulation system and wall assembly composed of compressed, stacked straw bales enclosed by metal lath covered on both sides with 15 mm cement stucco and coated (on the outer surface of the interior only) with a waterproof finish provides sufficiency of compliance with Sentences 9.25.2.1.(1), (2) and (4), Sentence 9.25.2.3.(1), Article 9.25.3.1., Article 9.25.4.1., Sentence 9.25.4.2.(5) and Articles 9.28.4.2. and 9.28.4.3. of the Ontario Building Code at 977 Meadow Wood Road, Mississauga, Ontario.

APPLICANT
Ms. Beth Northrup et al., property owners
Mississauga, Ontario

RESPONDENT
Mr. Agris Robeznieks
Chief Building Official
City of Mississauga

PANEL
Mr. Kenneth Peaker (Chair-Designate)
Mr. Fred Barkhouse
Mr. John Guthrie

PLACE
Toronto, Ontario

DATES OF HEARING

August 26 and October 7, 1999

DATE OF RULING
October 7, 1999

APPEARANCES

Mr. Martin Liefhebber, Architect
Martin Liefhebber Architect Inc.
Toronto, Ontario
Agent for the Applicant

Mr. John Straube, P. Eng.
University of Waterloo
Waterloo, Ontario
Independent Expert

Mr. Frank Spagnolo
Manager, Building Engineering & Inspections
City of Mississauga
Designate for the Respondent

RULING

1. The Applicant

Ms. Beth Northrup et al., property owners, Mississauga, Ontario have received a building permit under the *Building Code Act, 1992* to construct a detached, two storey house at 977 Meadow Wood Road, Mississauga, Ontario.

2. Description of Construction

The Applicants are currently constructing a new detached, two storey, Group C - residential dwelling with a building area of 270 m^2 that is to be constructed of combustible material. The floor plan shows the house to be L-shaped. Common areas such as the kitchen, dining room, living room, family room, library, greenhouse, etc. are to be located on the ground floor. The second floor will contain three separated sleeping areas, each with their own bathroom and each served by their own stairs. The house will also have a finished, partial basement containing a workroom, laundry room, wine cellar and storage space. The basement is to be located under the central area of the dwelling. The house is to be heated by hydronic heating installed in the floor assemblies in the basement, first and second floors. It will also be equipped with four heat recovery ventilators.

The foundation walls of the building, for both the excavated (the basement) and unexcavated areas, are to be made with durisol concrete blocks. The floors are to be poured concrete slabs. Over the basement area, the concrete floor slab will be supported on the durisol block foundation. For the other areas, the poured floors will be slabs on grade. The super-structure of the house is to be post and beam construction. The exterior walls on the ground floor will not

be used to support any vertical loading from the structure. These walls are proposed to be constructed of straw bales covered with stucco and are the subject of these proceedings. The walls are designed merely to rest on the poured concrete slabs and act as "fill" between the post and beam structural members.

Specifically, the proposed wall assembly, as described in terms of a horizontal section from the exterior of the building to the interior, is to consist of three coats of cement stucco finish with a total thickness of 15 mm as the exterior cladding. The outermost coating, smoothed to finished texture, will be 3 mm in thickness, while the inner two layers are to be 6 mm each. The stucco is to be applied directly onto a floor to ceiling wire mesh with 25.8 cm^2 openings with a minimum weight of 0.98 kg/m^2 that will be stretched across compressed, stacked 460 mm thick straw bales. The innermost coating is to be embedded by pressure spray onto the mesh/straw fibre face. The wire mesh proposed to enclose the straw bales on their exterior and interior surfaces is to be held tight to the straw by tie wires placed between each course of bales 355mm high and every 915 mm horizontally.

The straw bales themselves are the dead stalks of cereal grain and are described as two-string bales having dimensions of approximately 460 mm wide by 915 mm long and 355 mm high. They are shown as having an RSI-value of 6.55. The wire mesh and three coats of stucco (spray, scratch and skim coats) are also found on the interior of the house, with the smooth last layer of stucco forming the finished wall. The interior wall surface, unlike the exterior, is to be treated (on the outer surface only) with a waterproof finish.

