

# research report

## **Cold-Formed Steel Walls with Fiberboard Sheathing – Shear Wall Testing**

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**American Iron and Steel Institute**



**Steel Framing Alliance™**

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## **PREFACE**

This report was developed by the NAHB Research Center for the Steel Framing Alliance and the Lateral Design Task Group of the AISI Committee on Framing Standards. The objective of this project was to evaluate the performance of fiberboard sheathing on steel-framed walls.

The project involved the conducting of four monotonic tests. The results of these tests are available to serve as basis of a code change to permit use of fiberboard sheathing on steel-framed walls and the addition of design values to the *AISI Standard for Cold-Formed Steel Framing - Lateral Design*.

Research Team  
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**COLD-FORMED STEEL WALLS WITH  
FIBERBOARD SHEATHING -  
SHEAR WALL TESTING**

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# COLD-FORMED STEEL WALLS WITH FIBERBOARD SHEATHING - SHEAR WALL TESTING

## PURPOSE

The purpose of this test program was to conduct shear wall testing of cold-formed steel walls sheathed with structural fiberboard sheathing.

## TEST METHOD

The tests were performed according to the general provisions of ASTM Standard E564 *“Standard Practice for Static Load Test for Shear Resistance of Framed Walls for Buildings”*. Two tests were done for each assembly.

Shear wall testing was conducted in accordance with the general provisions of ASTM E 564-00 *“Standard Practice for Static Load Test for Shear Resistance of Framed Walls for Buildings”*. A total of two test configurations were tested in accordance with Tables 1 and 2. A sample size of two was used with each wall configuration. A total of four shear wall specimens were tested. Testing was performed at the Laboratory Facilities of the NAHB Research Center in Upper Marlboro, MD in August of 2005. Figure 1 shows a schematic of a shear wall test setup including instrumentation.

## TEST SPECIMENS

Four 8-foot wide by 8-foot-tall wall specimens were tested. The uplift corners of the wall specimens were restrained with Simpson Strong-Tie HTT22 hold-downs (see Figure 10). The characteristics of each of the tested walls are summarized in Table 1. Figures 2 through 4 show typical wall specimen.

## EQUIPMENT

The tests were performed using a racking shear apparatus. Cylinder motion was controlled using a computer-based system.. Wall drift was measured using a string potentiometer. Wall uplift, slip, and compressive deformation were measured using Linear Variable Differential Transformers (LVDTs) (see Figures 4 through 8). Load was measured using an electronic load cell (see Figure 9). Load and displacement readings were recorded using a digital data acquisition system. All instruments were calibrated in accordance with the NAHB Research Center Laboratory Quality Manual.

## SHEAR WALL TESTING

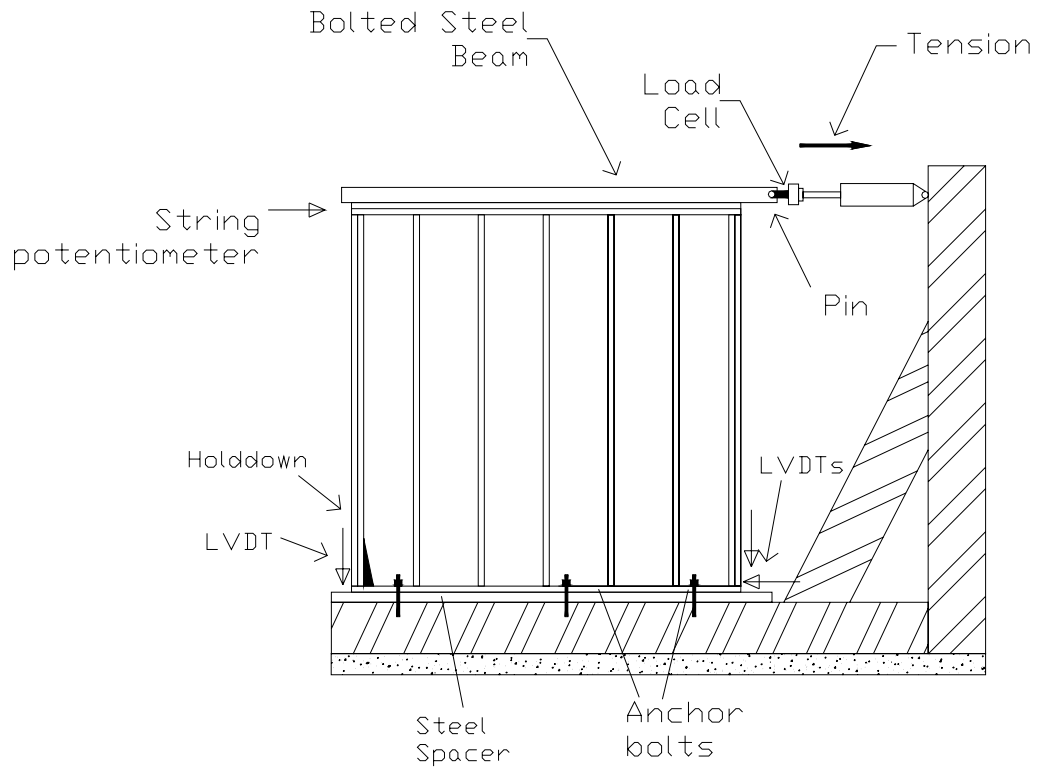
Shear walls were tested by displacing the top of the specimen at a constant rate of 0.3 inch/min. Displacement was applied with a hydraulic actuator using a tube steel distribution beam bolted to the top plate. Specimens were tested to failure defined as a drop in load to less than 80 percent of the peak load. A multi-step loading history was used in accordance with ASTM E 564-00. The peak load for the first specimen of each configuration was estimated using the principle of engineering mechanics to set target loads for the loading history. Specimens were set on a 3.5-inch-wide steel channel spacer to allow for sheathing panel rotation without interference with the setup

