COUNCIL OF FOREST INDUSTRIES OF B.C., CANADA

TECHNICAL NOTE 91.1

EFFECT OF SPRAY-APPLIED POLYURETHANE FOAM INSULATION ON THE RACKING LOAD OF A PLYWOOD SHEATHED WOOD FRAME WALL

by

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1.0 INTRODUCTION

This test program was carried out to provide an indication of the effect of spray applied polyurethane foam insulation on the strength of a typical plywood sheathed wood frame wall.

Rigid polyurethane foams are thermosetting cellular plastics. Applied through a spray gun, a liquid mixture immediately expands and hardens to produce a tough, rigid closed cell foam which bonds to the applied surface.

Testing was conducted by the Technical Development and Engineering Department of the Council of Forest Industries of British Columbia (COFI) at the expense of Tasman Barrier Systems, a specialist in the application of spray-in-place polyurethane foam.

2.0 PROCEDURE AND APPARATUS

Testing was carried out according to ASTM E 72 - 80 **STANDARDS METHODS OF CONDUCTING STRENGTH TESTS OF PANELS FOR BUILDING CONSTRUCTION** (Section 14: Racking Load - Evaluation of Sheathing Materials on a Standard Wood Frame) except that only one panel of each construction was tested.

Two identically constructed walls, one with polyurethane foam insulation and one without, were tested for racking strength. Tests were carried out used a wall racking apparatus designed and built by the staff of the COFI Technical Development and Engineering Department in accordance with relevant information presented in ASTM E 72. A schematic of the test assembly is presented as Figure 1.

A horizontal load was hydraulically applied at the upper left point of each wall assembly through an 89 mm x 89 mm timber firmly bolted to the top of the wall assembly. The applied load, and the deflection at the upper right of the wall assembly, were continuously recorded on an X-Y recorder. The applied load was also displayed on a digital readout device. Deflections at the lower left and lower right of the wall assembly were measured using mechanical dial gauges.

Load was measured with an accuracy better than +0.1%, and deflection measuring equipment had an accuracy of +0.05 mm or better.