Described vertically, the wall assembly is built of 7 courses of straw bales laid overlapping in a flemish bond. The typical bale wall in the subject structure will be nearly 2.5 m in height. To provide lateral stability for the stacked bales, a system of wall stabilizers will be installed at the top (shown as the "top ladder") and bottom ("sill plate") of the proposed wall assemblies. These stabilizers consist of a pair of parallel pressure treated (bottom only) 2" by 6" boards laid flat and bolted to the concrete floor and ceiling assemblies running along the perimeter of the building. Running perpendicular between the 2" by 6" boards and spaced at 1.22 m on centre will be 2" by 6" wood cross pieces (thus making the top and bottom stabilizers resemble a ladder). (The voids created between the 2" by 6" members will be filled by 2" mineral fibre rigid insulation.) Attached to the top and bottom 2" by 6" stabilizers and spanning the full vertical height of the wall are to be 19 mm diameter bracing wires rated at 590 kg stress and spaced every 1.22 m. Additional lateral strength will be created by a series of 50 mm by 19 mm by 810 mm wood spikes that are to be driven through the middle of the bales. (Similar length bamboo shoots or re-bars may also be used as spikes.)

The construction details at the corners are similar to the typical proposed straw bale wall, except that they are provided with one additional stabilizing feature. At each corner of the structure, a custom bent 1.83 m long, 10 mm diameter reinforcing steel bar, will be placed in between each course of bale so that the bar extends equal amounts into both sections of the walls that form the corner. The corner reinforcement bars will then be secured to the lateral stability spikes.

As the walls are non-structural, the rough openings for the windows and doors are required to be framed in wood and connected at the top and bottom 2" by 6" wall stabilizers. Because the straw bale walls are to be approximately 510 mm thick, the wood framing provided for the doors and windows will be lined with 13 mm plywood to complete the rough openings. For both the headers and sills of the openings, the horizontal framing members run underneath and act

to support the plywood. The spaces created between the plywood and the 2" by 6"s are to be insulated with mineral fibre batt insulation.

The electrical services provided in the straw walls will be channelled through noncombustible raceways set 38 mm into the bales. Electrical boxes are to be supported in the walls by fastening them to wooden wedges that will be driven into cavities cut out of the bales.

The exterior side of the straw bale walls will be protected from the elements, especially exposure to excessive moisture due to driving rain or snow, by two design features of the house. The first is the 0.9 m overhang of the roof, which will provide direct protection to the upper portion of the straw bale walls (which are located on the ground floor only). The proposed roof design of the house is to resemble an english cottage with a thatched roof. It will slope at a 45^0 angle from horizontal and will extend in most areas to the upper portion of the ground floor. The second protective feature is a 710 mm high masonry veneer splash skirt comprised of 93 mm thick blocks capped by a precast coping sill provided around the base of the exterior of the bale walls and constructed directly upon the edge of the concrete block basement foundation wall.

The above described straw bale wall assembly is proposed for a total of roughly 70 % of the entire ground floor perimeter of the house. There is no straw bale wall system proposed anywhere on the second floor. In fact, the intended english cottage-style roof is to comprise most of the second floor walls. The little vertical wall that is found on the second floor is to be built with conventional wall assemblies using mineral wool insulation.

The construction in dispute involves the proposed straw bale wall system.

3. Dispute

The issue at dispute between the Applicant and Respondent is whether the proposed insulation system and wall assembly composed of compressed, stacked straw bales enclosed by metal lath covered on both sides with 15 mm cement stucco and coated (on the outer surface of the interior only) with a waterproof finish provides sufficiency of compliance with Sentences 9.25.2.1.(1), (2) and (4), Sentence 9.25.2.3.(1), Article 9.25.3.1., Article 9.25.4.1., Sentence 9.25.4.2.(5) and Articles 9.28.4.2. and 9.28.4.3. of the Ontario Building Code. There are four separate areas of dispute with respect to the proposed wall assembly.

The first involves the intended use of straw bales as the insulation material. Sentences 9.25.2.1.(1) and (2) in general require that insulation be provided between heated and unheated spaces and Sentence (4) requires the insulation valves to conform with Table 9.25.2.1. For the proposed structure, Table 9.25.2.1. requires the exterior straw bale wall system to be insulated with not less than RSI 3.00 insulation. While the RSI value of straw is generally accepted as high, it is often inconsistent in terms of density and therefore difficult to measure with exactness. Further, Sentence 9.25.2.3.(1) states that insulation shall conform to one of the standards listed. To date, straw has not been shown to meet any of the referenced standards.

