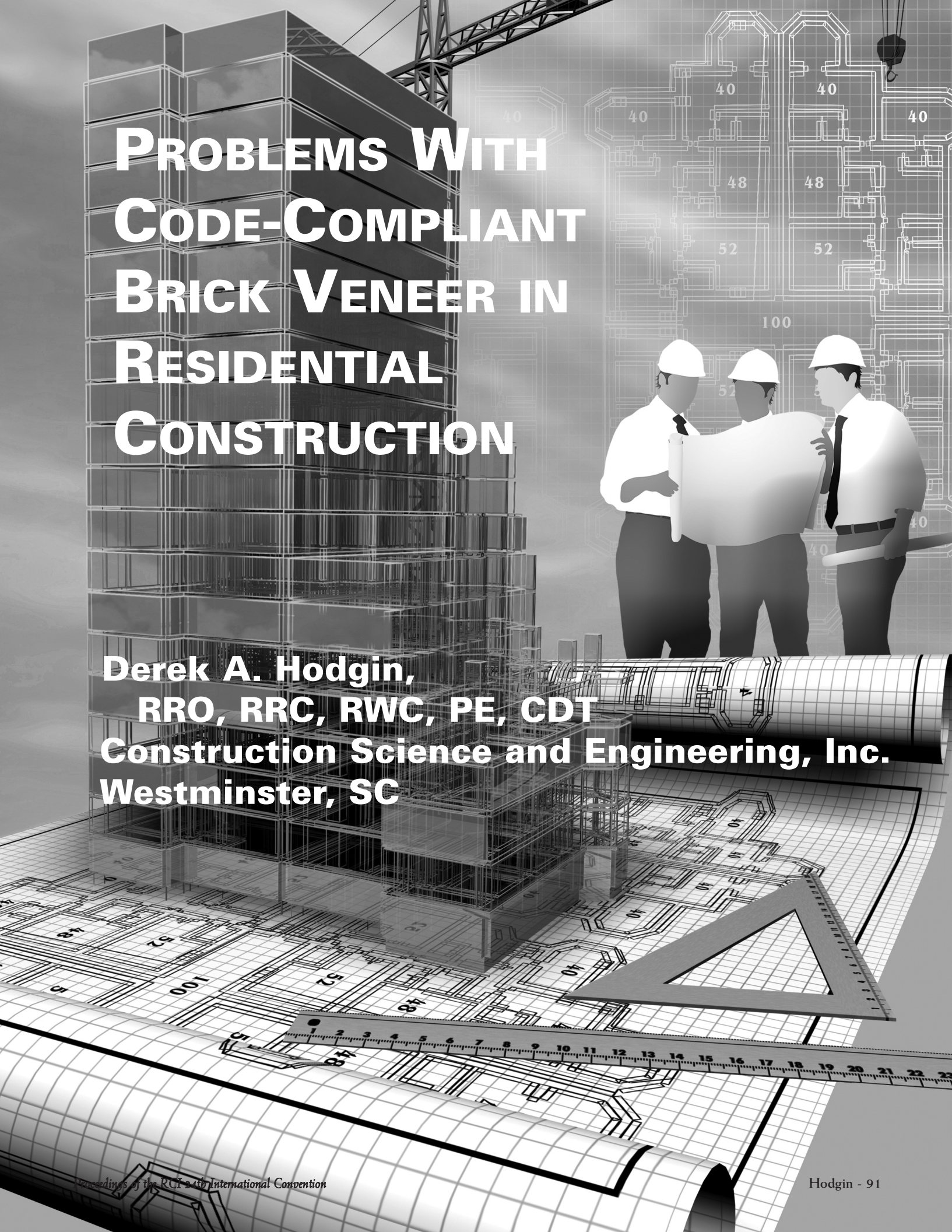
Problems With Code-Compliant Brick Veneer in Residential Construction



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ABSTRACT

This presentation addresses significant performance issues that arise in code-compliant modern residential brick veneer construction. A brief overview of brick construction will be provided, including a discussion of barrier and drainage wall design concepts. A timeline of industry standards and building code requirements regarding brick installation details will be provided, with a concentration on current building code requirements that can result in problems. Issues regarding proper material selection for various climates will be discussed, including pros and cons of various construction methodologies. Photographs of various forensic investigations will be provided to discuss the particular details that have resulted in damage. Discussion of these investigations will include what went wrong, who was responsible, and if the construction met the applicable codes and standards at the time of construction. Recommended "best practices" will be discussed that will comply with building code requirements while substantially reducing the risk of damage.