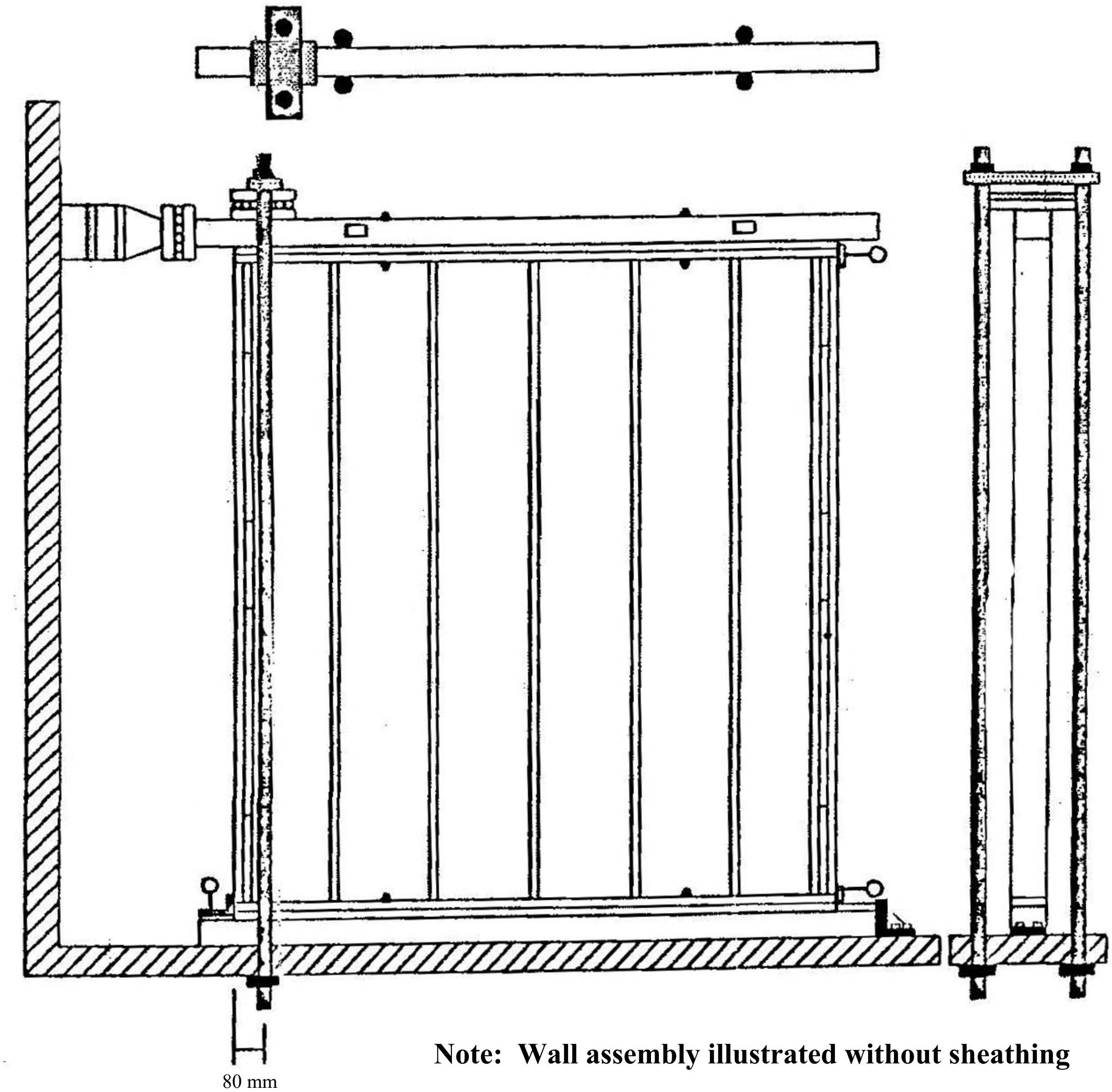

Figure 1: Schematic of the Test Apparatus

3.0 MATERIALS

The standard wood frame specified in ASTM E 72 -80 was constructed and sheathed using the following materials:

> Plywood:9.5 mm - 3 ply Sheathing grade COFI EXTERIOR Canadian Softwood Plywood (CSP)
>
> Lumber:38 mm x 89 mm No. 1 grade Douglas Fir
>
> Nails:2" common nails for sheathing attachment
> 3" and 3.5" common nails for frame construction

Plywood for both walls was obtained from the same source and visually matched for this testing, as was the lumber. The plywood was in an air-dry condition, and the moisture content of the lumber was in the range specified by ASTM E-72 (between 12% and 15%).

The plywood sheathing was horizontally attached to the frame (face grain perpendicular to studs) using 2" common nails spaced at 150 mm on centres along panel edges and 300 mm o.c. along intermediate supports. Nail heads were driven flush with the sheathing. The completed wall assembly was 2.4 m by 2.4 m in dimension.

After both walls were constructed, one wall had spray-applied polyurethane foam insulation with a nominal density of 40 kg/m^3 (2.5 pcf) applied by Tasman Barrier Systems in accordance with their standard procedure to the back of the sheathing, to a nominal expanded thickness of 44 mm (1¾") and with a slight taper to the studs.

4.0 EVALUATION AND RESULTS

For each measuring device, the movement under each racking load was calculated as the difference between the readings when the load was applied and the initial readings at the start of the test (absolute zero before cycling). Set was calculated as the difference between the readings when the load was removed and the initial reading at the start of the test.

The dial at the lower left (attached to the stud) measured panel rotation, the dial at the lower right measured panel slippage, and the reading at the upper right measured the total of the other two plus the deformation of the panel. The horizontal deflection of the wall assembly at any load was therefore calculated as the reading at the upper right minus the sum of the readings of the other two.

The thickness and density of the polyurethane foam insulation was determined by removing samples from three locations. Samples were approximately 60 - 65 mm square. The average thickness was 44 mm, and the average density was 40 kg/m^3 (2.5 pcf).

Table 1 presents deflections and set at 3.5 kN, 7.0 kN, 10.5 kN, and at ultimate load for each wall assembly.

The load-deflection curves for the tested wall assemblies are presented as Figure 2.