**TABLE 1  
WALL SPECIMEN CHARACTERISTICS**

<b>STEEL FRAMING</b>	
<b>FRAMING COMPONENT</b>	<b>DESCRIPTION</b>
Specimen Size	8 Foot Long x 8 Foot Wide
Stud Size and Grade	362S162-33, 33 ksi (yield strength was not verified by testing)
Track Size and Grade	362T125-33, 33 ksi (yield strength was not verified by testing)
Stud Spacing	24 inches on center
Sheathing Fasteners	No. 8 x 1" modified Truss Head Screws (Head Diameter = 0.43") Edge Distance = 1/2"
Framing Fasteners	No. 8 x 1/2" modified Truss Head Screws
Sheathing Screw Spacing	See Table 2
Anchorage	1/2-inch bolts with round cut washers spaced 4 feet on center
Hold-down at corners	Simpson Strong-Tie HTT22 attached with No. 8 screws; Hold-down raised about 1" from the sill plate
<b>SHEATHING PANELS</b>	
Sheathing Panel Type	Structural Fiberboard Sheathing conforming to ANSI/AHA A194.1
Panel Size and Thickness	48" Wide x 96" Long, 1/2" Nominal Thickness
Installation	Sheathing Parallel to Studs

**TABLE 2  
FASTENING SCHEDULE OF FIBERBOARD SHEATHING**

<b>ON CENTER SCREW SPACING</b>		
<b>WALL TEST NO.</b>	<b>PERIMETER (EDGE) (in.)</b>	<b>FIELD (INTERMEDIATE) (in.)</b>
1	3	6
2	3	6
3	2	6
4	2	6