SPEAKER

Mr. Derek A. Hodgin, PE, RRO, RRC, RWC, CDT, is a forensic engineer and owner of Construction Science and Engineering, Inc. (CSE), an engineering consulting firm based in Westminster, SC. Hodgin is licensed as a professional engineer in 15 states; certified as an RRO, RRC, and RWC with RCI; as a Construction Document Technologist with CSI; as a third-party EIFS Inspector and Moisture Analyst with the Exterior Design Institute; and as a residential roofing inspector with Haag Engineering, Inc. He is a member of the Waterproofing Contractors Association, RCI, RICOWI, NRCA, the APA Engineered Wood Association, and the Forest Products Society.

Mr. Hodgin specializes in failure investigations of all types of building envelopes and roof systems. He has investigated numerous types of residential and commercial roof failures related to hurricanes, tornadoes, hail, fire, ice, and deficient construction. He has investigated many buildings that have been damaged due to moisture migration in exterior walls. He has also designed high-wind-resistant roof assemblies for projects in the southeastern U.S. and Caribbean. His technical articles have appeared in national and international trade publications and symposia proceedings.

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BACKGROUND

Brick construction has been around for a very long time. Bricks of various form have been used in construction for thousands of years. Early brick construction consisted of solid, load-bearing walls. Solid masonry walls typically perform as barrier wall systems. In such a system, the outside of the brick wall gets wet during a rain event, but the mass and thickness of the wall precludes problems of interior water intrusion. Modern brick construction typically includes brick veneer installed in front of wall framing covered with sheathing. In these cases, the brick veneer walls are intended to perform as a drainage wall system. Water that penetrates the brick veneer migrates through a drainage cavity and exits through weep holes and flashing located at the base of the wall and at interruptions in the drainage cavity (i.e., windows and doors).

Many brick veneer buildings have provided years of trouble-free performance. These buildings were constructed using simple, common-sense details that have proven successful. Many of these details are available from the Brick Industry Association (BIA), formerly known as the Brick Institute of America. These details are summarized in a series of published technical notes. The first series of technical notes was published in July 1950.

THE PROBLEMS

Water intrusion and damage associated with brick veneer cladding (i.e., staining, deterioration, wood rot, and mold) are the subjects of numerous construction litigation cases. Investigation of some of these buildings revealed construction details that were consistent with building code requirements but were inconsistent with good workmanship and long-accepted trade practices. How could this be?

It turns out that these buildings were constructed in accordance with the International Residential Code (IRC), the current building code that was created by combining parts and pieces of nearly all of our previous building codes (i.e., the CABO code, the BOCA code, Uniform Building Code, Standard Building Code, etc.). The IRC currently includes several provisions related to brick veneer construction (carried over from the CABO code) that directly defy established details that we know make good sense.

This report references the 2000 IRC; however, similar problematic provisions exist in the 1995 CABO, the 1996/1997 CABO Amendments, the 2003 IRC, and the 2006 IRC. The 2000 IRC is also referenced because the author has more significant experience with the older building codes due to the period of time that it takes for building problems to "ripen," become noticeable to the building occupant, and become the subject of construction litigation. The most problematic provisions of the 2000 IRC are discussed in more detail below.

OMISSION OF WEATHER-RESISTANT MEMBRANE

W tt C Sy:

Section 703.2 of the 2000 IRC states:

> *Asphalt-saturated felt free from holes and breaks, weighing not less than 14 pounds per 100 square feet (0.683 kg/m^2) and complying with ASTM D 226 or other approved weather-resistant material shall be applied over studs or sheathing of all exterior walls as required by Table 703.4.*

Additionally, Section 703.7.4.2 of the 2000 IRC states:

> *The weather-resistant membrane or asphalt-saturated felt required by Section 703.2 is not required over water-repellent sheathing materials.*

W tR ty Sy:

To delete the use of a weather-resistant membrane makes no sense, even in the presence of an air space. The reality of construction is that the width of the air space will vary due to imperfections in one or all of the following: wall framing, foundation, and bricklaying. The air space will also include mortar slop and droppings that collect at the base of the wall and on top of wall ties (*Photo 1*). The mortar will bridge the airspace, touching the unprotected wall sheathing. Therefore, even when the required 1-inch air space is planned for, it is rarely achieved (*Photo 2*). Additionally, the author has observed garbage (i.e., food wrappers and containers, construction debris, soda and beer cans, etc.) in the air space on numerous

Table 703.4
Weather-Resistant Siding Attachment and Minimum Thickness

Siding Material	Nominal Thickness (inches)	Joint Treatment	Sheathing Paper Required
Brick veneer	2	Section 703	Yes (13)
Concrete masonry veneer	2		

(13) For masonry veneer, a weather-resistant membrane or building paper is not required over water-repellent sheathing materials when a 1-inch air space is provided between the veneer and the sheathing. When the 1-inch space is filled with mortar, a weather-resistant membrane or building paper is required over studs or sheathing.

