COLD-FORMED STEEL SLIP-TRACK CONNECTION

by

James R. Gerloff

A Report Submitted to the Faculty of the
Milwaukee School of Engineering
in Partial Fulfillment of the
Requirements for the Degree of
Master of Science

Milwaukee, Wisconsin
January, 2004

ABSTRACT

The slip-track connection is one of the most commonly used connections when designing curtain wall systems. There is little guidance in the American Iron and Steel Institutes' (AISI) *North American Specification for the Design of Cold-Formed Steel Structural Members* (2001). This paper presents the nominal capacities for a slip-track connection as well as the effective distribution width of the track. Several methods of analysis were reviewed along with an example of each method. A parametric study of the slip-track connection was conducted as well as finite element modeling. A total of 108 test specimens were tested in different combinations with stud widths of 1 5/8" and 2 1/2". The specimens had a stud spacing of 16" and 24", a gap between the web of the track and the top of the stud of 1/2" and 1", and track thickness varying from 14, 16, to 18 gage. Seventy-two test specimens were tested in combinations with varying stud widths, stud spacing, and track thickness. Thirty-six test specimens were tested with alternate fastener spacing. These tests yielded higher failure loads, and for the sake of being conservative, only the tests with the fasteners located at the stud location are used in determining the nominal capacity. Finite element analysis was completed following the tests. A stud spacing of 24 inches was analyzed, with a stud flange of 1 5/8", a slip gap of 1/2", and track thickness of 18, 16, and 14 gages. Proposed design procedures based on the results of this project are provided.

ACKNOWLEDGMENTS

First and foremost, I would like to thank the sponsors of this research: Matsen Ford Design and Dietrich Industries. Matsen Ford Design provided the necessary financial support for the hot-rolled steel test frame. Dietrich donated all the required cold formed steel framing members, provided material testing of our specimens, and graciously gave us an extensive tour of their plant. Without their financial support and contributions this research would not have been possible.

Thank you to H. Peter Huttelmaier, Ph.D., Douglas Stahl, Ph.D., and Richard DeVries, Ph.D. at Milwaukee School of Engineering, Mahmoud Maamouri, Ph.D., and all those involved at Computerized Structural Design for their guidance and expertise on this subject. Their continuous support helped make the completion of this project successful and enjoyable.

A special thanks goes out to my wife Sarah and family for their assistance with test set up, testing and endless encouragement.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

GLOSSARY

Finite Element Analysis (FEA) — Finite elements that act independently which are analyzed in a computer for an approximate solution.

psi — pounds per square inch

lbs or lb — pounds

in. — inch

kips — 1000 pounds

ksi— kips per square inch or 1000 pounds per square inch

CHAPTER 1: INTRODUCTION

1.1 Background

Construction has changed greatly over the years, and as wood became scarce and increasingly more expensive, new products were developed as an alternate method to wood construction. Cold-formed steel became the ideal alternative to traditional wood framing construction methods. Cold-formed steel framing can act as an infill between floors or curtain walls, load-bearing walls, roof trusses or purlins, and can even be designed as shear walls.

In the building industry, cold-formed steel is typically used as a secondary structural member, but it can also be used as part of the primary structural system. When cold-formed framing is part of the secondary structural system, the members transfer the lateral loads to the primary structural frame. The American Iron and Steel Institutes' (AISI) *North American Specification for the Design of Cold-Formed Steel Structural Members* [1], provides guidelines on how to design cold-formed members and limited guidance on connections.

1.2 Problem Statement

One commonly used connection with little guidance is the slip-track connection. The slip-track connection consists of a cold-formed track that is generally attached to the underside of a structural beam. Cold-formed studs are placed in this track but are typically not attached to it by any mechanical means (see Figure 1.2-1). There is a gap between the top of the stud and the web of the track, and the flanges of the track transfer the lateral load from the studs into the structure. The track will move with the structure, and as the structure deflects, the studs will not be loaded axially unless the structure deflects greater than the gap provided. The studs are only designed to withstand lateral loads and not designed to carry any axial loads, so the gap specified is very important. Per Section D4 of the AISI Specification, “both ends of the stud shall be connected to restrain rotation about the longitudinal stud axis and horizontal displacement perpendicular to the stud axis” [1], which can be satisfied by any of the construction methods as seen in Figure 1.2-1.

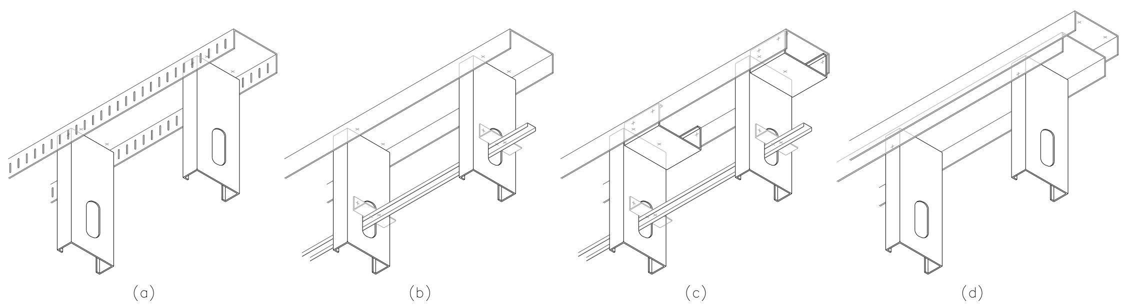


Figure 1.2-1 — Typical Slip-Track Connections.

In Figure 1.2-1(a), the slip-track has vertical slots in the leg. This allows for a screw to connect the stud and the track together, while still allowing for vertical movement. In Figure 1.2-1(b), the track simply rides up and down the stud with no connection. Bridging is required near the top of the studs to provide lateral and some rotational stability to the top of the stud. In Figure 1.2-1(c), when higher loads are applied, blocking is attached to the track and located near the end of the stud. This is typically done at door and window jambs. In Figure 1.2-1(d), a deep-leg track is attached to the studs, and then that assembly is slipped into another track. With this connection, the entire leg of the track would have to fail.

The focus of this project is the connection shown in Figure 1.2-1(b). This connection is extensively used yet has minimal guidance for design.

1.3 Objectives and Scope

The main objective of this project is to determine appropriate design guidelines for the slip-track connection. In order to accomplish this, research of publications and review of existing design practices for the connection, extensive testing, and finite element modeling were performed.

CHAPTER 2: LITERATURE REVIEW / PRESENT PRACTICES

Currently there is minimal research of the slip-track connection. There has been no finite element modeling and limited testing. Current practices are based on basic elementary theory. A brief summary and design examples of the currently used design methods are as follows.

2.1 Army Corps of Engineers [2]

The design of the track thickness is based on allowable stress design. The track thickness will be greater than the thickness of the steel stud used in the wall. The minimum base metal thickness for the track is determined by the following equation:

$$t = \left[\frac{7.5338 \times P \times e}{F_y \times b_{eff}}\right]^{1/2}, \tag{2.1-1}$$

where:

- t = required thickness of track (in.),
- P = the reaction of the stud due to wind (lbs),
- e = the gap between the stud and the top channel (in.),
- F_y = the yield strength of the track metal (psi),
- b_{eff} = the effective width of the top channel flange for analysis, also, the effective width is less than the stud spacing (in.).

For a single track system:

$$b_{eff} = W_{stud} + 2 \times \left[\frac{e + 1.25}{\tan(30)}\right], \tag{2.1-2}$$

where:

W_{stud} = the width of the stud flange (in.).

In the Army Corps of Engineers TI 809-07 [3] (superceding ETL 1110-3-439), the effective width equation (b_{eff}) is slightly modified, by replacing 1.25" with the variable D. So (2.1-2) would be revised to the following:

$$b_{eff} = W_{stud} + 2 \times \left[\frac{e + D}{\tan(30)} \right], \tag{2.1-3}$$

where:

D = the depth of track overlap in a slip-track connection, 1.25 in. min. (in.).

Figure 2.1-1 shows the stress distribution of the track due to the load applied from the stud according to the Army Corps of Engineers procedure. The safety factor for this procedure is 1.67, and includes a 1.33 increase in allowable stress for wind.

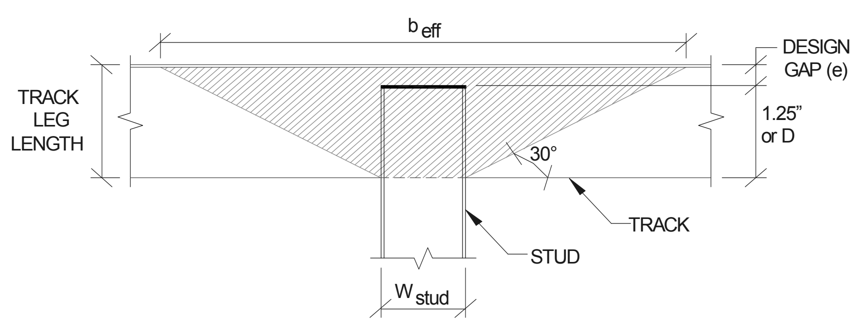


Figure 2.1-1 — Army Corps of Engineers Stress Distribution.

2.2 Metal Stud Manufacturers Association (MSMA) [4]

The procedure is based on the Army Corps of Engineers [2] procedure with some modifications. The effective width equation (b_{eff}) is the same as (2.1-2), but the required thickness is as follows:

$$t = \left[\frac{7.5 \times P \times e}{F_y \times b_{eff}} \right]^{1/2}, \quad (2.2\text{-}1)$$

where, e is defined as the gap between the track web and the application of the reaction (1.5 $\times$ design gap). The thickness equation can directly be derived as follows:

$$f_b = \frac{M}{S} \quad (2.2\text{-}2)$$

and

$$F_b = 0.6 \times F_y \times (4/3), \quad (2.2\text{-}3)$$

where:

M = P $\times$ e (Reaction due to wind load $\times$ e) (lb-in.), (2.2-4)

e = 1.5 $\times$ design gap (in.),

S = 1/6 $\times$ b_{eff} $\times$ t^2 (effective section modulus of plate in bending) (in.^{3}), (2.2-5)

b_{eff} = use (2.1-2). Also, the effective width is less than the stud spacing (in.),

0.6 = Safety Reduction Factor (5/3 Safety Factor),

(4/3) = stress increase for wind loading.

Setting (2.2-2) equal to (2.2-3) and substituting in (2.2-4), and (2.2-5):

$$\frac{P \times e}{1/6 \times b_{eff} \times t^2} = 0.6 \times F_y \times (4/3). \quad (2.2\text{-}6)$$

Solving (2.2-6) for t gives the same result as (2.2-1). See Figure 2.2-1 for the stress distribution of the track due to the load applied from the stud according to MSMA [4].

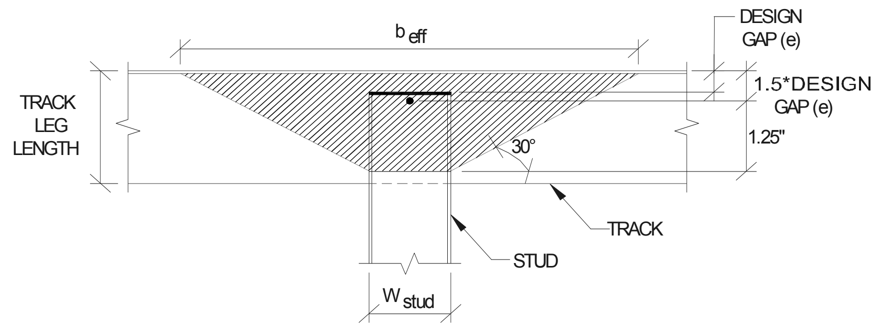


Figure 2.2-1 — Metal Stud Manufacturers Association Stress Distribution.

2.3 Steel Stud Manufacturers Association (SSMA) [5]

The SSMA procedure is based on the Metal Stud Manufactures Association [4] procedure with some slight modifications. The effective width equation (b_{eff}) is the same as (2.1-2), and the thickness equation is the same as (2.2-1), with, P defined as the maximum reaction at the top of the stud, multiplied by 0.75 for wind loads. Per Section A5.1.3 of the AISI 1996 Specification [6], a 0.75 load reduction factor is allowed for wind loading. However the thickness equation already has a built-in 3/4-load reduction factor for wind. So a reduction factor is being applied twice in this documentation, and the safety factor becomes (5/4) instead of (5/3) in the MSMA approach.

2.4 Design of Single Deep Leg Track to Accommodate Vertical Deflection by Rahman [7]

The Metal Stud Manufacturers Association [4] procedure was used with the following modifications. The 3/4-load reduction factor for wind was removed from the thickness equation and replaced by ω giving:

$$t = \left[\frac{10 \times \omega \times P \times e}{F_y \times b_{eff}}\right]^{1/2}, \qquad (2.4\text{-}1)$$

where:

ω = wind/seismic load reduction factor. Load standards (e.g. IBC 2000, Sec. 1605.3.1 [8] and UBC 97, Sec. 1612.3.1 [9]) require ω = 1.0 for a dead plus wind load combination without any increase in allowable stresses.

The effective width (b_{eff}) is as follows:

$$b_{eff} = W_{stud} + 2 \times \left[\frac{e + 1.25}{\tan(30)} \right] \leq S \text{ ,} \quad (2.4\text{-}2)$$

where:

S = Stud Spacing (in.).

Design equations on deflection can also be found in this document as well as in the AISI Design Guide CF02-1 [10]. The same safety reduction and safety factors are used in the procedure as in the MSMA [4] procedure given in Section 2.2; however, no increase in wind was used.

2.5 Behavior of Cold-Formed Steel Stud-to-Track Connections by Bolte [11]

The following method was developed by testing 14 specimens at the University of Missouri-Rolla and an additional 12 of the specimens tested at Milwaukee School of Engineering:

$$P_{ndt} = \frac{w_{dt} \times t^2 \times F_y}{4 \times e} \text{ .} \quad (2.5\text{-}1)$$

Solving Equation 2.5-1 for thickness:

$$t = \left(\frac{P_{ndt} \times 4 \times e}{F_y \times w_{dt}} \right)^{1/2} \text{ .} \quad (2.5\text{-}2)$$

For $(e/t)^2 < 100$

$$w_{dt} = \frac{12 \times (e/t)^2}{100} + b_{stud}. \tag{2.5-3}$$

For $(e/t)^2 \geq 100$

$$w_{dt} = 12 + b_{stud}. \tag{2.5-4}$$

These equations are intended to be used with the following resistance factor and factor of safety:

$\Phi = 0.59$ Resistance Factor (Load and Resistance Factor Design)

and

$\Omega = 2.62$ Factor of Safety (Allowable Stress Design).

In (2.5-1):

P_{ndt} = Nominal strength of deflection track when subjected to transverse loads (kips),

w_{dt} = Effective track length (in.),

t = Nominal track thickness (in.),

F_y = Design yield strength of track material (ksi),

e = End or slip gap (in.),

b_{stud} = Nominal stud flange width (in.).

The expressions are valid within the following limits of the investigation:

Stud Sections:

- Design Base Metal Thickness: 0.045" – 0.071"
- Design Yield Strength: 33 ksi – 50 ksi
- Nominal Depth: 3.50" – 6.0"
- Stud Spacing: 16" – 24" on center

Track Sections:

- Design Base Metal Thickness: 0.045" – 0.071"
- Design Yield Strength: 33 ksi – 50 ksi
- Nominal Depth: 3.50" – 6.0"
- Nominal Flange Width: 2" – 2.375"

It was concluded that these formulas were less conservative than current design practices, and that this procedure should be used in designing a slip-track connection; however, additional testing should be done for the slip-track connection that have parameters outside the limits of this investigation.

2.6 Roark's Formulas for Stress and Strain [12]

A general principle in structural engineering is that load transfers to stiffer elements. Since the web of the stud is very stiff and the flange and lip have very little stiffness, it can be assumed that the load from the stud transfers from the web of the stud to the track, acting like a point load. The bending stress at any point along a cantilevered plate subjected to a point load is defined as follows:

$$\sigma = K_m \times (6 \times P/t^2)\ , \qquad (2.6\text{-}1)$$

where:

K_m = stress coefficient for location of load and the point in question,

K_y = deflection coefficient for location of load and the point in question, See Roark and Young for deflection equations.

P = applied load (lbs),

t = thickness of plate (in.).

Using (2.6-1), the K_m value is determined from Table 2.6-1

Where:

c = the distance from the fixed edge to the location of the point load (in.),

a = the distance from the fixed edge to the free edge (in.),

z = the location of stress in question along the fixed edge (in.).

Table 2.6-1 — Stress and Deflection Coefficients [12].

c/a \ z/a		0	0.25	0.50	1.0	1.5	2	∞
1.0	K_m	0.509	0.474	0.390	0.205	0.091	0.037	0
	K_y	0.524	0.470	0.380	0.215	0.108	0.049	0
0.75	K_m	0.428	0.387	0.284	0.140	0.059	0.023	0
	K_y	0.318	0.294	0.243	0.138	0.069	0.031	0
0.50	K_m	0.370	0.302	0.196	0.076	0.029	0.011	0
0.25	K_m	0.332	0.172	0.073	0.022	0.007	0.003	0

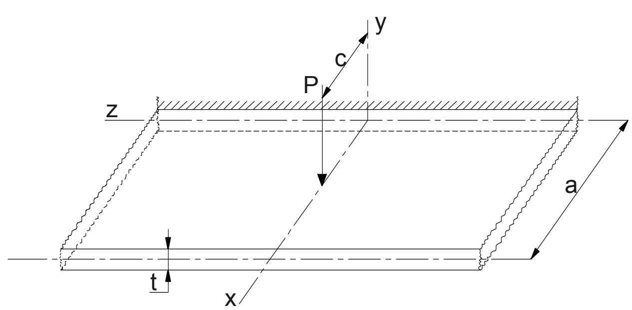


Figure 2.6-1 — Representation of a, c, and z in a Plate [12].

A graphic representation of Table 2.6-1 is shown in Figure 2.6-2 from Timoshenko's Theory of Plates and Shells [13].

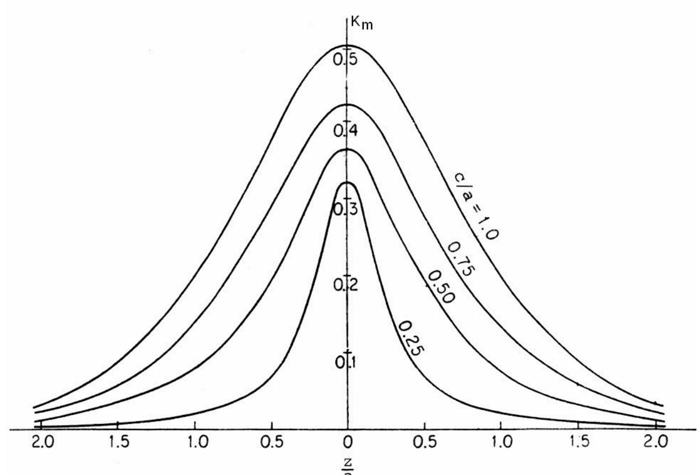


Figure 2.6-2 — K_m Coefficient Figure Adapted from Timoshenko [13].

Applying a Safety Factor (SF) to (2.6-1) and solving for t, the following equation is derived:

$$t = \left(\frac{SF \times K_m \times 6 \times P}{F_y} \right)^{1/2} . \qquad (2.6\text{-}2)$$

The effective width of the flange can also be derived by setting the stress in (2.6.1) equal to M / S, where M = P $\times$ e and S = $b_{eff} \times t^2 / 6$ which yields the following equation:

$$b_{eff} = \frac{c}{K_m} . \qquad (2.6\text{-}3)$$

2.7 Current Engineering Firms' Design Practices

Design practices vary greatly depending on individuals and engineering firms. Section 1.1(b) of the AISI Specification [1] allows engineers and firms to use rational engineering analysis based on appropriate theory, related testing if data is available, and engineering judgment when designing members and connections. Some firms use the 60 degrees stress distribution shown in Section 2.1 to Section 2.4, which follows the most recent publications. Other firms decrease the stress distribution angle to 45 degrees, which is approximately what Roark, and Young [12], and Timoshenko [13] support. Another variance is the load application point. In current engineering practices, the load application point is where the load is applied at the end of the stud, which is equal to the design gap. The design methods presented in Section 2.2 to 2.4 change the load application point to 1.5 $\times$ the design gap. Current design practices assume that the entire stud flange bears on the track and contributes to the effective distribution width. Thus:

$$t = \left[\frac{7.5 \times P \times e}{F_y \times b_{eff}} \right]^{1/2} , \qquad (2.7\text{-}1)$$

where:

t = required thickness of track (in.),

P = the reaction of the stud (lbs),

e = the gap between the stud and the top channel (in.),

F_y = the yield strength of the metal (psi),

b_{eff} = the effective width of the track flange, (also known as the effective width), is less than the stud spacing (in.).

For a single track system:

$$b_{eff} = W_{stud} + 2 \cdot L_{track} \times \tan(\theta), \qquad (2.7\text{-}2)$$

where:

W_{stud} = the width of the stud flange (in.),

L_{track} = Length of the track leg (in.),

θ = Angle of stress distribution, between 45 and 60 (degrees).

See Figure 2.7-1 for the stress distribution of the track due to the load applied from the stud according to current design procedures. The safety factor for this procedure is 5/3, and includes a 4/3 increase in allowable stress for wind.

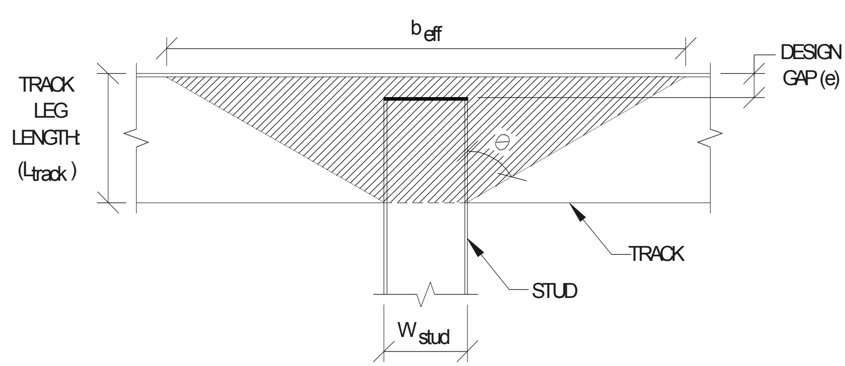


Figure 2.7-1 — Current Engineering Practices Stress Distribution.

2.8 Design Examples of Present Practices

Using the different design methods, determine the minimum track thickness for slip-track connection shown in Figure 2.8-1 using Allowable Stress Design (ASD). The reaction at the end of the stud is P = 160 lbs (allowable load). The yield strength of the track is 33,000 psi.

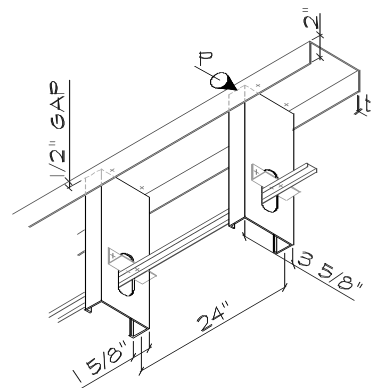


Figure 2.8-1 — Design Example.

2.8.1 Army Corps of Engineers [3]

Given:

$F_y = 33{,}000$ psi.

$P = 160$ lbs.

$e = 1/2$ in.

$D = 1\ 1/2$ in.

$W_{stud} = 1\ 5/8$ in.

Solution:

$$b_{eff} = W_{stud} + 2\times\left[\frac{e+D}{\tan(30)}\right] = 1\ 5/8 + 2\times\left[\frac{1/2 + 1\ 1/2}{\tan(30)}\right] = 8.55 \text{ in.} \qquad (2.1\text{-}3)$$

$$t = \left[\frac{7.5338\times P\times e}{F_y \times b_{eff}}\right]^{1/2} = \left[\frac{7.5338\times 160\times 1/2}{33{,}000\times 8.55}\right]^{1/2} = 0.0461 \text{in.} \qquad (2.1\text{-}1)$$

Note: Safety Factor = 1.67 and a 1.33 increase in allowable stress for wind.

2.8.2 Metal Stud Manufacturers Association (MSMA) [4]

Given:

$F_y = 33{,}000$ psi.

$P = 160$ lbs.

Design Gap = 1/2 in.

W_{stud} = 1 5/8 in.

Solution:

$$e = 1.5 \times \text{DesignGap} = 1.5 \times 1/2 = 0.75\,\text{in.}$$

$$b_{eff} = W_{stud} + 2 \times \left[\frac{e + 1.25}{\tan(30)}\right] = 1\,5/8 + 2 \times \left[\frac{0.75 + 1.25}{\tan(30)}\right] = 8.55\,\text{in.} \qquad (2.1\text{-}2)$$

$$t = \left[\frac{7.5 \times P \times e}{F_y \times b_{eff}}\right]^{1/2} = \left[\frac{7.5 \times 160 \times 0.75}{33{,}000 \times 8.55}\right]^{1/2} = 0.0546\,\text{in.} \qquad (2.2\text{-}1)$$

Note: Safety Factor = 5/3 and a 4/3 increase in allowable stress for wind.

2.8.3 Steel Stud Manufacturers Association (SSMA) [5]

Given:

F_y = 33,000 psi.

P = 160 lbs $\times$ 0.75 (for wind) = 120 lbs.

Design Gap = 1/2 in.

W_{stud} = 1 5/8 in.

Solution:

$$e = 1.5 \times \text{DesignGap} = 1.5 \times 1/2 = 0.75\,\text{in.}$$

$$b_{eff} = W_{stud} + 2 \times \left[\frac{e + 1.25}{\tan(30)}\right] = 1\,5/8 + 2 \times \left[\frac{0.75 + 1.25}{\tan(30)}\right] = 8.55\,\text{in.} \qquad (2.1\text{-}2)$$

$$t = \left[\frac{7.5 \times P \times e}{F_y \times b_{eff}}\right]^{1/2} = \left[\frac{7.5 \times 120 \times 0.75}{33{,}000 \times 8.55}\right]^{1/2} = 0.0489\,\text{in.} \qquad (2.2\text{-}1)$$

Note: Safety Factor = 5/4 and a 4/3 increase in allowable stress for wind.

2.8.4 Design of Single Deep Leg Track to Accommodate Vertical Deflection by Rahman [7]

Given:

F_y = 33,000 psi.

P = 160 lbs.

Design gap = 1/2 in.

W_{stud} = 1 5/8 in.

ω = 1.0.

Solution:

$$e = 1.5 \times \text{Design Gap} = 1.5 \times 1/2 = 0.75 \,\text{in.}$$

$$b_{eff} = W_{stud} + 2 \times \left[\frac{e + 1.25}{\tan(30)} \right] = 1\,5/8 + 2 \times \left[\frac{0.75 + 1.25}{\tan(30)} \right] = 8.55 \,\text{in.} < 24 \,\text{in.} \quad OK \tag{2.4-2}$$

$$t = \left[\frac{10 \times \omega \times P \times e}{F_y \times b_{eff}} \right]^{1/2} = \left[\frac{10 \times 1.0 \times 160 \times 0.75}{33{,}000 \times 8.55} \right]^{1/2} = 0.0652 \,\text{in.} \tag{2.4-1}$$

Note: Safety Factor = 5/3.

2.8.5 Behavior of Cold-Formed Steel Stud-to-Track Connections by Bolte [11]

Given:

F_y = 33,000 psi.

P = 160 lbs.

Ω = 2.62.

e = 1/2 in.

b_{stud} = 1 5/8 in.

P_{ndt} = P $\times$ Ω = 160 $\times$ 2.62 = 419.2 lbs.

Solution:

Assume $(e/t)^2 \geq 100$

$$w_{dt} = 12 + b_{stud} = 12 + 1\ 5/8 = 13.625\,\text{in.} \tag{2.5-4}$$

$$t = \left(\frac{P_{ndt} \times 4 \times e}{F_y \times w_{dt}}\right)^{1/2} = \left(\frac{419.2 \times 4 \times 1/2}{33{,}000 \times 13.625}\right)^{1/2} = 0.0432\,\text{in.} \tag{2.5-2}$$

Verify that $(e/t)^2 \geq 100$: $(e/t)^2 = (0.5/0.0432)^2 = 134.1 \geq 100$ $\therefore$ OK

Note: Safety Factor = 2.62.

2.8.6 Roark's Formulas for Stress and Strain [12]

Given:

F_y = 33,000 psi.

P = 160 lbs.

c = 1/2 in.

a = 2 in.

z = 0 in. (at point of maximum stress).

Solution:

c/a = (1/2) / 2 = 0.25

z/a = 0 / 2 = 0

Km = 0.332 from Table 2.6-1

SF = Assume 5/3 for a safety factor

$$b_{eff} = \frac{c}{K_m} = \frac{2}{0.332} = 6.024\,\text{in.} \tag{2.6-3}$$

$$t = \left(\frac{SF \times K_m \times 6 \times P}{F_y}\right)^{1/2} = \left(\frac{(5/3) \times 0.332 \times 6 \times 160}{33{,}000}\right)^{1/2} = 0.1269\,\text{in.} \tag{2.6-2}$$

Note: Safety Factor = 5/3.

2.8.7 Current Engineering Firms' Design Practices

Given:

F_y = 33,000 psi.

P = 160 lbs.

e = 1/2 in.

W_{stud} = 1 5/8 in.

L_{track} = 2 in.

θ = 45° to 60°.

Solution:

$$\begin{aligned} b_{eff} &= W_{stud} + 2 \times L_{track} \times \tan(\theta) = 1\ 5/8 + 2 \times 2 \times \tan(45\ \text{to}\ 60) \\ &= 5.625\,\text{in. to } 8.55\,\text{in.} \end{aligned} \tag{2.7-2}$$

$$t = \left[\frac{7.5 \times P \times e}{F_y \times b_{eff}}\right]^{1/2} = \left[\frac{7.5 \times 160 \times 1/2}{33{,}000 \times (5.625\ \text{to}\ 8.55)}\right]^{1/2} = 0.0461\,\text{in. to } 0.0569\,\text{in.} \tag{2.7-1}$$

Note: Safety Factor = 5/3 and a 4/3 increase in allowable stress for wind.

2.8.8 Summary of Examples

A summary of the results of the current design procedures can be found in Table 2.8.8-1.

Table 2.8.8-1 — Summary of Current Design Practices, Example.

Section / Method	b_{eff} (in.)	$t_{req'd}$ (in.)	Safety Factor (ASD)	Stress Increase for Wind
2.1 Army Corps of Engineers	8.55	0.0461	1.67	1.33
2.2 MSMA	8.55	0.0516	5/3	4/3
2.3 SSMA	8.55	0.0489	5/4	4/3
2.4 Design of Single Deep Leg Track to Accommodate Vertical Deflection by Rahman	8.55	0.0652	5/3	--
2.5 Behavior of Cold-Formed Steel Stud-to-Track Connections by Bolte	13.625	0.0432	2.62	--
2.6 Roark's Formulas for Stress and Strain	6.024	0.1269	5/3	--
2.7 Current Engineering Firms' Design Practices	5.625 - 8.55	0.0467 - 0.0569	5/3	4/3

CHAPTER 3: EXPERIMENTAL PROGRAM

3.1 Introduction

Testing was conducted at the Milwaukee School of Engineering's Construction Science and Engineering Center (CSEC) Laboratory to determine the capacity of the slip-track connection. The chosen parameters of the parametric study were broad enough to develop a procedure that accurately determines the behavior of the connection.

3.2 Test Specimen

The array of tests that can be conducted are endless. The different test parameters include depth, leg length, and thickness of the track; depth, flange width, thickness and spacing of the stud; the gap between the top of the stud and the web of the track (from this point referred to as slip gap); and fastener location and spacing. The testing was limited to varying the leg length, thickness of the track, flange width and spacing of the stud and slip gap. The parametric study parameters were chosen to investigate the track thickness of 18, 16, 14 gage, with a track leg length of 2" and 3" and a slip gap of 1/2" and 1", respectively. The studs had a flange width of 1 5/8" and 2 1/2" with spacing of 16" and 24" on center. Fasteners were placed in the center of the web of the track at the stud locations (see Figure 3.4-1). Some additional tests were conducted with the fasteners located between the studs (see Figure 3.4-2). This testing was out of the scope of this project, but results are provided in Appendix B for reference.

Dietrich Industries, which is a manufacturer of metal framing products located in Hammond Indiana, conducted tensile testing with specimens taken from the tracks used in this study. The testing was conducted with a Tinius-Olsen Universal Testing Machine (60,000 lb ElectoMatic) in accordance with American Standard of Testing and Materials (ASTM A 370 - 97a) [14]. See Table 3.2-1 for stud and track dimensions as defined in Figure 3.2-1 and tensile testing results. See Appendix A for additional information on the tensile test results.

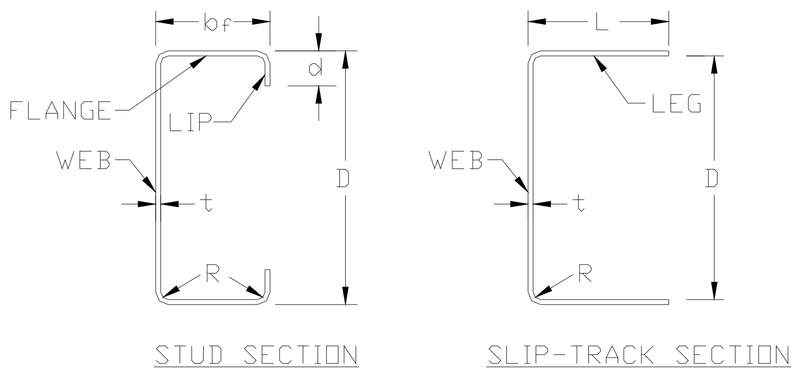


Figure 3.2-1 — Specimen Dimensions.

Table 3.2-1 — Specimen Properties and Dimensions.

Section	D (in.)	b_f (in.)	L (in.)	d (in.)	t* (in.)	R†† (in.)	F_y††† (ksi)	F_u (ksi)
Stud	3.625	1.625	--	0.5	0.0713**	0.0938	--	--
	3.625	2.5	--	0.625	0.0713**	0.0938	--	--
Track	3.625	--	2	--	0.0464	0.0696	39.4	50.6
	3.625	--	2	--	0.0568	0.0852	44.5	49.4
	3.625	--	2	--	0.0709	0.0938	38.6	47
	3.625	--	3	--	0.0440	0.0660	22.8***	43.9
	3.625	--	3	--	0.0466†	0.0699	33.6	46.9
	3.625	--	3	--	0.0713	0.0938	40.6	47

* Measured thickness of base metal after removing galvanized coating.
** Actual thickness was not measured; thickness based on 14 gage.
*** Additional tests were conducted to verify the low yield strength.
† The thickness of these coupons suggests that they may be 18-gage material, not 16-gage material…
†† R is estimated as maximum of $1.5 \times t$ or 3/32".
††† Yield strength determined using the 0.2% offset method according to (ASTM A 370 - 97a).

Test Parameters:

- Track Thickness: 18, 16 and 14 gage.
- Track Leg Length: 2” and 3”.
- Slip Gap: 1/2” and 1”.
- Stud Flange Width: 1 5/8” and 2 1/2”.
- Stud Spacing: 16” and 24”.

3.3 Test Assembly

The test assembly, shown in Figures 3.3-1 and 3.3-6, consisted of two 4’-0” cold-formed studs assembled so that the open ends of the studs were facing outward. When the test was conducted, the load transferred from the transfer beam to the web of the studs. Since the shear center of the stud is located outside the web, the stud would have a tendency to roll about its longitudinal axis. Facing the studs in the opposite direction, along with torsional restraints, would remove the tendency to roll and would ensure only vertical displacement - not lateral translation. Each stud was attached to a track at the bottom of the stud (see Figure 3.3-2) to provide a torsional restraint and ensure a uniform length. Remnant pieces of studs were used as reinforcement at the bearing end of the studs and at the transfer beam load application location to ensure that the studs would not fail due to the high concentration of loads (see Figure 3.3-5). In a typical stud wall, bridging or blocking is provided near the slip-track, as shown in Figure 1.2-1(b), and sheathing is attached to the studs. These attachments provide rotational restraint to the studs. In order to simulate this, blocking was attached near the end of the studs. A remnant piece of stud was attached to the studs with clip angles and screws as shown in

Figure 3.3-3. This connection was placed as close to the slip-track as possible so that stud rotation was kept to a minimum.

Tracks were cut to a length of 32" for the 16" stud spacing and 48" for the 24" stud spacing. To simulate field construction, 5/16" diameter holes were drilled into the center of the web of the track, at the stud location (see Figure 3.4-1). Additional tests were conducted with holes spaced at each end of the track and at the center of the track to simulate fasteners being located in between the stud locations (see Figure 3.4-2).

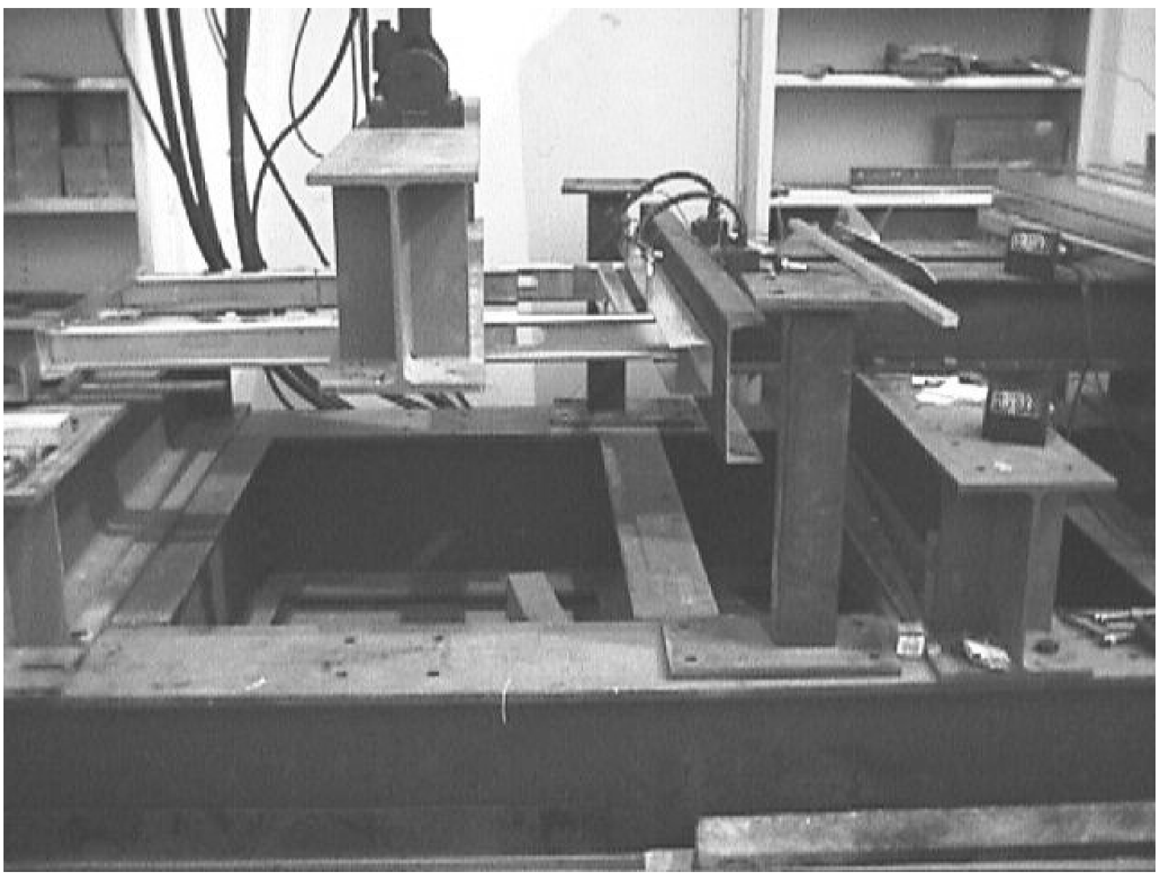


Figure 3.3-1 — Overall Test Setup.

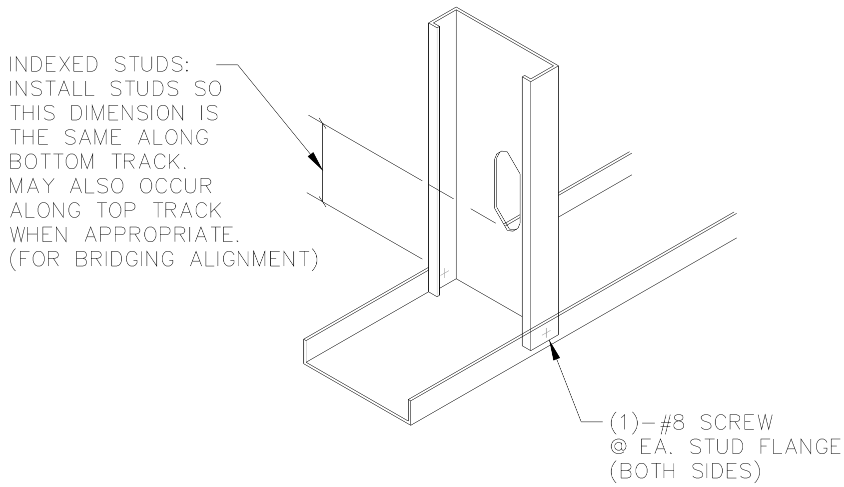


Figure 3.3-2 — Stud to Track Connection.

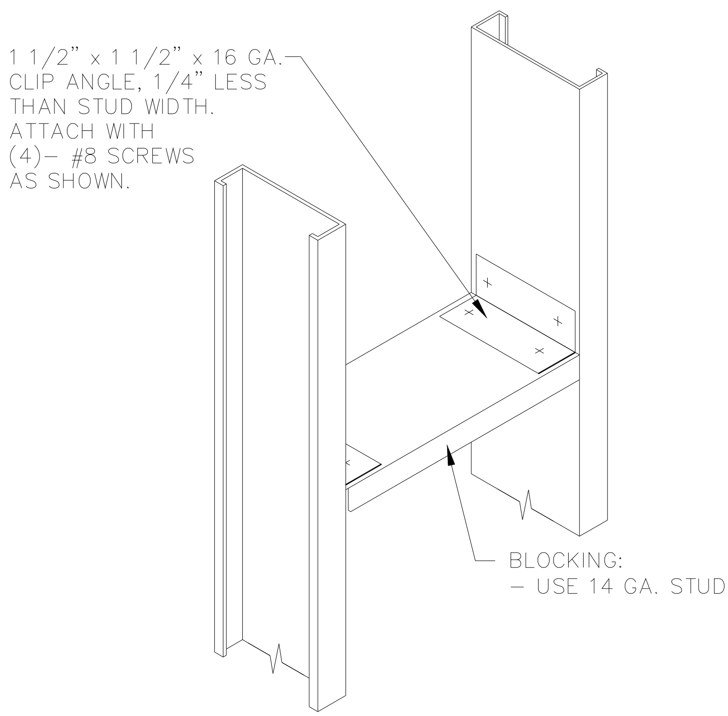


Figure 3.3-3 — Blocking Connection.