**FIGURE 1  
SHEAR WALL SETUP**





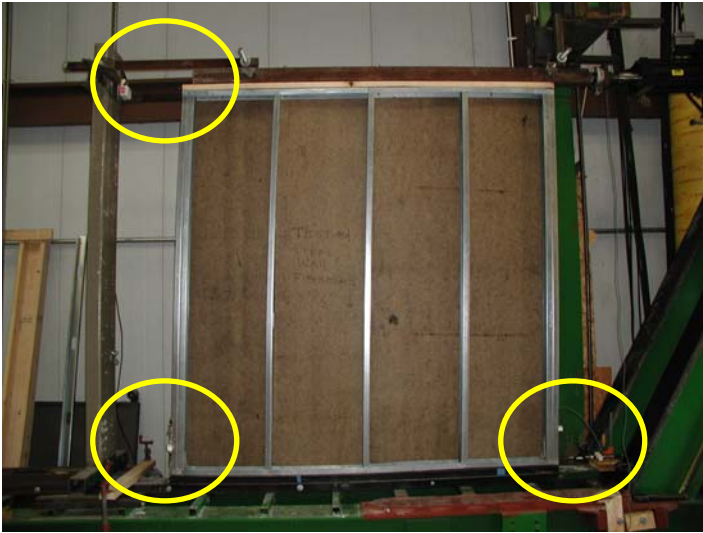
**FIGURE 2  
WALL SPECIMEN**



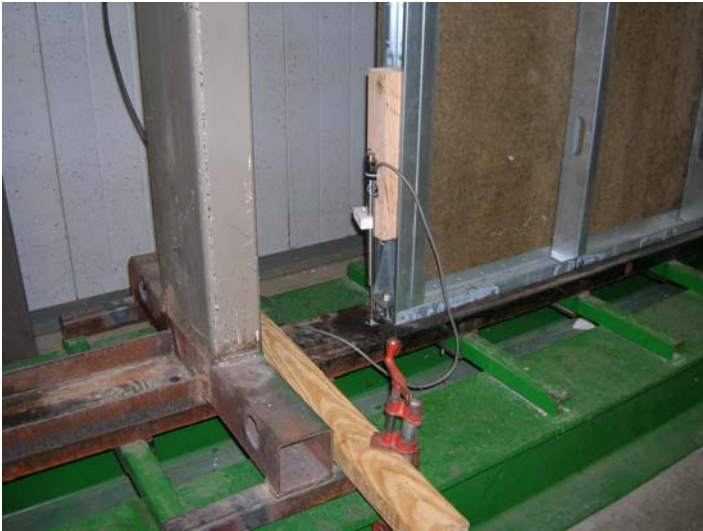
**FIGURE 3  
FIBERBOARD  
SHEATHING W/ 3"  
SCREW SPACING**



**FIGURE 4  
FIBERBOARD  
SHEATHING W/ 2"  
SCREW SPACING**



**FIGURE 5  
LOCATION OF LVDTS**



**FIGURE 6  
TENSION STUD VDTs**



**FIGURE 7  
COMPRESSION STUD LVDTs**



**FIGURE 8  
TOP TENSION STUD LVDTS**



**FIGURE 9  
LOAD CELL**



**FIGURE 10  
TENSION STUD HOLD-DOWN**

## RESULTS

The peak loads for the four tested wall specimens are tabulated in Table 3. Figures 11 through 14 show the load-deformation relationship for the tested walls. Figures 15 through 20 show the failure of the tested wall assemblies. Failure was associated with screw tear out between the fiberboard sheets at the middle of the wall. None of the studs buckled during the test or at peak loads.

Table 4 provides a comparison between the nominal shear values (in pounds per linear foot of wall) for wood and steel walls sheathed with fiberboard sheathing. The shear values for the wood walls were taken from the American Forest and Paper Association, 2001 Edition Supplement, Special Design Provisions for Wind and Seismic, ASD/LRFD, Manual for Engineered Wood Construction.

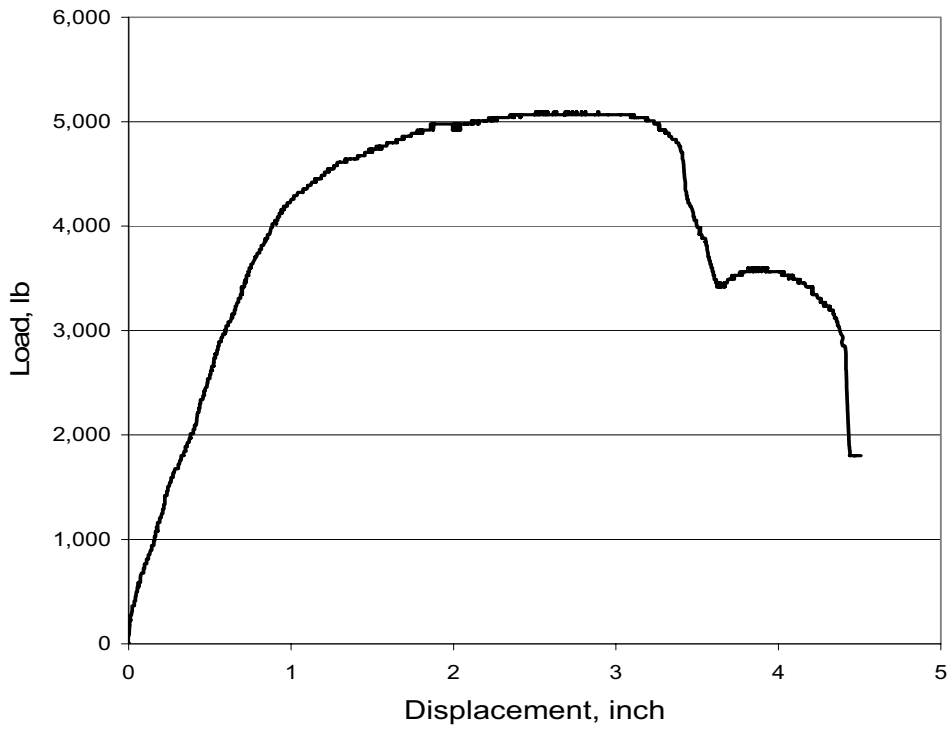
**TABLE 3  
SHEAR WALL TEST RESULTS**

Test No.	Screw Size	On-Center Perimeter Screw Spacing	Peak Load, lb	Average Peak Load, lb
1	#8 x 1/2"	3"	5,096	4,935
2			4,775	
3		2"	5,478	5,369
4			5,260	