Section 9.38 is an alternative to the insulation requirements of Section 9.25. There are no referenced standards listed in this Subsection, and as such any evaluation of the straw as an acceptable insulation material must demonstrate an adequate level of performance to meet

Code requirements.

The second dispute relates to the provision of an air barrier in the subject wall assembly. Article 9.25.3.1. stipulates that a thermally insulated wall assembly be provided with a continuous air barrier. This barrier is designed to prevent the passage of air from inside of the building to the exterior and vice versa. It can be placed anywhere in the wall assembly as long as its location does not cause increased moisture condensation in the wall cavity. The Applicant has not provided a typical sheet or panel type of air barrier. At dispute, therefore, is whether the applications, interior and exterior, of cement stucco act as an air barrier and thus provide sufficiency of compliance with Article 9.25.3.1.

Closely related to this issue is the third dispute; the requirement for a vapour barrier found in Article 9.25.4.1. Basically, this provision requires that a vapour barrier be included in a thermally insulated wall assembly. The vapour barrier must be on the warm side of the insulation to prevent the build up of condensation in the wall. The Applicant is proposing to apply, on the interior surface of the straw bale walls, a vapour barrier coating. Sentence 9.25.4.2.(5) of the Code permits such coatings to act as a vapour barrier if its permeance conforms to CAN/CGSB-1.501-M , "Method for Permeance of Coated Wallboard." This standard obviously pertains to coatings applied to gypsum board. The Applicant's wall will be constructed of cement stucco, not gypsum board.

The final issue is the proposed use of stucco as the wall sheathing. Article 9.28.4.2. permits the sheathing beneath stucco to be waived where certain galvanized wire (1.19 mm in diameter) applied horizontally to the framing at vertical intervals of 150 mm or less is used, or where paper-backed welded wire metal lath is installed as per Article 9.28.4.3. However, the Applicant is proposing to use a wire mesh on the interior and exterior wall faces tied together at vertical intervals of 355 mm, the height of the straw bales. Moreover, the proposed wire mesh is not paper-backed. As noted, the Applicant is proposing to apply the stucco directly to the straw face which will be enclosed on both the interior and exterior with wire mesh. At issue is whether the straw face is an appropriate backing for stucco application.

4. Provisions of the Ontario Building Code

Article 9.25.2.1. - Required Insulation

(1) All walls, ceilings and floors separating heated space from unheated space, the exterior air or the exterior soil shall be provided with sufficient thermal insulation to prevent moisture condensation on their room side during the winter and to ensure comfortable conditions for the occupants. (See A-9.1.1.1. in Appendix A.)

(2) Insulation shall be provided between heated and unheated spaces and between heated spaces and the exterior, and around the perimeter of concrete slabs-on-ground.

(4) Except as permitted in Sentences (5), (6), (7), (8), (13) and (14) the minimum thermal resistance of insulation shall conform to Table 9.25.2.1.

Article 9.25.2.3. - Insulation Materials

(1) Except as required in Sentence (2), thermal insulation shall conform to the requirements of:

(a) CAN/CGSB-51.20-M, "Thermal Insulation, Polystyrene, Boards and Pipe Covering";

(b) CGSB 51-GP-21M, "Thermal Insulation, Urethane and Isocyanuratem Unfaced";

(c) CAN/CGSB-51.23, "Spray Applied Rigid Polyurethane Cellular Plastic Thermal insulation";

(d) CAN/CGSB-51.25M, "Thermal Insulation, Phenolic, Faced";

(e) CAN/CGSB-51.26-M, "Thermal Insulation, Urethane and Isocyanurate, Board, Faced";

(f) CAN/CGSB-51-GP-27M, "Thermal Insulation, Polystyrene, Loose Fill";

(g) CGSB 51 -GP-60M, "Thermal Insulation, Cellulose Fibre, Loose Fill";

(h) CSA A101, "Thermal Insulation, Mineral Fibre, for Buildings"; or

(i) CAN/CSA-A247-M, "Insulating Fibreboard".