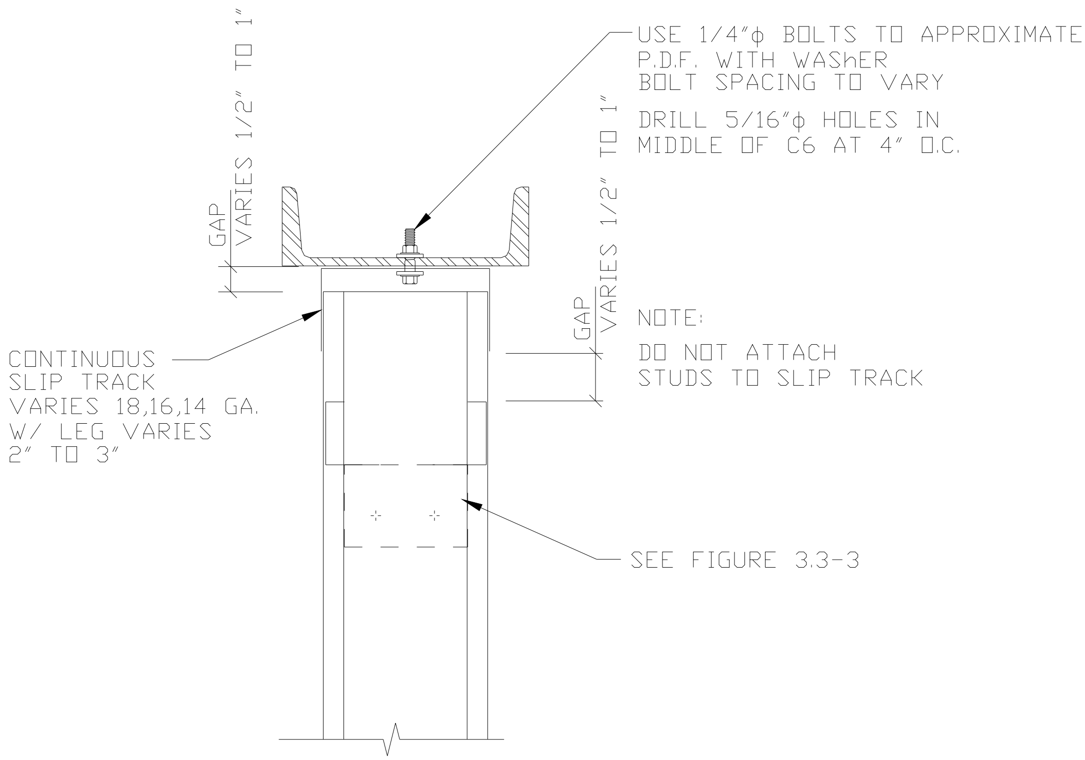


Figure 3.3-4 — Slip-Track Detail.

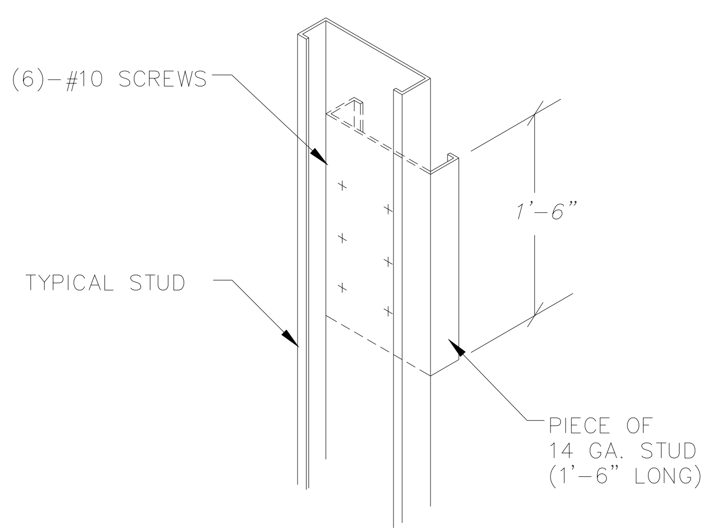


Figure 3.3-5 — Stud Reinforcement.

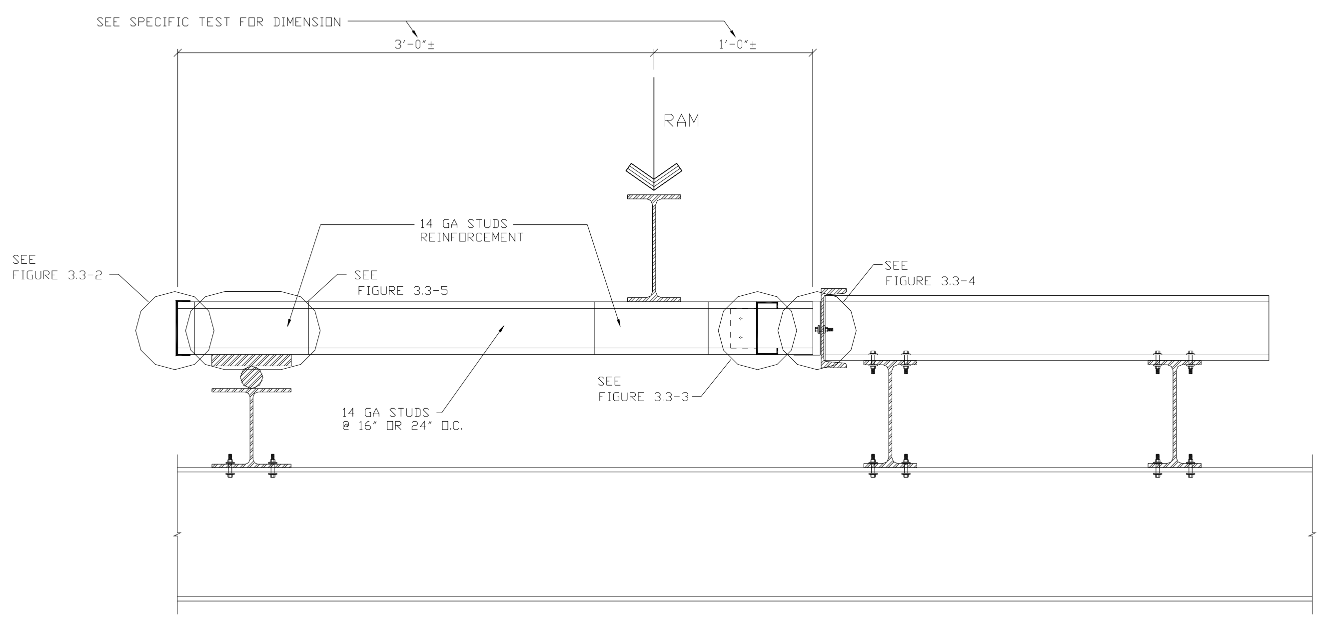


Figure 3.3-6 — Overall View of Test Assembly.

3.4 Test Procedure and Observation

Each track tested was connected to the steel test frame using 1/4” diameter bolts with washers. A bolt was placed at each stud location for test “a”, as shown in Figure 3.4-1. The bolt location for test “b” is shown in Figure 3.4-2.

The test frame was then slipped into the slip-track, with a 1/2” or 1” block placed in between the studs and the web of the track. This was done to ensure consistency in the slip gap. The back end of the test assembly was placed on top of a 1” diameter rod to act as a roller support. The 1/2” or 1” blocks were removed from the slip-track. The ram and spreader beam was then lowered to just above the test frame. Linear variable differential transducers (LVDT’s) were placed at the top of each stud, near the web of the stud (see Figure 3.4-3). The reason they were not placed underneath the track is due to the fact that large deflections would occur, possibly causing damage to the LVDT’s. Measurements were taken to determine the location of the supports and the location of the spreader beam. The spreader beam was as close to centered on the test frame as possible. The computer was reset and the load was zeroed out. The test was run at the rate shown in Appendix B.

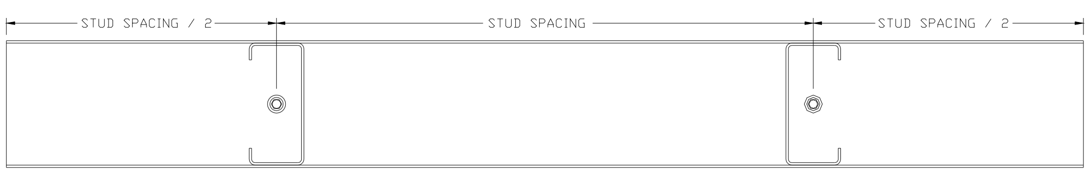


Figure 3.4-1 — Test "a" Bolt Location.

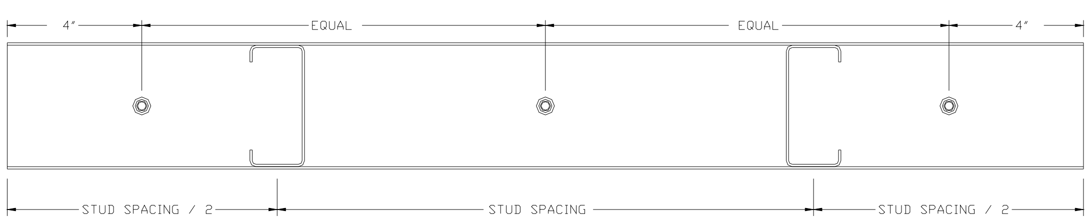


Figure 3.4-2 — Test "b" Bolt Location.

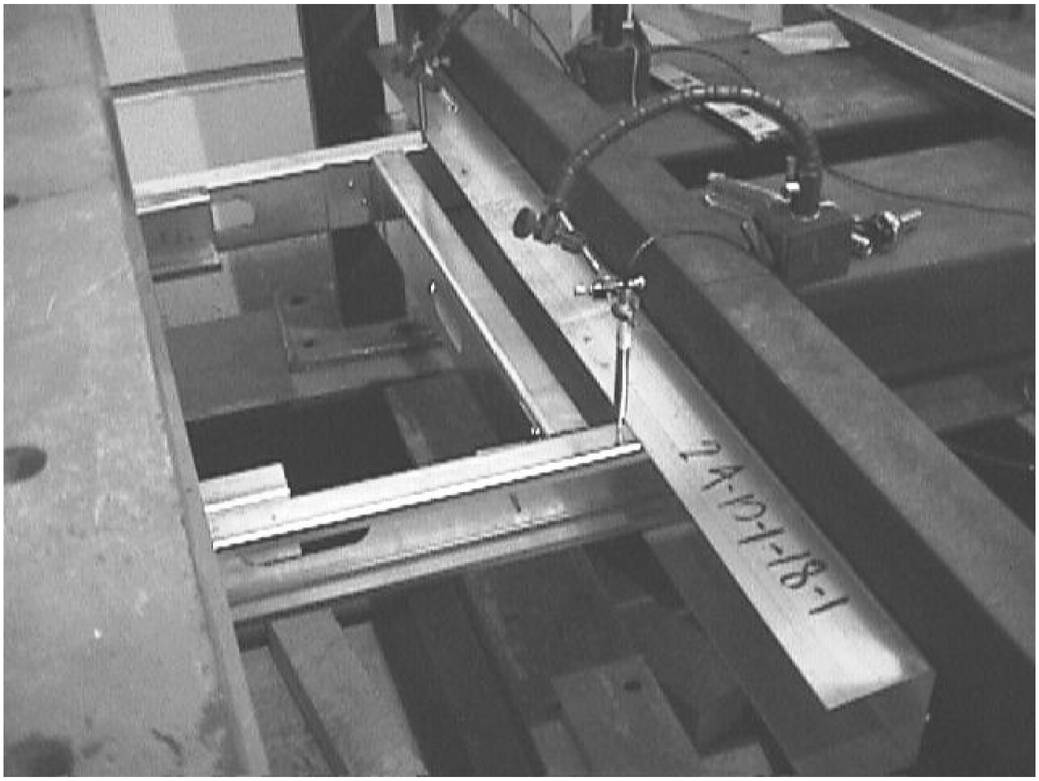


Figure 3.4-3 — LVDT Placement.

Each specimen was tested until failure. Failure was the point at which any increase in displacement of the track and stud assembly did not yield any additional increase in load. Large deflections of the track and stud assembly were witnessed at failure loads. When the load was applied to the studs, observations showed that the flange and lip of the stud rotated along with the track (see Figure 3.4-4). The typical assumption from current design methods shows that stud width contributed to the effective width of the track. From the data analysis it can be seen that minimal load increase, and in some cases, decrease in load, was attained with a larger stud flange width. Local yielding of the track occurred where the stud end was loading the track and at the web/flange intersection (see Figure 3.4-5). Figure 3.4-6 shows a typical load versus displacement plot of the tests performed; for additional plots, see Appendix B.

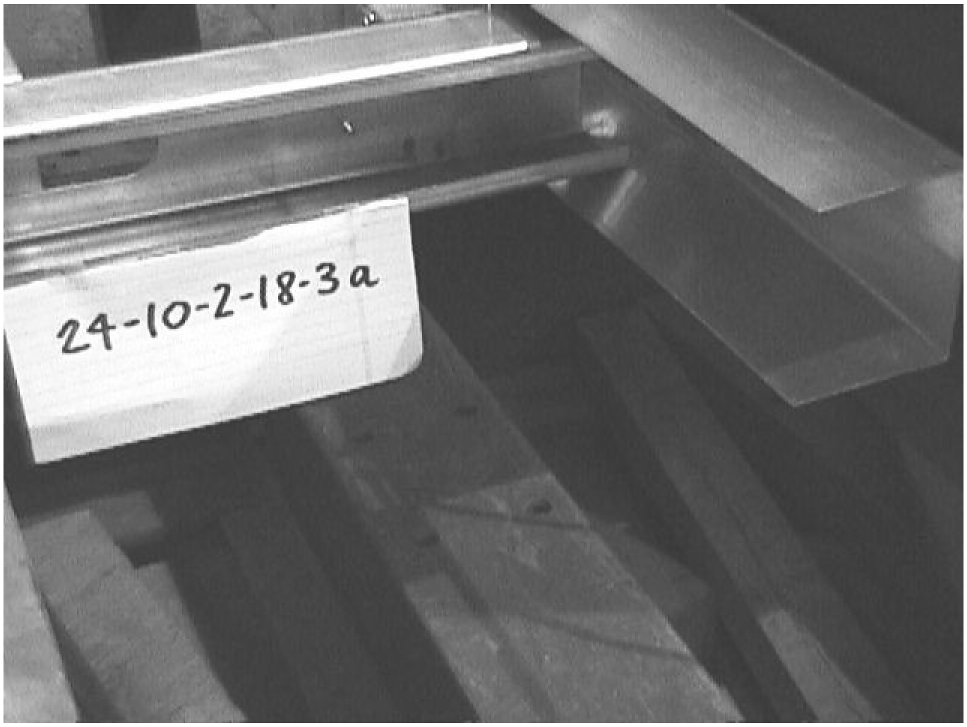


Figure 3.4-4 — Stud Flange Rotating During Test.

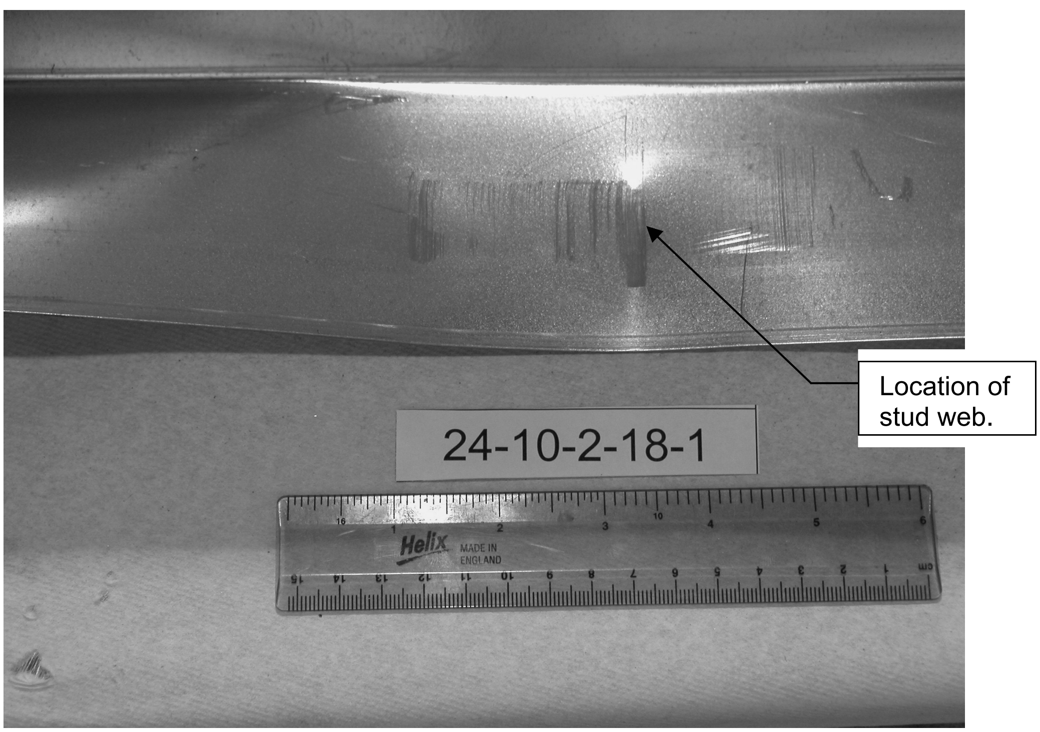


Figure 3.4-5 — Stud Indentation on Track after Test.

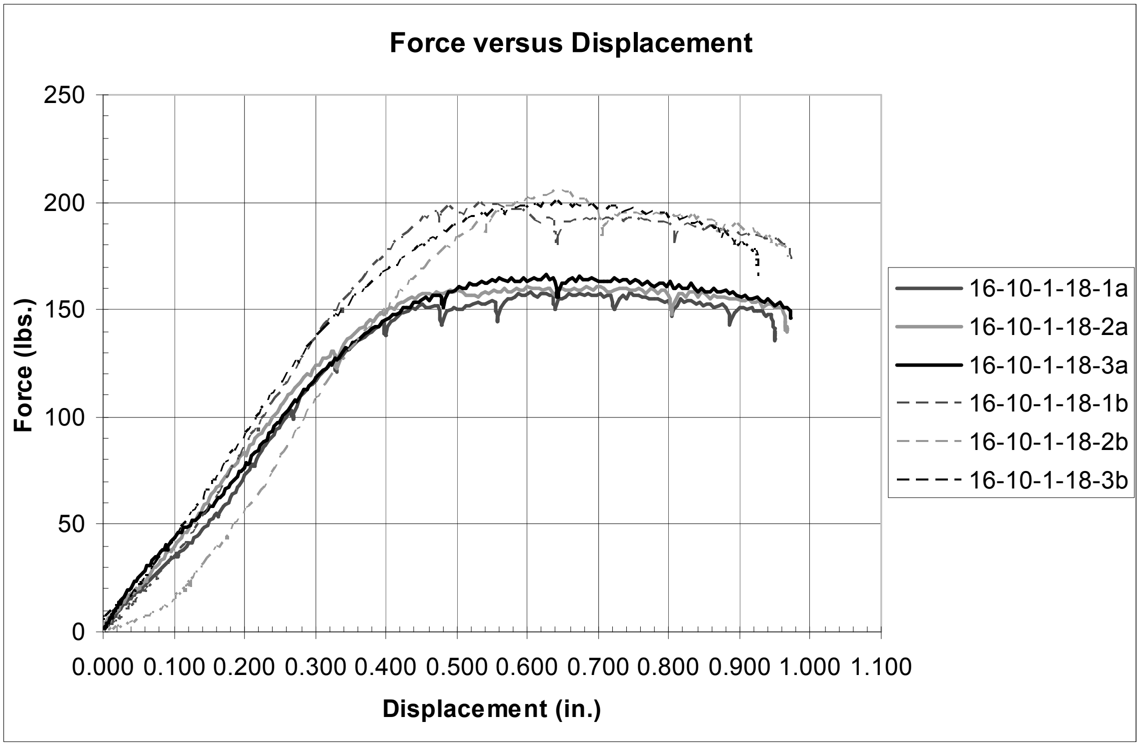


Figure 3.4-6 — Typical Load versus Displacement Plot.

3.5 Test Results

The following results were obtained from testing. The failure loads (P_{test}) given are the loads applied at the end of each stud. Test results shown are from testing with Test "a" bolt locations (see Figure 3.4-1). Table 3.5.1 is a summary of average nominal loads from each of the three tests conducted. These values will be used in determining the proposed design procedure.

Slip-track tests were also conducted at University Missouri-Rolla [11], and are shown in Table 3.5-2. Since each test was conducted twice, the average of the tests will be used for comparison. Note that the specimen numbers have been changed to MSOE's conventional style of naming for ease of comparison.

Table 3.5-1 — Average MSOE Test Results.

Specimen Name	Track Thickness t (in.)	Track Leg Length L (in.)	Slip Gap e (in.)	Stud Spacing s (in.)	Stud Flange Width b_f (in.)	F_y (ksi)	P_{test} (lbs)
16-05-1-14 a	0.0709	2	0.5	16	1 5/8	38.6	796
16-05-1-16 a	0.0568	2	0.5	16	1 5/8	44.5	590
16-05-1-18 a	0.0464	2	0.5	16	1 5/8	39.4	458
24-05-1-14 a	0.0709	2	0.5	24	1 5/8	38.6	854
24-05-1-16 a	0.0568	2	0.5	24	1 5/8	44.5	708
24-05-1-18 a	0.0464	2	0.5	24	1 5/8	39.4	651
16-05-2-14 a	0.0709	2	0.5	16	2 1/2	38.6	879
16-05-2-16 a	0.0568	2	0.5	16	2 1/2	44.5	642
16-05-2-18 a	0.0464	2	0.5	16	2 1/2	39.4	520
24-05-2-14 a	0.0709	2	0.5	24	2 1/2	38.6	1010
24-05-2-16 a	0.0568	2	0.5	24	2 1/2	44.5	802
24-05-2-18 a	0.0464	2	0.5	24	2 1/2	39.4	713
16-10-1-14 a	0.0713	3	1.0	16	1 5/8	40.6	612
16-10-1-16 a	0.0466	3	1.0	16	1 5/8	33.6	258
16-10-1-18 a	0.0440	3	1.0	16	1 5/8	22.8	162
24-10-1-14 a	0.0713	3	1.0	24	1 5/8	40.6	810
24-10-1-16 a	0.0466	3	1.0	24	1 5/8	33.6	342
24-10-1-18 a	0.0440	3	1.0	24	1 5/8	22.8	214
16-10-2-14 a	0.0713	3	1.0	16	2 1/2	40.6	635
16-10-2-16 a	0.0466	3	1.0	16	2 1/2	33.6	274
16-10-2-18 a	0.0440	3	1.0	16	2 1/2	22.8	187
24-10-2-14 a	0.0713	3	1.0	24	2 1/2	40.6	750
24-10-2-16 a	0.0466	3	1.0	24	2 1/2	33.6	335
24-10-2-18 a	0.0440	3	1.0	24	2 1/2	22.8	209

Table 3.5-2 — University of Missouri-Rolla Test Results.

Specimen No.	Track Thickness t (in.)	Track Leg Length L (in.)	Slip Gap e (in.)	Stud Spacing s (in.)	Stud Flange Width b_f (in.)	F_y (ksi)	P_{test} (lbs)
Specimen name: (UMR: 18-01-1-16)							
1 & 2 Average	0.052	2	0.125	18	1.625	46.7	941.5
Specimen name: (UMR: 12-05-1-16)							
3 & 4 Average	0.052	2	0.5	12	1.625	46.7	850
Specimen name: (UMR: 18-05-1-16)							
5 & 6 Average	0.052	2	0.5	18	1.625	46.7	750
Specimen name: (UMR: 12-07-1-16)							
7 & 8 Average	0.052	2	0.75	12	1.625	46.7	516.5
Specimen name: (UMR: 18-07-1-16)							
9 & 10 Average	0.052	2	0.75	18	1.625	46.7	666.5
Specimen name: (UMR: 12-12-1-16)							
11 & 12 Average	0.052	2	1.25	12	1.625	46.7	342
Specimen name: (UMR: 18-12-1-16)							
13 & 14 Average	0.052	2	1.25	18	1.625	46.7	358.5

3.6 Test Evaluation

Different parameters of the test array were chosen, so that a comparison could be made for each contributing factor. Stud spacing, flange width, slip gap, and track thickness were varied to see the effects each had on the effective width of the track in bending.

The previous methods of analysis base the load on the moment divided by the elastic section modulus or plastic section modulus of the plate in bending, depending on whether the load is an allowable strength or an ultimate strength design. The basis for our design will use ultimate loads, so analysis of the connection will be based on the plastic section modulus of the plate (track) in bending. The plastic section modulus of a plate in bending is as follows:

$$Z_x = \frac{1}{4} \times b_{eff} \times t^2 . \tag{3.6-1}$$

Limiting the bending stress to yield of the track material is shown below:

$$f_b = F_y , \tag{3.6-2}$$

and

$$f_b = \frac{M}{Z_x} , \tag{3.6-3}$$

where:

M $= P_n \times e$, (3.6-4)

P_n = nominal connection capacity (lbs),

e = Design gap (in.),

Z_x = plastic section modulus (in.^{3}),

b_{eff} = Effective width of track (in.),

t = track thickness (in.),

F_y = yield strength of track (ksi).

Substituting (3.6-5) and (3.6-1) in (3.6-3) and setting that result into (3.6-2) attains the following equation:

$$\frac{P_n \times e}{\frac{1}{4} \times b_{eff} \times t^2} = F_y \,. \tag{3.6-5}$$

The nominal connection capacity and effective width can be derived from (3.6-5) as follows:

$$P_n = \frac{b_{eff} \times t^2 \times F_y}{4 \times e} \,. \tag{3.6-6}$$

The effective width of the track in bending can also be derived from (3.6-5) as follows:

$$b_{eff} = \frac{P_n \times 4 \times e}{t^2 \times F_y} \,. \tag{3.6-7}$$

Table 3.6-1 lists the effective widths for each design method, and the effective width from the test results (b_{eff}) using (3.6-7). Effective widths from other procedures are given for comparison.

In order to develop a procedure that can correctly determine the nominal load of this connection, a comparison of each variable needs to be reviewed. A comparison of test failure load versus stud spacing, stud flange width, design gap, and track thickness are presented in the following Figures 3.6-1 to 3.6-4. The effective width for each test (b_{eff}) using (3.6-7) versus stud spacing, stud flange width, design gap, and track thickness are shown in Figures 3.6-5 to 3.6-8.

When comparing Load or Effective Width versus Stud Spacing figures (Figure 3.6-1 and Figure 3.6-5), the increase in load is not parallel for all tests and actually decreases with a wider stud spacing for some results. A spacing variable will not be included in the formulation of the effective width; however, the effective width will be limited to the spacing of the studs.

As shown in Figure 3.6-2 and Figure 3.6-6, when comparing the Load or Effective Width versus Stud Flange Width, the load is almost constant with the different stud flange width tested. A slight increase is observed, but due to the minimal increase, a stud flange width variable (b_f) is not used. Additional testing should be conducted to determine if an appropriate factor should be incorporated into the effective width equation.

The main contributing factors to the effective width are the design gap (see Figure 3.6-3 and Figure 3.6-7) and the thickness of the track (see Figure 3.6-4 and Figure 3.6-8). A relationship between the design gap and the track thickness was developed through curve fitting and regression analysis that closely determined the effective width of the track in bending. The equation that best predicts the effective width of the track in bending is as follows:

$$b_{eff} = 0.11 \times \frac{e^{0.5}}{t^{1.5}} + 5.5 \leq S \,. \tag{3.6-8}$$

Table 3.6-2 lists the proposed design procedure equation results for the effective width using (3.6-8) and the nominal connection capacity using (3.6-6). Figure 3.6-9 shows the effective width versus $e^{0.5}/t^{1.5}$, which shows the proposed equation for the effective width (3.6-8). Figure 3.6-10 shows the nominal connection capacity versus the test results. Table 3.6-3 compares the nominal test capacities with the current design methods and the proposed design procedure. Safety factors or stress increases were removed to show only the nominal capacities.

Table 3.6-1 — Comparison of Effective Width of Tests and Current Design Methods.

Specimen Name	Design Gap e (in.)	Track Thickness t (in.)	Yield of Track Material F_y (ksi)	P_{test} (lbs)	b_{eff} (in.) Using (3.6-7)	Army Corps b_{eff} (in.)	MSMA, SSMA, Rahman b_{eff} (in.)	Bolte b_{eff} (in.)
16-05-1-14 a	0.5	0.0709	38.6	796	8.21	8.55	8.55	7.60
16-05-1-16 a	0.5	0.0568	44.5	590	8.24	8.55	8.55	10.93
16-05-1-18 a	0.5	0.0464	39.4	458	10.80	8.55	8.55	13.63
24-05-1-14 a	0.5	0.0709	38.6	854	8.81	8.55	8.55	7.60
24-05-1-16 a	0.5	0.0568	44.5	708	9.89	8.55	8.55	10.93
24-05-1-18 a	0.5	0.0464	39.4	651	15.37	8.55	8.55	13.63
16-05-2-14 a	0.5	0.0709	38.6	879	9.07	9.43	9.43	8.48
16-05-2-16 a	0.5	0.0568	44.5	642	8.96	9.43	9.43	11.81
16-05-2-18 a	0.5	0.0464	39.4	520	12.29	9.43	9.43	14.50
24-05-2-14 a	0.5	0.0709	38.6	1010	10.43	9.43	9.43	8.48
24-05-2-16 a	0.5	0.0568	44.5	802	11.20	9.43	9.43	11.81
24-05-2-18 a	0.5	0.0464	39.4	713	16.84	9.43	9.43	14.50
16-10-1-14 a	1	0.0713	40.6	612	11.86	12.02	11.15	13.63
16-10-1-16 a	1	0.0466	33.6	258	14.16	12.02	11.15	13.63
16-10-1-18 a	1	0.0440	22.8	162	14.68	12.02	11.15	13.63
24-10-1-14 a	1	0.0713	40.6	810	15.69	12.02	11.15	13.63
24-10-1-16 a	1	0.0466	33.6	342	18.75	12.02	11.15	13.63
24-10-1-18 a	1	0.0440	22.8	214	19.41	12.02	11.15	13.63
16-10-2-14 a	1	0.0713	40.6	635	12.30	12.89	12.03	14.50
16-10-2-16 a	1	0.0466	33.6	274	15.01	12.89	12.03	14.50
16-10-2-18 a	1	0.0440	22.8	187	16.93	12.89	12.03	14.50
24-10-2-14 a	1	0.0713	40.6	750	14.53	12.89	12.03	14.50
24-10-2-16 a	1	0.0466	33.6	335	18.36	12.89	12.03	14.50
24-10-2-18 a	1	0.0440	22.8	209	19.01	12.89	12.03	14.50
UMR: 18-01-1-16	0.125	0.0520	46.7	942	3.73	8.55	6.60	2.32
UMR: 12-05-1-16	0.5	0.0520	46.7	850	13.46	8.55	8.55	12.72
UMR: 18-05-1-16	0.5	0.0520	46.7	750	11.88	8.55	8.55	12.72
UMR: 12-07-1-16	0.75	0.0520	46.7	517	12.27	8.55	9.85	13.63
UMR: 18-07-1-16	0.75	0.0520	46.7	667	15.83	8.55	9.85	13.63
UMR: 12-12-1-16	1.25	0.0520	46.7	342	13.54	8.55	12.45	13.63
UMR: 18-12-1-16	1.25	0.0520	46.7	359	14.20	8.55	12.45	13.63

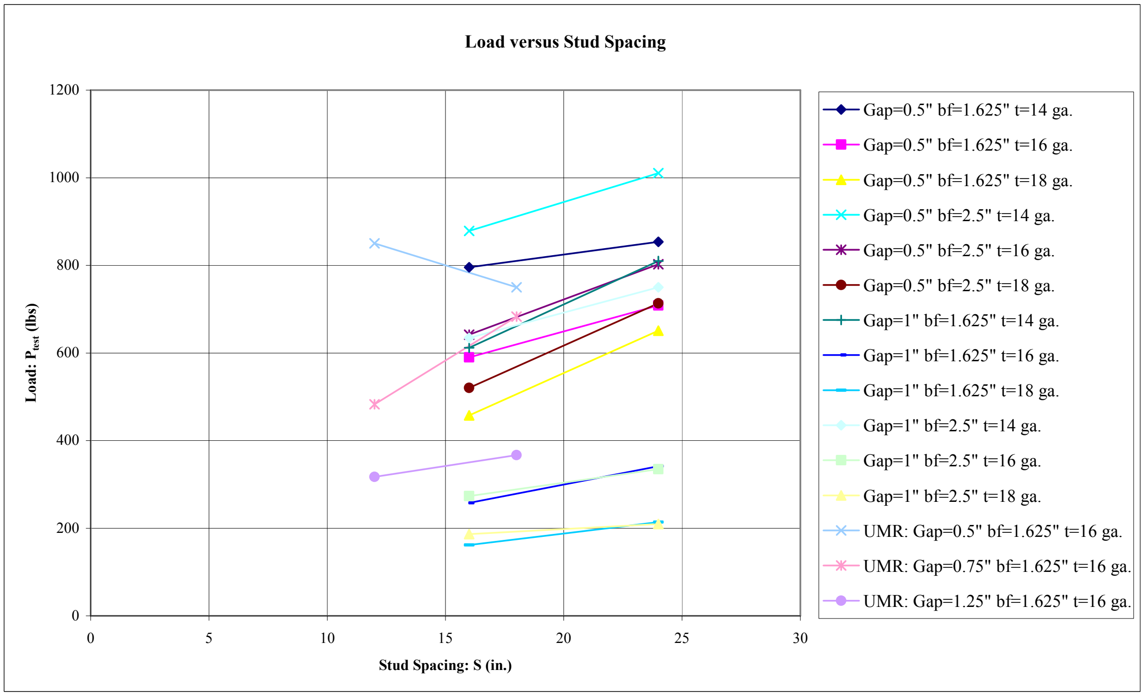


Figure 3.6-1 — Load versus Stud Spacing.

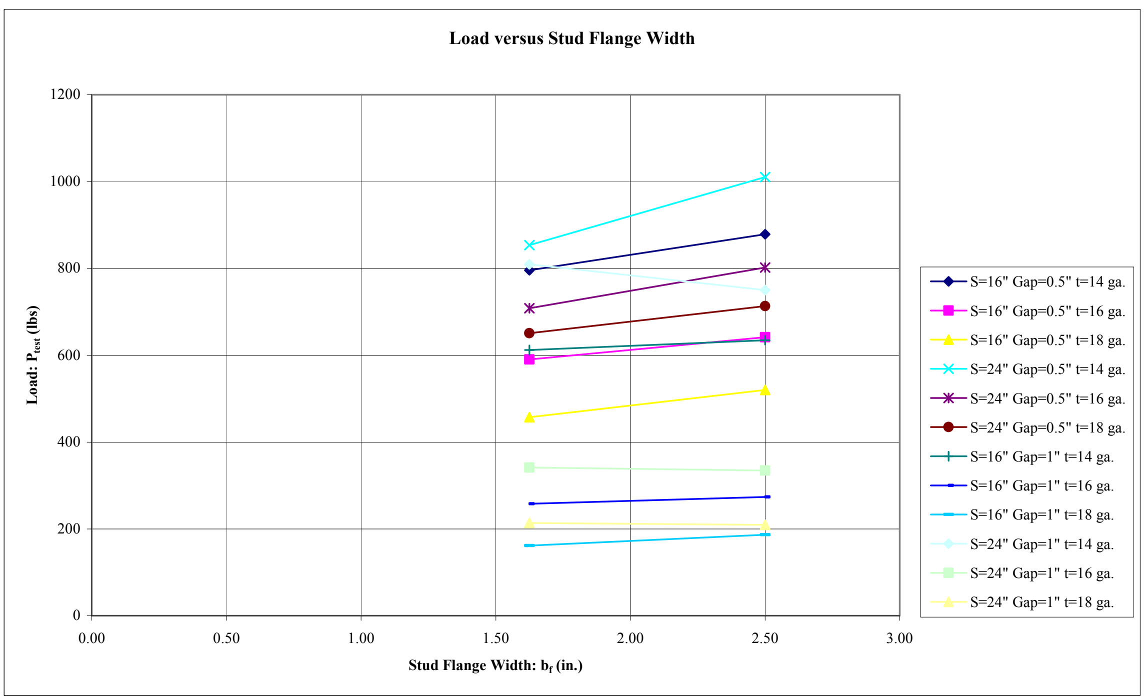


Figure 3.6-2 — Load versus Stud Flange Width.

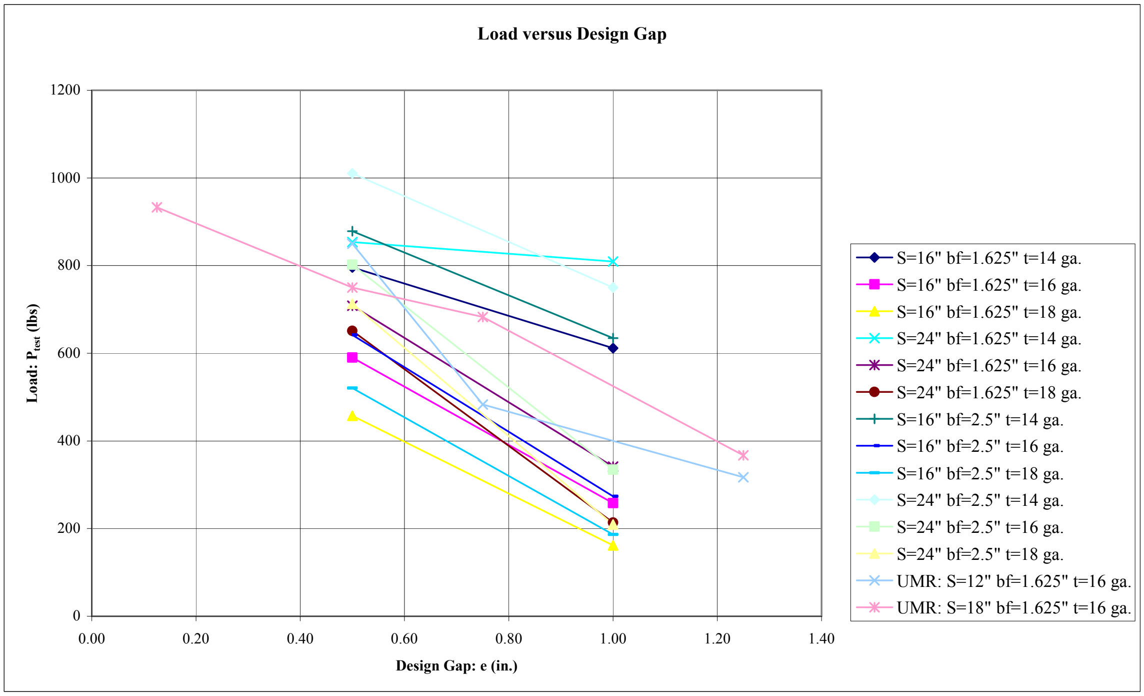


Figure 3.6-3 — Load versus Design Gap.

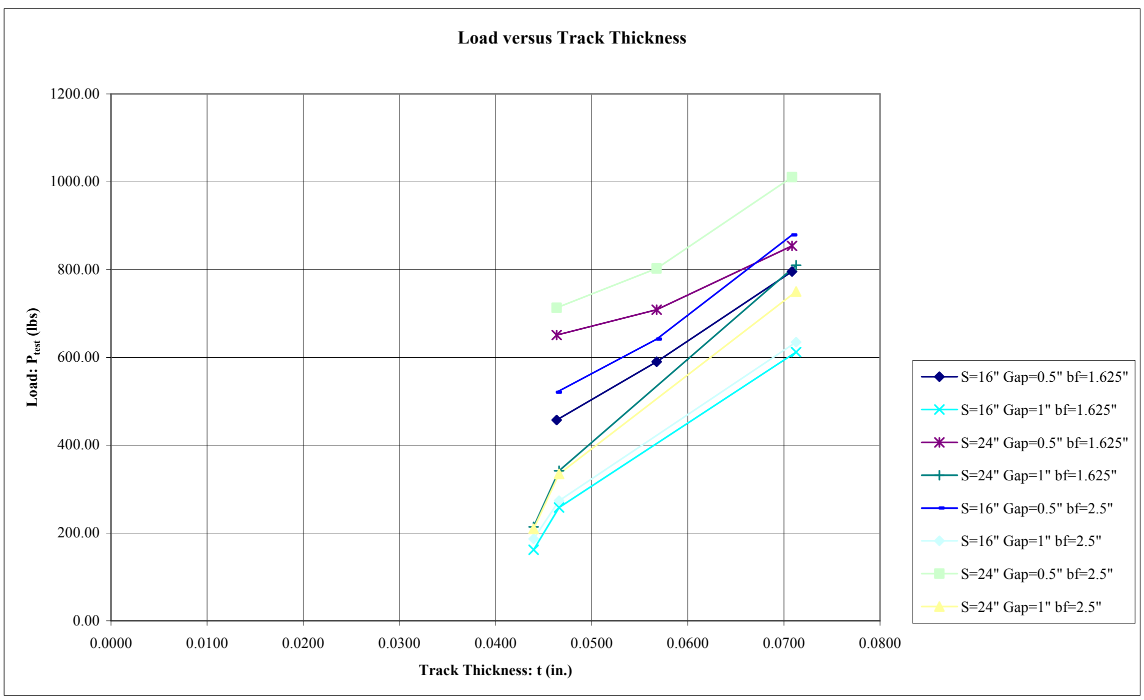


Figure 3.6-4 — Load versus Track Thickness.

