

**U.S. Department of Housing and Urban Development  
Office of Policy Development and Research**

**STEEL FRAMED RESIDENTIAL  
CONSTRUCTION: DEMONSTRATION  
HOMES**

**ADDENDUM: INSTALLATION OF  
FOAM INSULATION AND VINYL  
SIDING**

**Steel Framed Residential Construction: Demonstration Homes**  
**Addendum: Installation of Foam Insulation and Vinyl Siding**

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## Foreword

Recent materials advances, technical development, availability concerns, and economic uncertainty have prompted homebuilders to examine alternatives to traditional framing materials and methods. Although the alternatives have existed for some time, builders continue to use traditional materials. In many instances, their hesitancy can be attributed to a lack of information that will guide them in using alternative construction materials.

In response to heightened interest, the U.S. Department of Housing and Urban Development (HUD) commissioned a review of available structural materials for homebuilding. The results, *Alternatives to Lumber and Plywood in Home Construction*, were published in 1993 and identified several promising materials. Further study results released in 1994 (*Alternative Framing Materials in Residential Construction: Three Case Studies*) provided insight into the installed cost of several systems.

HUD is continuing to research new materials. A previous report, *Steel Framed Residential Construction: Demonstration Homes* provides builders with practical information and experience, based on the actual construction of two steel framed homes. This addendum provides additional experience on the installation of foam insulation and vinyl siding on one of these steel-framed homes. It will play a vital role in the Departments' cooperative effort with the homebuilding and steel industries to develop cost-effective, prescriptive methods for steel framed homes.

I hope this report will help guide builders in the use of this promising new technique, enhancing housing affordability and promoting healthy competition in the optimal use and preservation of our natural resources.

Michael A. Stegman  
Assistant Secretary for Policy  
Development and Research

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## INTRODUCTION

In 1993 and 1994, the NAHB Research Center wrote two reports for the U.S. Department of Housing and Urban Development (HUD) describing the potential for several alternative structural materials in the construction of homes<sup>1</sup>. Steel was identified as a material with significant potential to overcome technical, regulatory, and economic barriers associated with the home construction industry in the United States.

As a result of previous findings and to compliment the development of prescriptive construction guidelines (also sponsored by HUD), two demonstration projects evaluated the use of steel as an alternative framing material for homes<sup>2</sup>. These demonstrations provided an opportunity for participants and observers to experience steel framing and improve their understanding of steel-frame construction.

This report documents the installation of exterior foam insulation and vinyl siding at the second demonstration project, which consisted of a 720 square-foot (66.9 m<sup>2</sup>) home at the NAHB Research Center in Upper Marlboro, Maryland. The foam insulation consisted of one- and two-inch thick extruded polystyrene (XPS) and one-inch thick polyisocyanurate. Conclusions are provided at the end of the report based on the observations and hands-on experiences of Research Center personnel.

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<sup>1</sup> *Alternatives to Lumber and Plywood in Home Construction*, HUD-1409-PDR dated August 1993; *Alternative Framing Materials in Residential Construction: Three Case Studies*, HUD-1496-PDR dated October 1994.

<sup>2</sup> *Steel Framed Residential Construction: Demonstration Homes*, HUD-1568-PDR dated December 1995.



## **BACKGROUND**

Demonstration Home 2 consisted of the basic framework for a 720 square-foot (66.9 m<sup>2</sup>) one-story house with an attached garage. Its primary purpose was to demonstrate a variety of practical steel-framing details and methods of construction. Several low-cost fastening methods for insulation panels and vinyl siding were investigated. These methods included tools, techniques, and fasteners currently used with steel framing, along with a technology which may be feasible provided additional development.

### **Capacitor Discharge Stud Welding**

Capacitor discharge (CD) welding is a spot welding technique which is currently used to attach rigid fiberglass board to sheet metal HVAC ductwork. The method is similar to spot welding, except the weld is produced with a hand-held gun welds the steel pins to the sheet metal. The gun is connected to a small capacitor discharge welder, which supplies an instantaneous discharge of electrical energy to weld the pin to the metal surface. The gun has a trigger which controls the welder. The welder has a voltage control to regulate the electrical discharge, which determines the strength of the weld.

### **Pneumatic Pins**

This method is analogous to pneumatic nailers used in wood-framed construction. Adjustments to the air pressure and standoff on the gun are needed to control the penetration of the pins. The pins are similar to nails with a knurled surface added to provide a better grip to the sheet steel. Pneumatic pins have been used for attaching of sheathing to steel trusses, walls, and floors. They have also been used for the attachment of rigid insulation.

## **Self-Drilling Screws**

Self-drilling screws have been the principal fastener in cold-formed steel construction. These screws have a fluted tip which drills through the steel allowing the threads to engage. A variable speed electric screwgun is used to install these screws.