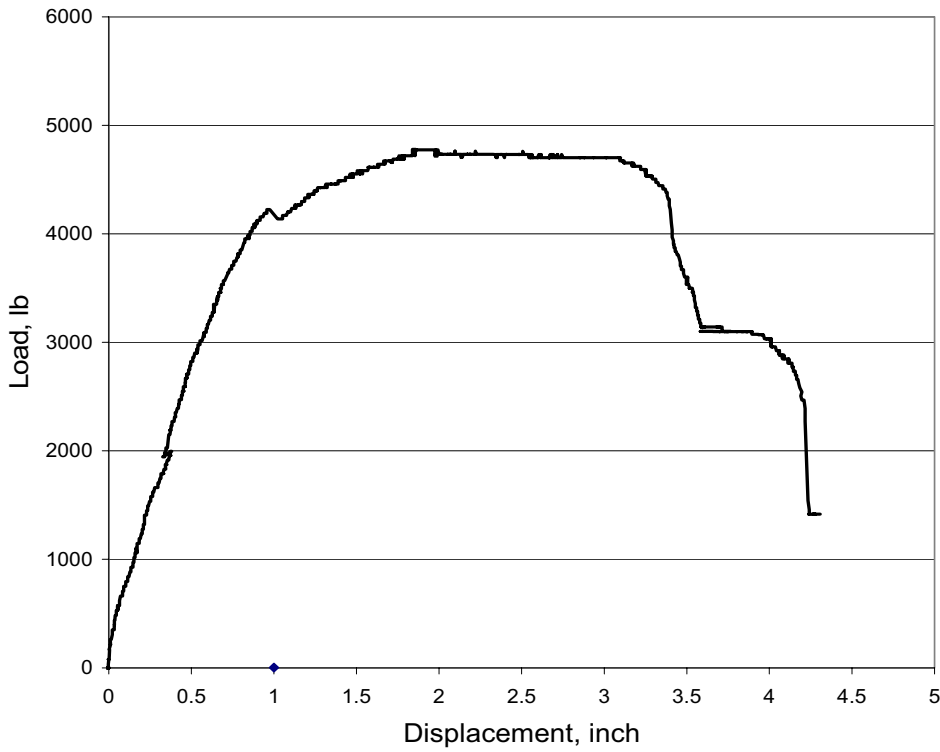
**TABLE 4  
COMPARISON OF NOMINAL SHEAR VALUES (LB/FT)**

Wall	Intermediate (Field) Fastener Spacing		
	6"	6"	6"
	Edge (Perimeter) Fastener Spacing		
	2"	3"	4"
Wood <sup>1</sup>	730	645	475
Steel	671	617	-

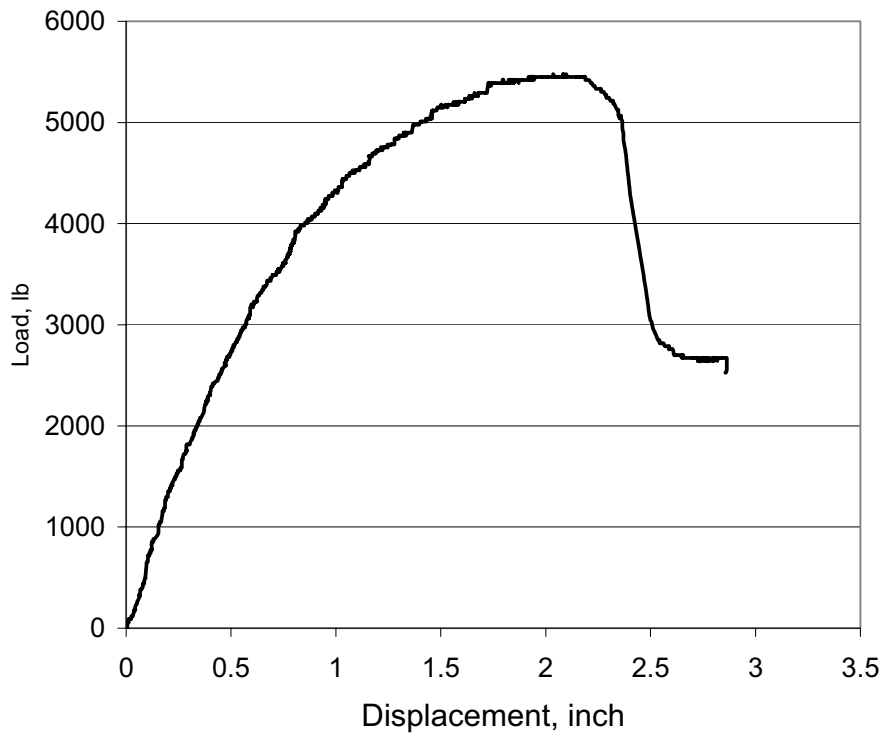
<sup>1</sup> Nominal shear values are based on Douglas-Fir-Larch or Southern Pine grades. Adjustment factors should be used for other grades (Refer to Table 4.3A of AF&PA Manual for Engineered Wood Construction).