TABLE 1 SUMMARY OF LOAD-DEFLECTION DATA

LOAD (kN)	**DEFLECTION (mm)**		**DIFF. %**	**SET (mm)**		**DIFF. %**	**SET/DEFLECTION %**	
	A*	**B***		**A**	**B**		**A**	**B**
3.5	2.87	0.93	-67.6	0.85	0.15	-82.4	29.5	16.1
7.0	7.70	2.39	-69.0	2.85	0.75	-73.7	37.0	31.4
10.5	16.5	4.02	-75.6	7.00	2.00	-71.4	42.5	49.8
ULT**	47.6	23.6	-50.4	-	-	-	-	-

* A = Standard wall assembly
B = Sprayed wall assembly

** Ultimate load for standard wall assembly was 13 000 N
Ultimate load for sprayed wall assembly was 31 900 N

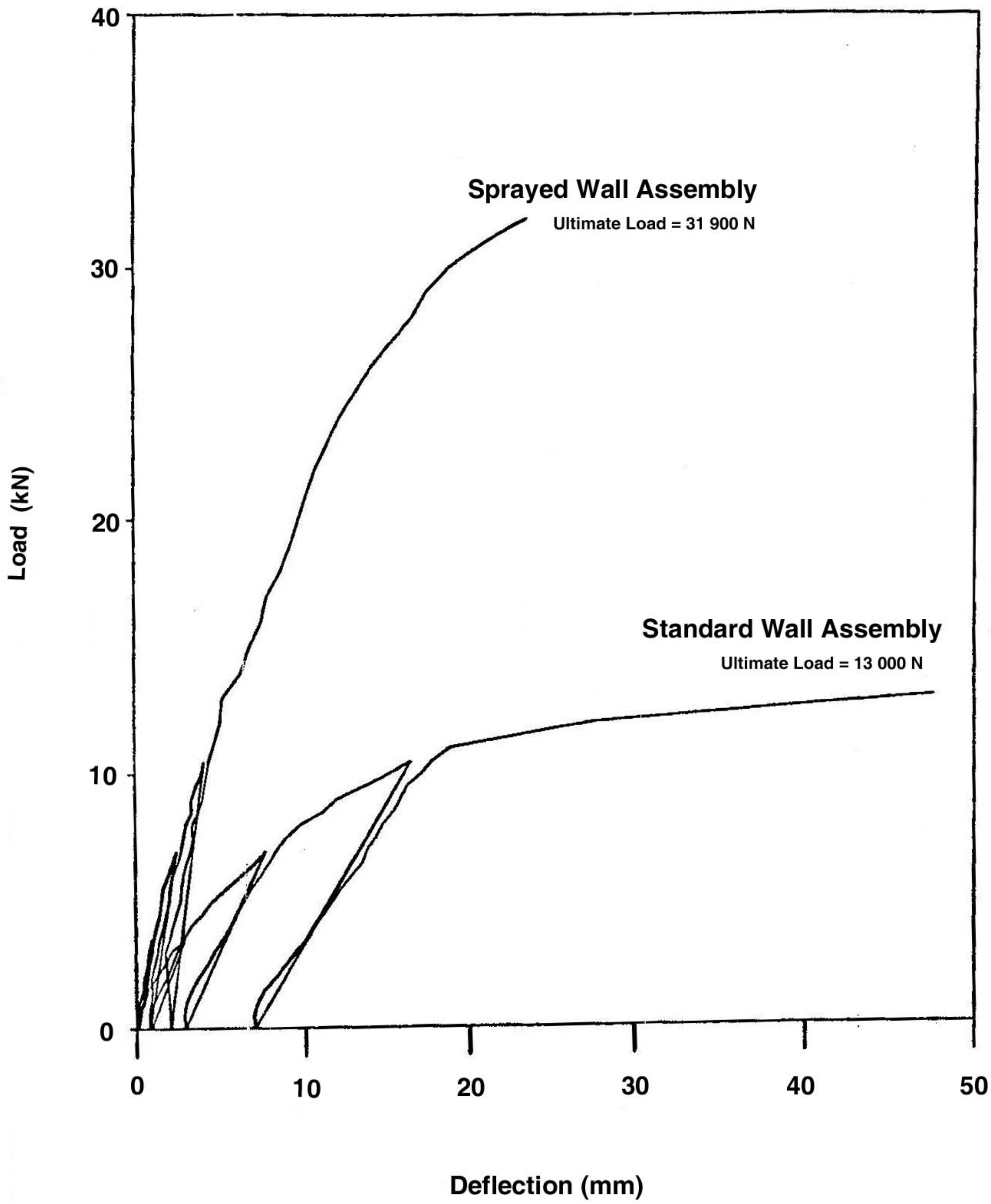

Figure 2: Load-Deflection Curves for Tested Wall Assemblies