Photo 1 – Mortar droppings collect on top of metal brick ties and bridge the 1-inch air space, coming into direct contact with a highly permeable weather-resistant membrane.

occasions.

The concept of a water-repellent sheathing material is also subject to debate. In particular, it is often argued that Exposure 1 plywood and/or oriented strand board (OSB) are water-repellent and do not require protection. While local code officials may accept a wall sheathed with Exposure 1 OSB as providing an adequate weather-resistive membrane, the author strongly disagrees with this practice. Specifically, Exposure 1 sheathing panels are marketed as water-resistant, but they are not decay-resistant. The concept of Exposure 1 panels is that if a rain shower gets the panels wet before the contractor gets the opportunity to "dry in" the building, the panels do not have to be replaced. However, when exposed to repeated wetting and drying (i.e., at a mortar bridge, at an imperfect flashing detail, etc.), rot will likely occur. APA – The Engineered Wood Association – addressed this issue in a *Technical Topics* bulletin (TT-005) issued in December 2000. This bulletin recommends the use of "building paper or other code-approved weather-resistive or air infiltration barrier material in all frame wall systems that include wood structural panel sheathing and/or siding materials."

Photo 2 – A typical 1-inch air space ends up being reduced due to the presence of mortar and variations in wall framing and brick alignment.

INCONSISTENT BUILDING CODE REQUIREMENTS

Even though this article is written specifically for residential construction problems, it is worth noting an inconsistency regarding the use of weather-resistant membranes that exists between the International Residential Code (IRC) and the International Building Code (IBC), which governs multifamily residential and commercial construction. It appears that this inconsistency has resulted from the adoption of different sections of codes that preceded the development of the IRC and IBC. Specifically, it appears that the IRC and IBC adopted sections from the CABO and BOCA codes respectively regarding the use of weather-resistive barriers. The IRC is discussed above. In contrast, the IBC requirement is provided below for reference.

Section 1404.2 of the 2000 IBC states:

> *A minimum of one layer of No. 15 asphalt felt, complying with ASTM D 226 for Type 1 felt, shall be attached to the sheathing with flashing as described in Section 1405.3, in such a manner as to provide a continuous water-resistive barrier behind the exterior wall veneer.*

The IBC does not make exceptions to this requirement. The inconsistency between the two codes suggests that somehow water behaves differently on commercial and residential buildings. Unfortunately, the reality is that water has the potential to cause damage to all buildings, regardless of their type.