Article 9.25.3.1. - Required Barrier to Air Leakage

(1) Thermally insulated wall, ceiling and floor assemblies shall be constructed so as to include an air barrier system which will provide a continuous barrier to air leakage:
(a) from the interior of the building into wall, floor, attic or roof spaces sufficient to prevent excessive moisture condensation in such spaces during the winter; and
(b) from the exterior inward sufficient to prevent moisture condensation on the room side during winter. (See Appendix A.)

Article 9.25.4.1. - Required Barrier to Vapour Diffusion

(1) Thermally insulated wall, ceiling and floor assemblies shall be constructed with a vapour shall be constructed with a vapour barrier sufficient to prevent condensation in the wall spaces, floor spaces or attic or roof spaces.

Article 9.25.4.2. - Vapour Barrier Materials

(5) Where a coating is applied to gypsum board to function as the vapour barrier, the permeance of the coating shall be determined in accordance with CAN/CGSB-1.501-M, "Method for Permeance of Coated Wallboard".

Article 9.28.4.2. - No Sheathing Required

(1) Sheathing need not be provided beneath stucco where not less than 1.19 mm (0.047 in) diam galvanized wire is applied horizontally to the framing at vertical intervals not exceeding 150 mm ($5^{7/8}$ in), or where paper-backed welded wire metal lath is used.

Article 9.28.4.3. - Stucco Lath Specifications

(1) Stucco lath shall conform to Table 9.28.4.3. (See Appendix A.)

5. Applicant's Position

The Agent for the Applicants indicated that in order to demonstrate the sufficiency of compliance of the proposed wall system, it would be necessary for him to deal with the relevant provisions of the OBC that pertain to a more conventional wall assembly. As a result, he stated that he would present arguments regarding the four identified areas of dispute; straw as insulation, lack of a conventional air barrier, a vapour barrier coating applied to cement stucco and straw as a backing for stucco.

On the issue of straw as insulation, the Agent noted that there are two principal aspects in so far as the Building Code is concerned. The first of these pertains to Sentence 9.25.2.3.(1) of the Code which requires insulation to meet one of the listed standards. He argued that the listed tests were all designed for manufactured, not natural, materials and as a result it would be difficult and perhaps inappropriate to test straw using the referenced criteria. He stated that under the Architectural Graphic Standards, however, non-manufactured materials have been recognized as insulation. As well, the ASHRAE standard, "1977 Fundamentals", lists RSI values for wood, wool, linen, cork, wood ash, saw dust and snow. The Agent noted that it was precisely because straw is a natural and chemical free insulation material that it was deemed suitable for his clients. His goal, he indicated, was to design a home with as clean an environment as possible.

With respect to the other aspect regarding straw as insulation, i.e., determining its RSI value, the Agent asserted that any house fitted with straw as the thermal barrier would not be under insulated. Straw is comprised of roughly 90 per cent air voids, he added, which is the essential idea behind insulation. He claimed that various tests have been conducted to determine the RSI value of straw and the results ranged from a low of RSI 3.00 to a high of RSI 8.82. In particular, tests conducted at the Oak Ridge National Labs and the Technical University of Nova Scotia on full-scale wall assemblies similar to those proposed were found to have RSI values in the range of 4.55 to 5.25. He indicated that they are using an RSI value of 6.55 to determine the Heat Loss Calculations. The Agent noted that Sentences 9.25.2.1.(1), (2) and (4) require only an RSI value of 3.00. This, he argued, was easily met by the proposed 460 mm thick straw bales.

The Agent did acknowledge that the RSI values of straw can be variable. The issue is one of density and the fact that straw bales because of the material itself and the way it is packed usually do not possess uniform consistency. This explains much of the wide range of RSI results, he stated. The minimum density of straw that he would consider using for the proposed house would be 113 kg/m^3, which is consistent with the minimum requirement used by most US codes that contain standards for straw as insulation. Nevertheless, the actual straw used will probably have a considerably higher density, he added.

Regarding the second and third issues, air barrier and vapour barrier, the Agent noted that they are interconnected. He stated that the requirements related to these two items reflect the Building Code's philosophy of preventing the movement of air and moisture through a wall assembly, i.e., the building should be sealed as tightly as possible. The philosophy of his wall assembly is different, however. It is based upon the view that the wall should be able to "breathe" to a degree in order to allow for the passage of moisture in and especially out of the wall cavity. In this light, the Agent argued that adding an air barrier and vapour barrier would probably do more harm than good.