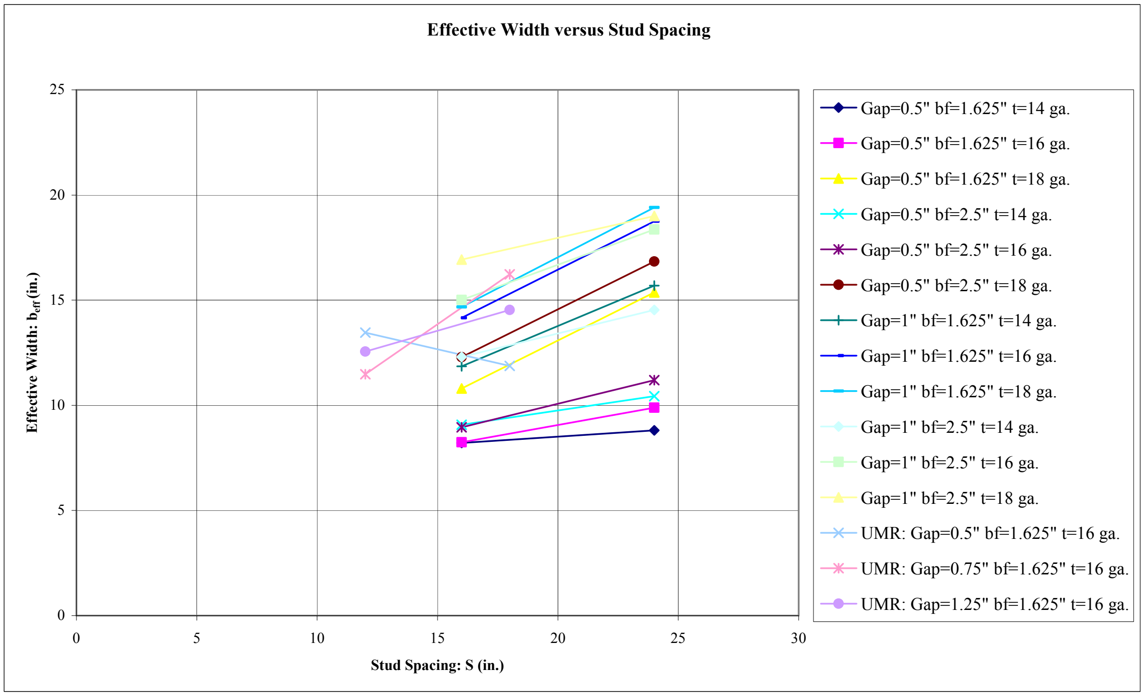


Figure 3.6-5 — Effective Width versus Stud Spacing.

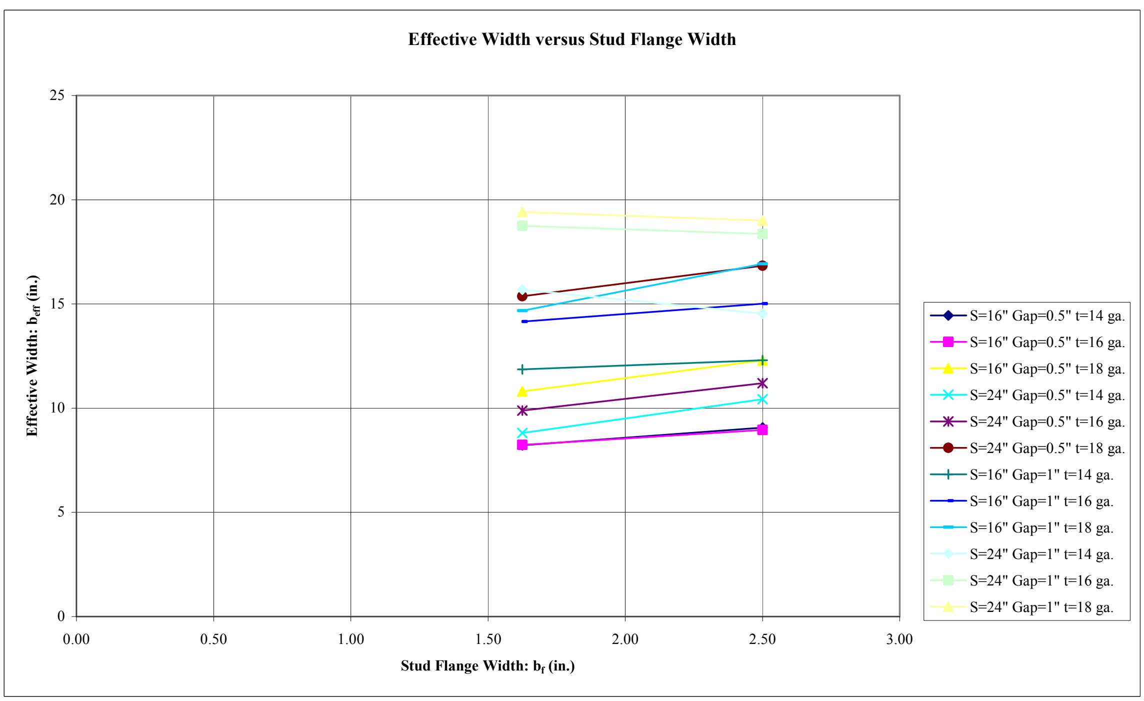


Figure 3.6-6 — Effective Width versus Stud Flange Width.

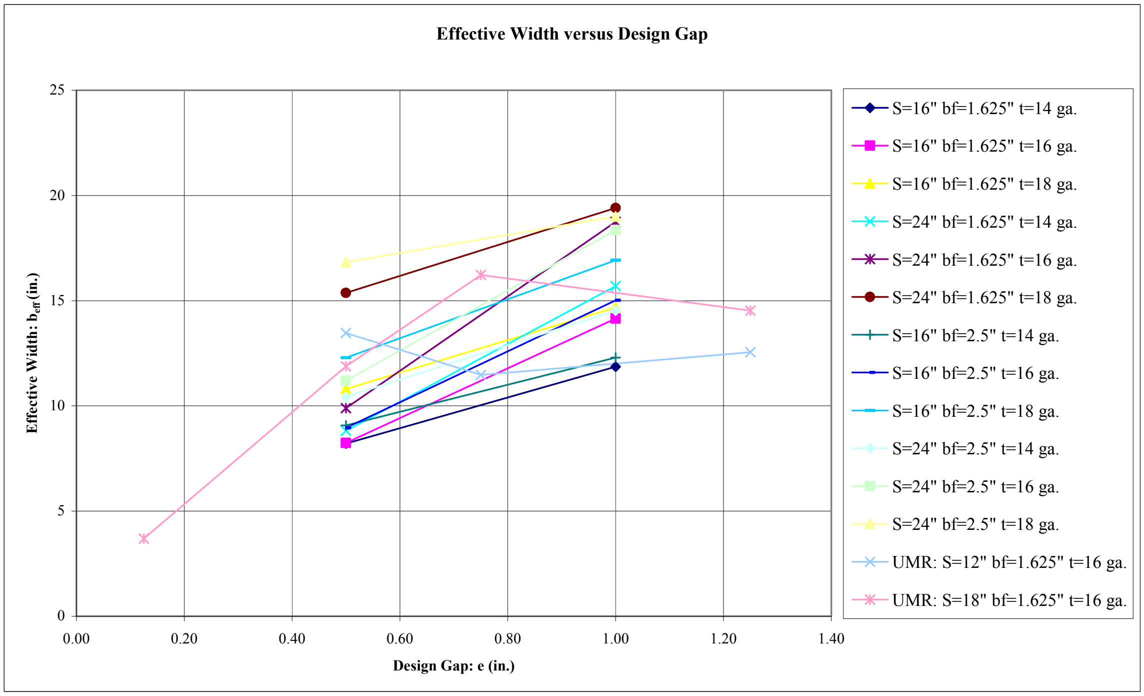


Figure 3.6-7 — Effective Width versus Design Gap.

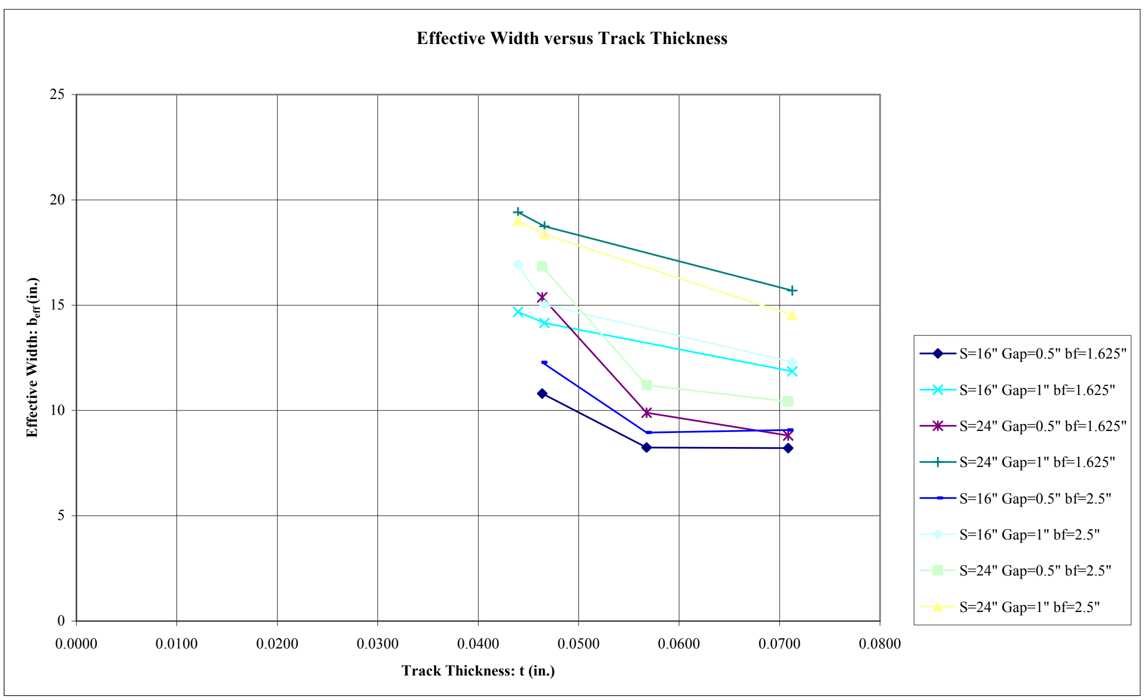


Figure 3.6-8 — Effective Width versus Track Thickness.

Table 3.6-2 — P_n using Proposed Design Equations.

Specimen Name	Design Gap e (in.)	Track Thickness t (in.)	$\frac{e^{0.5}}{t^{1.5}}$	b_{eff} (in.) Using (3.6-8)	b_{eff} (in.) Using (3.6-7)	P_n (lbs) Using (3.6-6)	P_{test} (lbs)	$\frac{P_{test}}{P_n}$
16-05-1-14 a	0.5	0.0709	37.5	9.62	8.21	932	796	0.85
16-05-1-16 a	0.5	0.0568	52.3	11.25	8.24	806	590	0.73
16-05-1-18 a	0.5	0.0464	70.8	13.29	10.80	5639	458	0.81
24-05-1-14 a	0.5	0.0709	37.5	9.62	8.81	932	854	0.92
24-05-1-16 a	0.5	0.0568	52.3	11.25	9.89	806	708	0.88
24-05-1-18 a	0.5	0.0464	70.8	13.29	15.37	563	651	1.16
16-05-2-14 a	0.5	0.0709	37.5	9.62	9.07	932	879	0.94
16-05-2-16 a	0.5	0.0568	52.3	11.25	8.96	806	642	0.80
16-05-2-18 a	0.5	0.0464	70.8	13.29	12.29	563	520	0.92
24-05-2-14 a	0.5	0.0709	37.5	9.62	10.43	932	1010	1.08
24-05-2-16 a	0.5	0.0568	52.3	11.25	11.20	806	802	1.00
24-05-2-18 a	0.5	0.0464	70.8	13.29	16.84	563	713	1.27
16-10-1-14 a	1	0.0713	52.6	11.28	11.86	582	612	1.05
16-10-1-16 a	1	0.0466	99.4	16.00	14.16	292	258	0.88
16-10-1-18 a	1	0.0440	108.5	16.00	14.68	176	162	0.92
24-10-1-14 a	1	0.0713	52.6	11.28	15.69	582	810	1.39
24-10-1-16 a	1	0.0466	99.4	16.43	18.75	299	342	1.14
24-10-1-18 a	1	0.0440	108.5	17.43	19.41	192	214	1.11
16-10-2-14 a	1	0.0713	52.6	11.28	12.30	582	635	1.09
16-10-2-16 a	1	0.0466	99.4	16.00	15.01	292	274	0.94
16-10-2-18 a	1	0.0440	108.5	16.00	16.93	176	187	1.06
24-10-2-14 a	1	0.0713	52.6	11.28	14.53	582	750	1.29
24-10-2-16 a	1	0.0466	99.4	16.43	18.36	299	335	1.12
24-10-2-18 a	1	0.0440	108.5	17.43	19.01	192	209	1.09
UMR: 18-01-1-16	0.125	0.0520	29.8	8.78	3.73	2217	942	0.42 *
UMR: 12-05-1-16	0.5	0.0520	59.6	12.00	13.46	758	850	1.12
UMR: 18-05-1-16	0.5	0.0520	59.6	12.06	11.88	761	750	0.99
UMR: 12-07-1-16	0.75	0.0520	73.0	12.00	12.27	505	517	1.02
UMR: 18-07-1-16	0.75	0.0520	73.0	13.53	15.83	570	667	1.17
UMR: 12-12-1-16	1.25	0.0520	94.3	12.00	13.54	303	3420	1.13
UMR: 18-12-1-16	1.25	0.0520	94.3	15.87	14.20	401	342	0.85

Average	**1.006**
Standard Deviation	**0.167**
Coefficient of Variation	**0.166**

- Value removed from Average and Standard Deviation and graphic representation. Ultimate load is assumed to be a stud failure, not a track failure at the load specified.
- Average and Standard Deviation are computed using the ultimate loads of the 72 tests performed by MSOE and 12 tests from UMR study, for a total of 84 tests.

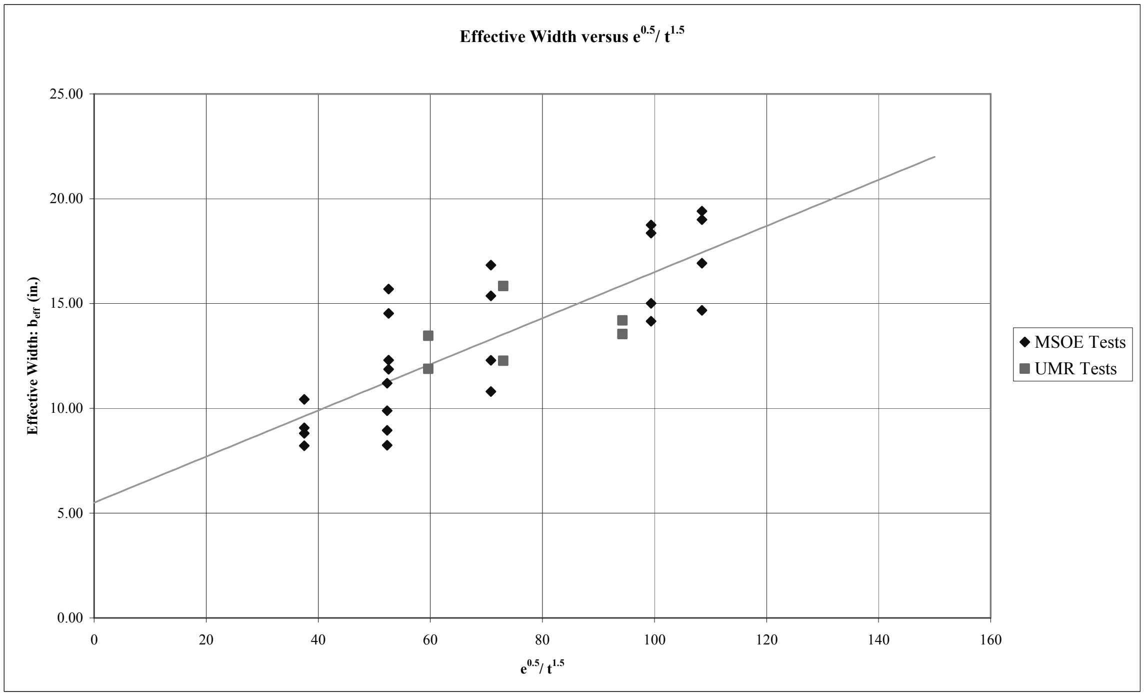


Figure 3.6-9 — Effective Width versus $e^{0.5}/t^{1.5}$.

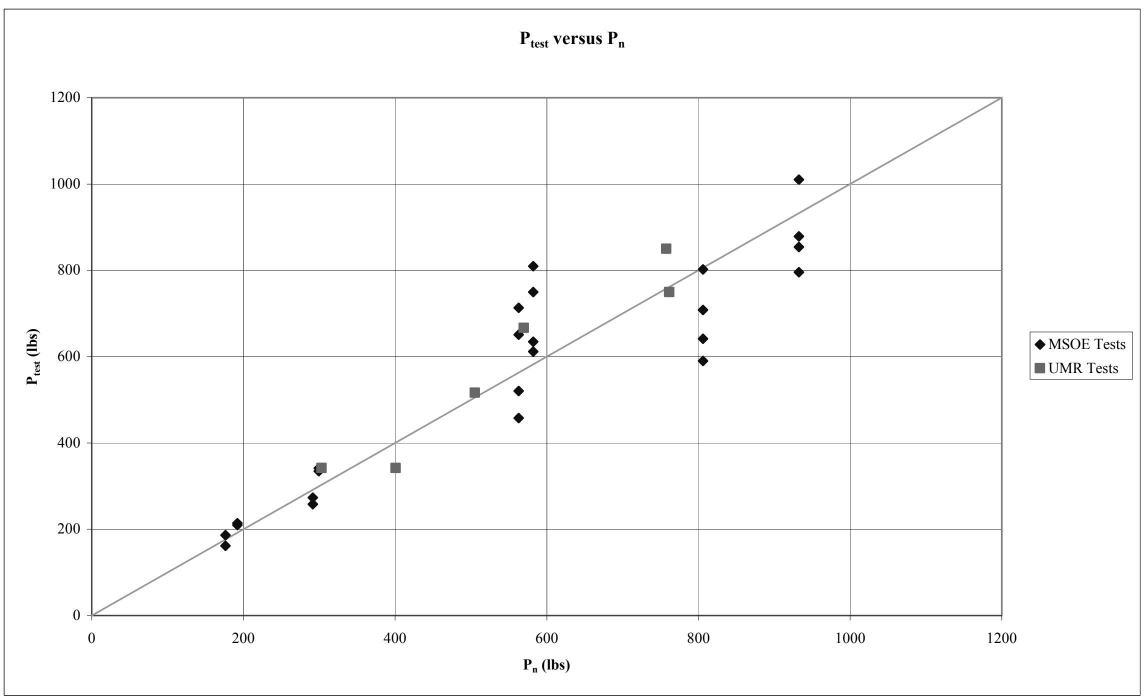


Figure 3.6-10 — P_n versus P_{test}.

Table 3.6-3 — Comparison of Nominal Test Capacities with Design Procedures.

Specimen	P_{test} (lbs.)	2.1-Army Corps of Engineers P_n (lbs.)	2.2-MSMA, 2.3-SSMA, 2.4-Rahman P_n (lbs.)	2.5 Bolte P_n (lbs.)	2.6 Roark's Formulas for Stress and Strain P_n (lbs.)	2.7 Current Engineering Firm Design Practices P_n (lbs.)	Proposed Design Procedure P_n (lbs.)
16-05-1-14 a	796	552	368	736	97	363 - 552	932
16-05-1-16 a	590	409	272	783	72	269 - 409	806
16-05-1-18 a	457	241	161	577	43	159 - 241	563
24-05-1-14 a	854	552	368	736	97	363 - 552	932
24-05-1-16 a	708	409	272	783	72	269 - 409	806
24-05-1-18 a	651	241	161	577	43	159 - 241	563
16-05-2-14 a	879	609	406	821	97	420 - 609	932
16-05-2-16 a	642	450	300	846	72	310 - 450	806
16-05-2-18 a	520	266	177	614	43	184 - 266	563
24-05-2-14 a	1010	609	406	821	97	420 - 609	932
24-05-2-16 a	802	450	300	846	72	310 - 450	806
24-05-2-18 a	713	266	177	614	43	184 - 266	563
16-10-1-14 a	612	413	256	703	100	262 - 413	582
16-10-1-16 a	258	146	90	248	35	93 - 146	299
16-10-1-18 a	162	88	55	150	21	56 - 88	192
24-10-1-14 a	810	413	256	703	100	262 - 413	582
24-10-1-16 a	342	146	90	248	35	93 - 146	299
24-10-1-18 a	214	88	55	150	21	56 - 88	192
16-10-2-14 a	635	443	276	748	100	292 - 443	582
16-10-2-16 a	274	157	97	264	35	103 - 157	299
16-10-2-18 a	187	95	59	160	21	62 - 95	192
24-10-2-14 a	750	443	276	748	100	292 - 443	582
24-10-2-16 a	335	157	97	264	35	103 - 157	299
24-10-2-18 a	209	95	59	160	21	62 - 95	192
UMR: 18-01-1-16	942	1440	741	586	254	947 - 1440	2217
UMR: 12-05-1-16	850	360	240	803	63	237 - 360	758
UMR: 18-05-1-16	750	360	240	803	63	237 - 360	761
UMR: 12-07-1-16	517	240	184	573	60	158 - 240	505
UMR: 18-07-1-16	667	240	184	573	60	158 - 240	570
UMR: 12-12-1-16	342	144	135	344	53	95 - 144	303
UMR: 18-12-1-16	359	144	140	344	53	95 - 144	401

3.7 Resistance Factor and Factor of Safety

Resistance factors and factors of safety are computed in accordance with the *Commentary* of the AISI Commentary Section A5 [15]. To determine the appropriate factors, the following equations are used:

$$\phi = 1.521 \times (P_m \times M_m \times F_m) \times e^{(-\beta_o \times \sqrt{V_R{}^2 + V_Q{}^2})}, \quad (3.7\text{-}1)$$

$$\Omega = \frac{(1.2 \times D/L + 1.6)}{\phi \times (D/L + 1)}, \quad (3.7\text{-}2)$$

and

$$V_R = \sqrt{V_P{}^2 + V_M{}^2 + V_F{}^2}, \quad (3.7\text{-}3)$$

where:

ϕ = Resistance Factor (LRFD),

Ω = Factor of Safety (ASD),

V_R = Coefficient of variation of resistance (Equation C-A5.1.1-6 of the AISI Commentary [15]),

V_P = Coefficient of variation of test results,

= 0.166 (from Table 3.6-2),

V_M = Coefficient of variation of material factor,

= 0.10 (AISI Specification Table F1 for Flexural Member – Bending Strength [1]),

V_F = Coefficient of variation of fabrication factor,

= 0.05 (AISI Specification Table F1 for Flexural Member – Bending Strength [1]).

M_m = ratio of the actual yield point to the minimum specified value,

= 1.10 Table F1 (Flexural Member – Bending Strength [1]),

P_m = mean ratio of the experimentally determined moment to the predicted moment for the actual material and cross-sectional properties of the test specimens,

= 1.006 (from Table 3.6-2),

F_m = mean ratio of the actual section modulus to the specified (nominal) value,

= 1.0 Table F1 (Flexural Member – Bending Strength [1]),

β_o = target reliability factor, per AISI Commentary [15],

= 3.5 for connections,

V_Q = Coefficient of variation of load effect,

= 0.21 Section F1.1(b) of the AISI Specification [1],

D/L = Dead Load to Live Load Ratio, 1/5.

The calculation of the resistance factor and factor of safety are as follows:

$$V_R = \sqrt{0.166^2 + 0.10^2 + 0.05^2} = 0.1998 \, , \tag{3.7-3}$$

$$\phi = 1.521 \times (1.006 \times 1.10 \times 1.0) \times e^{(-3.5 \times \sqrt{0.1998^2 + 0.21^2})} = 0.61 \, , \tag{3.7-1}$$

and

$$\Omega = \frac{(1.2 \times 1/5 + 1.6)}{0.61 \times (1/5 + 1)} = 2.51 \, . \tag{3.7-2}$$

A summary of the resistance factors and factor of safety is shown in Table 3.7-1.

Table 3.7-1 — Resistance Factors and Factor of Safety.

Ω (ASD)	ϕ (LRFD)
2.51	0.61

The coefficient of variation for load effect, V_Q, is determined using the 1.2D+1.6L load combination. This load combination yields the most conservative resistance factor and factor of safety for the load combinations in the AISI Specification [1].

3.8 Design Example of Proposed Design Procedure

Section 2.8 shows design examples for the present design practices using ASD. The following design example uses the same parameters as those in Section 2.8 for the proposed design procedure.

Given:

F_y = 33,000 psi.

P = 160 lbs (allowable load).

Ω = 2.51 (ASD).

e = 1/2 in.

$P_{n\ req'd} = P \times \Omega = 160 \times 2.51 = 401.6$ lbs.

Solution:

Assume t = 0.0400 in.

$$b_{eff} = 0.11 \times \frac{e^{0.5}}{t^{1.5}} + 5.5 \leq S, \tag{3.6-8}$$

$$= 0.11 \times \frac{(1/2)^{0.5}}{0.0400^{1.5}} + 5.5 \leq 24,$$

$$= 15.22 \leq 24,$$

$$b_{eff} = 15.22 \text{ in.}$$

$$P_n = \frac{b_{eff} \times t^2 \times F_y}{4 \times e}, \tag{3.6-6}$$

$$= \frac{15.22 \times 0.0400^2 \times 33000}{4 \times (1/2)},$$

$$P_n = 401.8\,\text{lbs}.$$

Note: Safety Factor = 2.51.

CHAPTER 4: FINITE ELEMENT ANALYSIS

4.1 Introduction

Finite element analysis (FEA) was conducted to verify the behavior of the slip-track connection and will be compared to the behavior from the tests performed. In order to accurately compare the behavior of the slip-track connection, a full scale finite element model is required. Due to the complexity of the finite element model, only 3 FEA's were conducted, with a track thickness of 0.0451", 0.0566" and 0.0713" (18, 16, and 14 gage), and a length of 48" for a stud spacing of 24". The length of the track leg is 2" with a slip gap of 1/2", and the length of the stud at 48". The load applied in the FEA models is at 20.5" from the end of the stud nearest the slip gap. Thus, the reaction at the end of each stud would be 20.5 / 48 x $P_{applied}$ (applied load). To evaluate the contact behavior at the connection, the applied loads were varied through an iterative non-linear procedure. The software package used to perform the FEA was GT Strudl [16], which performs an elastic material analysis. An isometric view of the slip-track model is shown in Figure 4.1-1.

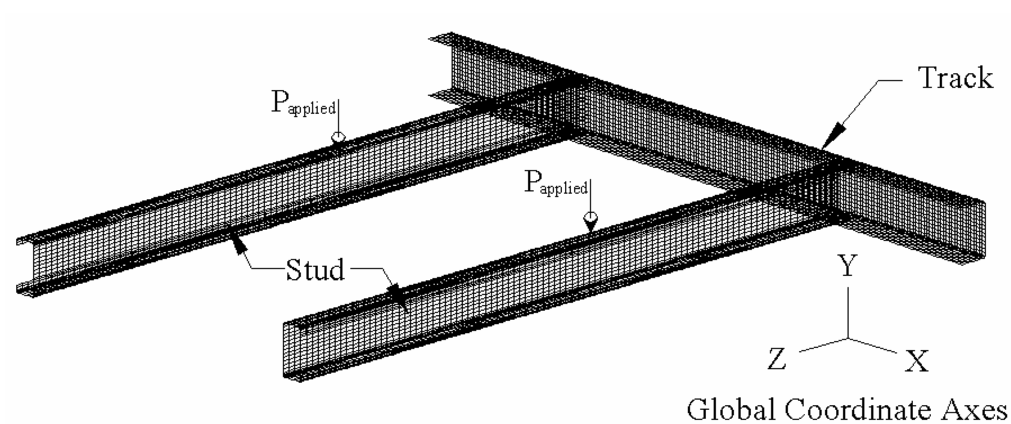


Figure 4.1-1 — Finite Element Model.

4.2 Finite Element Analysis Model Setup

Thin walled plate elements are recommended for sections. The plate element used for this model is the Stretching and Bending Hybrid Quadrilateral element with six degrees of freedom per node (SBHQ6, Table 6.4-1 of the GT Strudl Analysis User Guide [16]). The track section is made of 0.25” wide elements, with the legs, web and corners split up into 38 elements, for a total of 7258 elements per track. The stud section is made of 0.5” wide elements, with the lips, flanges, web and corners split up into 46 elements, for a total of 4370 elements per stud. See the following figure for a more detailed view of the element distribution.

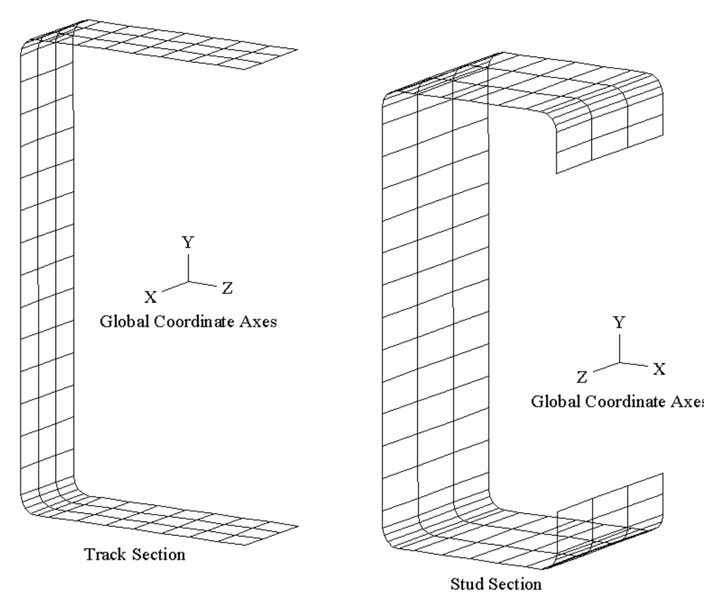


Figure 4.2-1 — Track and Stud Section.

The support provided at the end of the stud opposite the track is shown in Figure 4.2-2. At the center of the stud the support has three translational degrees-of-freedom restrained (along with the three corresponding translational force reaction components, F_x, F_y, and F_z). The support at the top end of the stud only has one translational degree-of-freedom restrained, which provided torsional restraint about the

Z-axis at this end of the stud. This support boundary condition allows for rotational displacement about the X and Y-axes.

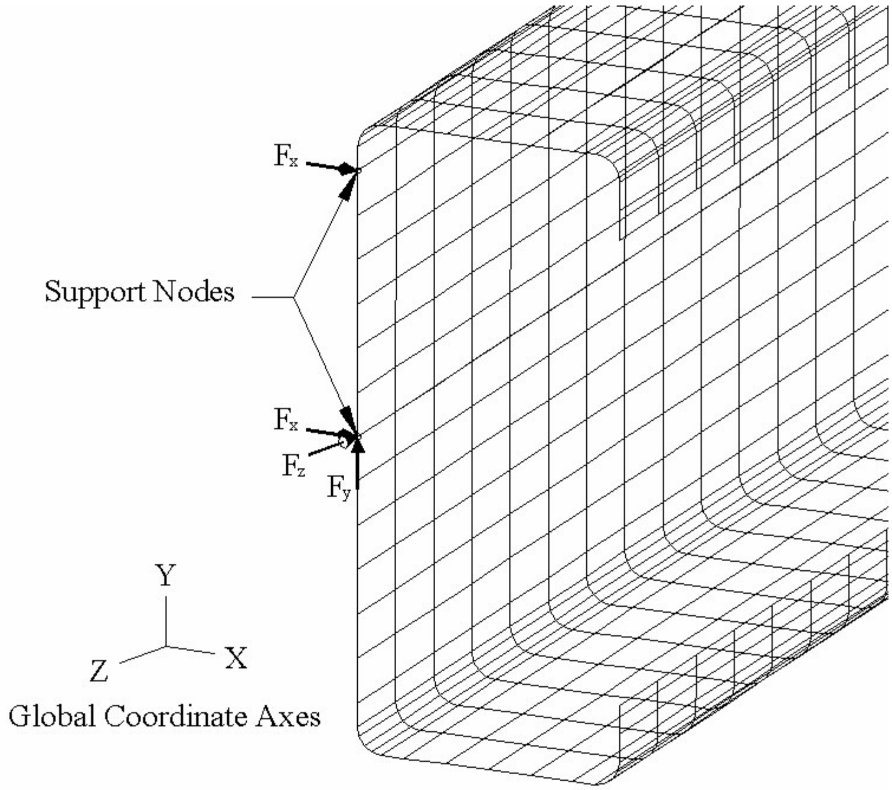


Figure 4.2-2 — Boundary conditions at the end of the stud.

Blocking was added to the tests to help keep the rotation of the stud at the track to a minimum. To simulate this, supports were added 2 1/2” from the end of the stud, nearest the track. The locations of these supports are shown in Figure 4.2-3. Each support only had one translational degree-of-freedom restrained (along with the corresponding translational force reaction component, F_x). This support allowed for translational displacement in the Y and Z-axes, and rotational displacement about the Y and Z-axes.

At the stud to track interface (Figure 4.2-4), 20 compression-only linking members were used to “connect” the track to the stud. If any of the linking members have tension, the software package would simply treat them as if they were not there. This would simulate the track and the stud separating and results in a non-linear, iterative analysis procedure.

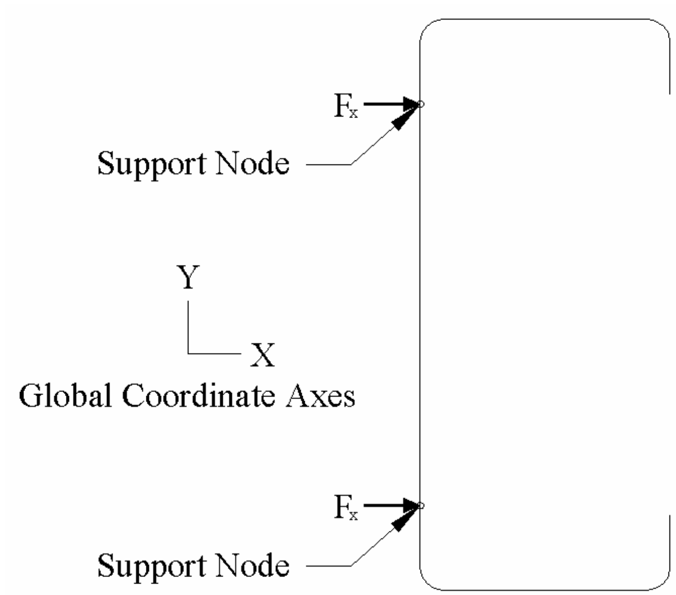


Figure 4.2-3 — Boundary conditions to simulate "blocking".

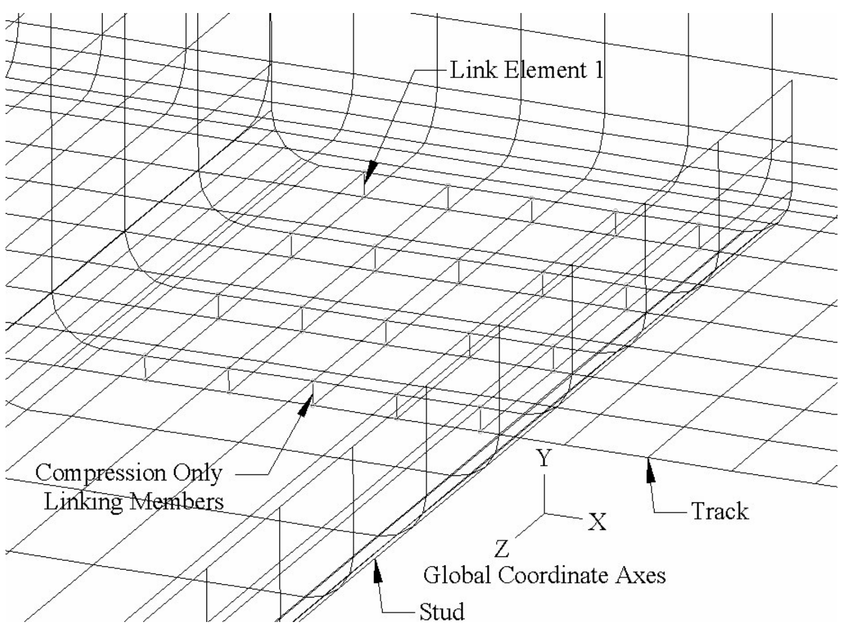


Figure 4.2-4 — Stud to track intersection.

The support locations for the track used to simulate the bolt have three translational degrees-of-freedom restrained (along with the three corresponding translational force reaction components, F_x, F_y, and F_z). This support is located similar to that of Figure 3.4-1. Compression only linking members along with a one degree-of-freedom support was used on the bottom of the track and all along the top of the track. These supports and linking member simulate the track bearing up against the channel during testing. Again, if there is tension in the linking member, the software package would treat the members as if they were not there, and F_z would not exist.

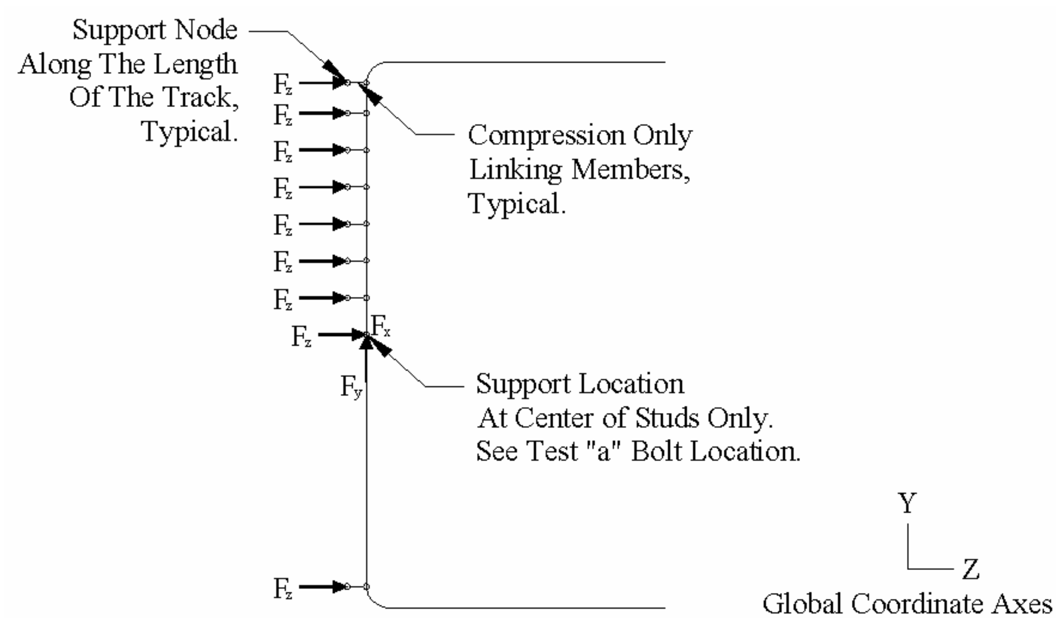


Figure 4.2-5 — Boundary conditions for the track.

4.3 Results of Computer Modeling

Finite Element Analysis showed that at the stud to track interface, *Link Element 1* in Figure 4.2-4 is the only member that transfers load to the track. All of the other "compression-only" members were found to have tension in them, and were treated as if they did not exist during the analysis. This shows that the flange of the track does not contribute to the effective width, and that this connection behaves as a point load on a plate.

The track displacement has been overlaid on the original position of the track in Figure 4.3-1 and 4.3-2. The location of *Link Element 1* has been shown for reference.

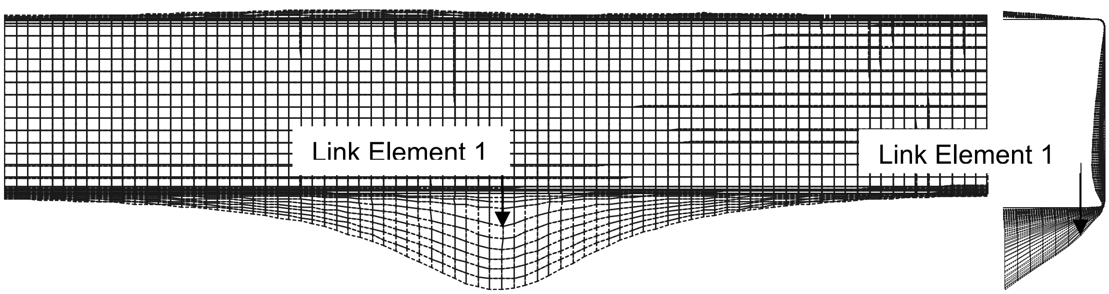


Figure 4.3-1 — Front and side view of track displacement.

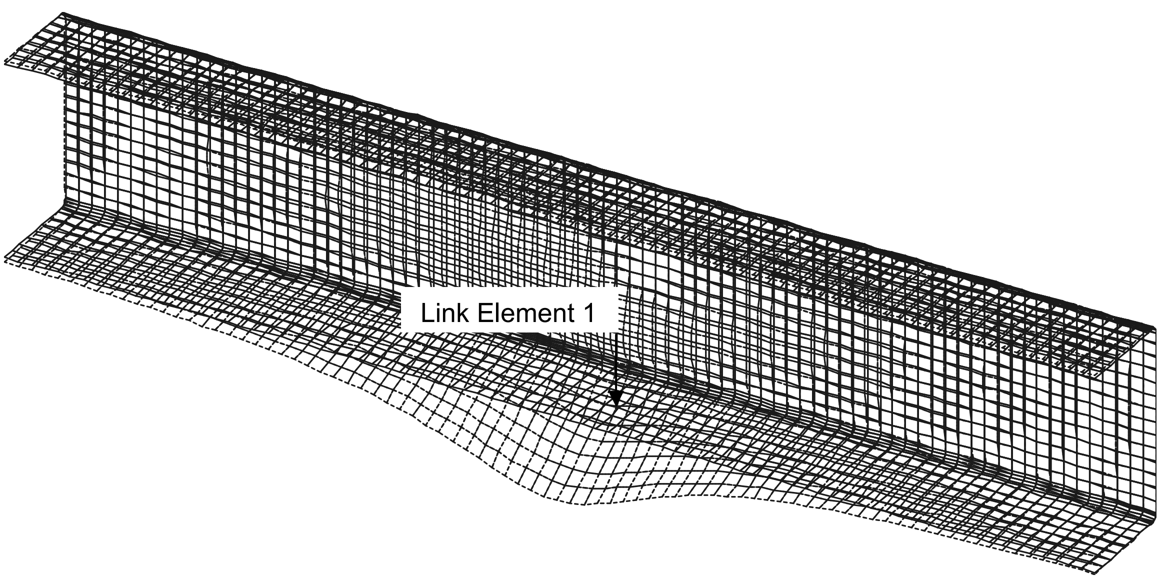


Figure 4.3-2 — 3-D view of track displacement.