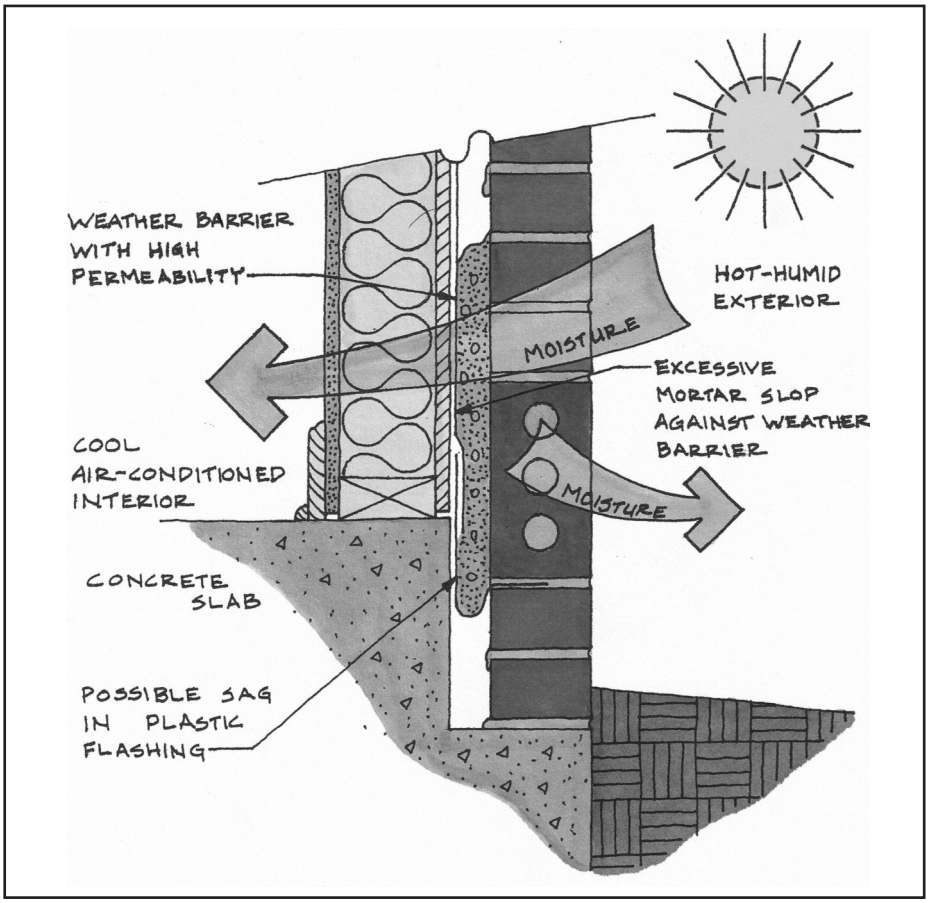

Figure 1

Photo 3 – Exterior view of a residential building with no obvious damage.

MORTAR-FILLED AIR SPACE

W t t C S y :

Section 703.7.4.3 of the 2000 IRC states:

> *As an alternate to the air space required by Section 703.7.4.2, mortar or grout shall be permitted to fill the air space. When the 1-inch (25.4-mm) space is filled with mortar, a weather-resistant membrane or building paper is required over studs or sheathing. When filling the air space, it is permitted to replace the sheathing and weather-resistant membrane or asphalt-saturated felt paper with a wire mesh and approved paper or an approved paper-backed reinforcement attached directly to the studs.*

W t R ty S y :

Since the approved weather-resistant membranes described above are highly permeable, water vapor has an easy time migrating through the wall assembly. In fact, the list of "approved" weather barriers includes materials with perm ratings of approximately 5 (#15 asphalt-saturated felt) to nearly 60 (spun-bond polyolefin). While these high-perm membranes are marketed as vapor-permeable (i.e., breathable) and liquid-water-impermeable, real-world construction details show otherwise.

In particular, when saturated mortar is in direct contact with a highly permeable membrane, liquid water can easily pass through to the unprotected areas of the wall assembly, resulting in deterioration and mold growth. The water is able to pass through the barrier due to capillary continuity, the same process that causes an otherwise dry camper to get wet in the morning when touching the side of a canvas tent. For this reason, allowing mortar (or any other absorbent construction material) to come into direct contact with a highly permeable membrane is not a good idea.

Problems can be particularly drastic in hot/humid climates due to the direction of moisture/vapor drive during the summer months. Specifically, the direction of moisture/vapor movement is from the hot-humid exterior environment and through

Photo 4 – View of the interior side of the wall shown in Photo 3 that was exposed during destructive testing. Both the exterior wall sheathing and dimensional wood framing members were rotten. An interior-side vapor barrier was placed behind the interior drywall.

the wall assembly toward the cool, air-conditioned interior environment.

This problem is made much worse when significant moisture is present in the wall assembly after a summer rain shower. The rain serves to saturate the brick veneer and the mortar slop that is in contact with the high perm weather barrier. When the sun comes out, some of the moisture is evaporated on the exterior wall surface. Unfortunately, most of the moisture (approximately two-thirds) is driven toward the interior (see *Figure 1*). Add one more problem to the mix (an interior-side vapor barrier that is also allowed by the building code), and you have the potential for a disaster (*Photos 3* and *4*), yet the entire wall assembly was built in accordance with building code requirements!

CONCLUSIONS

While the building code is intended to provide the construction industry with minimum standards, it is the author's opinion that portions of the current building code reflect details that are substandard and have resulted in significant damages. Structures located in mixed climates, such as the hot and humid areas of the southeastern United States, are particularly vulnerable to damage.

Until the building codes can reflect the time-tested best practices of the industry, we will likely continue to investigate the damages caused by code-compliant construction. Our current building codes need to be carefully reviewed and revised to reflect the construction details that we know will work.

REFERENCES

APA – The Engineered Wood Association, *Technical Topics TT-005* – APA "Building Paper Recommendations for Walls," December 2000.

International Code Council, Inc., *2000 International Building Code*, March 2000.

International Code Council, Inc., *2000 International Residential Code for One- and Two-Family Dwellings*; January 2000.