

Experimental Evaluation of the Strength and Behaviour of 16- and 18-Gauge Cold Formed Steel Top Track Systems

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PREFACE

This report was developed by the University of New Brunswick for the Canadian Sheet Steel Building Institute, the Steel Framing Alliance and the Prescriptive Methods Subcommittee of the AISI Committee on Framing Standards. The objective of this project was experimental determination of the strength and stiffness of load bearing top track assemblies.

This project involved tests on 60 assemblies, including track and 2x4 wood on a 3-5/8 inch stud wall, standard track on 3-5/8 inch stud wall, track and 2x6 wood on 6-inch stud wall, standard track on 6-inch stud wall and deep leg track on 3-5/8 inch stud wall. Based on the rather limited structural capacities, it was concluded that it was not worth pursuing the development of a design methodology or including details and span-load tables in the AISI *Standard for Cold-Formed Steel Framing – Prescriptive Method for One and Two Family Dwellings* for the tested assemblies.

Research Team
Steel Framing Alliance

**EXPERIMENTAL EVALUATION OF THE STRENGTH AND
BEHAVIOUR OF 16- AND 18-GAUGE COLD FORMED STEEL
TOP TRACK SYSTEMS - 92 MM AND 152 MM, 16"- and 24"-
SPANS (W & W/O 2X4 AND 2X6 WOOD TOP PLATES)**

**A Study Conducted at the University of New Brunswick Structural Engineering
Laboratory under the Supervision of J. L. Dawe, PhD, P.Eng.**

Submitted to: CSSBI; attn.: Steve Fox, PhD, P.Eng.

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1.0 INTRODUCTION

1.1 Background

This research project was proposed by the Canadian Sheet Steel Building Institute on behalf of the Steel Framing Alliance in order to continue research and the development of standards for cold-formed steel framing. The American Iron and Steel Institute has published the *Standard for Cold-Formed Steel Framing – Prescriptive Method for One and Two Family Dwellings* which provides member selection tables and construction methods that can be used to design and construct a residential home. One of the requirements in this standard is for in-line framing, where the roof framing must line up with a wall stud below to provide a direct load path. This requirement can be waived if there is a load distribution member provided to transfer the load from the roof framing to the wall studs.

It is common practice in residential framing to use roof trusses at 24 in. spacing and wall studs at 16 in spacing. In this situation a load distribution member is needed for the building to be constructed in accordance with the prescriptive method. At the present time the prescriptive method does not provide any selection tables for these load distribution members. Therefore, if a builder wants to use steel framing that is not in-line, an engineer would be needed to design this structural load distribution member. The steel industry wants to remove this limitation and provide prescriptive member selection tables and construction details for load-bearing top track configurations to be used within the limitations of the prescriptive method.

1.2 Objectives

The following objectives were proposed by the Steel Framing Alliance. The objectives of this research include the experimental determination of the strength and stiffness of the following load bearing top track assemblies:

- A. Track and 2x4 wood on 3-5/8 inch (92 mm) stud wall
- B. Standard Track on 3-5/8 inch (92mm) stud wall
- C. Track and 2x6 wood on 6 inch (152 mm) stud wall
- D. Standard Track on 6 inch (152 mm) stud wall
- E. Deep leg track on 3-5/8 inch (92 mm) stud wall

1.3 Scope

Research began with a literature review of topics pertaining to both cold-formed steel and top-load bearing tracks. Current standards for steel-frame residential housing and cold-formed steel were also examined.

Testing was performed on sixty specimens which were separated into 5 groups, based upon their composition including the type of track and whether the specimen was coupled with wood. Each group (A, B, C, D and E) consisted of 16- and 18-gauge tracks on 16 and 24 inch spans. All specimens were tested using a 100 000 kg Baldwin Universal Testing Machine and deflections were measured using linear strain converters (LSCs) placed underneath bearing points.

A theoretical analysis was completed, using formulae from the North American Specification for the Design of Cold Formed Steel Structural Members. The analytical results were compared with experimental results. Examination of the effects of uplift was beyond the scope of this research.

1.4 Outline

Part 2 of this report summarizes a recent NAHB study. In Part 3, the experimental program is outlined, while in Part 4 the results from tests are presented in written and in tabular form. Finally, Part 5 contains a summary and conclusion to the report as well as several recommendations. The terms, “Ult.” and “Max.” as well as ‘ultimate’ and “maximum” are used synonymously in this report.

2.0 NAHB Report

In March 2003, the National Association of Home Builders (NAHB) completed a study entitled “Cold-formed Steel Top Load Bearing Tracks”. At the time of testing, little evidence of research on top-load bearing tracks was found, although it did note that different configurations for the top track had been developed by Australians and a company known as Mitek (NAHB 2003).

The NAHB study tested three configurations of tracks – a deep-leg track, a standard track with a wood top plate, and a J-Track. All tests were performed with a 24” spacing, and loads at the centre of each span. Prescriptive Method tables were drawn up based on the results obtained. It was determined that the most applicable section for general residential construction was the combination of a 20 gauge standard track and a 2x4 wood top plate (NAHB 2003).

3.0 EXPERIMENTAL PROGRAM

3.1 Introduction

According to the CFS Code, framing must be in-line so that roof trusses are aligned with studs in the supporting stud wall or, otherwise, the building must be designed and approved by an accredited engineer. Another option is to use approved members to transfer roof truss loads to the wall studs. The main objective of this research was to investigate how standard light gauge steel tracks behave when used as top load-bearing tracks.