The stress level of the stud to track interface location (*Link Element 1*), at the higher loads, reaches a level beyond yielding. Since this is an elastic analysis, the stress limit is exceeded and this analysis is no longer valid. However, these stresses are very localized. Also, this procedure is considered to be a qualitative assessment to verify the observations during testing. As observed during testing, local yielding at this location occurred well before ultimate loads were reached. Figure 4.3-3 defines the stress location and orientation for the leg and web elements of the track to be used with Figure 4.3-4 to Figure 4.3-9. These figures are of the stresses for the model of a 24” stud spacing, ½” slip gap, 1 5/8” stud flange width using 16 gage (0.0566 in.) track. The applied load for this model is 200 lbs. Thus the reaction F_y = 110.89 lbs, and F_z = -52.53 lbs as shown in Figure 4.2-5. These stress diagrams are typical for all the models analyzed.

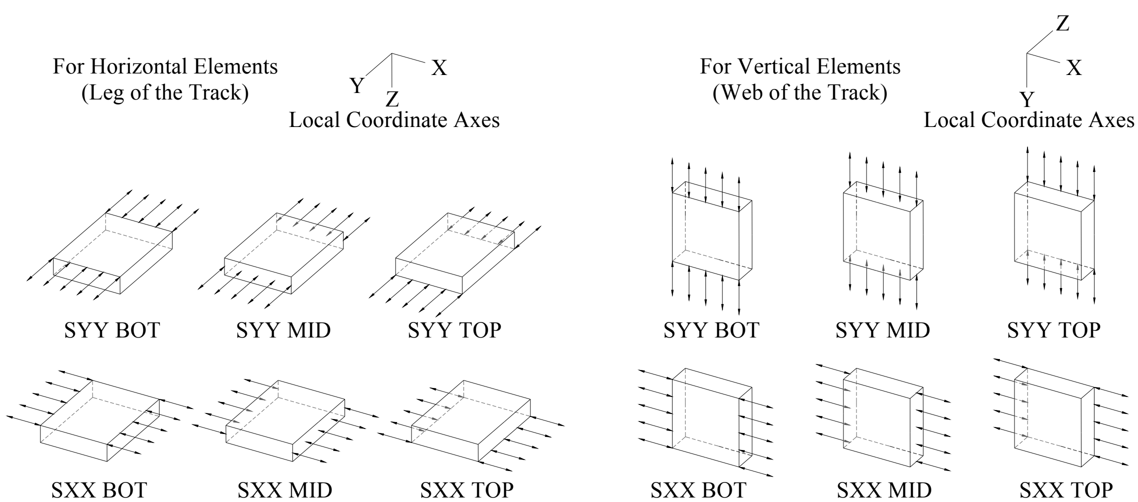


Figure 4.3-3 — Local element stress definitions.

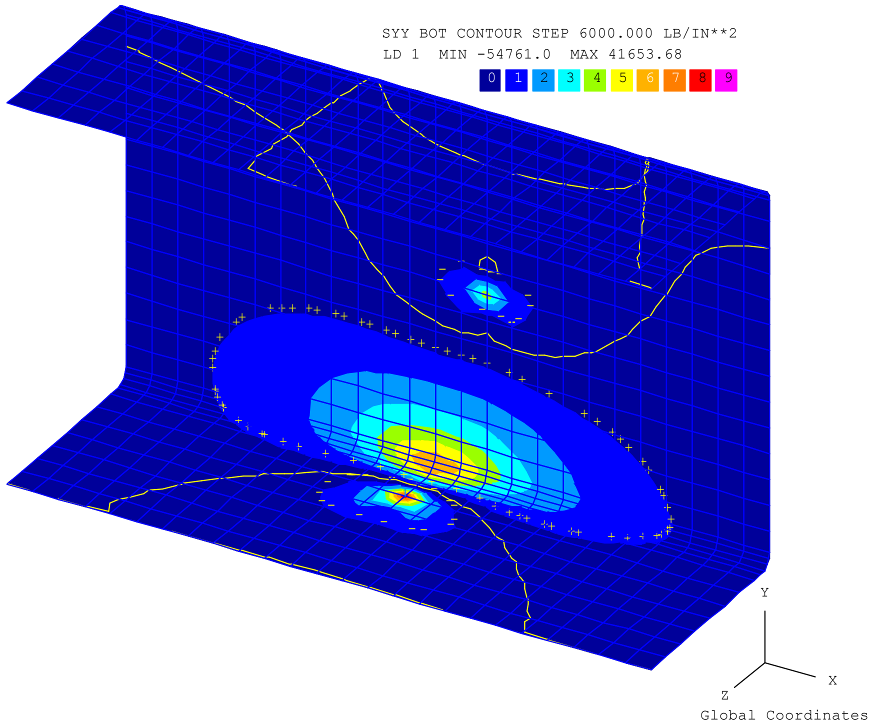


Figure 4.3-4 — SYY BOT Stress Diagram.

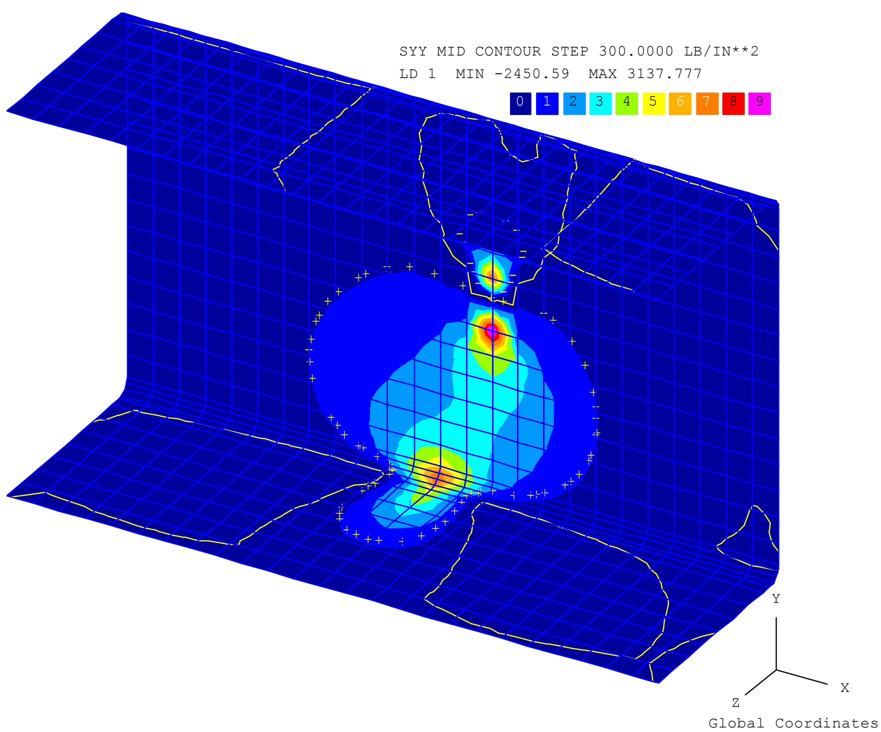


Figure 4.3-5 — SYY MID Stress Diagram.

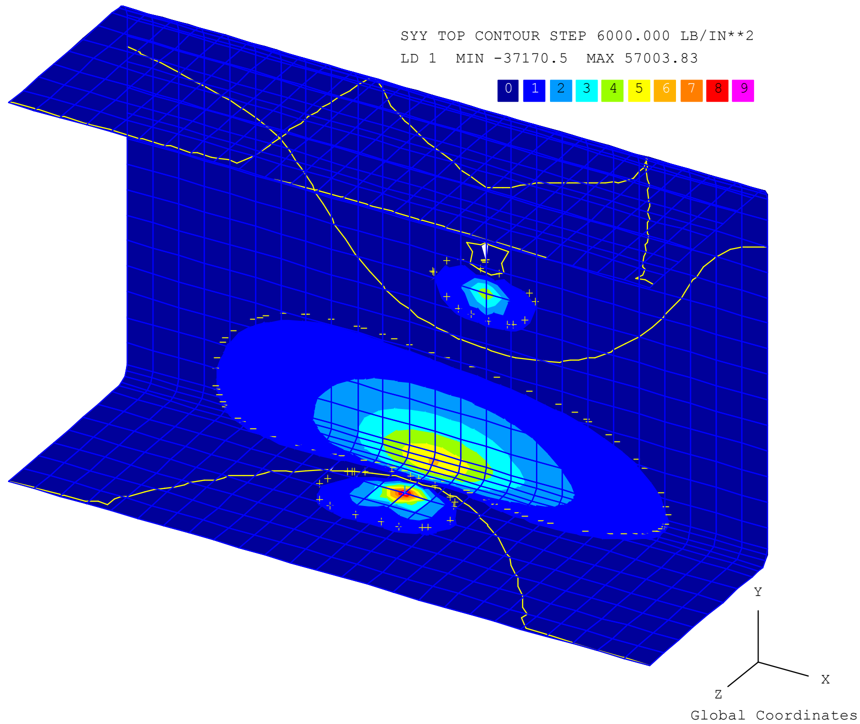


Figure 4.3-6 — SYY TOP Stress Diagram.

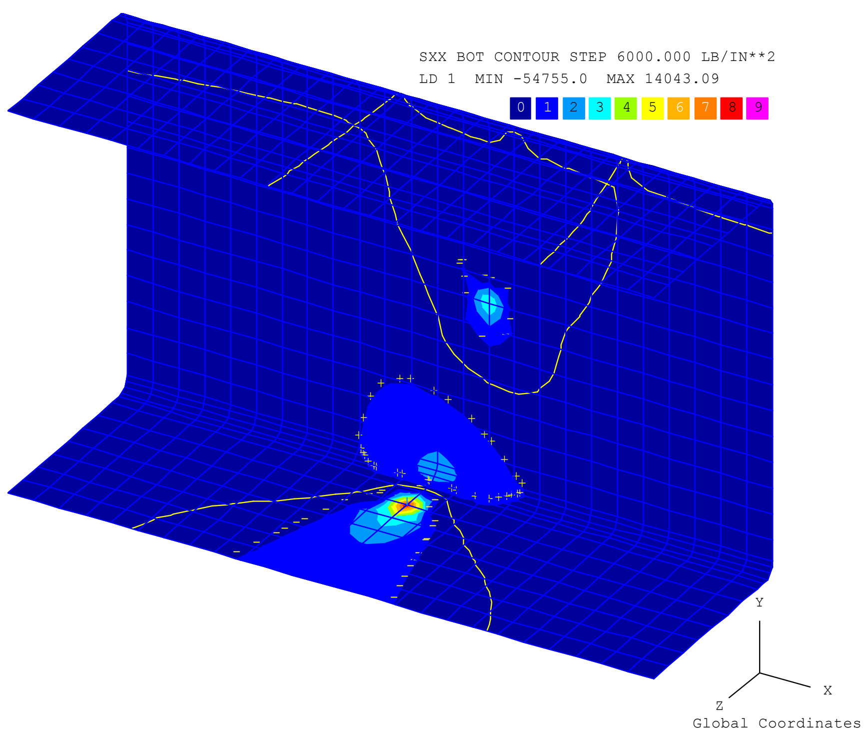


Figure 4.3-7 —SXX BOT Stress Diagram.

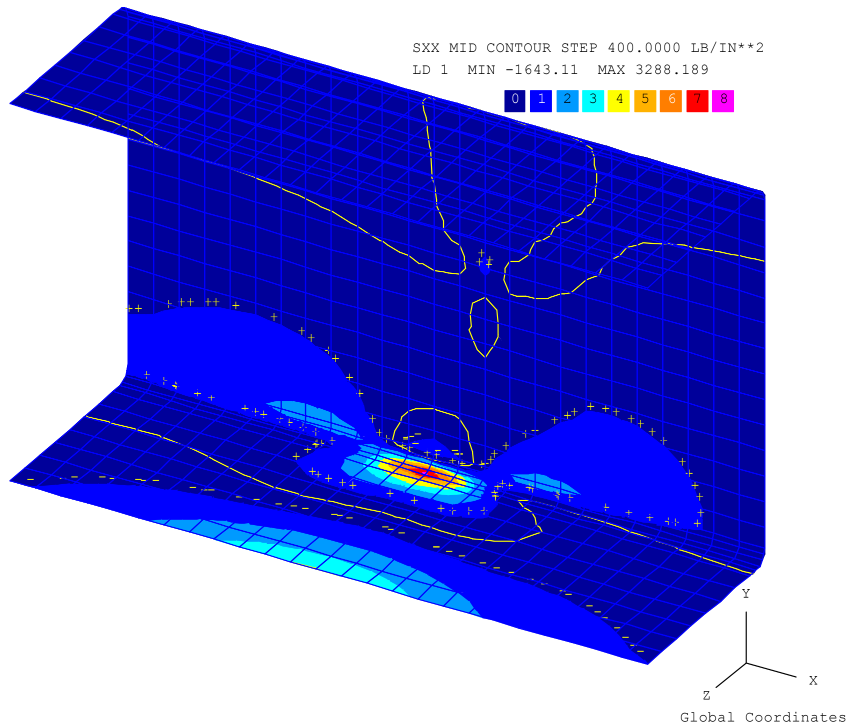


Figure 4.3-8 —SXX MID Stress Diagram.

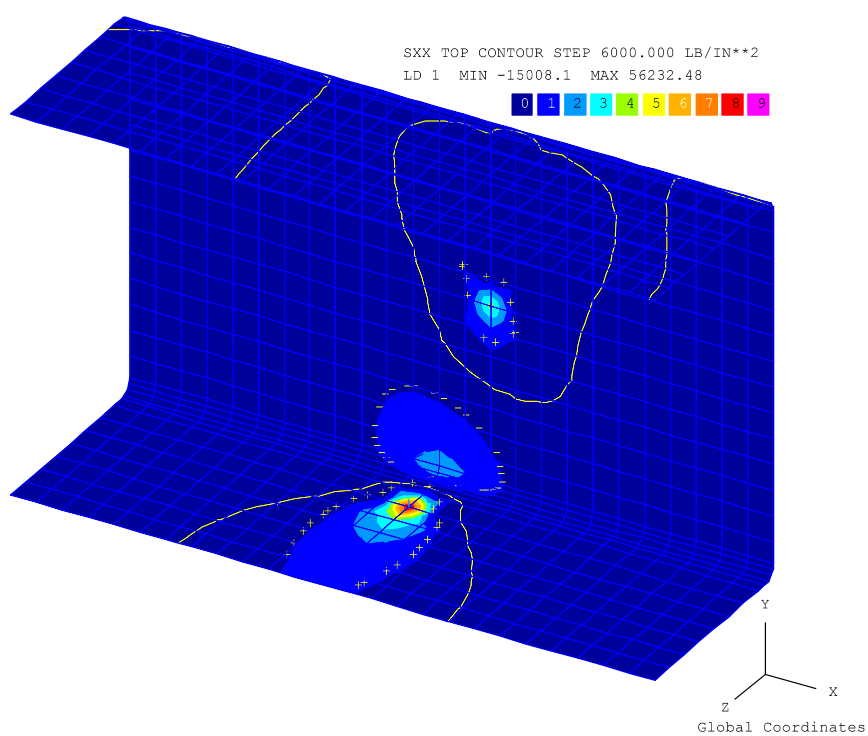


Figure 4.3-9 —SXX TOP Stress Diagram.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

Current design methods of the slip-track connection produce conservative results. In these methods, the stud flange width is used to compute the effective width of the track. Finite element analysis and test observations confirm that the stud flange rotates, thus acting like a point load on a plate; this is in contradiction to current design methods. The method presented in this paper results in a more economical design than current procedures.

The nominal capacities of the slip-track connection as well as the effective distribution width of the track can be described by the following equations:

$$b_{eff} = 0.11 \times \frac{e^{0.5}}{t^{1.5}} + 5.5 \le S\,, \tag{3.6-8}$$

and

$$P_n = \frac{b_{eff} \times t^2 \times F_y}{4 \times e}\,, \tag{3.6-6}$$

where:

P_n = Nominal capacity of the track leg in bending, kips,

b_{eff} = Effective distribution width of the track in bending, in.,

t = Nominal thickness of the track, in.,

F_y = Yield strength of track material, ksi,

e = Design slip gap, in.,

S = Stud spacing, in.

These equations are intended to be used with the following resistance factor and factors of safety:

Ω = 2.51 Factor of Safety (ASD)

and

ϕ = 0.61 Resistance Factor (LRFD).

A summary of the design example from Section 2.8 and 3.8 is shown in Table 5.1.

Table 5.1 — Summary of Design Examples.

Section / Method	b_{eff} (in.)	$t_{req'd}$ (in.)	Safety Factor (ASD)	Stress Increase for Wind
2.1 Army Corps of Engineers	8.55	0.0461	1.67	1.33
2.2 MSMA	8.55	0.0516	5/3	4/3
2.3 SSMA	8.55	0.0489	5/4	4/3
2.4 Design of Single Deep Leg Track to Accommodate Vertical Deflection by Rahman	8.55	0.0652	5/3	--
2.5 Behavior of Cold-Formed Steel Stud-to-Track Connections by Bolte	13.625	0.0432	2.62	--
2.6 Roark's Formulas for Stress and Strain	6.024	0.1269	5/3	--
2.7 Current Engineering Firms' Design Practices	5.625 - 8.55	0.0467 - 0.0569	5/3	4/3
3.8 Design Example of Proposed Design Procedure	15.22	0.0400	2.51	--

The proposed design procedure is more rational because it does not include any stress increase for wind. Section A5.1.3 of the 1996 AISI Specification [6] states that for load combinations which include wind loads, the resulting forces were permitted to be multiplied by 0.75, or a (4/3) stress increase. However, Section A4.1.2 in Appendix A of the 2001 AISI Specification [1] states that “the combined effects of two or more loads, excluding dead load, shall be permitted to be multiplied by 0.75.” For most conditions, the slip-track is designed to resist lateral loads only, so reducing the forces, or a stress increase is not allowed according the latest AISI Specification [1].

Displacements of the track at the stud location are excessive at the failure loads. When the safety factors are applied, the load is in the elastic range of the connection and as a result there is no permanent deflection of the slip-track.

The proposed design equations have been developed by testing the following parameters of this connection:

Stud Sections:

- Stud Flange Width: 1 5/8” – 2 1/2”.
- Nominal Depth: 3 5/8” – 6”.
- Stud Spacing: 12” – 24” inches on center.

Track Sections:

- Track Leg Length: 2” – 3”.
- Slip Gap: 1/8” and 1 1/4”.
- Base Metal Thickness: 0.0440” – 0.0713”.
- Yield Strength: 22.8 ksi – 46.7 ksi.
- Nominal Depth: 3 5/8” – 6”.

These design equations are not intended to be limited to the testing parameters. However, engineering judgment should be used to determine if the proposed design equations are valid for those connections outside the scope of the testing.

Recommendations for future testing to determine if factors outside the limits of this testing affect the nominal capacities are as follows:

- Stud Flange Width.
- Stud Depth.
- Stud Thickness.
- Track Thickness.
- Track Leg Lengths and Varying Slip Gaps.
- Additional Studies Should be Directed Towards Deflection Limitations of this Connection.

REFERENCES

[1] American Iron and Steel Institute. 2001. *North American Specification for the Design of Cold-Formed Steel Structural Members.* AISI Standard, 2001 Edition. Washington, DC: AISI.

[2] U.S. Army Corps of Engineers. July 1992. *Masonry Veneer/Steel Stud Walls (Nonbearing Construction).* Engineering Technical Letter 1110-3-439. Washington, DC: U.S. Army Corps of Engineers.

[3] U.S. Army Corps of Engineers, Engineering and Construction Division. November 1998. *Design of Cold-Formed Load Bearing Steel Systems and Masonry Veneer / Steel Stud Walls*. Technical Instructions TI 809-07. Washington, DC: U.S. Army Corps of Engineers.

[4] Metal Stud Manufacturers Association. March 1998. "Single Deflection Track Selection." *Construction Dimensions*, pp. 66-73.

[5] Steel Stud Manufacturers Association. January 2000. "Single Deflection Track Selection." Technical Note 1.

[6] American Iron and Steel Institute. 1996. *Specification for the Design of Cold-Formed Steel Structural Members*. AISI Standard, 1996 Edition. Washington, DC: AISI.

[7] Rahman, N. A. March 2003. "Design of Single Deep Leg Track to Accommodate Vertical Deflections." Raleigh, NC: The Steel Network, Inc.

[8] International Code Council. 2000. *International Building Code.* ICC Standard, 2000 Edition. Virginia: ICC.

[9] International Conference of Building Officials. 1997. *Uniform Building Code:* ICB Standard, 1997 Edition. California: International Conference of Building Officials.

[10] American Iron and Steel Institute. 2002. *Cold-Formed Steel Framing Design Guide.* AISI Design Guide CF02-1. Washington, DC: AISI.

[11] Bolte, William G. 2003. "Behavior of Cold-Formed Steel Stud-to-Track Connections" Master's Thesis, University of Missouri-Rolla.

[12] Roark, R. J., W. C. Young, and R. G. Budynas. 2001. *Roark's Formulas for Stress and Strain.* 7th ed. New York, NY: McGraw-Hill.

[13] Timoshenko, S. and S. Woinowski-Kreiger. 1959. *Theory of Plates and Shells.* 2nd Ed. New York, NY: McGraw-Hill.

[14] ASTM International. 1997. *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*. Designation: A370-97. West Conshohocken, PA: ASTM International.

[15] American Iron and Steel Institute. 2001, *Commentary on North American Specification for the Design of Cold-Formed Steel Structural Members*: AISI Standard, 2001 Edition. Washington, DC.

[16] GT STRUDL. February 1994. *Integrated CAE System for Structural Engineering Analysis and Design* (Revision 26). [Computer program]. *Available*: Computer Aided Structural Engineering Center, School of Civil and Environmental Engineering, Georgia Institute of Technology, Atlanta, Georgia 30332-0355.

BIBLIOGRAPHY

American Society for Civil Engineers. 2002. *Accommodating Building Deflections.* ASCE-SEI Committee on Cold-Formed Steel.

American Society for Civil Engineers. April 2003. “Accommodating Building Deflections.” *Structure Magazine*, pp. 16-18.

Steel Stud Manufacturers Association. April 2000. “Track Within a Track Deflection Assembly.” Technical Note 3.

APPENDIX A

Specimen Material Tests

MSOE Slip Track Test Material Properties
Material Property Tests

DDG/TJL
January 2002

Specimens fabricated 01/04/02

Tested by TJL of DDG, Hammond, IN

Specimens	Gauge	Design Thickness (in)	Minimum Delivered Thickness (in)	Coupon ID	Thickness (in)*	0.2% Yield (ksi)	Ultimate (ksi)	2-in Elongation (%)	Test Date	Comments
16-05-1-14-X	14	0.0713	0.0677	1	0.0709	37.9	46.9	32	1/29/2002	
16-05-2-14-X				2	0.0708	39.3	47.1	35		
24-05-1-14-X				3	0.0582	43.3	48.3	32		thin for 14-gauge **
24-05-2-14-X				Average (1&2)	0.0709	38.6	47.0	33.5		
				Std. Dev. (1&2)	0.0001	0.99	0.14	2.12		
16-05-1-16-X	16	0.0566	0.0538	1	0.0566	44.3	50.3	32	1/29/2002	
16-05-2-16-X				2	0.0568	45.9	49.3	35		
24-05-1-16-X				3	0.0569	43.2	48.6	36		
24-05-2-16-X				Average	0.0568	44.5	49.4	34.3		
				Std. Dev.	0.0002	1.36	0.85	2.08		
16-05-1-18-X	18	0.0451	0.0428	1	0.0463	40.4	50.9	26	1/29/2002	
16-05-2-18-X				2	0.0464	39.6	51.7	28		
24-05-1-18-X				3	0.0464	38.2	49.2	22		
24-05-2-18-X				Average	0.0464	39.4	50.6	25.3		
				Std. Dev.	0.0001	1.11	1.28	3.06		
16-10-1-14-X	14	0.0713	0.0677	1	0.0715	40.9	47.1	55	1/4/2002	
16-10-2-14-X				2	0.0711	40.5	47	52		
24-10-1-14-X				3	0.0712	40.5	46.9	54		
24-10-2-14-X				Average	0.0713	40.6	47.0	53.7		
				Std. Dev.	0.0002	0.23	0.10	1.53		
16-10-1-16-X	16	0.0566	0.0538	1	0.0444	23.5	43.5	37	1/29/2002	thin for 16-gauge***
16-10-2-16-X				2	0.0476	37.9	48.6	22		thin for 16-gauge
24-10-1-16-X				3	0.0478	39.3	48.7	28		thin for 16-gauge
24-10-2-16-X				Average	0.0466	33.6	46.9	29.0		
				Std. Dev.	0.0019	8.75	2.97	7.55		
16-10-1-18-X	18	0.0451	0.0428	1	0.0441	23	44.1	45	1/29/2002	
16-10-2-18-X				2	0.0436	22.8	43.9	43		
24-10-1-18-X				3	0.0442	22.6	43.8	44		
24-10-2-18-X				Average	0.0440	22.8	43.9	44.0		
				Std. Dev.	0.0003	0.20	0.15	1.00		

* Measured thickness of base metal after removing galvanized coating.
** The thickness of this coupon suggests that it is 16-gauge, not 14-gauge material...
*** The thickness of these coupons suggests that they may be 18-gauge material, not 16-gauge material...

Tested with Tinius-Olsen Universal Testing Machine (60,000 lb ElectoMatic)

MSOE Slip Track Test Material Properties DDG/TJL

3 5/8-in TSE 18-ga Track Specimens September/October 2002

Material shipped from Jame Gerloff, CSD from slip track test program at MSOE.
Material included both test coupons (E8) and lengths of previously tested track.

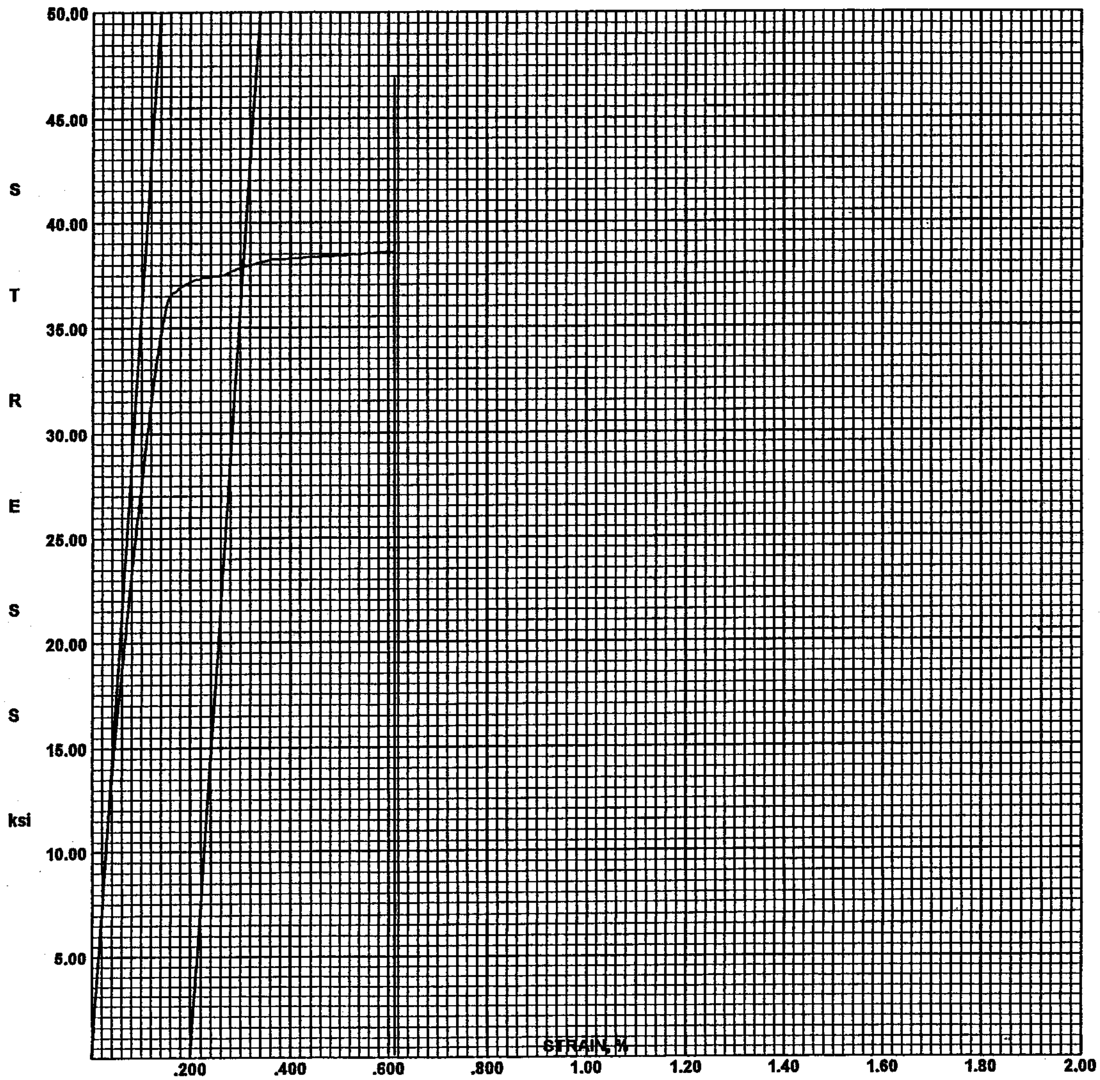
Specimen ID	Coupon ID	thickness (in)	0.2% Yield (ksi)	Ultimate (ksi)	2-in Elongation (%)
E8	1	0.0437	25.9	45.5	37
E8	2	0.0438	24.8	45.5	37
E8	3	0.0436	23.5	45.8	42
	Average	0.0437	24.7	45.6	38.7
	Std. Dev.	0.0001	1.20	0.17	2.89
16-10-2-18-1	1	0.0438	26.2	45.4	45
(9/20/02)	2	0.0440	24.0	45.5	45
	3	0.0438	26.3	45.4	45
16-10-2-18-1	1	0.0441	25.0	45.0	38
(10/10/02)	2	0.0441	25.9	45.6	37
	3	0.0442	23.7	45.2	37
16-10-1-18-2	1	0.0438	26.3	46.0	42
(9/20/02)	2	0.0446	24.6	44.3	45
	3	0.0438	25.4	45.8	49
16-10-1-18-2	1	0.0442	25.4	44.5	42
(10/10/02)	2	0.0439	23.1	45.2	43
	3	0.0442	24.3	45.2	43
16-10-2-18-2	1	0.0436	25.7	45.4	45
(9/20/02)	2	0.0440	25.0	45.3	43
	3	0.0440	25.5	45.4	44
16-10-2-18-2	1	0.0442	23.5	45.4	40
(10/10/02)	2	0.0442	23.8	45.9	45
	3	0.0442	27.3	46.1	44
16-10-1-18-3	1	0.0437	26.5	44.8	44
(9/20/02)	2	0.0434	26.4	46.2	46
	3	0.0433	24.3	46.7	47
16-10-1-18-3	1	0.044	25.1	45.4	38
(10/10/02)	2	0.0435	24.3	45.6	43
	3	0.0438	24.3	46.0	40
	Average	0.0439	25.1	45.5	43
	Std. Dev.	0.0003	1.11	0.54	3.16

All Specimens	thickness (in)	0.2% Yield (ksi)	Ultimate (ksi)	2-in Elongation (%)
Average	**0.0439**	**25.0**	**45.5**	**42.4**
Std. Dev.	0.0003	1.10	0.51	3.37
Minimum	0.0433	23.1	44.3	37.0
Maximum	0.0446	27.3	46.7	49.0

Notes:
Design thickness of 18-gage material is 0.0451-in
Minimum Delivered thickness of 18-gage material is 0.0428-in

Previous test results of SE 18 Track Specimens (January 2002):

Specimen ID	Coupon ID	thickness (in)	0.2% Yield (ksi)	Ultimate (ksi)	2-in Elongation (%)
TSE 18	1	0.0441	23	44.1	45
TSE 18	2	0.0436	22.8	43.9	43
TSE 18	3	0.0442	22.6	43.8	44
	Average	0.0440	22.8	43.9	44.0
	Std. Dev.	0.0003	0.20	0.15	1.00

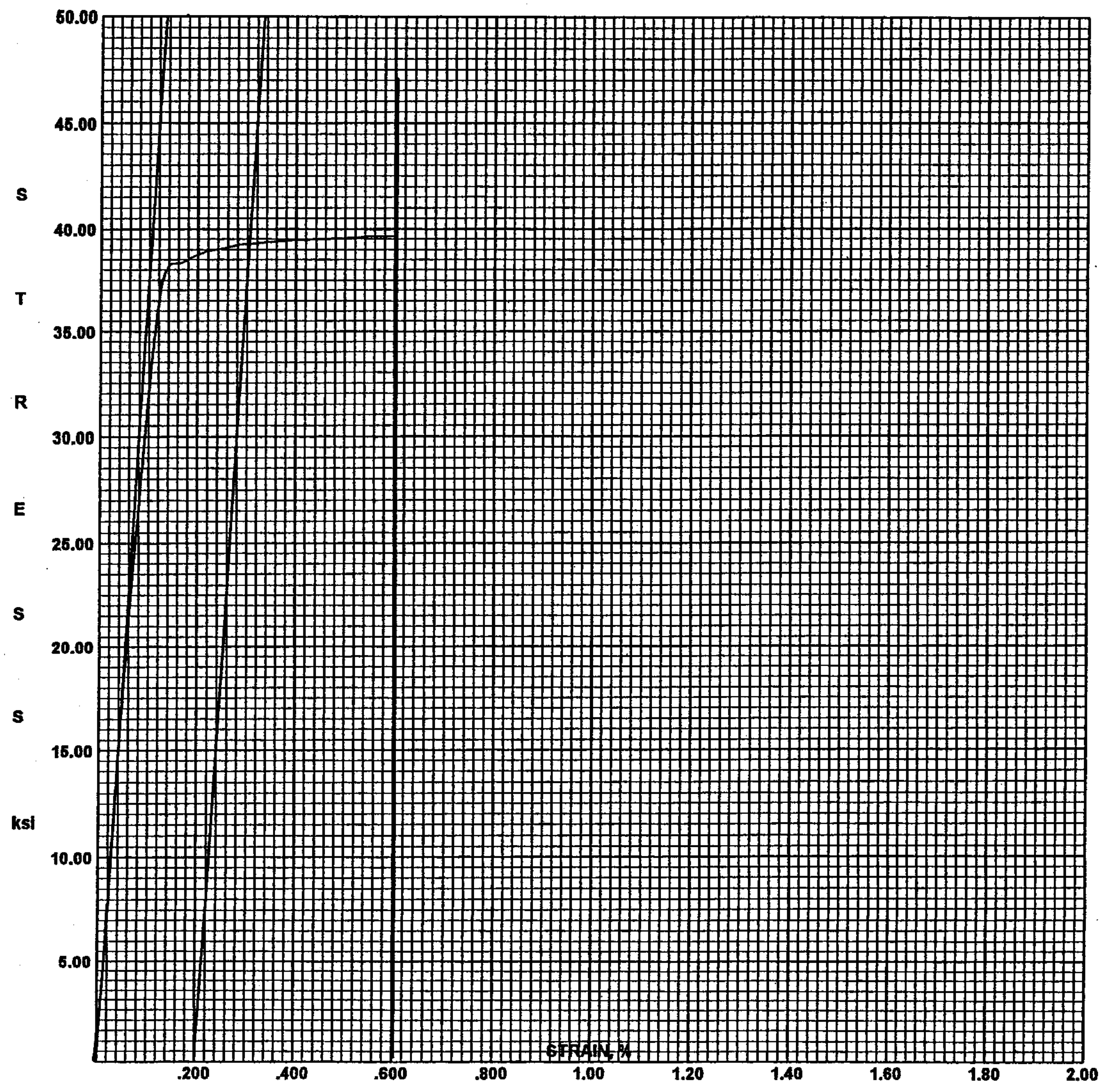


Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	14
<Not Defined>:	
Print Date:	January 29,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>
Bundle ID :	
Coupon No :	**TSC14-a**
Thk, in:	**0.0709**
CS Area, in²:	**0.0354**
OFS @ 0.2, lbf:	**1343**
Ultimate, lbf:	**1661**
Elapsed, sec:	**83.2**
OFS @ 0.2, ksi:	**37.9**
Ultimate, ksi:	**46.9**
TE (Man), %:	**32**

Specimen Break
Jan 29, 2002 4:28:01 PM

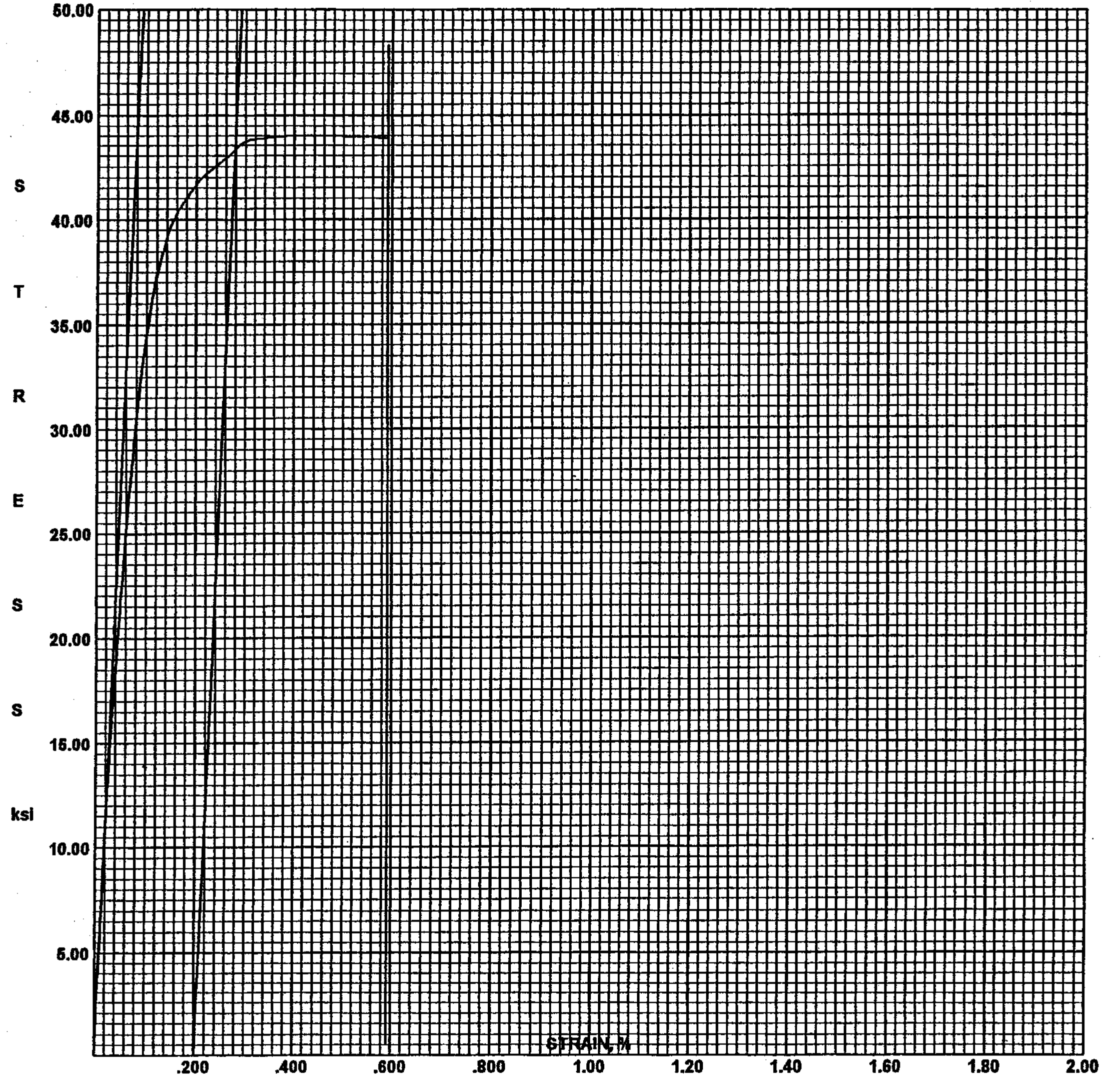


Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	14
<Not Defined>:	
Print Date:	January 29,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>
Bundle ID :	
Coupon No :	**TSC14-b**
Thk, in:	**0.0708**
CS Area, in²:	**0.0354**
OFS @ 0.2, lbf:	**1390**
Ultimate, lbf:	**1667**
Elapsed, sec:	**76.6**
OFS @ 0.2, ksi:	**39.3**
Ultimate, ksi:	**47.1**
TE (Man), %:	**35**

Specimen Break
Jan 29, 2002 4:32:24 PM



Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	14
<Not Defined>:	
Print Date:	January 29,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>

Bundle ID :	
Coupon No :	**TSC14-c**
Thk, in:	**0.0582**
CS Area, in²:	**0.0291**
OFS @ 0.2, lbf:	**1259**
Ultimate, lbf:	**1406**
Elapsed, sec:	**59.8**
OFS @ 0.2, ksi:	**43.3**
Ultimate, ksi:	**48.3**
TE (Man), %:	**32**