As a result, the Agent stated that their wall assembly, as proposed, will not contain an air barrier as envisaged under Article 9.25.3.1. of the OBC. While he acknowledged that an air barrier complying with the air leakage characteristics found in Article 9.25.3.2. would probably provide a greater degree of impermeability, he argued that cement stucco will also not allow for too much air movement. Being somewhat more porous, however, is a positive feature of cement stucco since the overall goal of the wall assembly is to allow some movement of moisture through vapour diffusion, while at the same time preventing as much air movement as possible.

In terms of whether cement stucco meets the prescriptive air leakage requirements, the Agent indicated that he was unaware of any available tests to indicate as such. By way of comparison though, he noted that cement board has been tested and has proved to provide quite a high level of impermeability. The Agent then added that in order to achieve a consistent air barrier as intended in the Code it is crucial to ensure that the caulking details are done right.

On the issue of the vapour barrier, the Agent indicated that the principle governing the design of the proposed wall assembly was not vapour tightness as intended in the OBC. Instead, limited moisture in the form of vapour will be allowed in and especially out of the wall. The Agent noted that the very nature of straw would allow for a significant amount of safe moisture storage in the assembly. This ability to safely store certain levels of moisture, he argued, acts as a vital buffer between the deposition and removal of moisture (wetting and drying) giving the wall assembly added time to achieve a safe moisture balance.

Nevertheless, the Agent stated that excessive vapour movement from the interior of the house into the wall would be prevented by a barrier in the form of a paint-applied coating to be provided on the outer surface of the interior wall. This coating, he submitted, will achieve a moderate permeability level of 300 ng/(Pa · s · m^2) and will thus meet the intent of the requirements of Sentence 9.25.4.1. of the OBC. He felt that applying this coating to stucco was not a problem. More importantly, however, he argued that applying such a coating is not inconsistent with the concept of a breathing wall. The exterior side of the wall due to its lack of a vapour barrier will have a higher degree of moisture movement by diffusion. Moreover, the vapour barrier coating will not prevent all moisture from moving in and out of the interior side of the wall, it will simply control too much from getting in. The Agent also noted that the four heat recovery ventilators will prevent too much moisture build up inside the house.

In terms of vapour originating from inside the straw bale wall, the Agent indicated that this will not be a problem. This is because the straw will be treated, which includes allowing it to dry for a period of at least a year, before it is used in the proposed wall assembly. Construction materials such as lumber and concrete block that are considered saturated will also be avoided or allowed to dry. Further, the Agent stated that he intends to take extreme care when constructing the straw bale walls to ensure that it does not get wet. (Allowing the straw to get wet during construction and not reducing its moisture content prior to installation are two significant contributors to past failures of straw walls, he noted.) Also, since straw is comprised of tubular stalks which, as noted, consist of 90 per cent air voids, it does not wick water very well and has poor capillary suction. This works to its advantage, the Agent argued, in that it will not draw water inwards towards the core of the straw bales. Like all cellulose material straw does absorb water, he noted, however, the moisture content can rise to 20 per cent before mould growth occurs.

While limited vapour movement will occur in the straw bale wall assembly, liquid moisture,

especially in the form of driving rain or snow, on the other hand, will be discouraged as much as possible, the Agent submitted. To this end, the exterior of the house has been designed with certain features to reduce the exposure of the straw bale walls to the elements. The roof of the house projects 900 mm over the top of the subject walls, thereby providing a generous protective overhang, he argued. The base of the walls are also protected, he noted, by the 710 mm proposed masonry splash skirt. This skirt will protect the straw walls from excessive water penetration by providing a guard against rain splashing and drifting snow. The masonry skirt, he explained, is designed with run off spaces and a 25 mm air gap between it and the bale wall to keep the straw as dry as possible. Again, exceptional attention will be paid to caulking the openings, joints, corners, etc. on the interior and especially the exterior of the house.