Specimens were tested in the research presented herein to determine maximum permissible loadings on such load-bearing top tracks. Five series of tests, constructed of different sizes of track and with or without wood members, were conducted with load spacing of 16 and 24 inches.

3.2 Specimen Identification

Specimens were designated according to their count number, objective letter, stud spacing, and gauge thickness. Therefore, for example, 3A24-18 indicates the third specimen tested according to the first objective (composite A-track and 2x4 wood on 3-5/8" stud) with a 24 inch stud spacing and 18-gauge steel thickness.

3.3 Fabrication

Each specimen was constructed as a frame consisting of three 8-inch long studs spaced at 16 or 24 inches and supporting a top track as described in objective A, B, C, D, or E. The assembly was completed by attaching a bottom track of the same specified size as the top track. Studs and track were connected with #8 hexagonal self-drilling screws. Standard 2x4 pieces of lumber were attached as required to top tracks using 3-inch long galvanized common nails. Stud spacing was either 610 mm (24") or 406 mm (16"). Typical specimens are diagrammatically illustrated in Figures 3.1 and 3.2.

The three types of top track employed in this research included 3-5/8 inch standard track, 6 inch standard track, and 3-5/8 inch deep leg track. Table 3.1 lists the different test groups, the

type of track used, and other fabrication details. The dimensions of all tracks and studs used are given in Tables 3.1, 3.2, and 3.3.

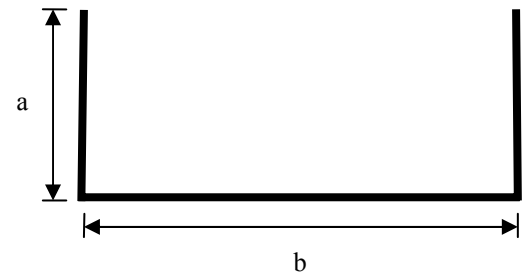
Table 3.1 – Fabrication Details of Test Specimens

Objective	Specimen	Gauge	Spacing	Top Track	Wood Top Plate
A	A16-16	16	16"	92 mm (3 5/8")	Yes
	A16-18	18	16"	92 mm (3 5/8")	Yes
	A24-16	16	24"	92 mm (3 5/8")	Yes
	A24-18	18	24"	92 mm (3 5/8")	Yes
B	B16-16	16	16"	92 mm (3 5/8")	No
	B16-18	18	16"	92 mm (3 5/8")	No
	B24-16	16	24"	92 mm (3 5/8")	No
	B24-18	18	24"	92 mm (3 5/8")	No
C	C16-16	16	16"	152 mm (6")	Yes
	C16-18	18	16"	152 mm (6")	Yes
	C24-16	16	24"	152 mm (6")	Yes
	C24-18	18	24"	152 mm (6")	Yes
D	D16-16	16	16"	152 mm (6")	No
	D16-18	18	16"	152 mm (6")	No
	D24-16	16	24"	152 mm (6")	No
	D24-18	18	24"	152 mm (6")	No
E	E16-16	16	16"	92 mm (3 5/8")-DL	No
	E16-18	18	16"	92 mm (3 5/8")-DL	No
	E24-16	16	24"	92 mm (3 5/8")-DL	No
	E24-18	18	24"	92 mm (3 5/8")-DL	No

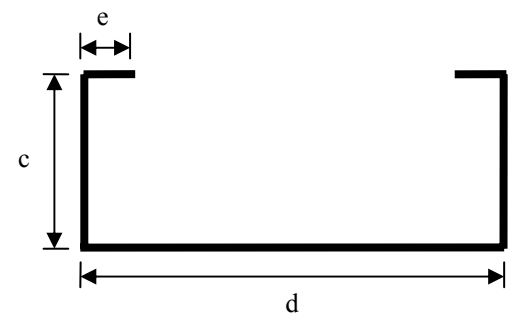
DL – Deep Leg (Std. leg otherwise); 18 ga. $\equiv$ 1.22 mm; 16 ga. $\equiv$ 1.52 mm

Table 3.2 – Track Dimensions

Designation	a(mm)	b(mm)
3 ⁵ / ₈ "	29.97	92.58
6"	29.97	152.91
DL	50.80	92.58

**Table 3.3 – Stud Dimensions**

Designation	c(mm)	d(mm)	e(mm)
3 ⁵ / ₈ "	41.28	92.08	12.7
6"	41.28	152.40	12.7



3.4 Experimental Set-up

Typical test set-ups are illustrated in Figures 3.1 and 3.2 which show the locations of the point-applied loads for the 16 inch and 24 inch stud spacing configurations. Figure 3.3 is a photograph of a typical set-up in the Baldwin UTM.

A distribution beam was used to transfer equal loads from the load head to the points of load application of each specimen. Reaction plates measuring approximately 18x50x250 mm were placed between each point of load application of the distribution beam and the test specimen. A W200x36 steel section was utilized as a support reaction beam for the majority of specimens. Due to various laboratory demands, it was necessary to replace this beam with a C230x30 steel section for all specimens under Objective C with the exception of specimen 1C16-16.

As shown in Figure 3.3, load cells were placed between two of the specimen supports and the platen of the UTM while a ball and socket joint was used to support the specimen at the third support point. Linear strain converters (LSCs) were used to measure deflections. Two LSCs were placed so as to measure downward movement of the distribution beam and another was positioned on the platen to track its progress upward. Steel restraints were placed at either end of the specimen to prevent in-plane and lateral movement.