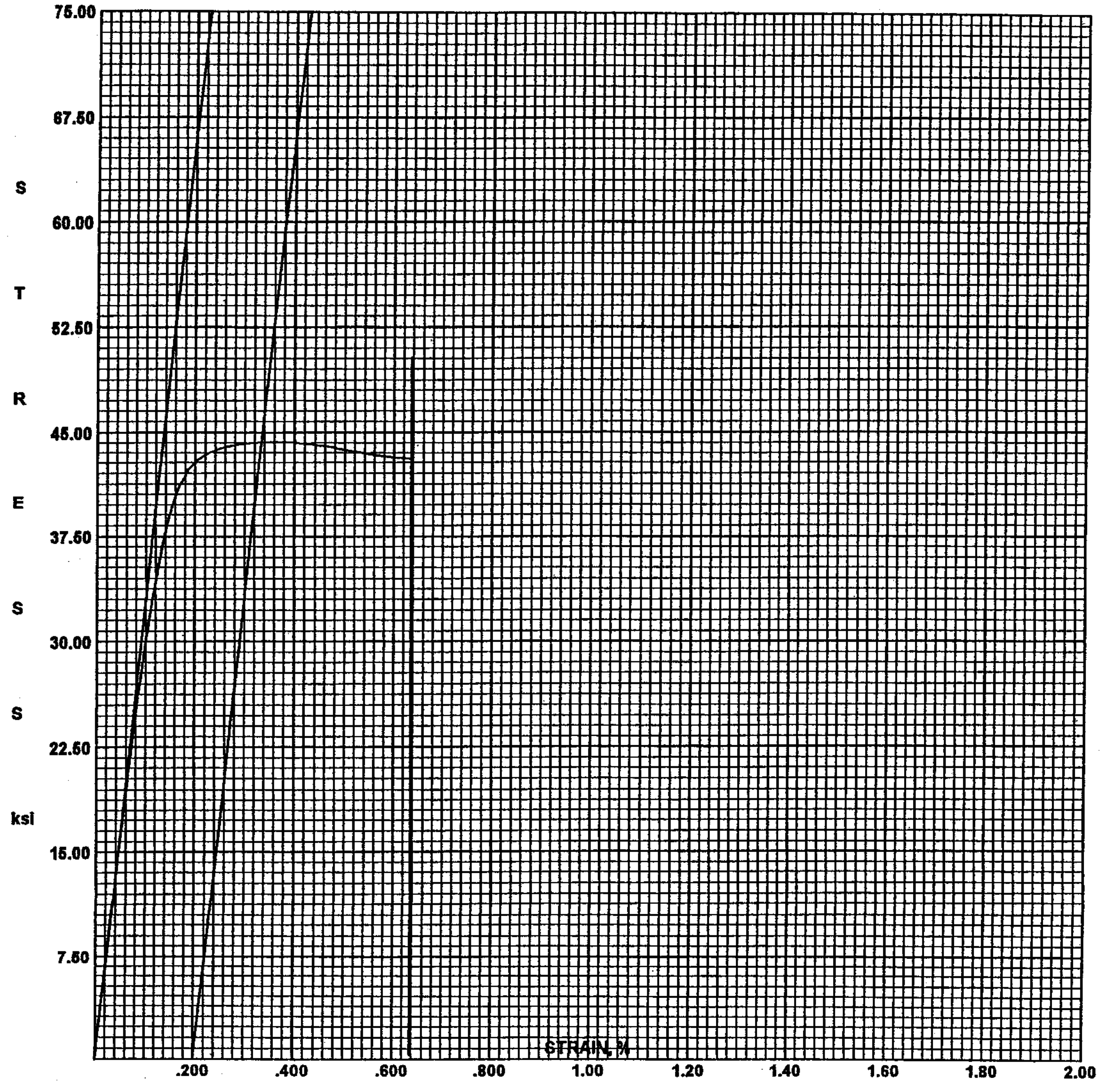
Specimen Break
Jan 29, 2002 4:34:37 PM

Dietrich Industries
Hammond, IN
Test Report
E8 ASTM Report

Test Performed By: LAWSON
Section Type: MSOE TRACK
Depth: 3 5/8
Gage: 16
<Not Defined>:

Print Date: January 30,2002
Load Range: 30000 lbf
Inst GL/Max: 2 in/4 %
X-Axis Ranges: 2 %/<Removed>

Bundle ID	Coupon No	Thk in	CS Area in²	OFS @ 0.2 lbf	Ultimate lbf	Elapsed sec	OFS @ 0.2 ksi	Ultimate ksi	TE (Man) %
	TSC16-A	0.0566	0.0283	1252	1422	79.2	44.3	50.3	32
TSC16-A	2	0.0568	0.0284	1302	1400	68.3	45.9	49.3	35
TSC16-A	3	0.0569	0.0284	1229	1382	69.7	43.2	48.6	36
Ave.							44.5	49.4	34.3
SD							1.358	0.866	2.08

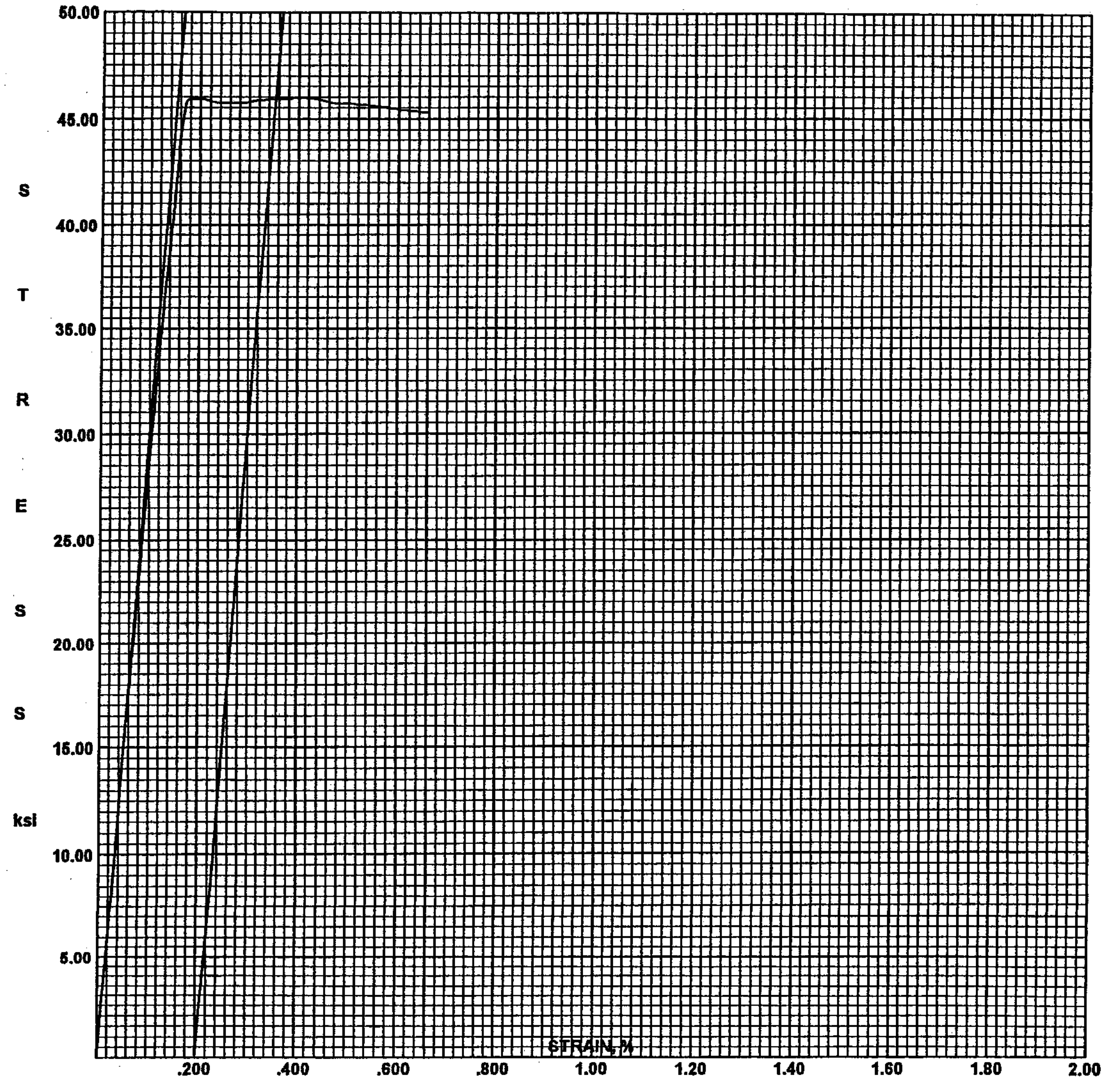


Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	16
<Not Defined>:	
Print Date:	January 30,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>
Bundle ID :	
Coupon No :	**TSC16-A**
Thk, in:	**0.0566**
CS Area, in²:	**0.0283**
OFS @ 0.2, lbf:	**1252**
Ultimate, lbf:	**1422**
Elapsed, sec:	**79.2**
OFS @ 0.2, ksi:	**44.3**
Ultimate, ksi:	**50.3**
TE (Man), %:	**32**

Specimen Break
Jan 30, 2002 2:46:13 PM

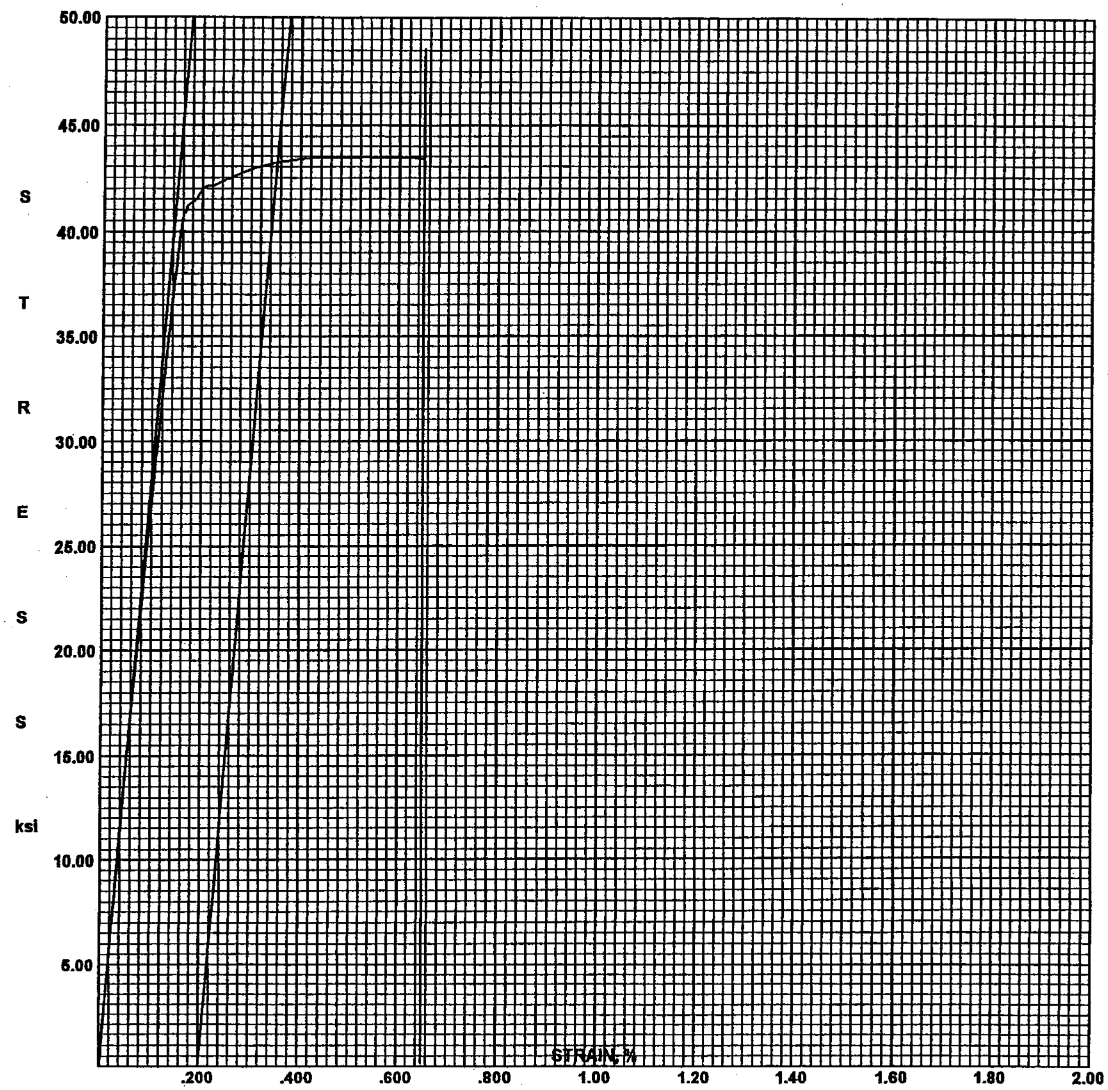


Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	16
<Not Defined>:	
Print Date:	January 30,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>
Bundle ID :	**TSC16-A**
Coupon No :	**2**
Thk, in:	**0.0568**
CS Area, in²:	**0.0284**
OFS @ 0.2, lbf:	**1302**
Ultimate, lbf:	**1400**
Elapsed, sec:	**68.3**
OFS @ 0.2, ksi:	**45.9**
Ultimate, ksi:	**49.3**
TE (Man), %:	**35**

Specimen Break
Jan 30, 2002 2:50:19 PM



Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	16
<Not Defined>:	
Print Date:	January 30,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>

Bundle ID :	**TSC16-A**
Coupon No :	**3**
Thk, in:	**0.0569**
CS Area, in²:	**0.0284**
OFS @ 0.2, lbf:	**1229**
Ultimate, lbf:	**1382**
Elapsed, sec:	**69.7**
OFS @ 0.2, ksi:	**43.2**
Ultimate, ksi:	**48.6**
TE (Man), %:	**36**

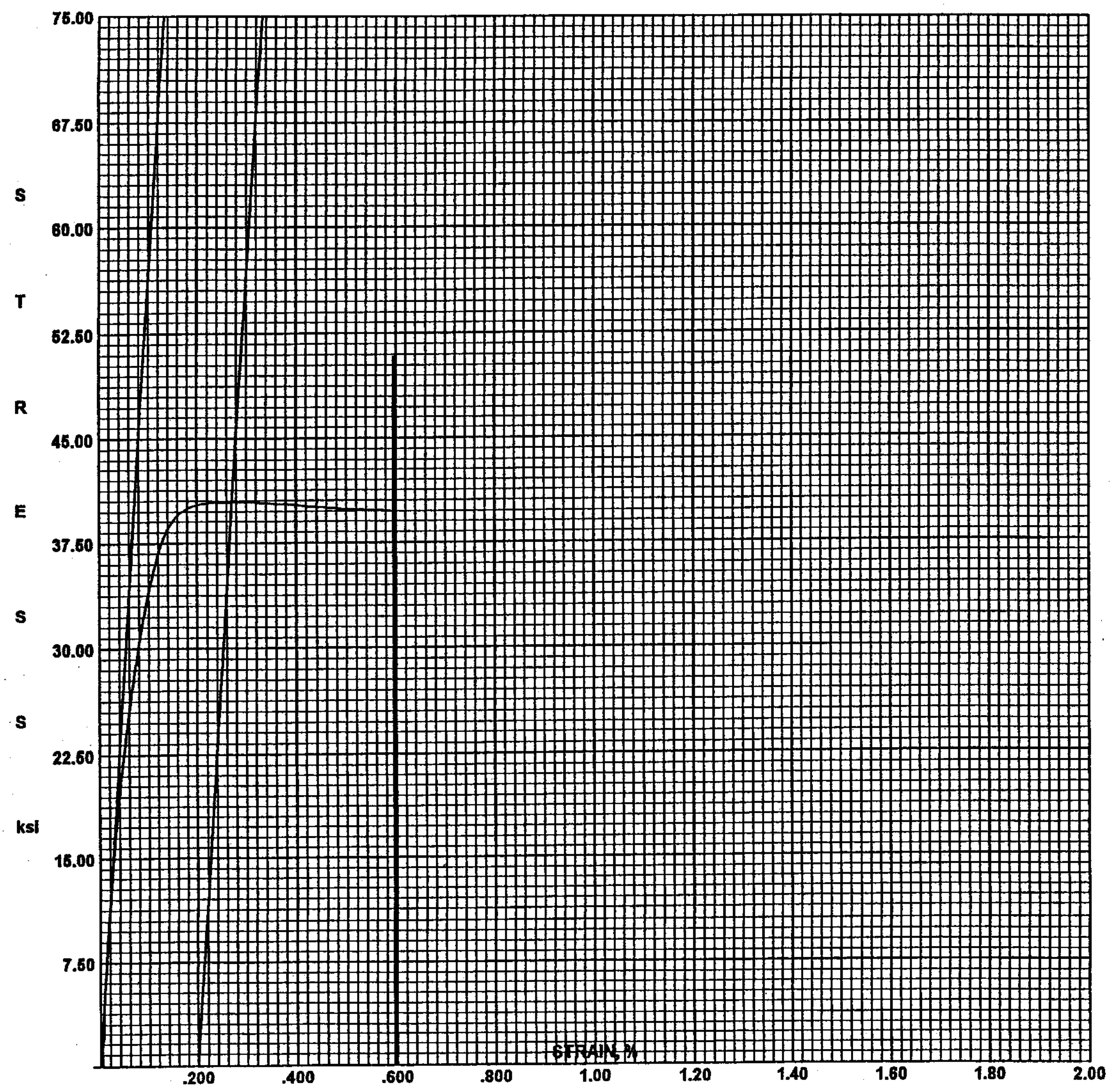
Specimen Break
Jan 30, 2002 2:52:57 PM

Dietrich Industries
Hammond, IN
Test Report
E8 ASTM Report

Test Performed By: LAWSON
Section Type: MSOE TRACK
Depth: 3 5/8
Gage: 16
<Not Defined>:

Print Date: January 30,2002
Load Range: 30000 lbf
Inst GL/Max: 2 in/4 %
X-Axis Ranges: 2 %/<Removed>

Bundle ID	Coupon No	Thk in	CS Area in²	OFS @ 0.2 lbf	Ultimate lbf	Elapsed sec	OFS @ 0.2 ksi	Ultimate ksi	TE (Man) %
TSC 18	1	0.0463	0.0232	935	1178	66.8	40.4	50.9	26
TSC 18	2	0.0464	0.0232	919	1202	87.2	39.6	51.7	28
TSC 18	3	0.0464	0.0232	885	1141	67.4	38.2	49.2	22
Ave.							39.4	50.6	25.3
SD							1.122	1.279	3.06

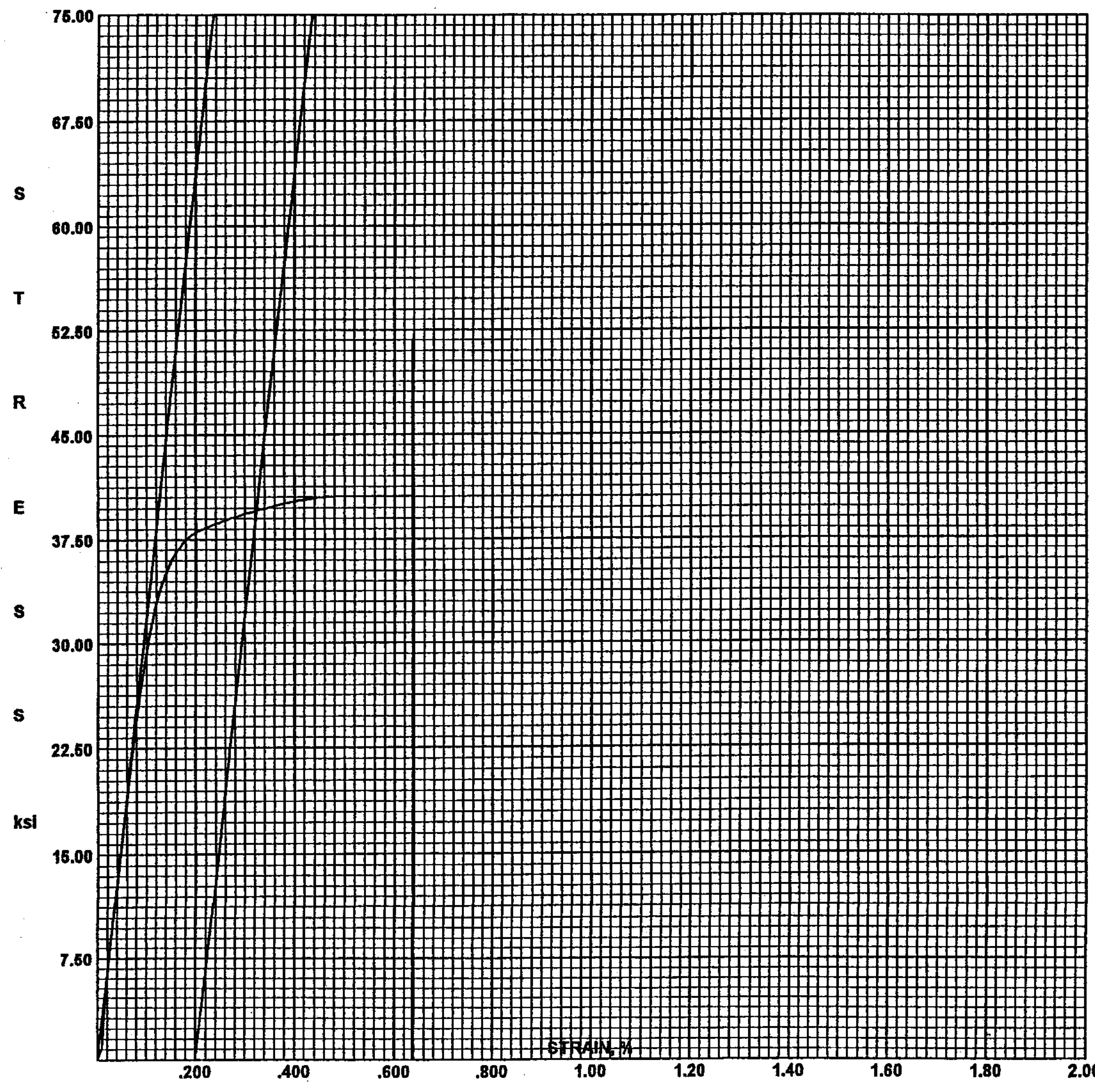


Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	16
<Not Defined>:	
Print Date:	January 30,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>
Bundle ID :	**TSC 18**
Coupon No :	**1**
Thk, in:	**0.0463**
CS Area, in²:	**0.0232**
OFS @ 0.2, lbf:	**935**
Ultimate, lbf:	**1178**
Elapsed, sec:	**66.8**
OFS @ 0.2, ksi:	**40.4**
Ultimate, ksi:	**50.9**
TE (Man), %:	**26**

Specimen Break
Jan 30, 2002 3:21:42 PM

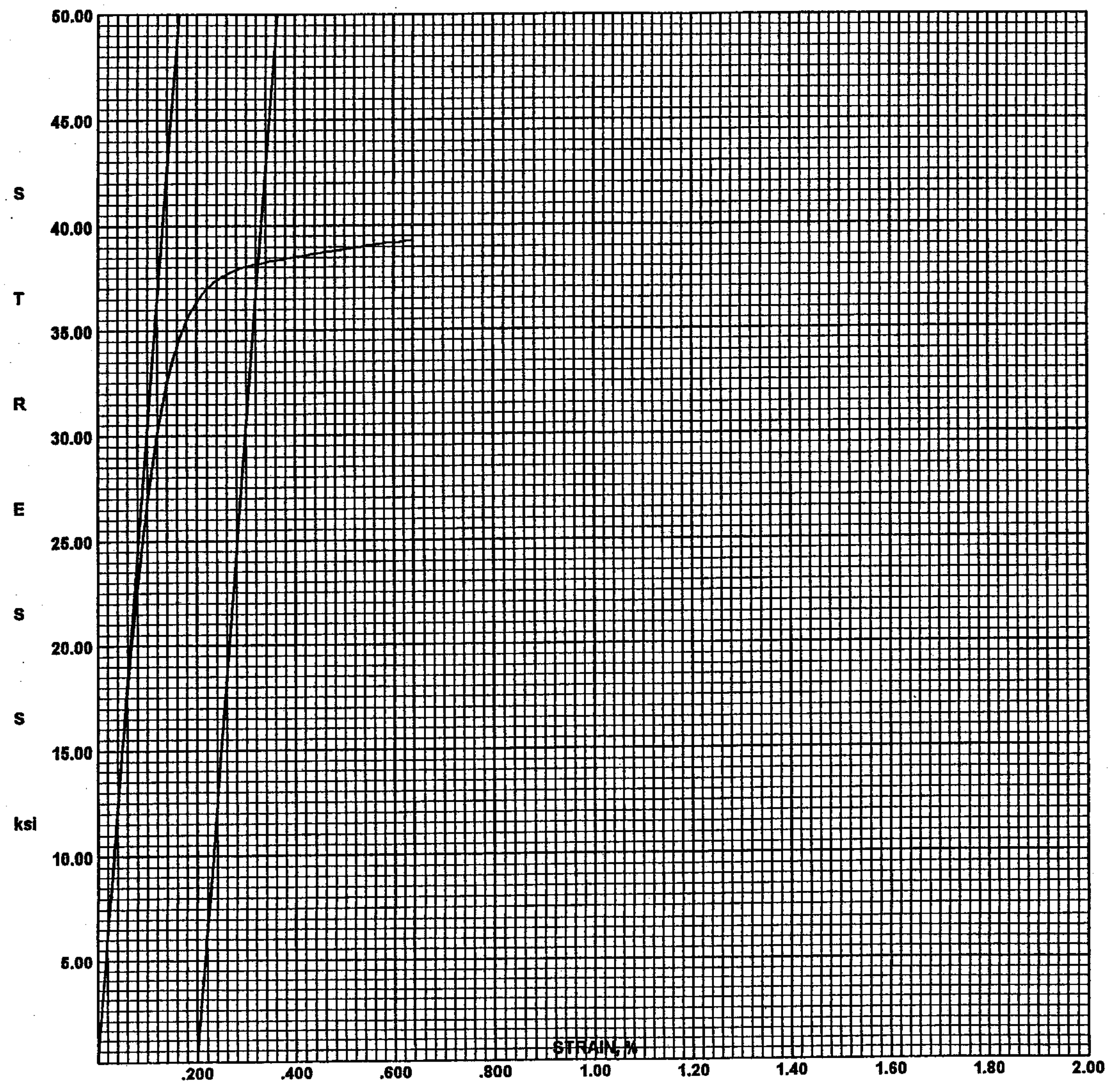


Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	16
<Not Defined>:	
Print Date:	January 30,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>
Bundle ID :	**TSC 18**
Coupon No :	**2**
Thk, in:	**0.0464**
CS Area, in²:	**0.0232**
OFS @ 0.2, lbf:	**919**
Ultimate, lbf:	**1202**
Elapsed, sec:	**87.2**
OFS @ 0.2, ksi:	**39.6**
Ultimate, ksi:	**51.7**
TE (Man), %:	**28**

Specimen Break
Jan 30, 2002 3:23:50 PM

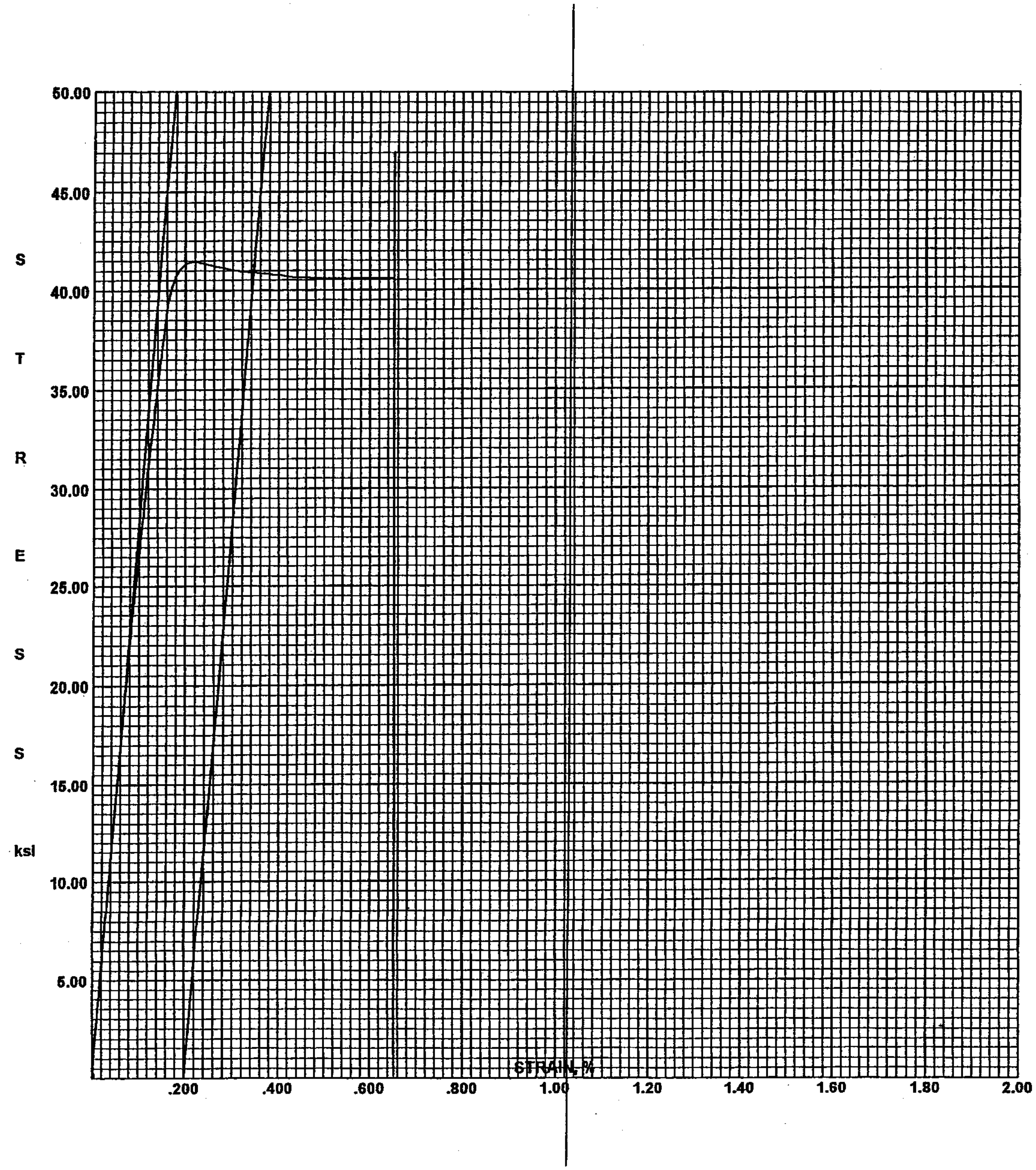


Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	16
<Not Defined>:	
Print Date:	January 30,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>
Bundle ID :	**TSC 18**
Coupon No :	**3**
Thk, in:	**0.0464**
CS Area, in²:	**0.0232**
OFS @ 0.2, lbf:	**885**
Ultimate, lbf:	**1141**
Elapsed, sec:	**67.4**
OFS @ 0.2, ksi:	**38.2**
Ultimate, ksi:	**49.2**
TE (Man), %:	**22**

Specimen Break
Jan 30, 2002 3:26:45 PM

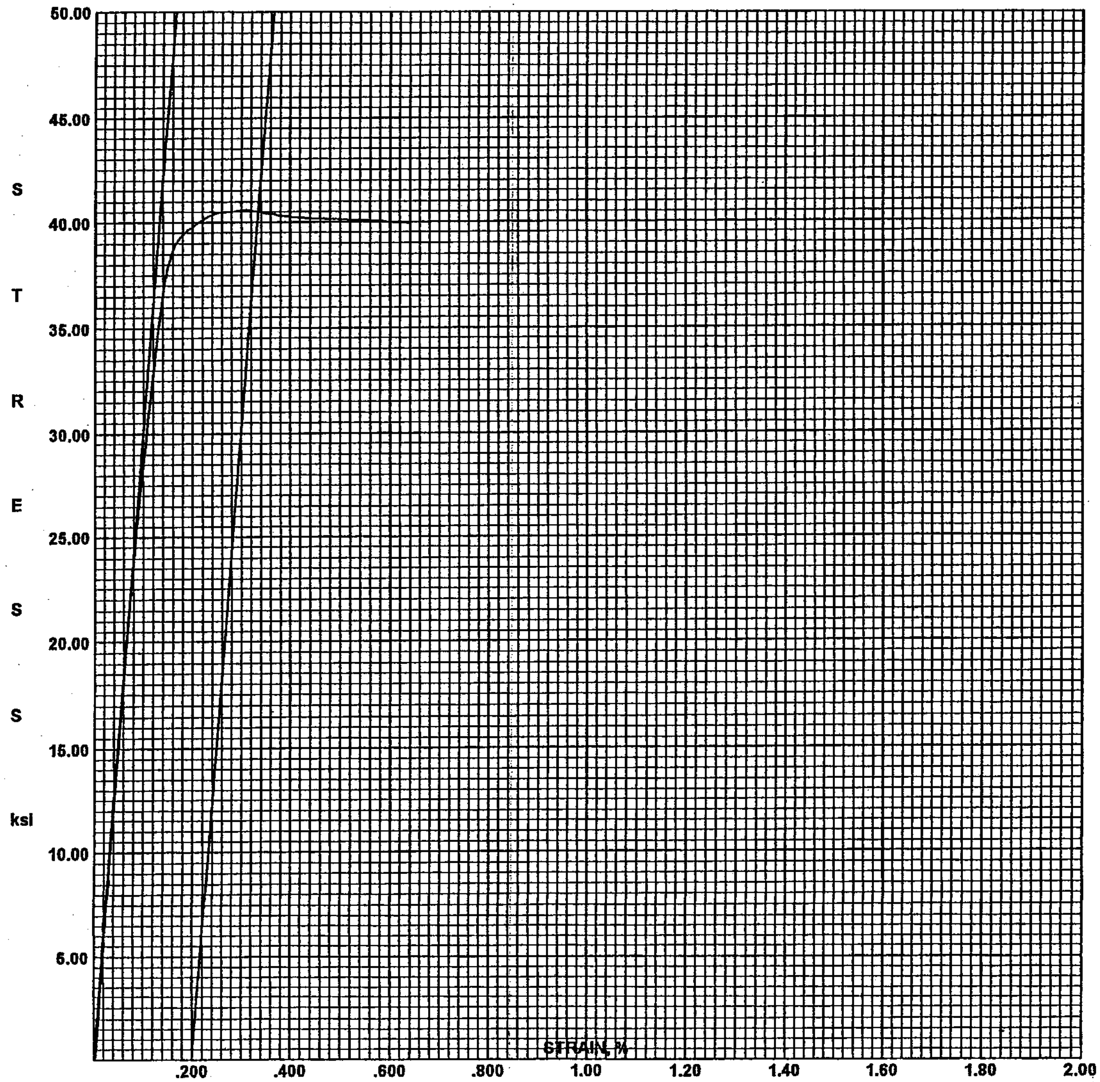


Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	14
<Not Defined>:	
Print Date:	January 4,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>
Bundle ID :	
Coupon No :	**TSE14-a**
Thk, in:	**0.0715**
CS Area, in²:	**0.0358**
OFS @ 0.2, lbf:	**1462**
Ultimate, lbf:	**1682**
Elapsed, sec:	**87.2**
OFS @ 0.2, ksi:	**40.9**
Ultimate, ksi:	**47.1**
TE (Man), %:	**55**

Specimen Break
Jan 4, 2002 3:31:18 PM

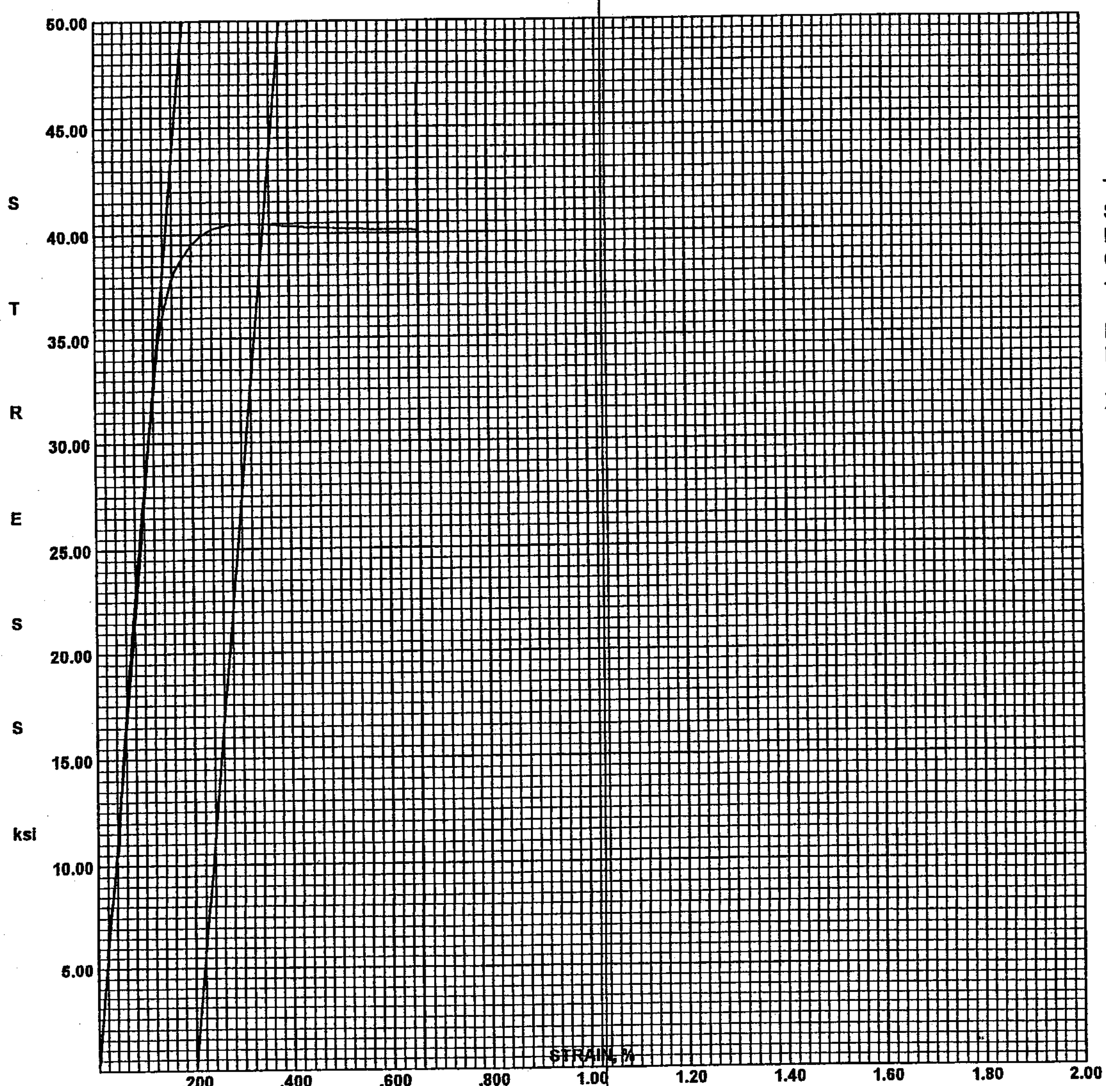


Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	14
<Not Defined>:	
Print Date:	January 4,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>
Bundle ID :	
Coupon No :	**TSE14-b**
Thk, in:	**0.0711**
CS Area, in²:	**0.0356**
OFS @ 0.2, lbf:	**1440**
Ultimate, lbf:	**1671**
Elapsed, sec:	**159.9**
OFS @ 0.2, ksi:	**40.5**
Ultimate, ksi:	**47**
TE (Man), %:	**52**

Specimen Break
Jan 4, 2002 3:38:30 PM



Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	14
<Not Defined>:	
Print Date:	January 4,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>
Bundle ID :	
Coupon No :	**TSE14-c**
Thk, in:	**0.0712**
CS Area, in²:	**0.0356**
OFS @ 0.2, lbf:	**1441**
Ultimate, lbf:	**1670**
Elapsed, sec:	**136.6**
OFS @ 0.2, ksi:	**40.5**
Ultimate, ksi:	**46.9**
TE (Man), %:	**54**

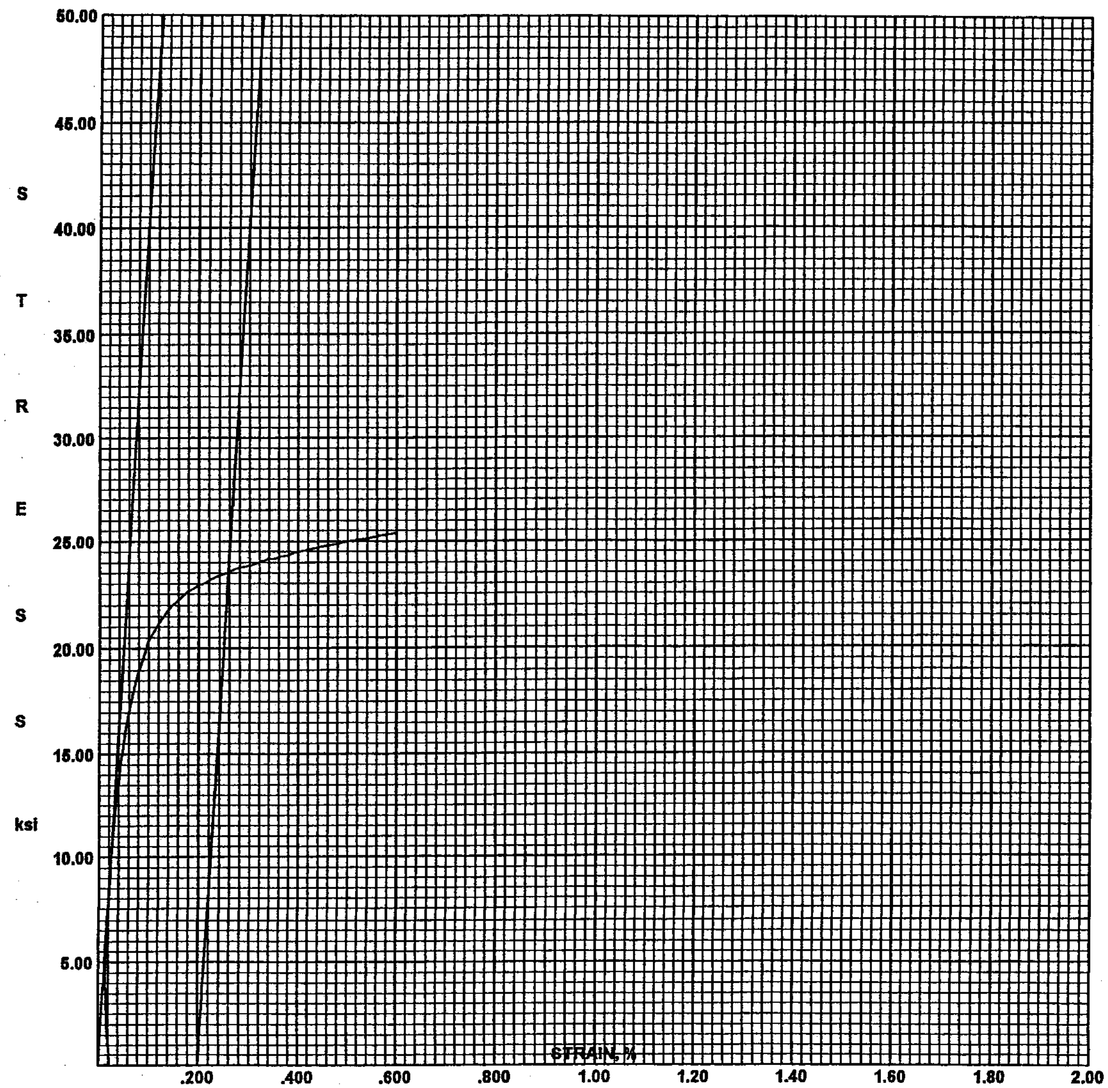
Specimen Break
Jan 4, 2002 3:41:42 PM

Dietrich Industries
Hammond, IN
Test Report
E8 ASTM Report

Test Performed By: LAWSON
Section Type: MSOE TRACK
Depth: 3 5/8
Gage: 16
<Not Defined>:

Print Date: January 30,2002
Load Range: 30000 lbf
Inst GL/Max: 2 in/4 %
X-Axis Ranges: 2 %/<Removed>

Bundle ID	Coupon No	Thk in	CS Area in²	OFS @ 0.2 lbf	Ultimate lbf	Elapsed sec	OFS @ 0.2 ksi	Ultimate ksi	TE (Man) %
TSE16	1	0.0444	0.0222	522	965	75.1	23.5	43.5	37
TSE16	2	0.0476	0.0238	904	1158	64.4	37.9	48.6	22
TSE16	3	0.0478	0.0239	941	1165	60.5	39.3	48.7	28
Ave.							33.6	46.9	29
SD							8.74	2.95	7.55

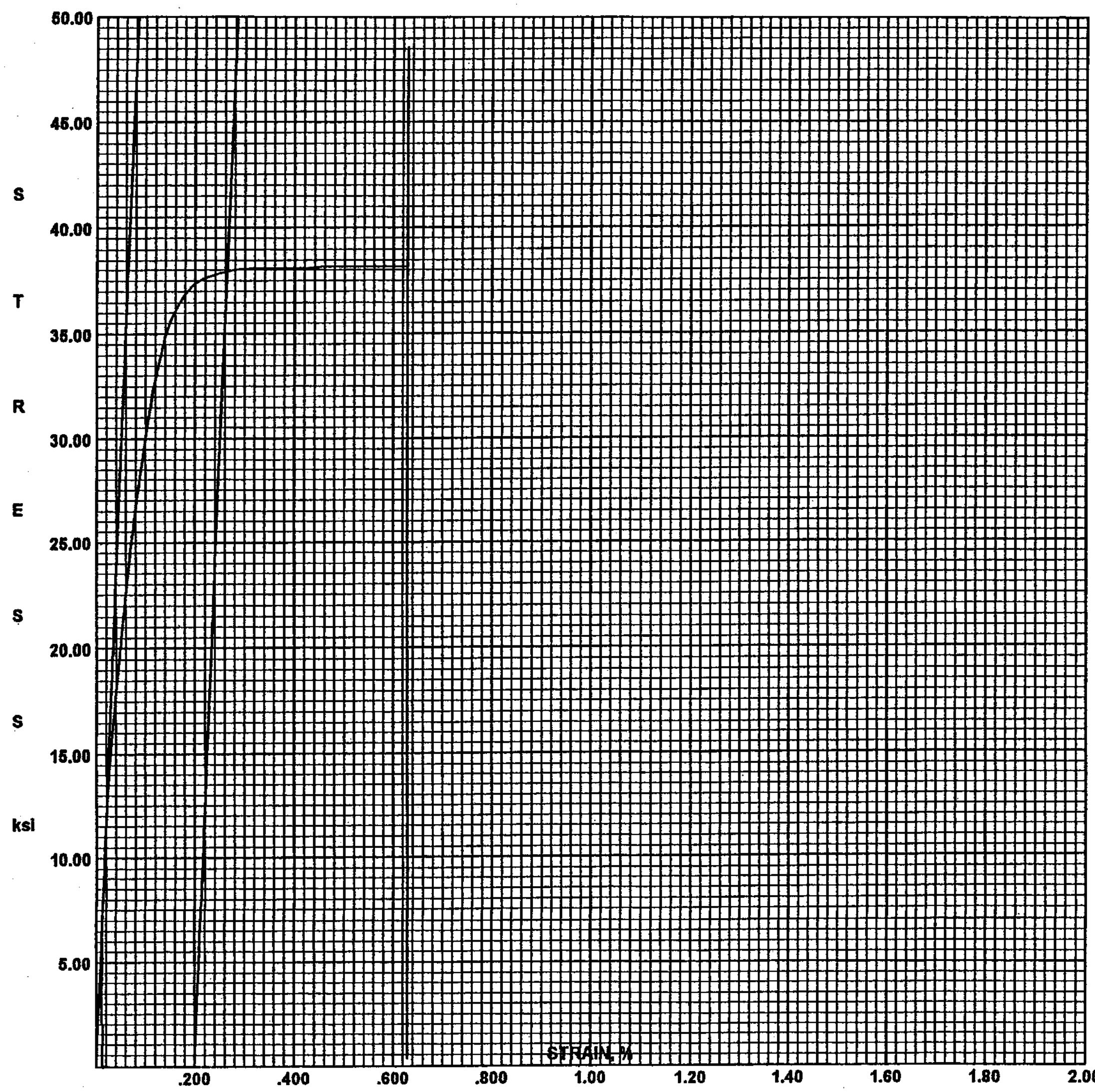


Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	16
<Not Defined>:	
Print Date:	January 30,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>
Bundle ID :	**TSE16**
Coupon No :	**1**
Thk, in:	**0.0444**
CS Area, in²:	**0.0222**
OFS @ 0.2, lbf:	**522**
Ultimate, lbf:	**965**
Elapsed, sec:	**75.1**
OFS @ 0.2, ksi:	**23.5**
Ultimate, ksi:	**43.5**
TE (Man), %:	**37**

Specimen Break
Jan 30, 2002 3:10:16 PM

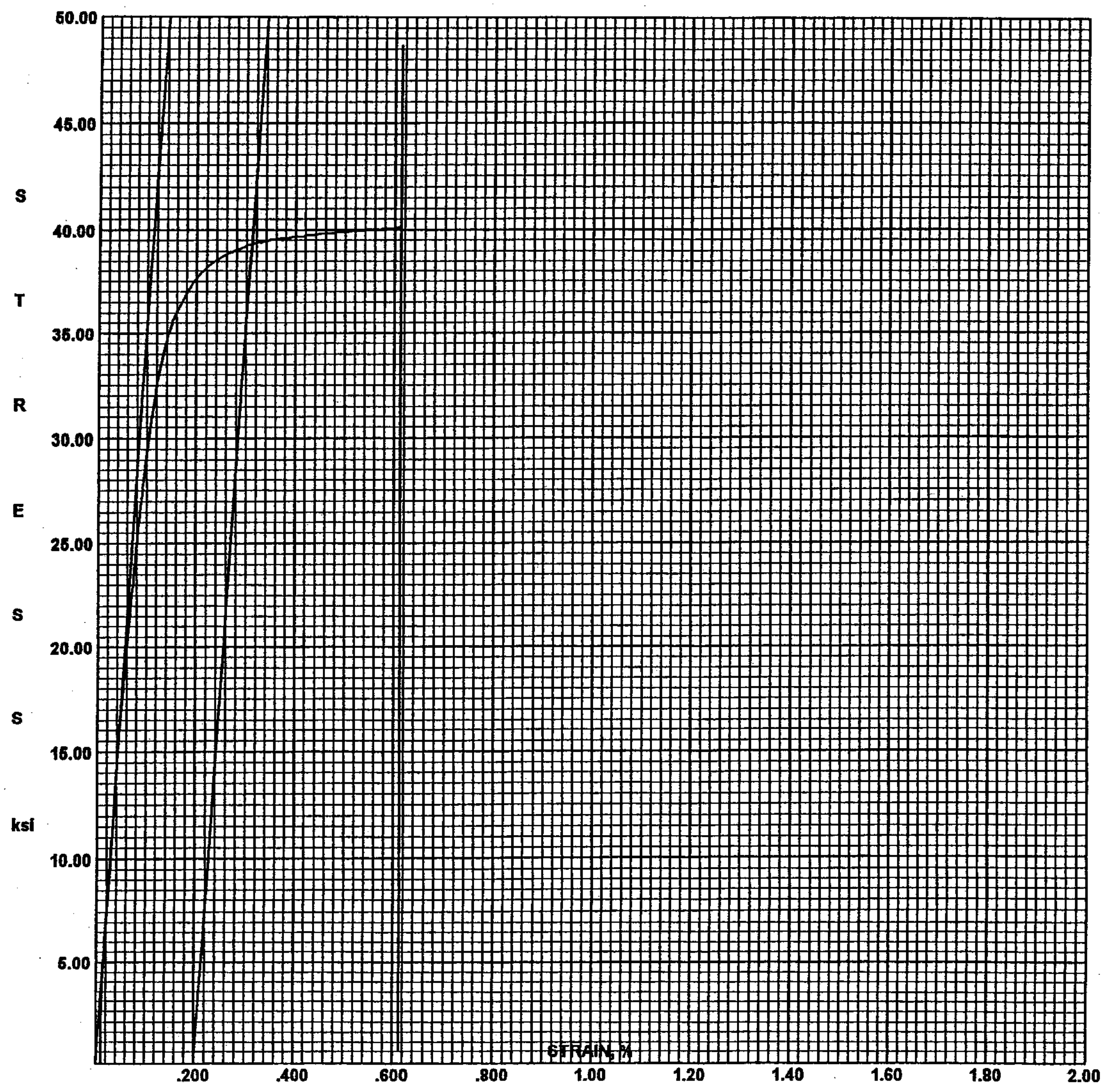


Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	16
<Not Defined>:	
Print Date:	January 30,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>
Bundle ID :	**TSE16**
Coupon No :	**2**
Thk, in:	**0.0476**
CS Area, in²:	**0.0238**
OFS @ 0.2, lbf:	**904**
Ultimate, lbf:	**1158**
Elapsed, sec:	**64.4**
OFS @ 0.2, ksi:	**37.9**
Ultimate, ksi:	**48.6**
TE (Man), %:	**22**

Specimen Break
Jan 30, 2002 3:12:36 PM



Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	16
<Not Defined>:	
Print Date:	January 30,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>
Bundle ID :	**TSE16**
Coupon No :	**3**
Thk, in:	**0.0478**
CS Area, in²:	**0.0239**
OFS @ 0.2, lbf:	**941**
Ultimate, lbf:	**1165**
Elapsed, sec:	**60.5**
OFS @ 0.2, ksi:	**39.3**
Ultimate, ksi:	**48.7**
TE (Man), %:	**28**

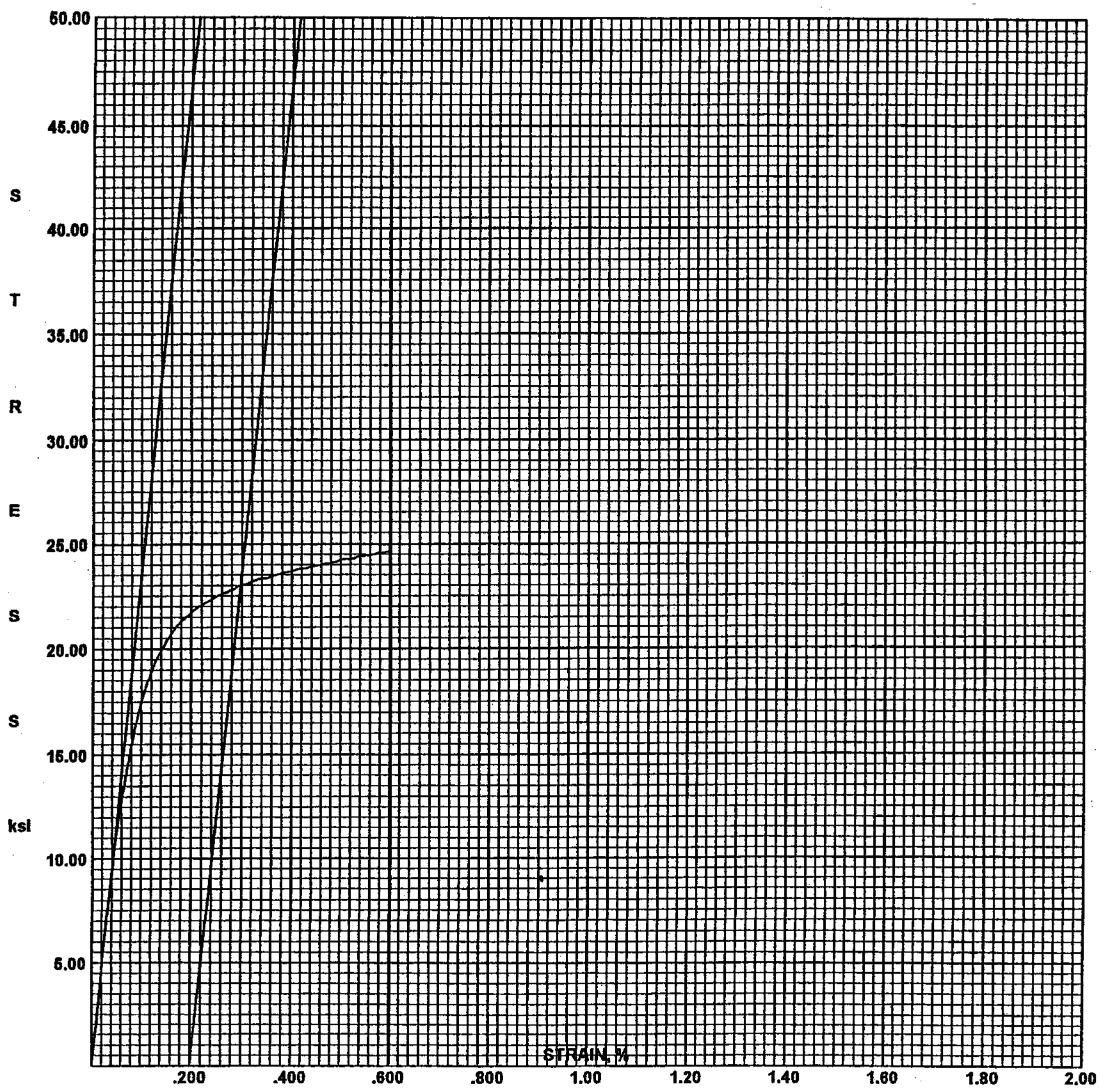
Specimen Break
Jan 30, 2002 3:16:44 PM

Dietrich Industries
Hammond, IN
Test Report
E8 ASTM Report

Test Performed By: LAWSON
Section Type: MSOE TRACK
Depth: 3 5/8
Gage: 18
<Not Defined>:

Print Date: January 30,2002
Load Range: 30000 lbf
Inst GL/Max: 2 in/4 %
X-Axis Ranges: 2 %/<Removed>

Bundle ID	Coupon No	Thk in	CS Area in^2	OFS @ 0.2 lbf	Ultimate lbf	Elapsed sec	OFS @ 0.2 ksi	Ultimate ksi	TE (Man) %
TSE18	1	0.0441	0.022	507	972	97.3	23	44.1	45
TSE18	2	0.0436	0.0218	496	956	108.9	22.8	43.9	43
TSE18	3	0.0442	0.0221	498	966	88.5	22.6	43.8	44
Ave.							22.8	43.9	44
SD							0.212	0.1606	1

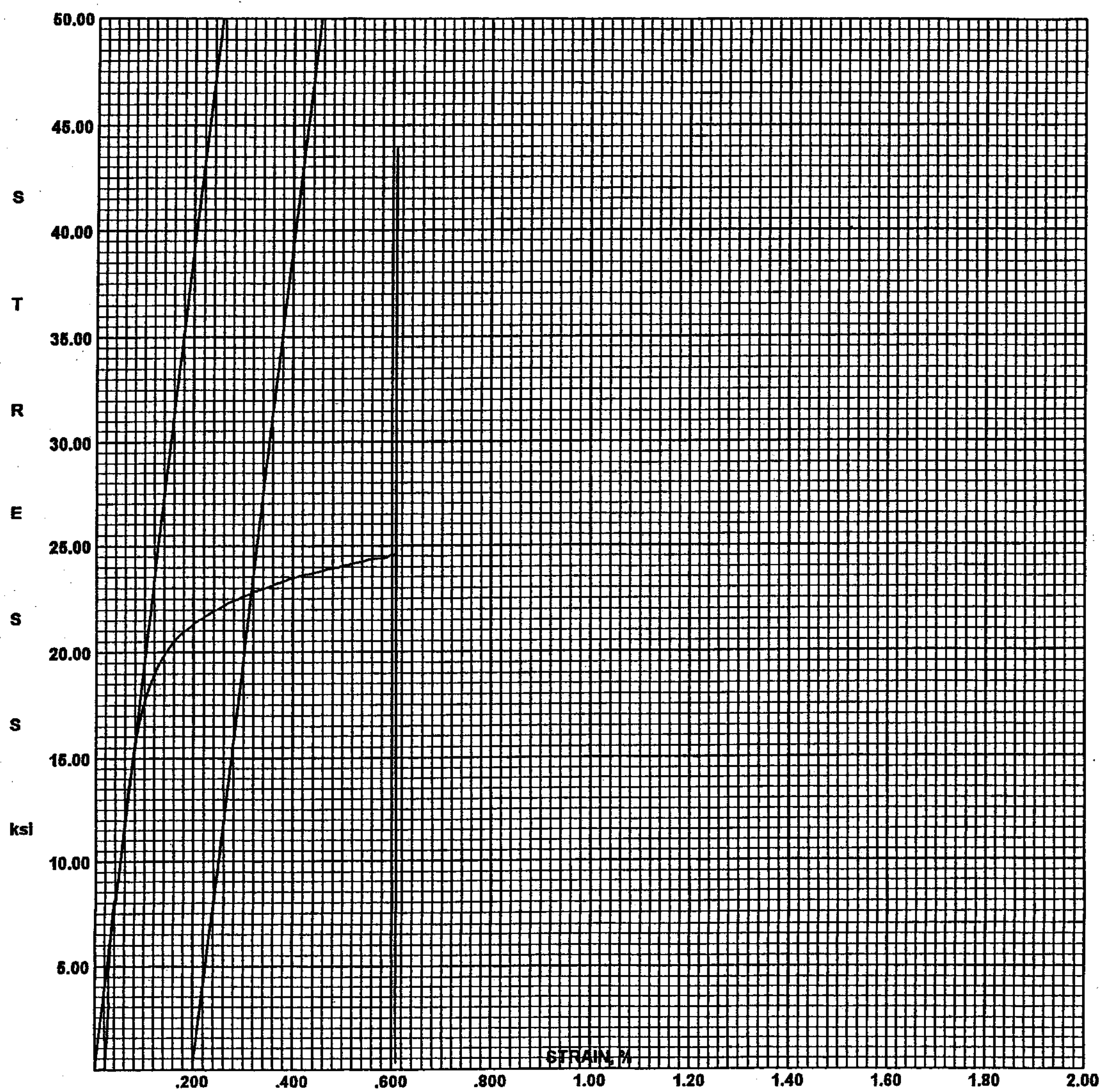


Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	18
<Not Defined>:	
Print Date:	January 30,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>
Bundle ID :	**TSE18**
Coupon No :	**1**
Thk, in:	**0.0441**
CS Area, in²:	**0.022**
OFS @ 0.2, lbf:	**507**
Ultimate, lbf:	**972**
Elapsed, sec:	**97.3**
OFS @ 0.2, ksi:	**23**
Ultimate, ksi:	**44.1**
TE (Man), %:	**45**

Specimen Break
Jan 30, 2002 3:02:24 PM

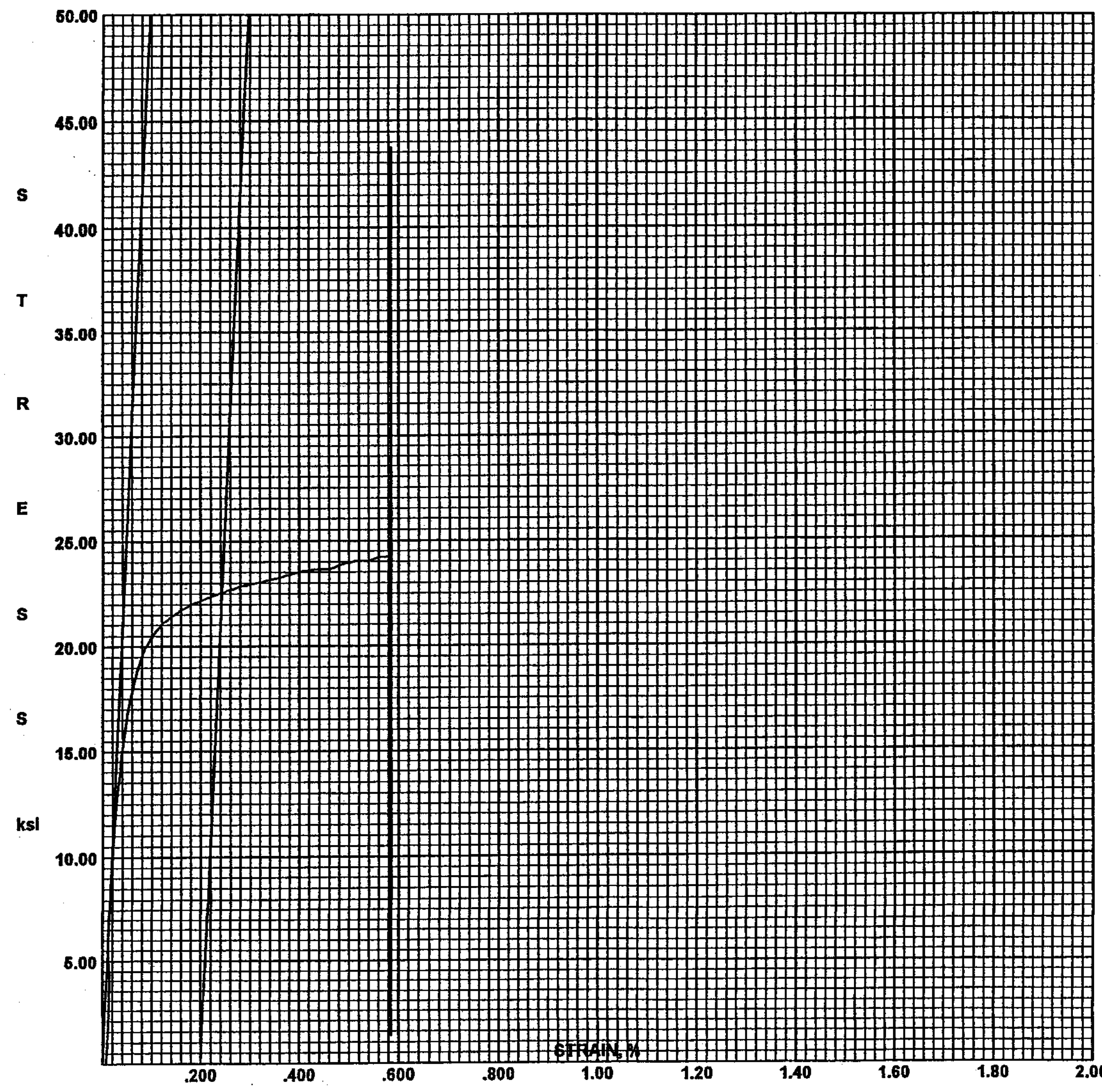


Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	18
<Not Defined>:	
Print Date:	January 30,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>
Bundle ID :	**TSE18**
Coupon No :	**2**
Thk, in:	**0.0436**
CS Area, in²:	**0.0218**
OFS @ 0.2, lbf:	**496**
Ultimate, lbf:	**956**
Elapsed, sec:	**108.9**
OFS @ 0.2, ksi:	**22.8**
Ultimate, ksi:	**43.9**
TE (Man), %:	**43**

Specimen Break
Jan 30, 2002 3:05:16 PM



Dietrich Industries
Hammond, IN
Test Report

E8 ASTM Report
Program #191,048-R1

Test Performed By:	LAWSON
Section Type:	MSOE TRACK
Depth:	3 5/8
Gage:	18
<Not Defined>:	
Print Date:	January 30,2002
Load Range:	30000 lbf
Inst GL/Max:	2 in/4 %
X-Axis Ranges:	2 %/<Removed>
Bundle ID :	**TSE18**
Coupon No :	**3**
Thk, in:	**0.0442**
CS Area, in²:	**0.0221**
OFS @ 0.2, lbf:	**498**
Ultimate, lbf:	**966**
Elapsed, sec:	**88.5**
OFS @ 0.2, ksi:	**22.6**
Ultimate, ksi:	**43.8**
TE (Man), %:	**44**

Specimen Break
Jan 30, 2002 3:07:48 PM

APPENDIX B

MSOE Slip-Track Test Results

Specimen Nomenclature

16-05-1-18-1a

Stud Spacing
16 = 16"o.c. or 24 = 24"o.c. or
12 = 12"o.c. or 18 = 18" o.c.

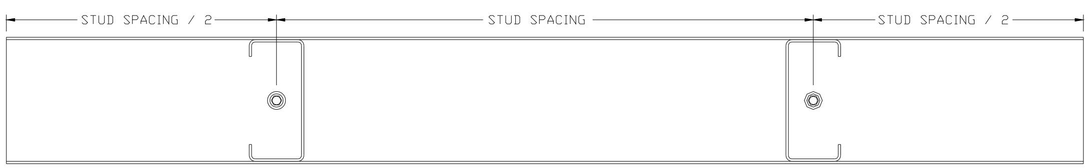
Gap between Stud and Track Web
05 = 1/2" or 10 = 1" or
01 = 1/8" or 07 = 3/4" or
12 = 1 1/4"

Stud Flange Width
1 = 1 5/8" and 2 = 2 1/2"

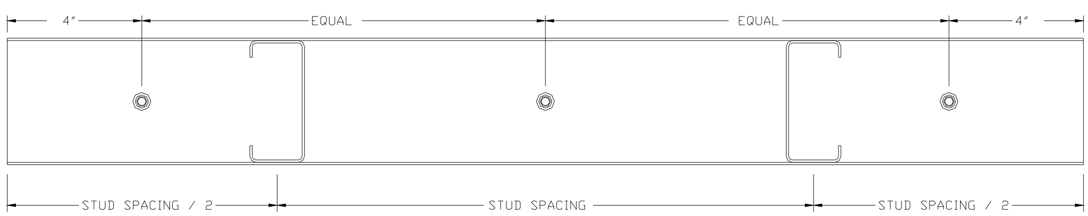
Fastener Location
See below

Test Number
1, 2, or 3

Track Thickness
18 = 18 gage
16 = 16 gage
14 = 14 gage

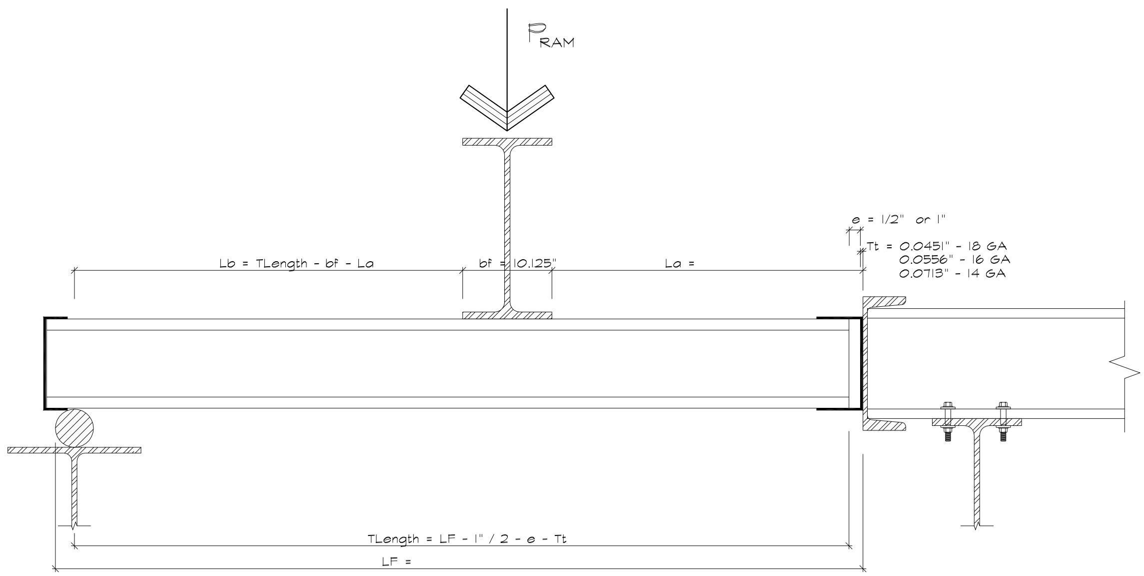


Test "a" Bolt Location.



Test "b" Bolt Location.

Test Variables

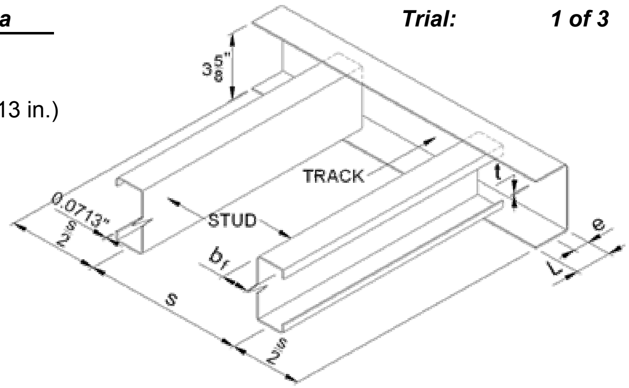


1 / A.1 SLIP TRACK DIMENSIONS

$$P_{test} = P_{RAM} / 2_{STUDS} * ((Lb + bf / 2) / TLength)$$

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-1-14-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

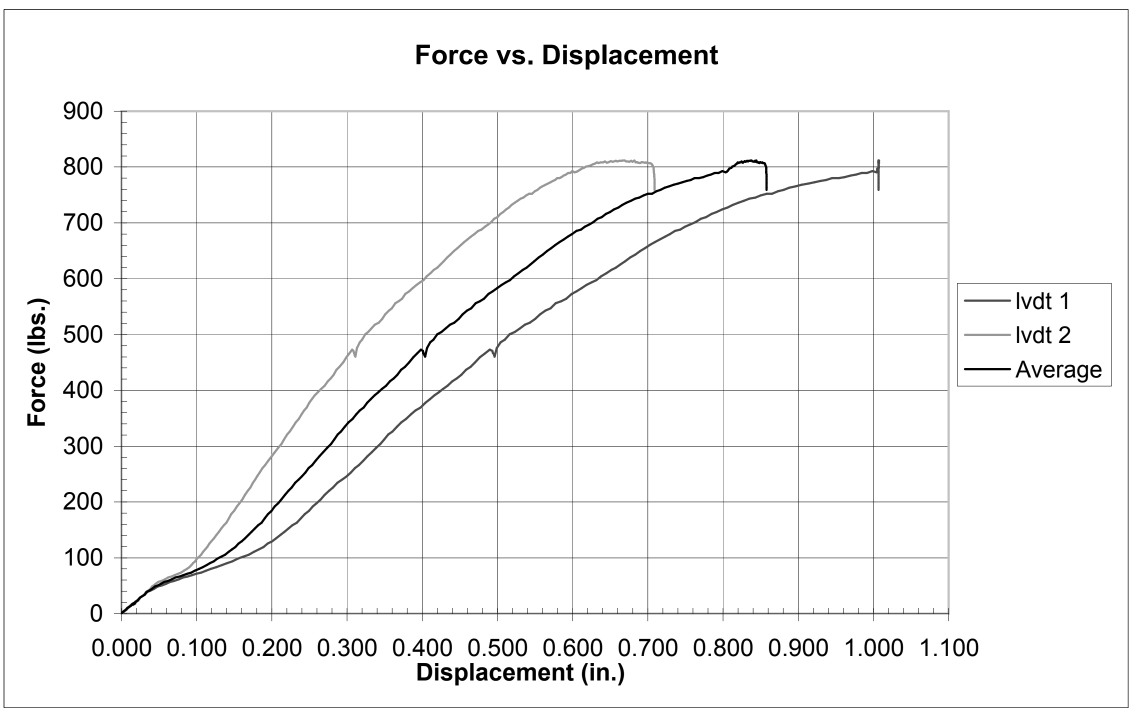
Thickness (in.) 0.0721 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Test (1 & 2)**
37.9	39.3	43.3	**38.6**

Measured Dimensions

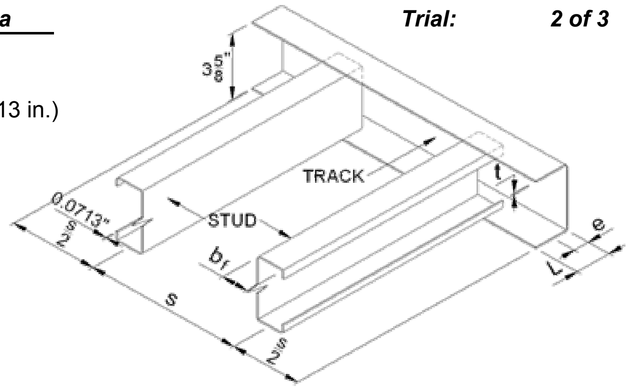
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 304 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-1-14-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

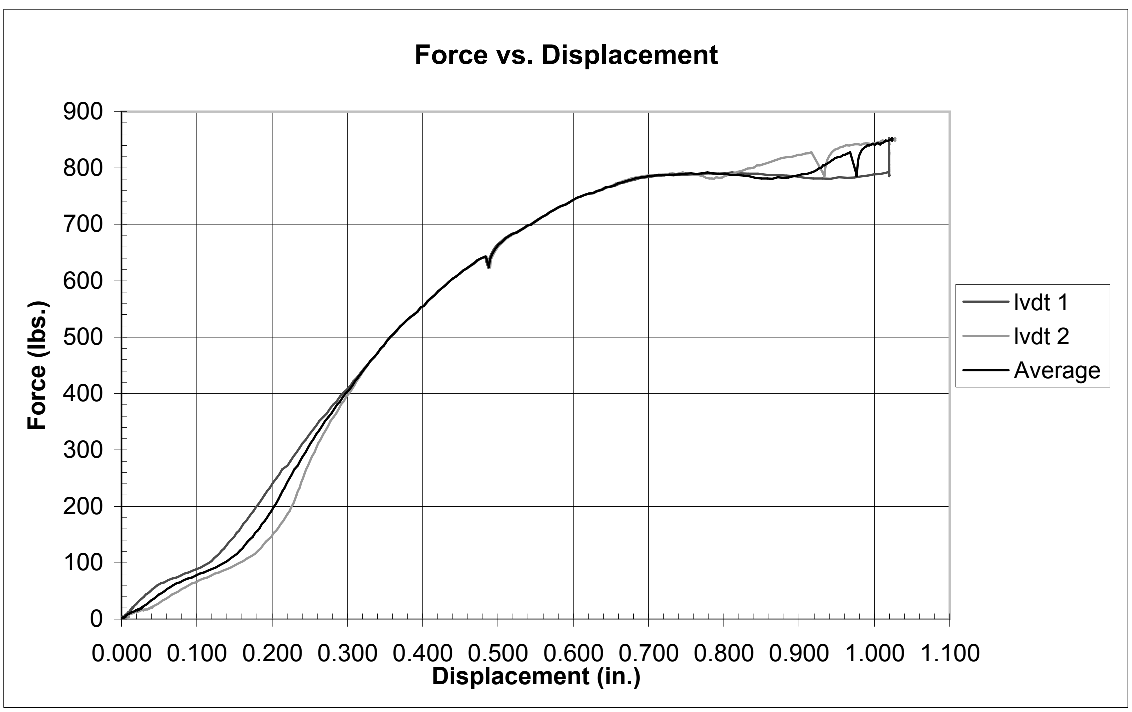
Thickness (in.) 0.0721 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Test (1 & 2)**
37.9	39.3	43.3	**38.6**

Measured Dimensions

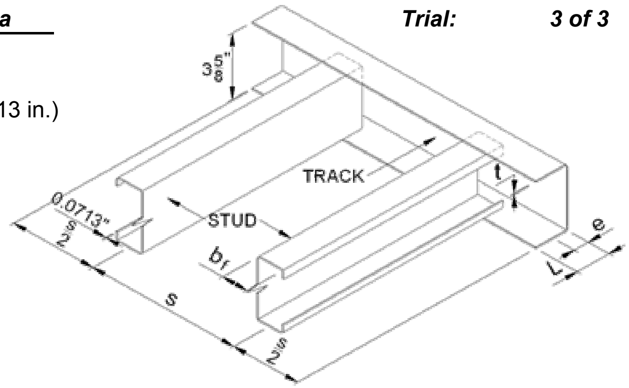
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 361 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-1-14-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

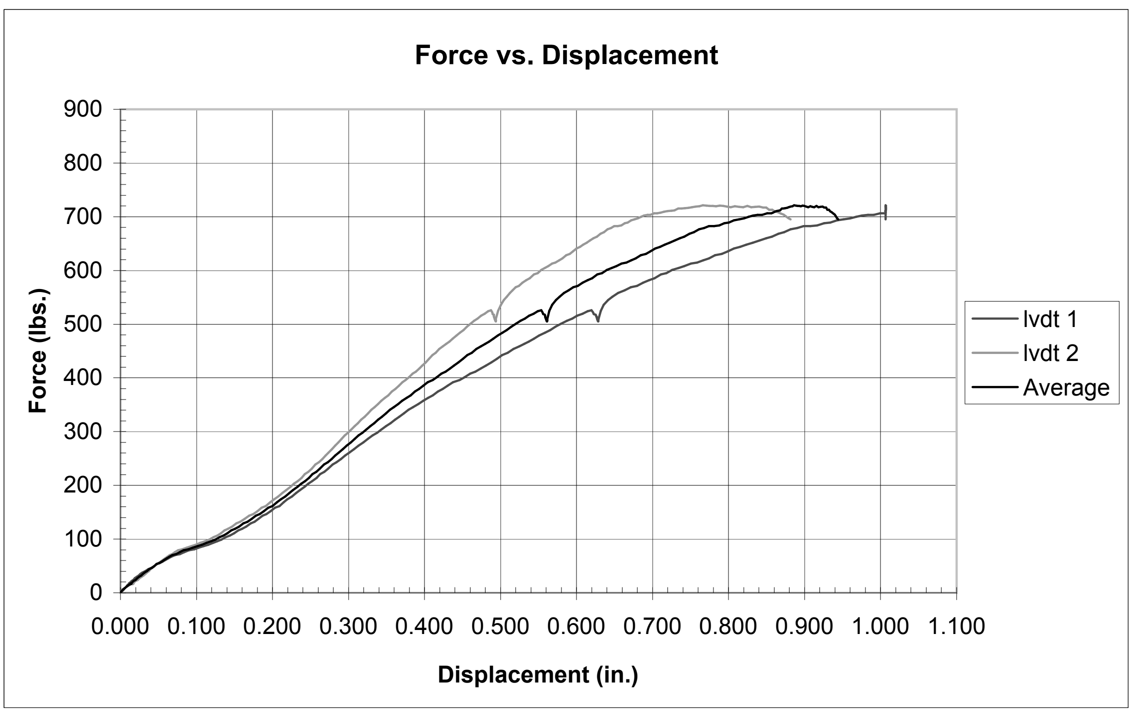
Thickness (in.) 0.0722 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	Average of Test (1 & 2)
37.9	39.3	43.3	**38.6**

Measured Dimensions

La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 274 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***16-05-1-14 Summary***

Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

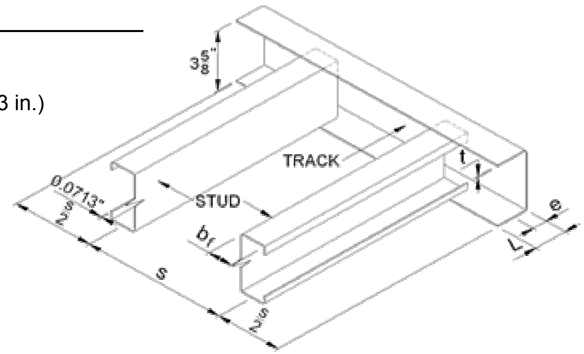
Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.



Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

Ram Speed: 0.1 inches in 20 seconds

Maximum Load of Tests:

16-05-1-14-1a 811.93 Lbs.

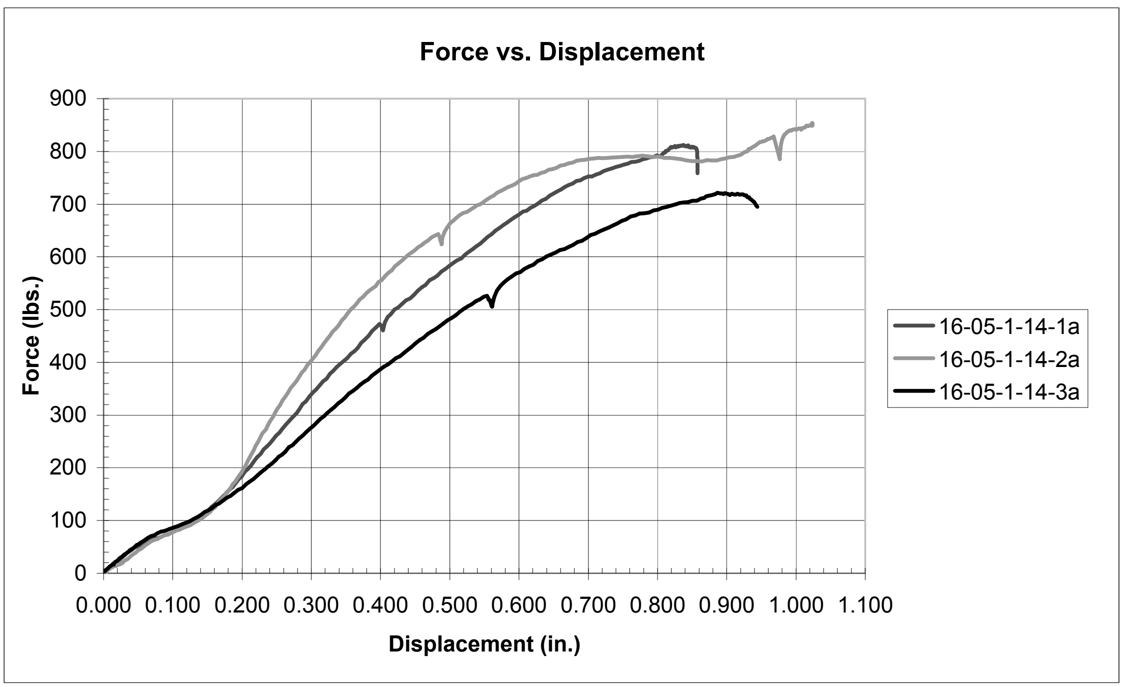
16-05-1-14-2a 853.66 Lbs.