Summarizing his arguments on issues two and three therefore, the Agent submitted that the intelligence of the straw bale wall is its simplicity - it basically contains only two materials; straw and stucco. But if forced to comply with Code standards for a typical wall assembly such as air and vapour barriers, the results could be dire. The goal of his wall system, and in fact much of the design of his house, is to minimize wetting and maximize drying. Minimizing the wetting of the wall assembly will be achieved by the interior vapour barrier coating and the heat recovery ventilators and by the exterior design features, the roof overhang and masonry splash skirt. Maximizing drying will occur through the lack of a corresponding vapour barrier coating on the exterior side of the wall, and the fact that the cement stucco used has a higher level of permeability than traditional barriers (200 to 480 ng/(Pa · s · m^2) and 400 to 800 ng/(Pa · s · m^2) if the stucco mix includes lime) to allow for moisture movement by diffusion. By providing the proposed combination of design features and wall assembly elements, the Agent argued that a vital balance between wetting and drying has been achieved. By adding or taking away from the combination proposed, the delicate balance of the wall assembly would be threatened.

The final issue in dispute is the appropriateness of straw as a backing for cement stucco. On this point the Agent argued that the attachment of stucco directly to straw is not a problem. The irregularity of the sides of the straw bales provides quite a course mounting surface to allow a strong bond between the fibre face of the straw and the stucco to occur. He noted that the wire mesh to be used to encase both sides of the straw bales is galvanized and complies with Sentence 9.28.4.3.(1), however, he acknowledged that it was not possible to meet the requirements related to the fastening of the wire mesh to the framing, nor will the wire mesh be paper-backed. Nevertheless, the Agent indicated that the inclusion of the proposed wire ties that join the interior and exterior wire meshes together was not necessary for the present non-structural straw bale house, but in doing so met the construction standards for straw bale houses in jurisdictions that are earthquake prone.

The Agent further argued that the proposed stucco clad on the straw bales would provide a level of performance similar to the properties of sheathing required under the OBC. He noted that as with plywood that is fastened to wood studs, the cement stucco applied to the straw is not required to bear any weight and needs only to provide a certain degree of lateral strength. He indicated that cement stucco used in such a way, with wire mesh and applied to straw, would provide more than an adequate degree of stiffness. As a result, he submitted that the proposed stucco cladding attached to straw meets the intent of the sheathing requirements and thereby provides sufficiency of compliance with Article 9.28.4.2.

In conclusion, the Agent explained that it was not his intention to use straw as a way to cut costs. Rather, the use of straw is to allow for the construction of a house of natural materials. Only by doing so will they be able to create as healthy an environment as possible.

Finally, the Agent stated that straw was gaining wider use as a construction material. He submitted a list of seven jurisdictions in Ontario that had previously allowed the use of straw bale in various buildings. He noted that this was only a partial list and that to his knowledge at least 50 building have been constructed in Ontario with straw as one of the materials. Properly treated and installed, straw is a viable construction material, the Agent indicated.

6. Respondent's Position

The Respondent submitted that the OBC does not address houses built with straw. They undertook to learn as much about as possible about straw as a construction material in order to assess the project under Section 2.7 "Equivalents" of the Building Code. Nevertheless, they felt it was still not possible to accept the proposal. In their view, there were too many unanswered questions.

In terms of the specific disputes, the Respondent indicated that he would discuss the matters point by point.

Regarding the use of straw as insulation, he noted that they are unsure if straw has been tested according to any of the listed standards in Sentence 9.25.2.3.(1). He indicated that no proof of conformance was offered. In terms of RSI value, the Respondent stated that they do not dispute that the thermal resistance of straw is high. Because of its inconsistency as a material and its consequent variable test results, however, he argued that it is difficult to assess the true RSI value, which, in turn, makes approving a heating system problematic. He suggested that tests be performed by a recognized testing agency in order to determine a more precise RSI value for straw as a insulation material.

On the issue of the air barrier, the Respondent noted that Article 9.25.3.1. requires a continuous air barrier for walls that are provided with thermal insulation. Sentence 9.25.3.2.(1) provides the performance standards required of the air barrier. He indicated that they are unsure how the proposed system provides an air barrier as intended in the OBC and how the straw bale wall will achieve the required performance level.