**FIGURE 11  
LOAD-DEFORMATION RELATIONSHIPS – TEST # 1**

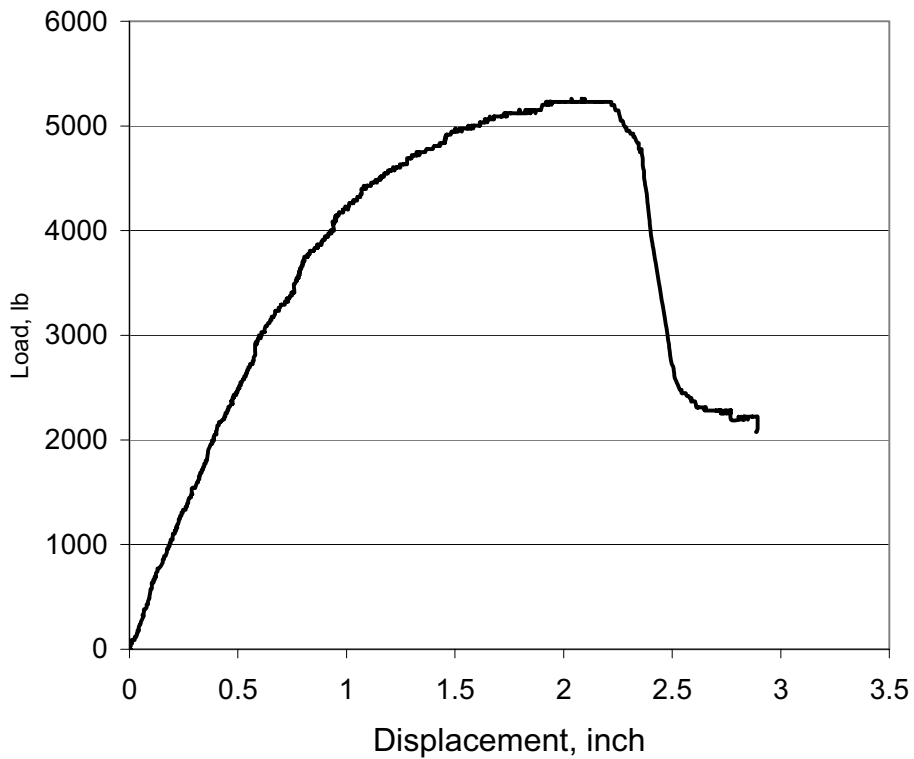


**FIGURE 12**



**LOAD-DEFORMATION RELATIONSHIPS – TEST # 2**

**FIGURE 13**



**LOAD-DEFORMATION RELATIONSHIPS – TEST # 3**

**FIGURE 14**  
**LOAD-DEFORMATION RELATIONSHIPS – TEST # 4**



**FIGURE 15**  
**FAILURE OF TESTED**  
**WALL**  
**(3" SCREW SPACING)**



**FIGURE 16**  
**FAILURE OF TESTED**  
**WALL**  
**(3" SCREW SPACING)**



**FIGURE 17**  
**FAILURE OF TESTED**  
**WALL**  
**(3" SCREW SPACING)**





**FIGURE 18**  
**FAILURE OF TESTED WALL**  
**(2" SCREW SPACING)**



**FIGURE 19**  
**FAILURE OF TESTED WALL**  
**(2" SCREW SPACING)**



**FIGURE 20**  
**FAILURE OF TESTED WALL**  
**(2" SCREW SPACING)**

## UNCERTAINTY

The uncertainty of the peak load measurements has been estimated to be 0.5 percent. The uncertainty of the displacement measurements has been estimated to be 1.05 percent. These estimates were made using Type B analysis at a 95 percent confidence level with a coverage factor of  $k=2$ .

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Nader Elhaji  
Project Manager



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Signature

September 8, 2005

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Date

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Date



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