16-05-1-14-3a 721.44 Lbs.

Track Material Property

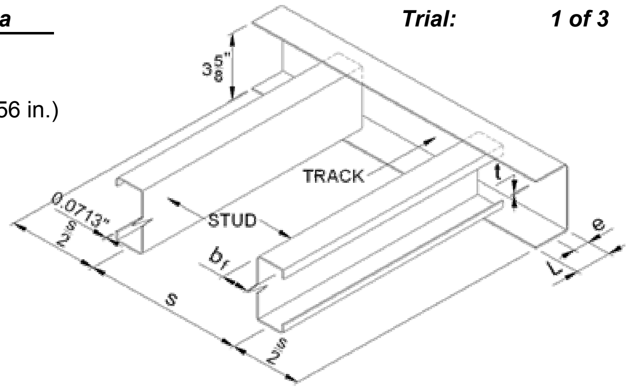
Yield (ksi)

Test #1	Test #2	Test #3	**Average of Test (1 & 2)**
37.9	39.3	43.3	**38.6**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-1-16-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

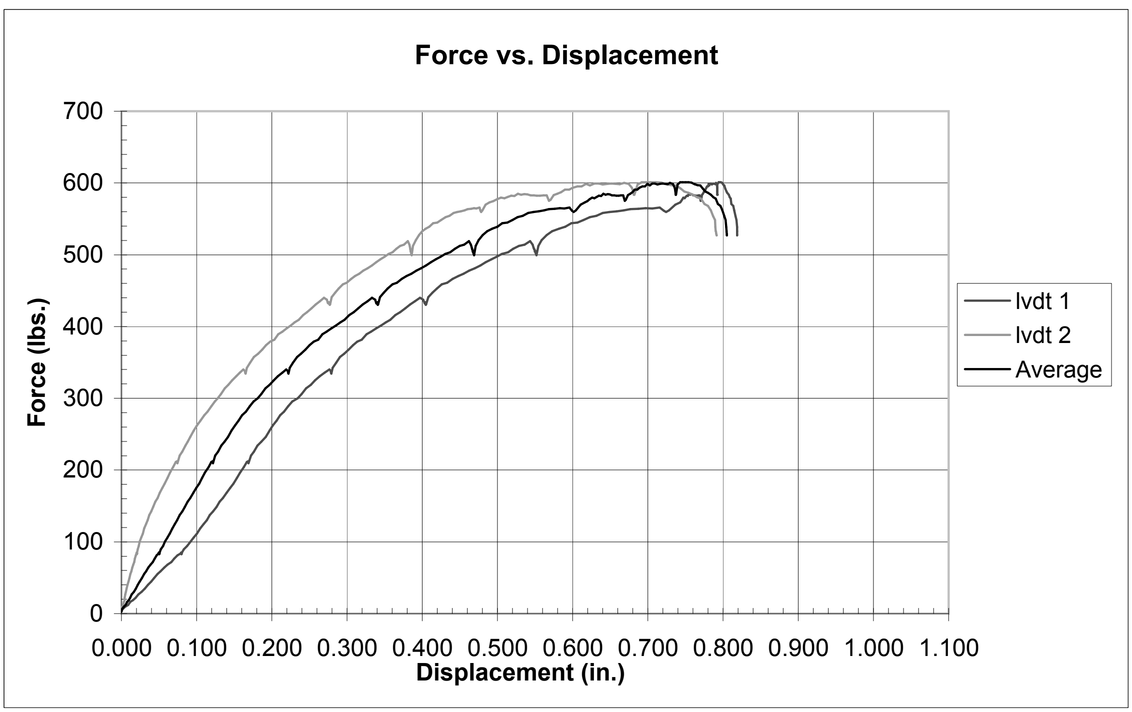
Thickness (in.) 0.0584 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
44.3	45.9	43.2	**44.5**

Measured Dimensions

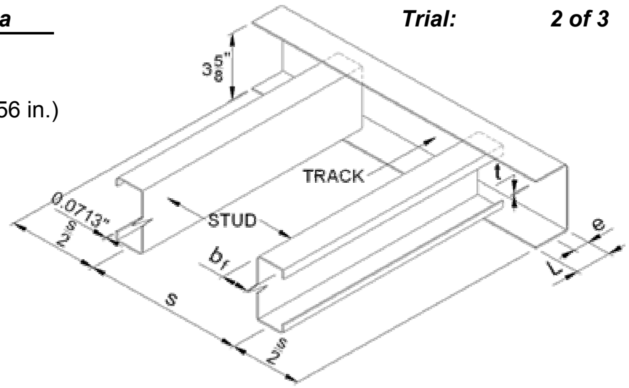
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 279 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-1-16-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

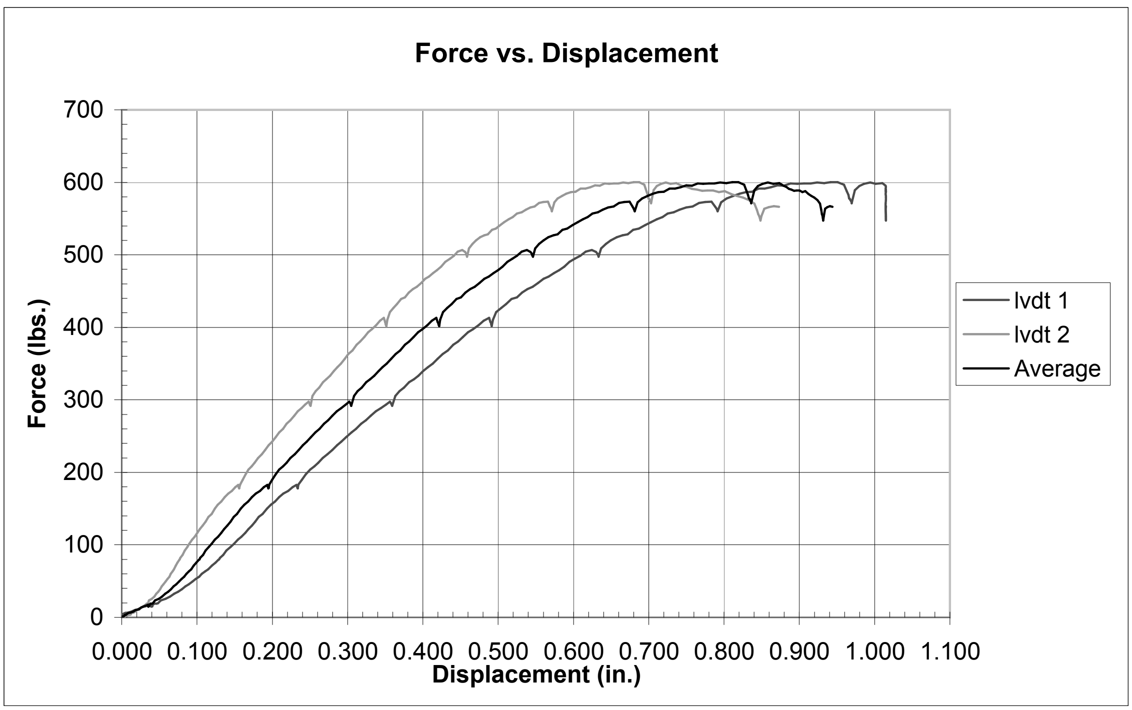
Thickness (in.) 0.0584 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
44.3	45.9	43.2	**44.5**

Measured Dimensions

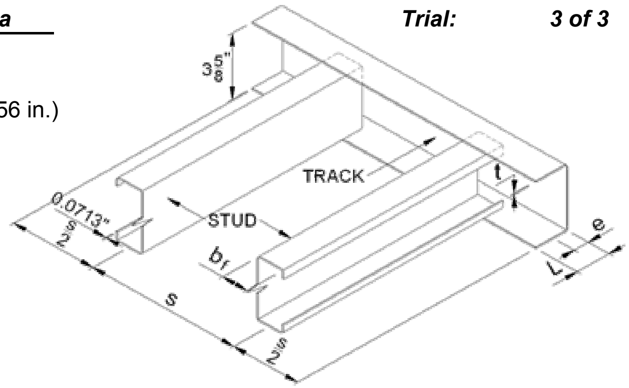
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 320 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-1-16-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

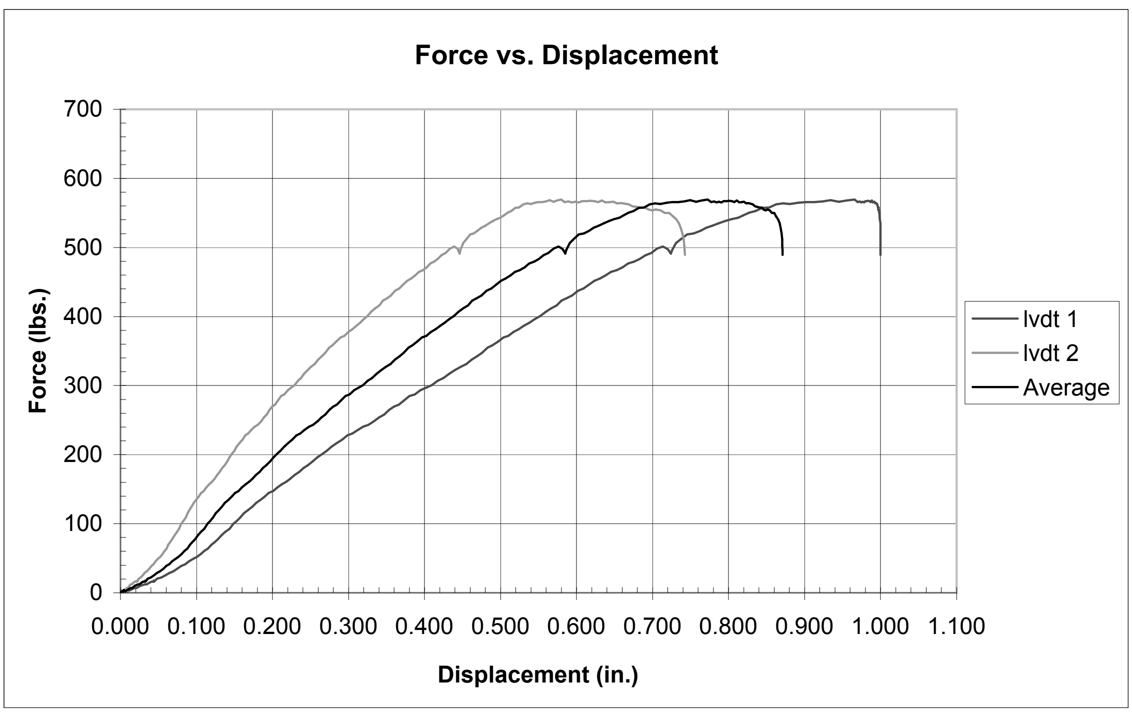
Thickness (in.) 0.0585 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
44.3	45.9	43.2	**44.5**

Measured Dimensions

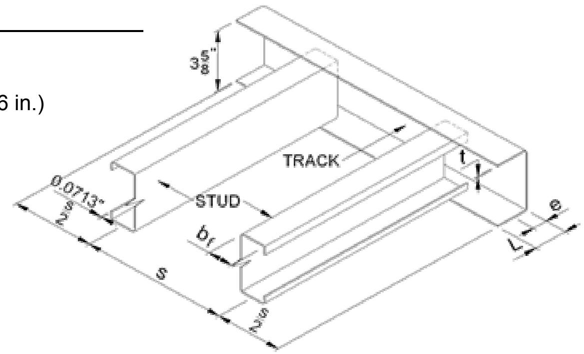
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 227 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***16-05-1-16 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t)	16 gage	(0.0556 in.)
Track Leg Length (L)	2 in.	

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e)	0.5 in.
Stud Flange Width (bf)	1 5/8 in.
Stud Spacing (s)	16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

Ram Speed: 0.1 inches in 20 seconds

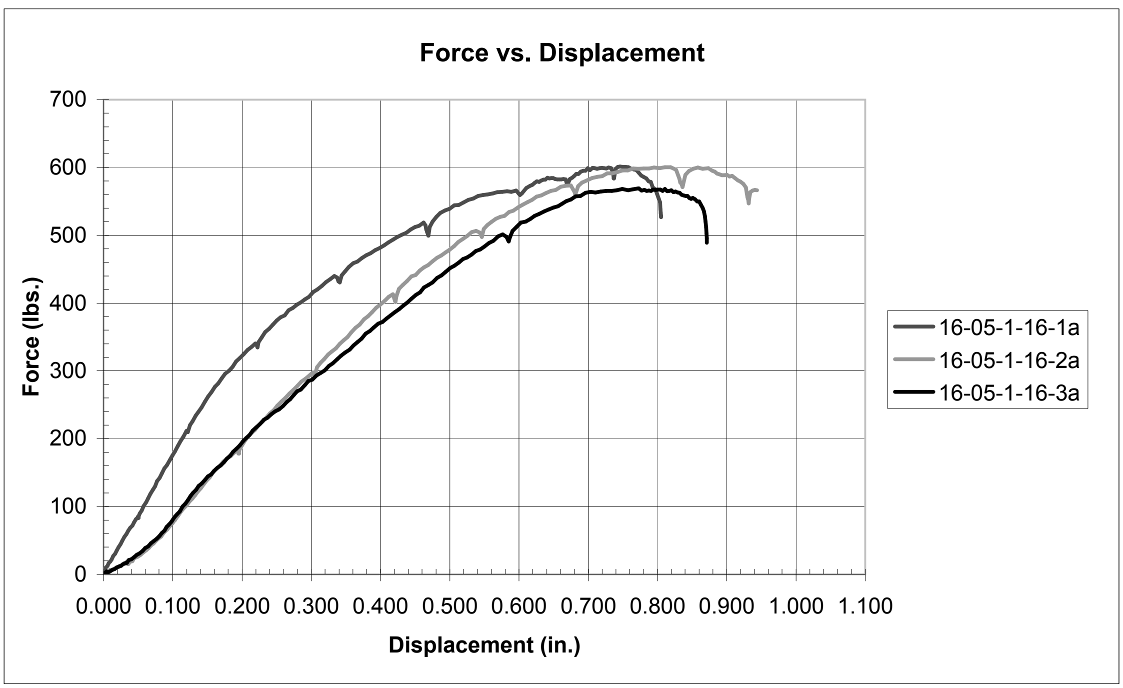
Maximum Load of Tests:

16-05-1-16-1a	601.24 Lbs.
16-05-1-16-2a	600.17 Lbs.
16-05-1-16-3a	569.15 Lbs.

Track Material Property

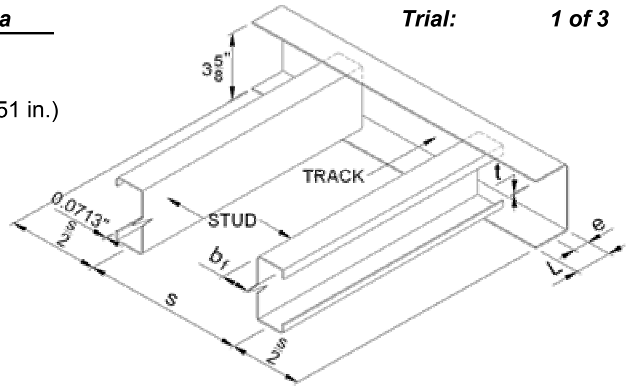
Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
44.3	45.9	43.2	**44.5**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-1-18-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

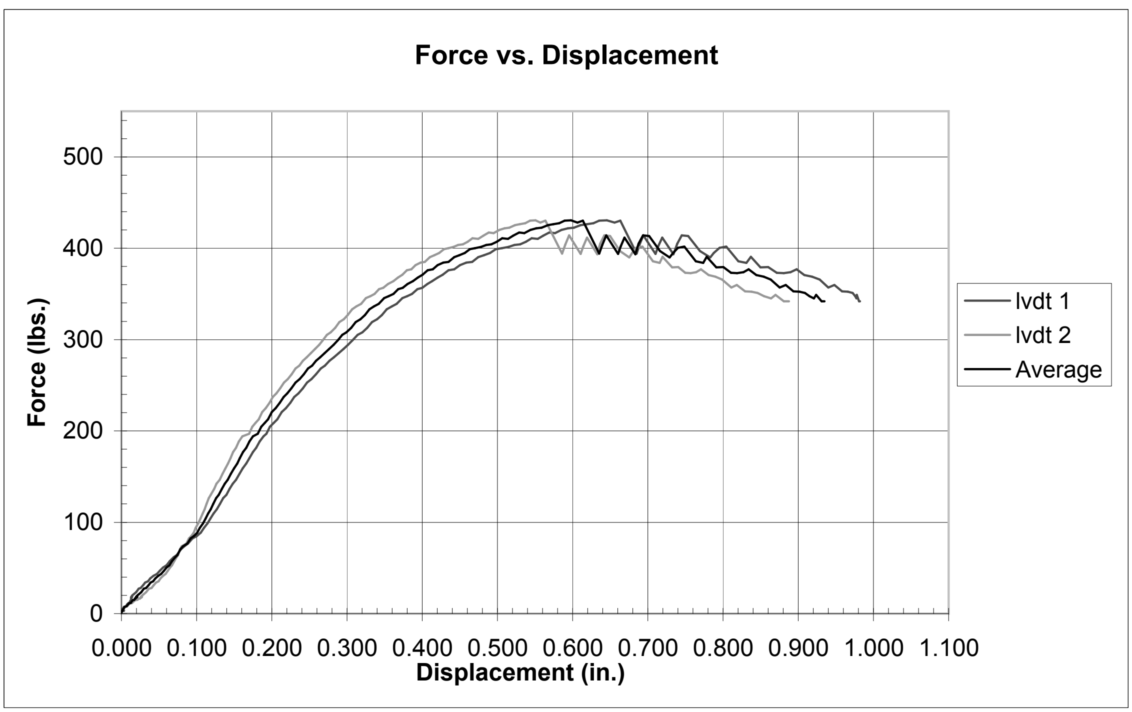
Thickness (in.) 0.0476 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.4	39.6	38.2	**39.4**

Measured Dimensions

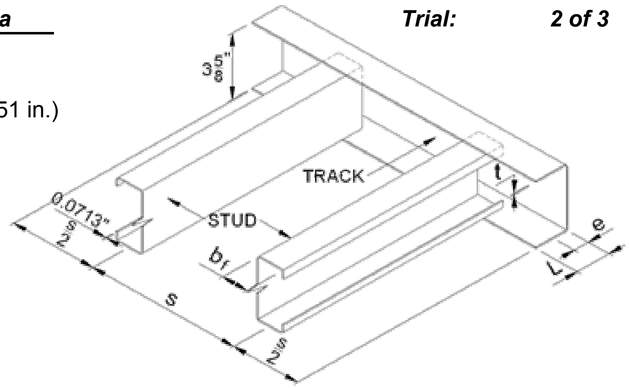
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 176 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-1-18-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

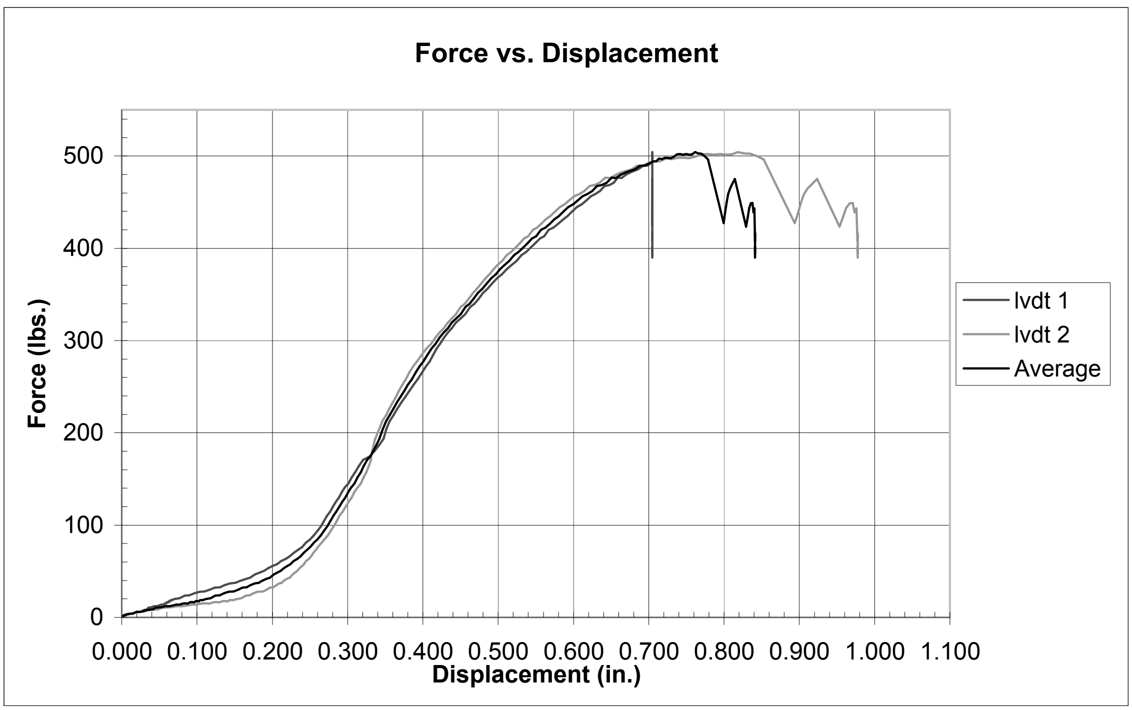
Thickness (in.) 0.0476 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.4	39.6	38.2	**39.4**

Measured Dimensions

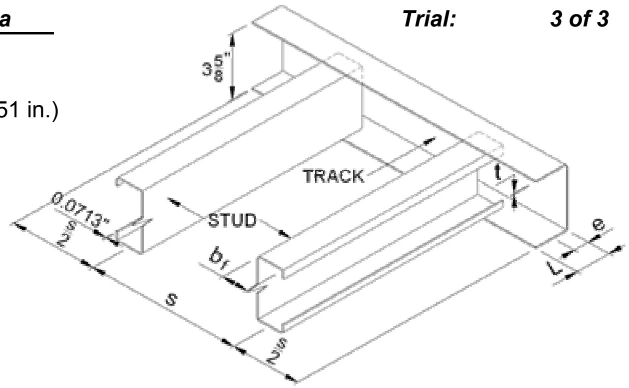
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 204 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-1-18-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

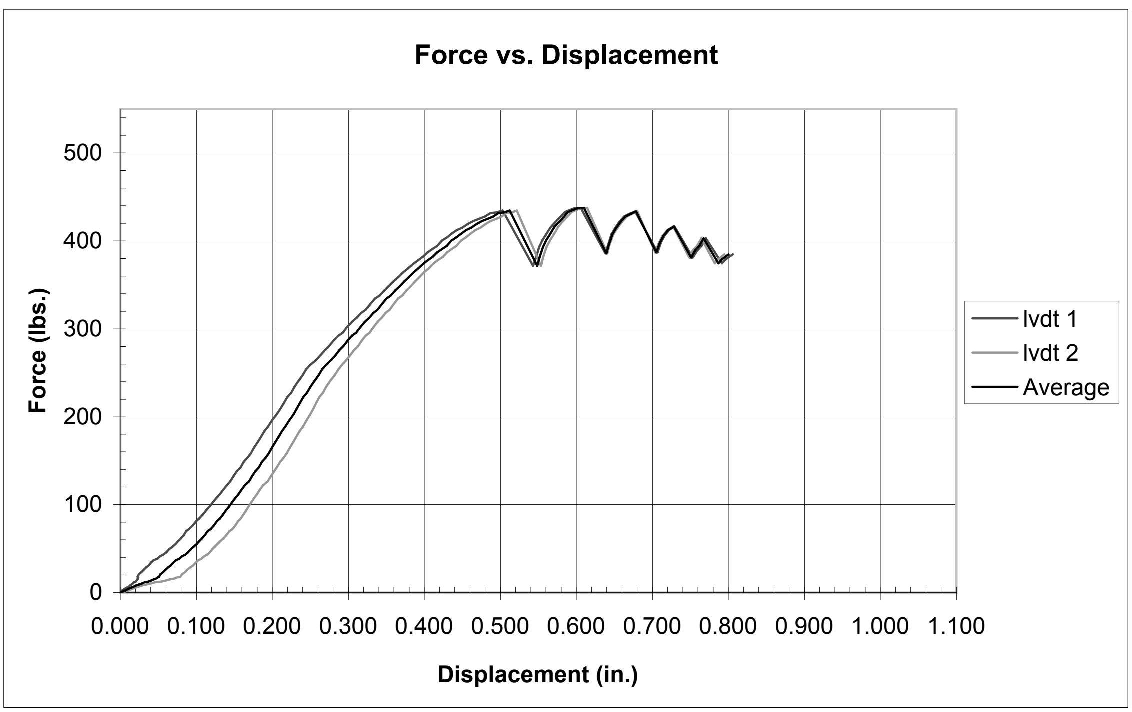
Thickness (in.) 0.0475 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.4	39.6	38.2	**39.4**

Measured Dimensions

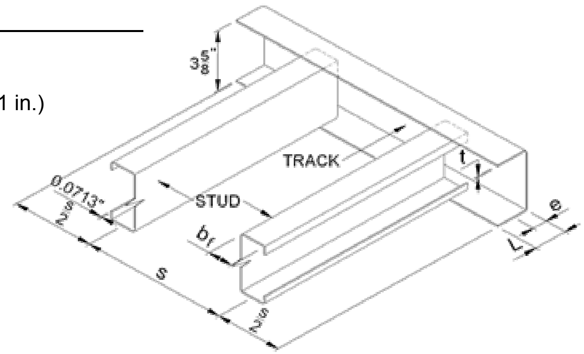
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 152 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***16-05-1-18 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t)	18 gage	(0.0451 in.)
Track Leg Length (L)	2 in.	

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e)	0.5 in.
Stud Flange Width (bf)	1 5/8 in.
Stud Spacing (s)	16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

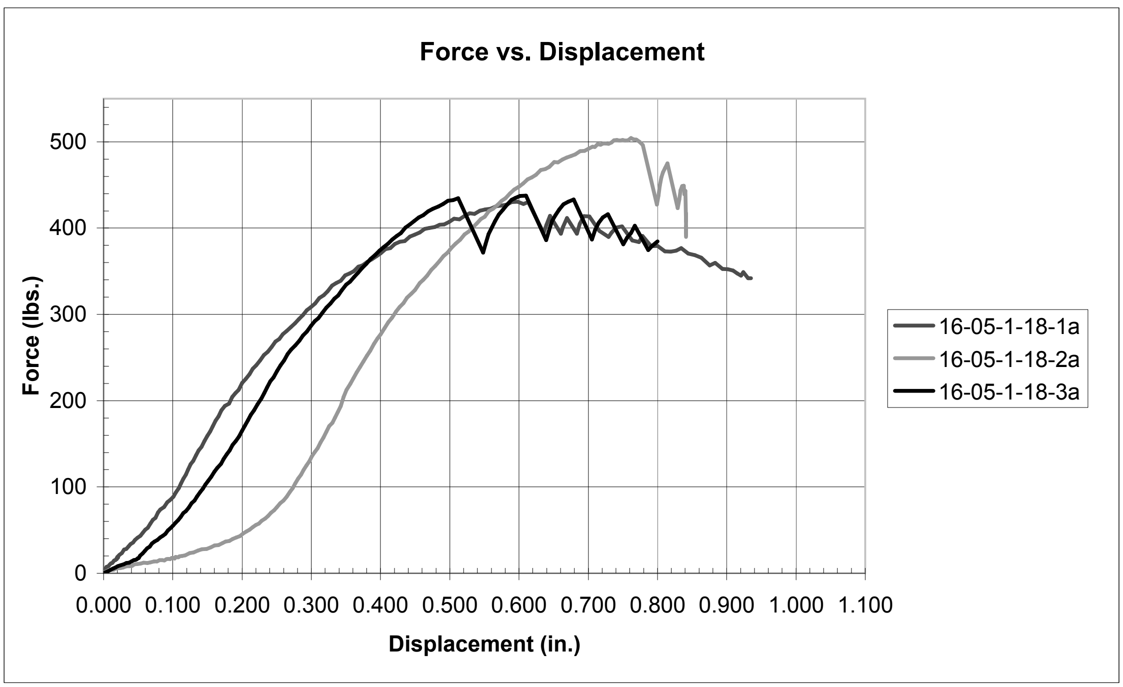
Ram Speed: 0.1 inches in 20 seconds

Maximum Load of Tests:

16-05-1-18-1a	430.61 Lbs.
16-05-1-18-2a	504.40 Lbs.
16-05-1-18-3a	437.48 Lbs.

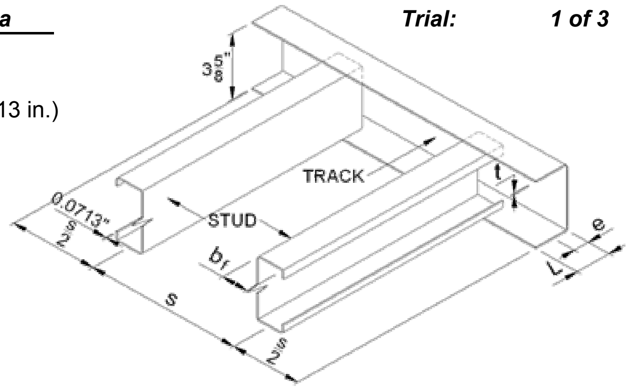
Track Material Property

	Test #1	Test #2	Test #3	**Average of Tests**
Yield (ksi)	40.4	39.6	38.2	**39.4**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-2-14-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

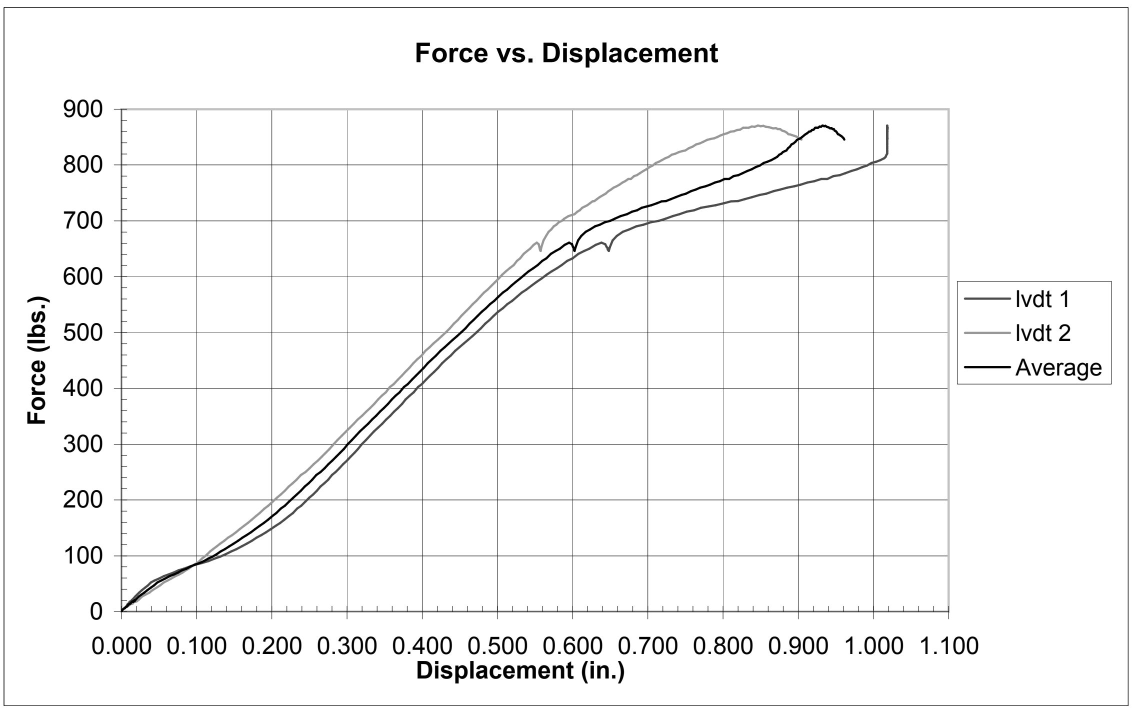
Thickness (in.) 0.0726 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
37.9	39.3	43.3	**38.6**

Measured Dimensions

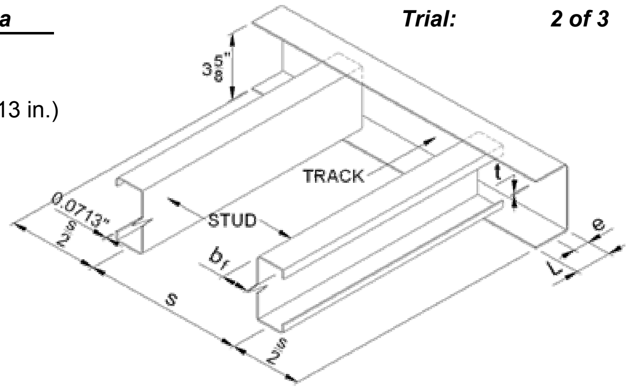
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 293 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-2-14-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

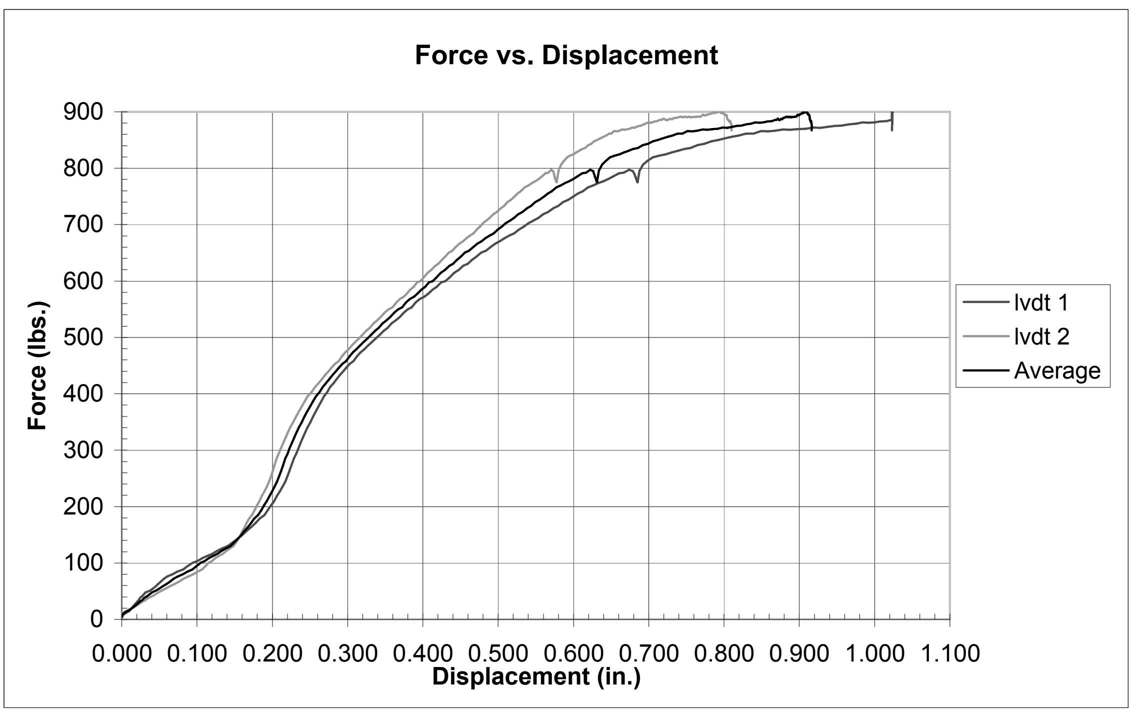
Thickness (in.) 0.0720 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
37.9	39.3	43.3	**38.6**

Measured Dimensions

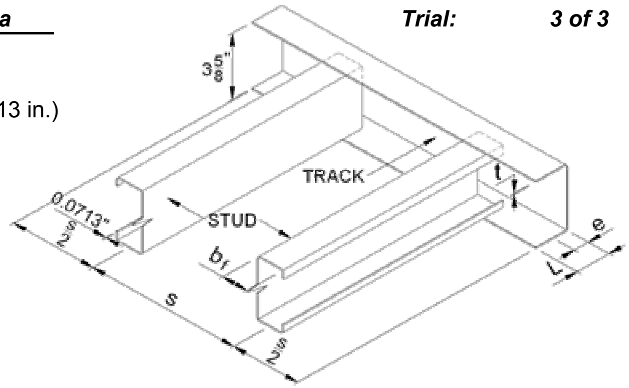
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 260 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-2-14-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

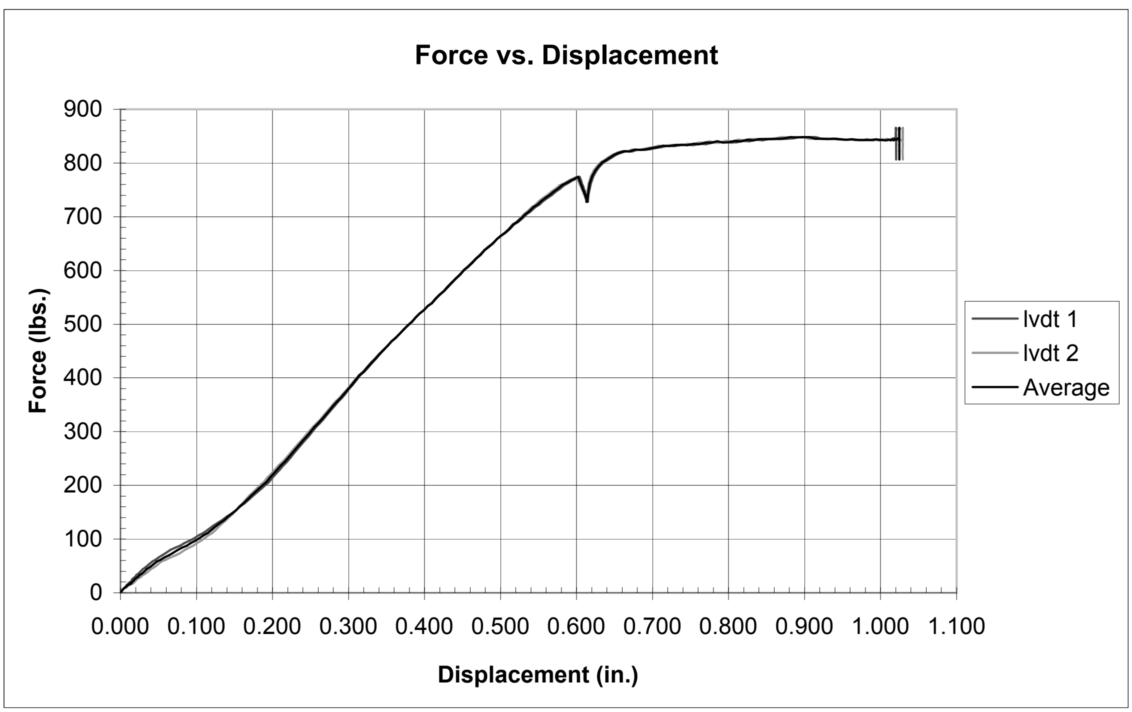
Thickness (in.) 0.0718 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
37.9	39.3	43.3	**38.6**

Measured Dimensions

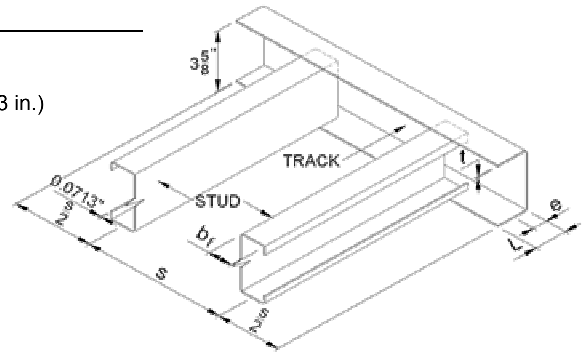
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 312 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***16-05-2-14 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t)	14 gage	(0.0713 in.)
Track Leg Length (L)	2 in.	

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e)	0.5 in.
Stud Flange Width (bf)	2 1/2 in.
Stud Spacing (s)	16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

Ram Speed: 0.1 inches in 20 seconds

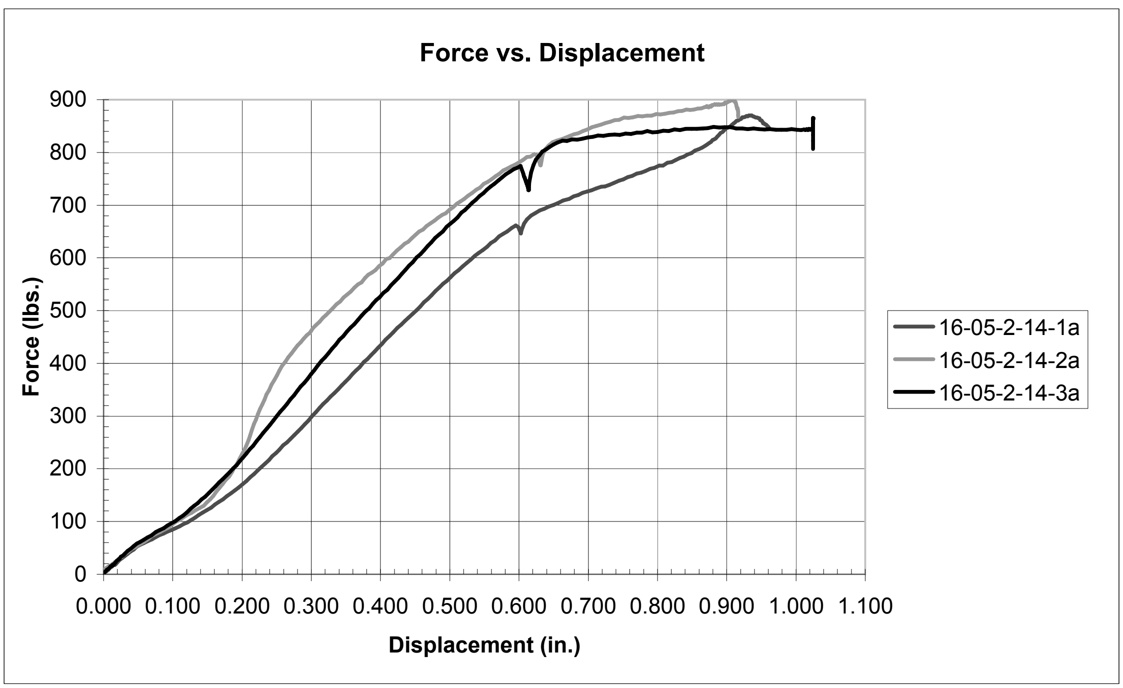
Maximum Load of Tests:

16-05-2-14-1a	870.48 Lbs.
16-05-2-14-2a	900.13 Lbs.
16-05-2-14-3a	865.43 Lbs.