Their view on the vapour barrier was similar. One is required in thermally insulated walls according to Article 9.25.4.1. The vapour barrier proposed, a paint-applied coating, the Respondent argued, is intended to be used on wallboard. They are unsure how it will perform when coated on stucco and if it will meet the OBC requirements of a vapour barrier.

With respect to the last issue, the Respondent indicated that the exceptions found in Article 9.28.4.2. that permit the sheathing beneath stucco to be waived have not been met in the proposed wire mesh reinforcement system. As a result, their position is that a paper-backed metal lath system conforming to Sentence 9.28.4.3.(1) be used to provide rigidity to the wall in lieu of a recognized sheathing material.

The Respondent concluded by stating that they did not want to prevent the Applicants from building their proposed house. However, they felt the Code offered them little flexibility in terms of accepting such a unique application. Nonetheless, they felt that the hearing has been a learning process for them and that it has increased their knowledge of the proposal, which, in turn, has increased their comfort level regarding the use of straw as a construction material.

7. Commission Ruling

It is the decision of the Building Code Commission that the proposed non-structural insulated wall assembly composed of compressed, stacked straw bales enclosed by metal lath and covered on both sides with a 15 mm layer of cement stucco and coated (on the interior surface of the inside only) with a waterproof finish provides sufficiency of compliance with Sentences 9.25.2.1.(1), (2) and (4), Sentence 9.25.2.3.(1), Article 9.25.3.1., Article 9.25.4.1., Sentence 9.25.4.2.(5) and Articles 9.28.4.2. and 9.28.4.3. on condition:

i. That the appointed independent consultant who is a recognized building science expert and a registered professional engineer in the Province of Ontario and that the architect of the project who is a registered professional architect in the Province of Ontario provide their professional stamps on the architectural drawings and details provided to the municipality;
ii. That the independent consultant ensure that the recommendations regarding straw bale construction contained in his report to the Commission are adhered to in the subject building;
iii. That the independent consultant review and approve the as constructed building and submit written confirmation of same with the municipality;
iv. That the proposed straw bale wall assembly be used on the ground floor only of the subject dwelling;
v. That the proposed straw bale wall assembly be used in a non-structural situation only;
vi. That the proposed straw bale wall assembly be constructed with a system of horizontal stabilizers consisting of a top ladder and bottom sill plate connected together with a series of pretension vertical tie down wires;
vii. That the proposed straw bale wall assembly be further constructed with angled re-bars laid flat on each course of bales at the dwelling's corners and that a series of spikes, having a length of more than twice the height of the bales used, be driven vertically downward into the bale courses;
viii. That the proposed straw bale wall assembly be further constructed with wire mesh installed on both the interior and exterior surface of the straw that spans from top to bottom of the wall and which are fastened to the top ladder and the bottom sill plate and that both wire meshes are tied together by a series of tie backs running horizontally through the straw;
ix. That the window and door units in the proposed straw bale wall assembly be supported with wooden framing members that are attached to the top ladder and bottom sill plate;
x. That the proposed straw intended for use in this dwelling consist of prestressed, two-string bales with a minimum density of 113 kg/m^3 and a minimum RSI value of 3.00 (for Zone 1);
xi. That the proposed straw be treated and dried prior to installation in the subject dwelling and that it be kept dry at all times during construction;
xii. That the proposed dwelling be constructed with a roof projecting 900 mm over the walls of the subject house; and
xiii. That the proposed dwelling be constructed with a 710 mm high masonry splash skirt surrounding the ground floor perimeter of the house and attached to the subject straw and stucco wall assemblies.

8. Reasons

With conformance to the above conditions, the Commission is satisfied that the proposed wall assembly will be properly designed by a licenced architect and reviewed, inspected and approved by a certified engineer expertly qualified in this field, that the wall assembly will be used in the appropriate circumstances for the subject house, that the wall assembly will be constructed with adequate vertical and lateral support, that the walls be sufficiently air tight and vapour permeable as required in engineer's report, that the straw will be appropriately treated and handled before and during construction, and that the house itself will be designed to protect the exterior walls from excessive exposure to moisture.

Dated at **Toronto** this **7th** day in the month of **October** in the year **1999** for application number **1999-46**.

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Mr. Kenneth Peaker, Chair-Designate

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Mr. Fred Barkhouse

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Mr. John Guthrie