## OBSERVATIONS

### Foam Insulation Installation

CD stud welding was tested for the attachment of one and two inch XPS and Vinyl siding. First the pins were welded to the studs (see Figure 1). The insulation was pressed over the pins to sit against the wall. Locking washers were slipped over the pins to hold the insulation in place. Any pin left protruding beyond the washer was sniped off with a pair of wire snips (see Figure 2). The CD stud welding process proved to be a fast method for the attachment of the insulative sheathing. The portable equipment made the system very usable on site. The large washers for the pins seemed effective in holding the insulation to the frame, even with winds in excess of thirty miles per hour. The CD Stud Welding process has potential problems concerning corrosion that must be addressed before it can become a viable insulation fastening system. The welding process burns off the steel framing's galvanized coating in the area adjacent to the pin. In addition, the pins are not galvanized. Corrosion of the



**Figure 1** Installation of weld pins

pins over time, may cause the failure of the connections.





**Figure 2** Clipping pin protruding past washer

Self-drilling screws were tested for the attachment of one inch foam insulation. Each screw was first inserted through a plastic washer. The screws are pushed through the insulation and driven through the steel stud until the washer pulls tight against the insulation (see Figure 3). This has been the primary method for the attachment of foam insulation to steel frames, thus it is no surprise that the



**Figure 3** Attachment of insulation using screws and washers

screws proved to be an effective method for attaching foam insulation.

## OBSERVATIONS

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## **Vinyl Siding Installation**

CD stud welding was tested for the attachment of vinyl siding. The method used was similar to the attachment of foam insulation. Each pin, after being loaded in the gun, had to be inserted through the punchout in the siding and pushed through the insulation to rest against the steel. The diameter of the washers available for the test was too large and interfered with the top edge of the siding. Each washer had to be cut so that it could rest close to the vinyl siding. Figure 4 shows the washers used to secure the starter strip for the vinyl siding. The CD stud welding process has some problems that have to be addressed before it can become a viable vinyl siding fastening system. The problem with the burning of the galvanized coating discussed previously is a serious concern, as failure of the pins could cause the siding to sag or fall off. In addition, the welding process burned the foam insulation in the vicinity of the weld. The burn hole in one sample was approximately 1/2 inch in diameter. Figure 4 shows burn marks on the XPS associated with the welding process. The pins that were used for this experiment seemed unable to hold the siding unless the locking washers were pressed tight against the siding. This will not allow the siding to expand and contract with variation in temperature, causing buckling and warping of the siding.





**Figure 4** Weld pins used to secure starter strip for vinyl siding



**Figure 5** View of finished wall

Pneumatic driven pins were tested for the attachment of vinyl siding over one inch of foam sheathing. Initial adjustment of the air pressure and the nailer standoff provided the proper penetration of the pins. Proper penetration of the pin is important because driving the pin tight against the siding would not allow

for expansion and contraction of the siding, causing warping and bowing. Once



**Figure 6** Siding secured using pneumatic pins

the tool was adjusted, most of the pins were driven to the correct depth (see Figure 5).

When a pin was driven too tight, the siding was pried from the pin and a new pin was installed. During initial attempts to attach the siding it was determined that the end of the gun was too large and would not allow for the pin to be shot through the punchout in the siding. Modifications were made to the nose piece which allowed each pin to be centered on the punch out when the nose piece rested on the top lip of the siding. After this modification the siding installation proceeded efficiently. Pneumatic pins seem to be a viable alternative to screws when attaching vinyl siding to steel studs. An 8' x 24' wall section was completed in under an hour with two people (see Figure 6). The only problem with this system is that the nailer will only shoot pins up to 1-1/2" long. This limits the system to installations involving one inch or less of exterior sheathing. Further modification of the nailer may allow for the use of longer pins with thicker foams..

Self-drilling screws were tested for the attachment of vinyl siding over two inches of foam sheathing. For this test three inch, bugle head, self-drilling screws were used. They were installed with an industrial quality variable speed screwgun, and magnetic bit holder with a phillips tip. Surprisingly, the two inches of XPS had very little effect on the installation of the siding. Some extra care had to be taken to hold the screw straight while driving it into the 33 mil studs (see Figure 7). Screws have an advantage over the pneumatic pins because, if driven too



**Figure 7** Screws used to attach vinyl siding

tight, they can be backed off . Bugle head screws were the wrong choice for this application. They tended to pull through the punchouts in the vinyl siding. Hex Head or pancake head screws would have held the siding much more effectively due to the head configuration providing a flat surface to secure the siding.

## CONCLUSIONS

This demonstration project provided useful observations on the installation of foam insulation and vinyl siding. The following conclusions are drawn from this demonstration project:

- 1) CD welding has potential to become a feasible fastening system for attaching foam insulation to steel frames, but will need to be modified to permit its use in homebuilding;
- 2) Self-drilling screws coupled with washers are an effective method for installing foam insulation;
- 3) CD welding has little potential for the attachment of vinyl siding unless corrosion and pin strength issues are addressed;
- 4) Pneumatic pins hold a lot of potential for the attachment of vinyl siding. The system needs little modification. It is an efficient system for installation of vinyl siding over foam insulation one inch thick or less. Considerable modifications will be needed for installations over thicker foam insulation;
- 5) Self-drilling screws are the conventional method for attaching vinyl siding to steel frames and should remain so, especially for installation of siding over thick layers of foam insulation.