Track Material Property

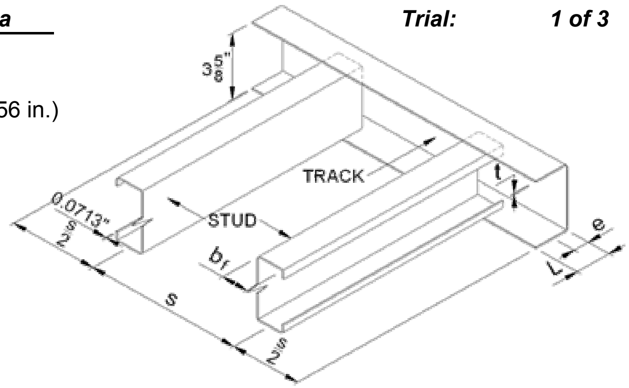
Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
37.9	39.3	43.3	**38.6**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-2-16-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

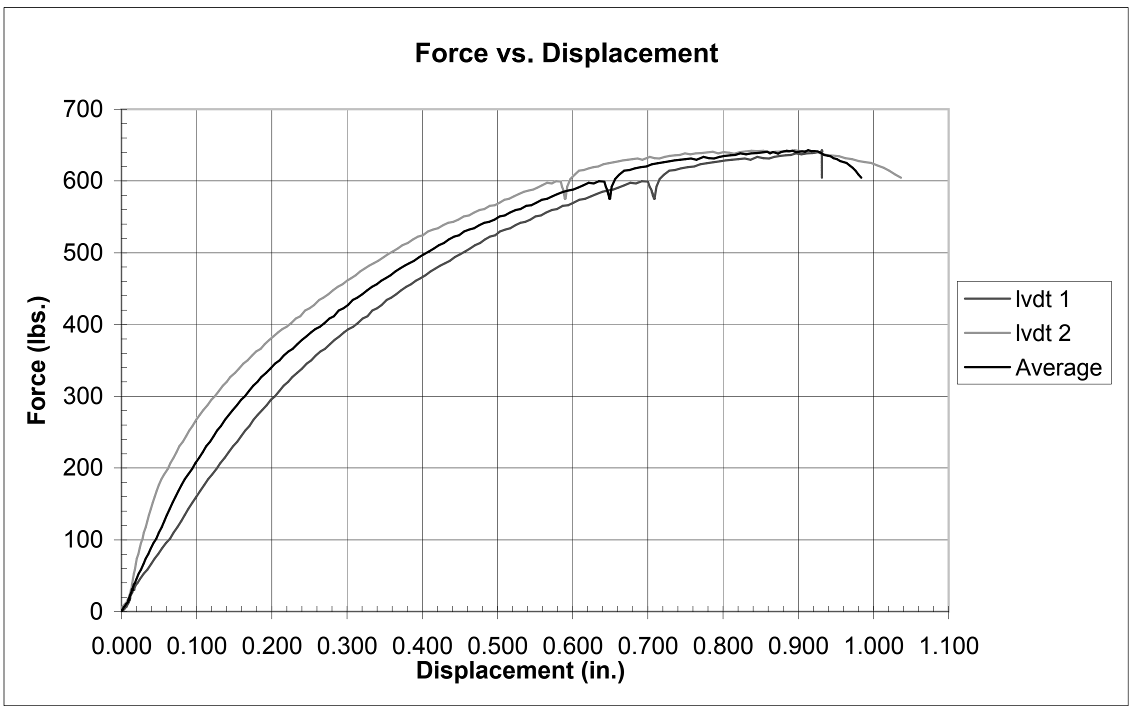
Thickness (in.) 0.0586 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
44.3	45.9	43.2	**44.5**

Measured Dimensions

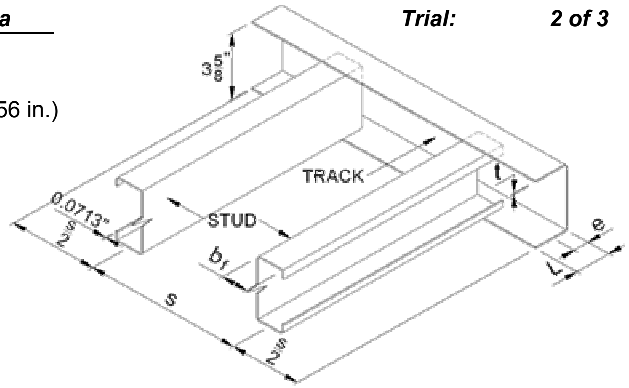
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 270 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-2-16-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

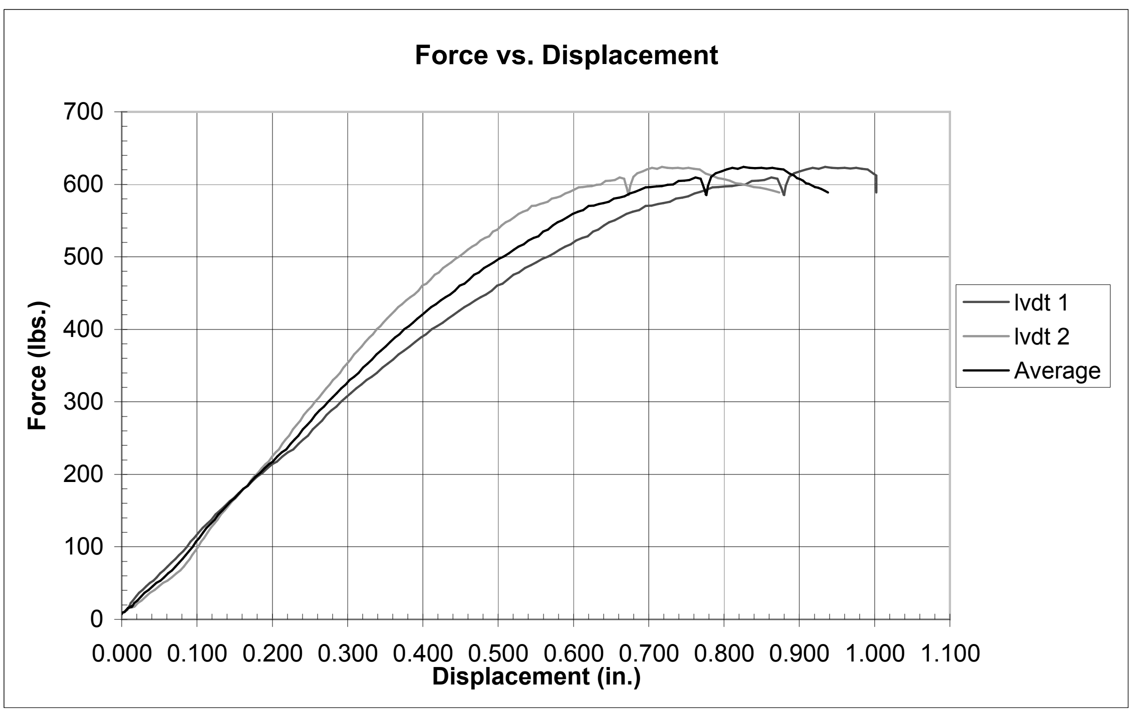
Thickness (in.) 0.0585 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	Average of Tests
44.3	45.9	43.2	**44.5**

Measured Dimensions

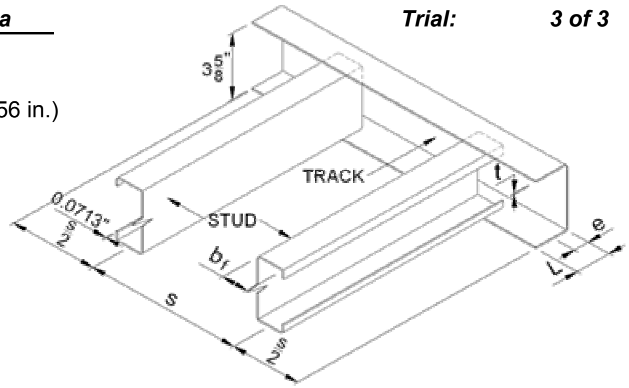
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 192 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-2-16-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

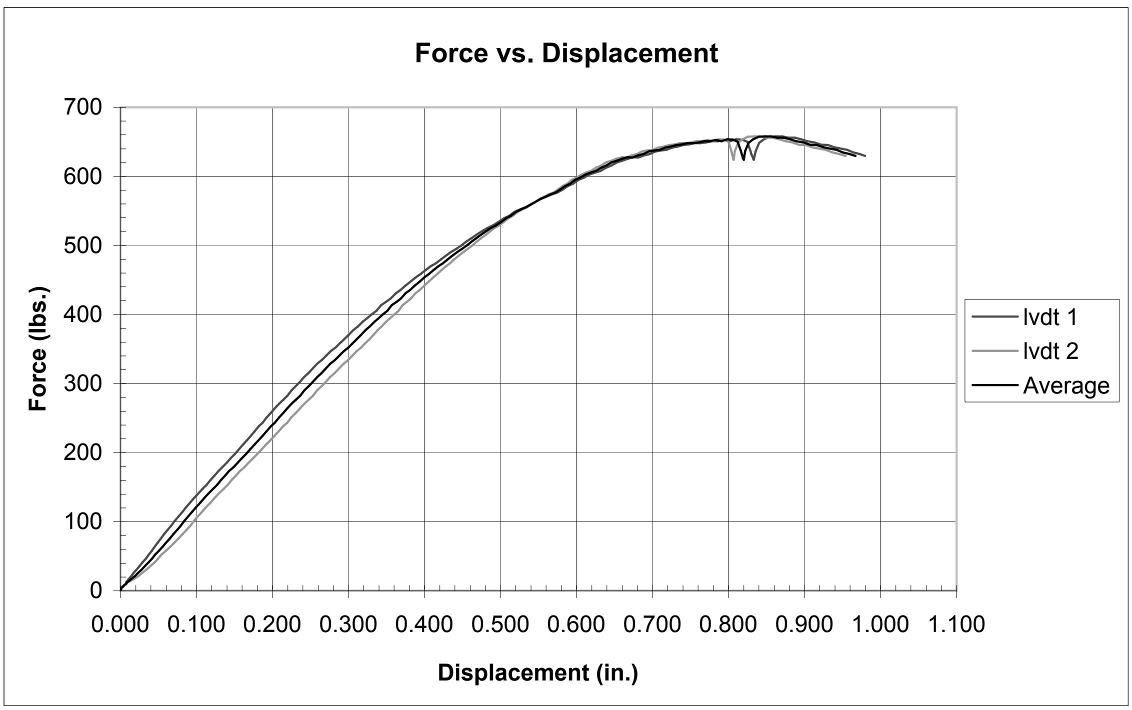
Thickness (in.) 0.0579 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	Average of Tests
44.3	45.9	43.2	**44.5**

Measured Dimensions

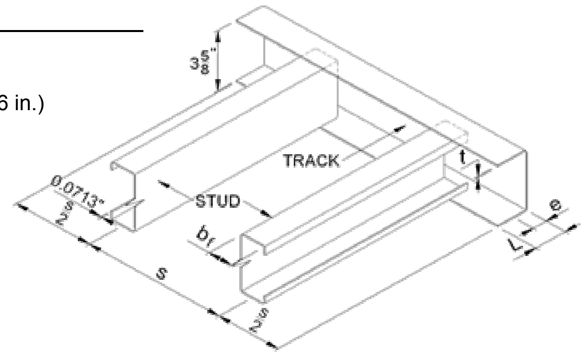
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 185 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***16-05-2-16 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t)	16 gage	(0.0556 in.)
Track Leg Length (L)	2 in.	

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e)	0.5 in.
Stud Flange Width (bf)	2 1/2 in.
Stud Spacing (s)	16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

Ram Speed: 0.1 inches in 20 seconds

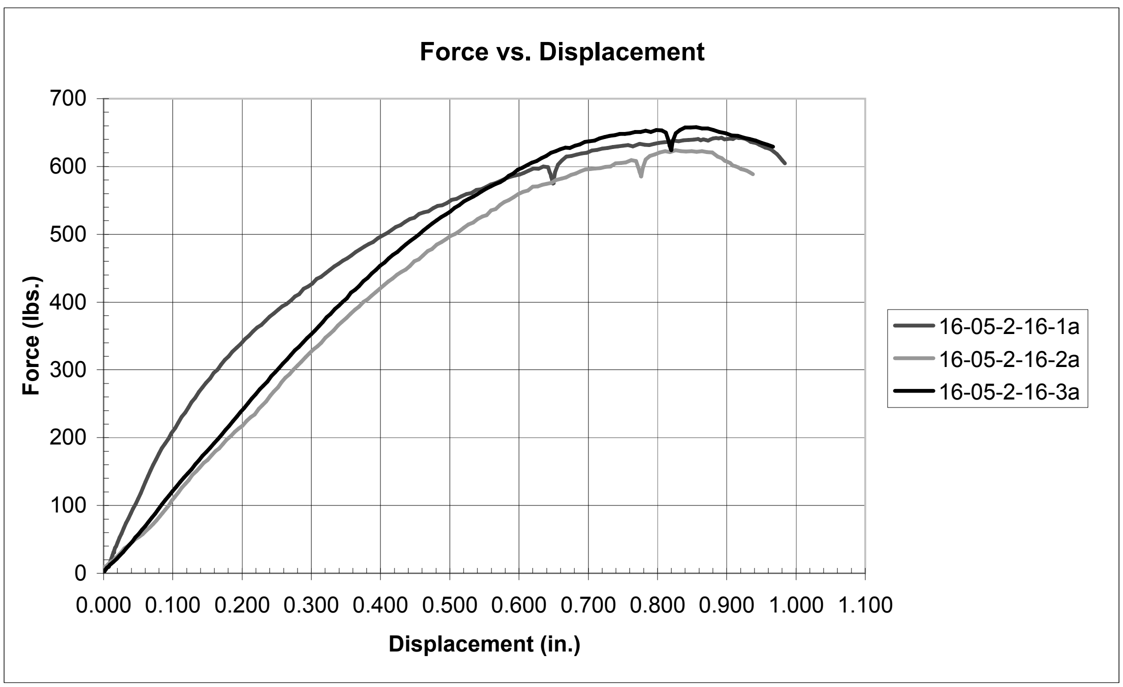
Maximum Load of Tests:

16-05-2-16-1a	643.11 Lbs.
16-05-2-16-2a	624.01 Lbs.
16-05-2-16-3a	657.81 Lbs.

Track Material Property

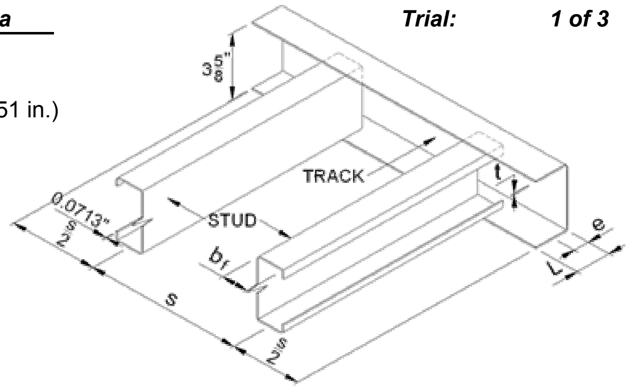
Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
44.3	45.9	43.2	**44.5**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-2-18-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

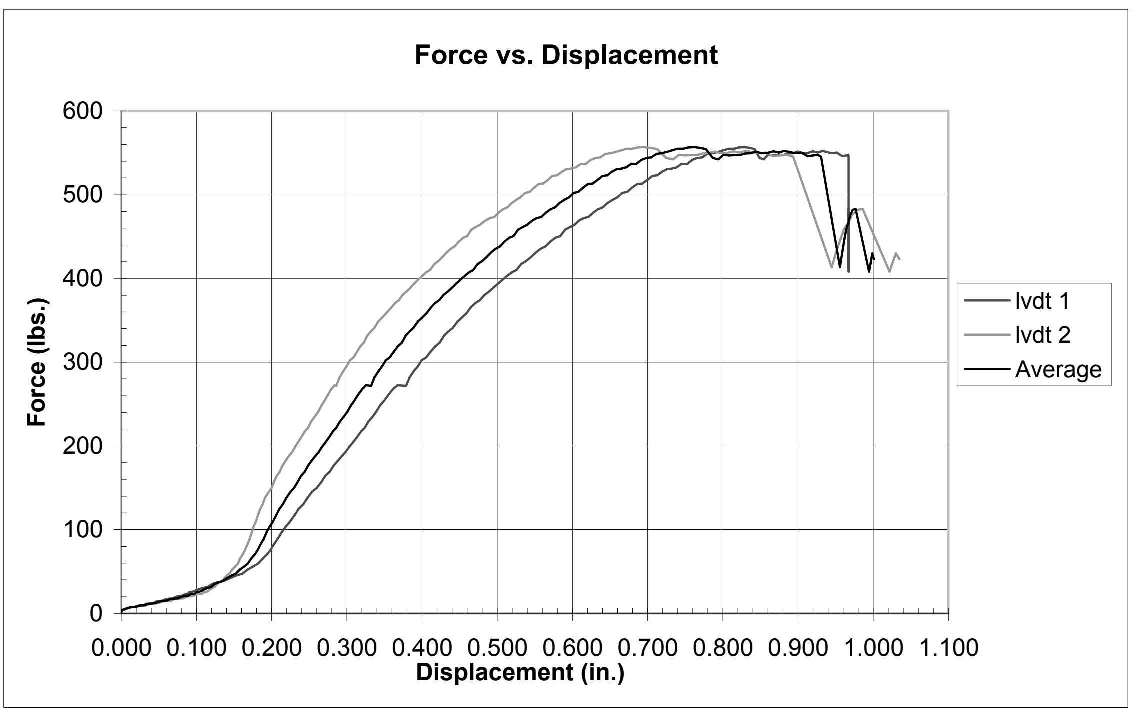
Thickness (in.) 0.0478 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.4	39.6	38.2	**39.4**

Measured Dimensions

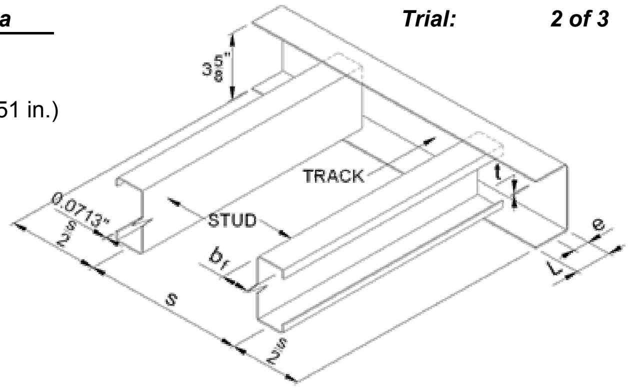
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 191 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-2-18-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

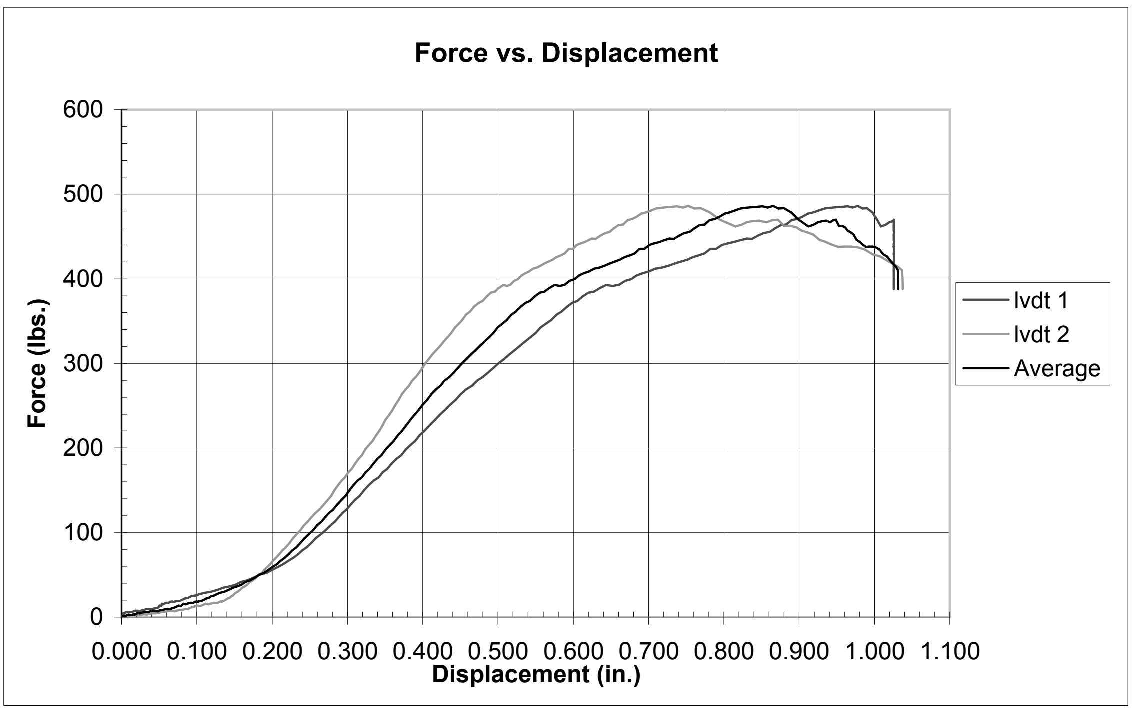
Thickness (in.) 0.0473 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.4	39.6	38.2	**39.4**

Measured Dimensions

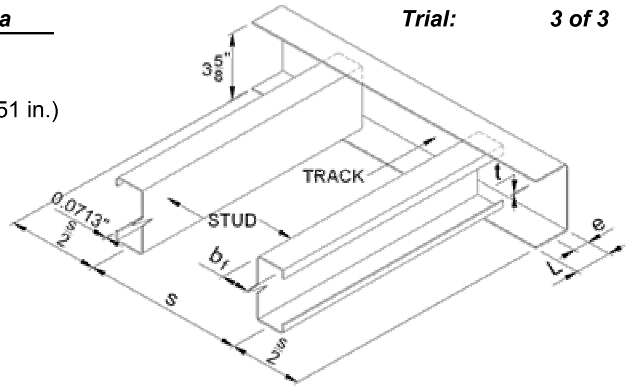
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 210 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-05-2-18-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

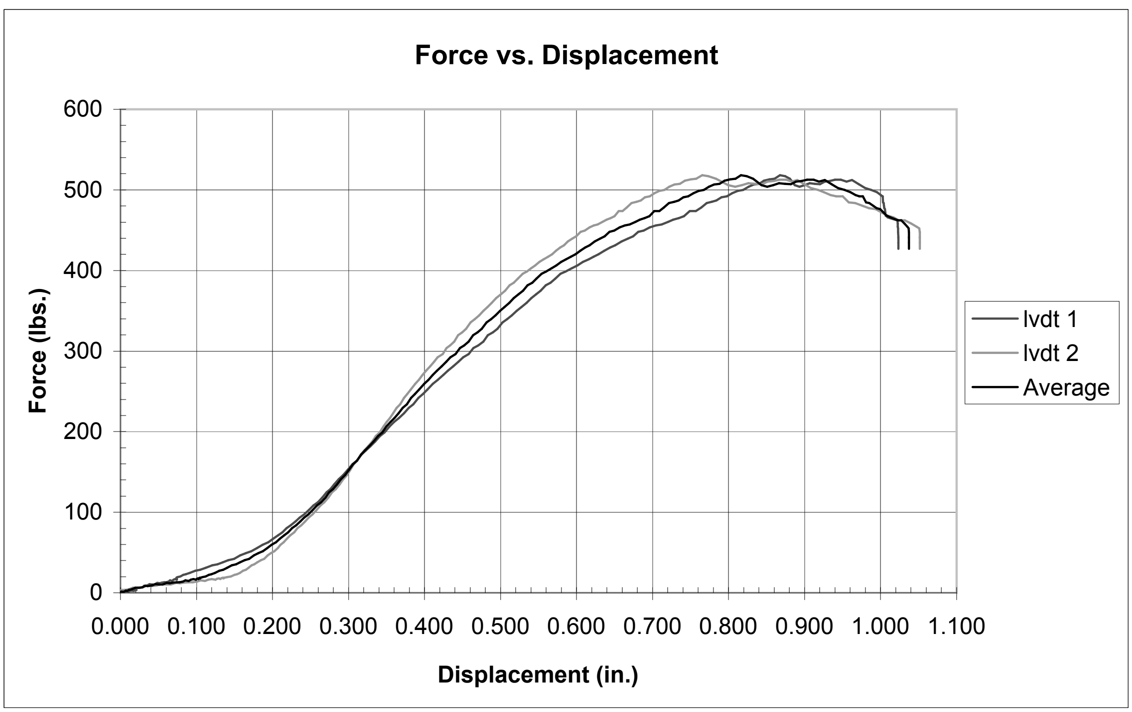
Thickness (in.) 0.0479 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.4	39.6	38.2	**39.4**

Measured Dimensions

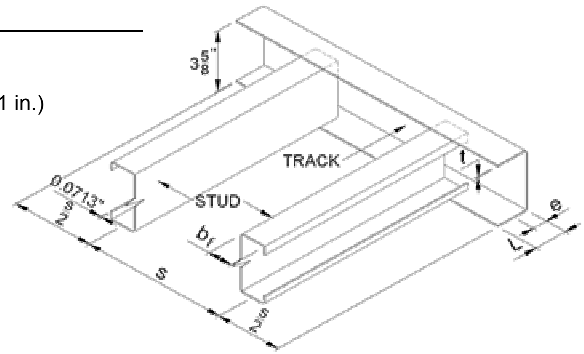
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 207 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***16-05-2-18 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t)	18 gage	(0.0451 in.)
Track Leg Length (L)	2 in.	

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e)	0.5 in.
Stud Flange Width (bf)	2 1/2 in.
Stud Spacing (s)	16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

Ram Speed: 0.1 inches in 20 seconds

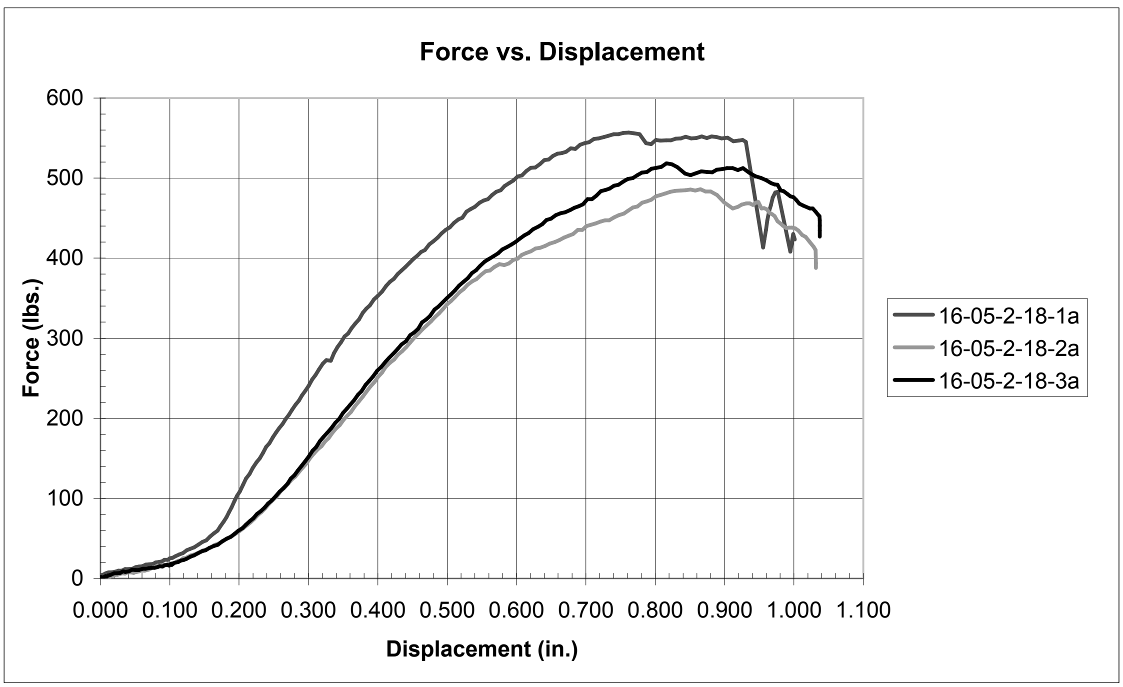
Maximum Load of Tests:

16-05-2-18-1a	556.65 Lbs.
16-05-2-18-2a	486.22 Lbs.
16-05-2-18-3a	518.30 Lbs.

Track Material Property

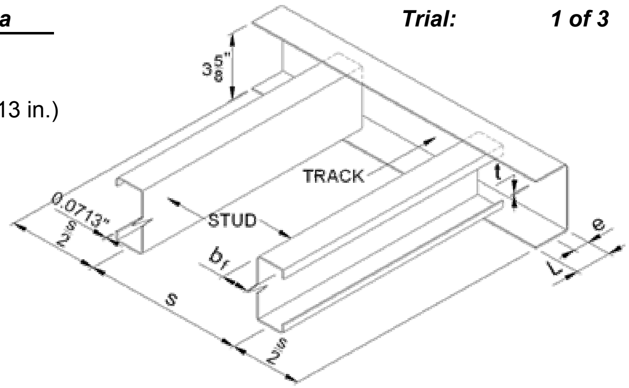
Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.4	39.6	38.2	**39.4**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-14-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

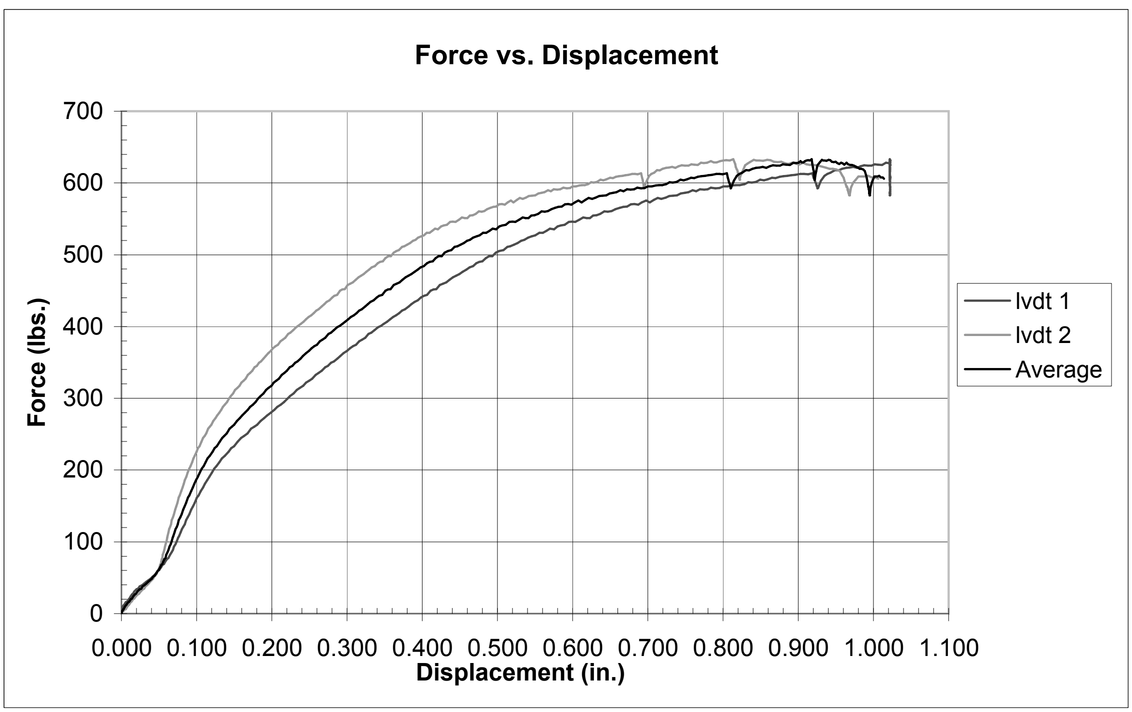
Thickness (in.) 0.0720 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

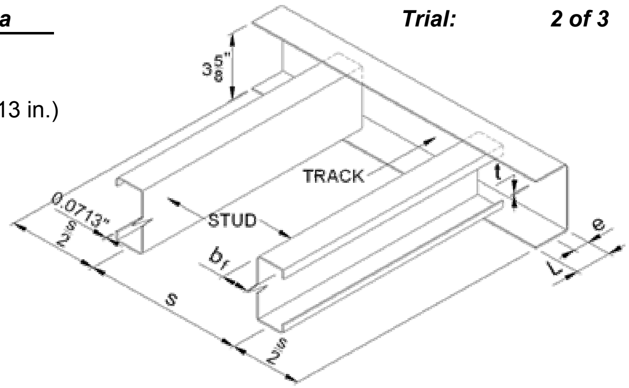
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 366 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-14-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

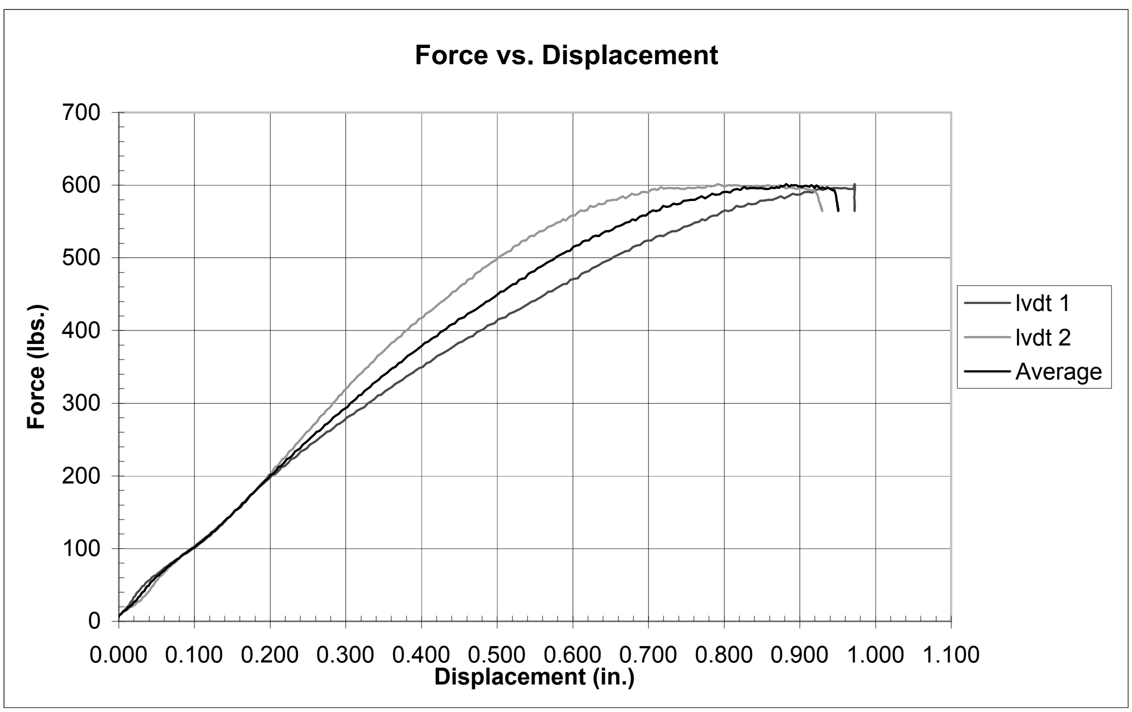
Thickness (in.) 0.0718 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	Average of Tests
40.9	40.5	40.5	**40.6**

Measured Dimensions

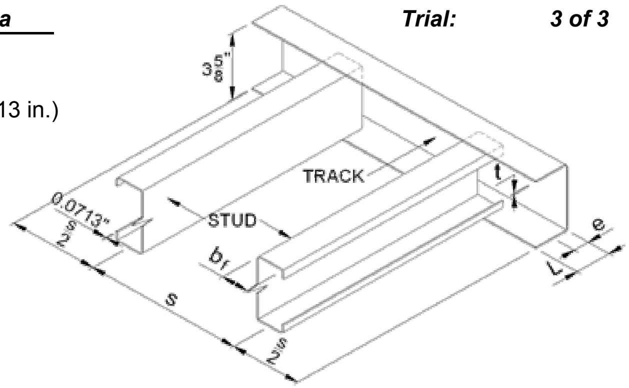
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 315 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-14-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

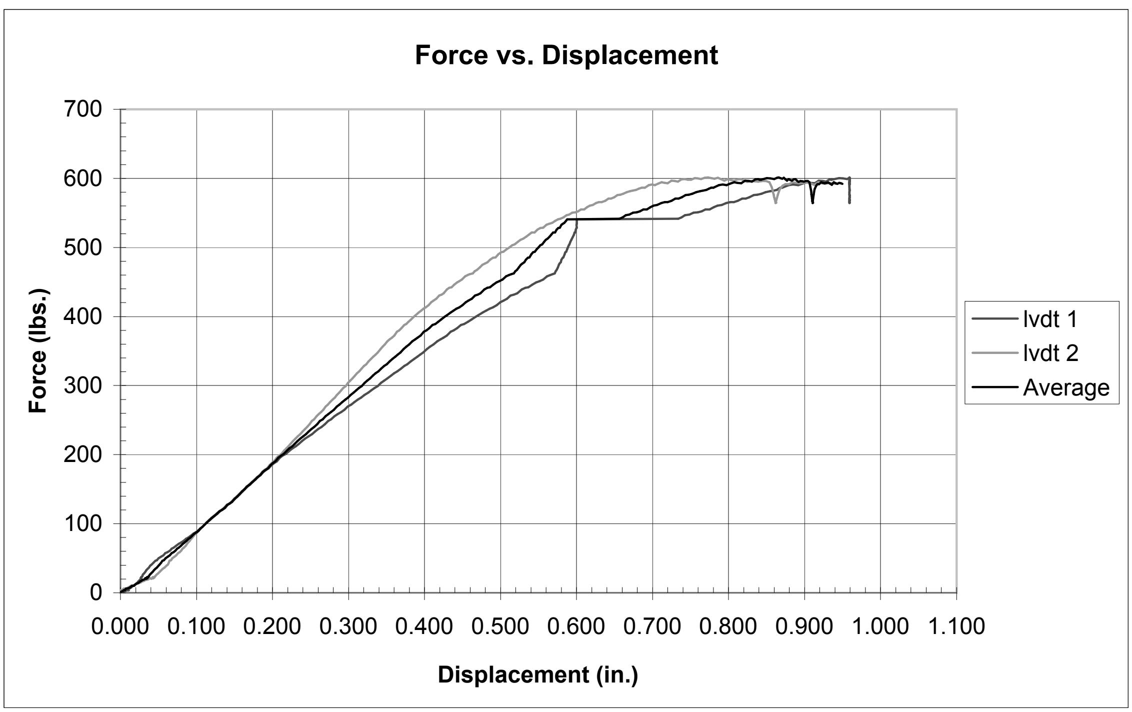
Thickness (in.) 0.0722 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

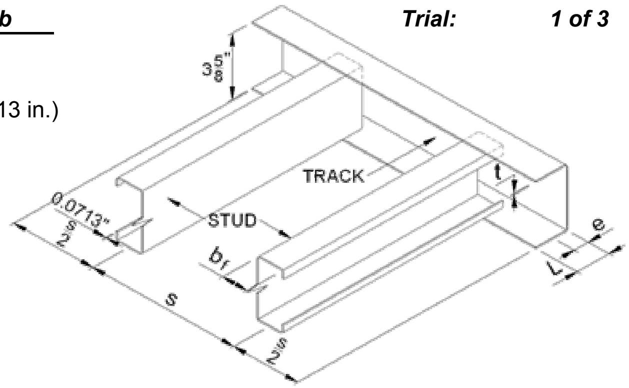
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 319 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-14-1b*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

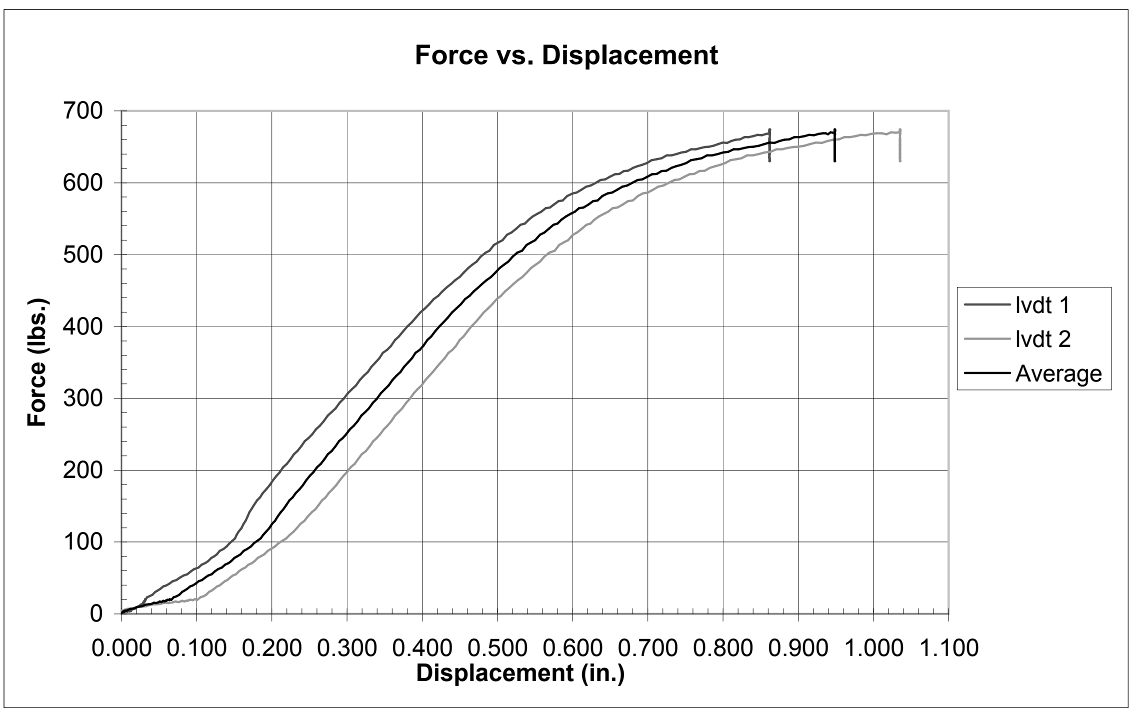
Thickness (in.) 0.0720 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

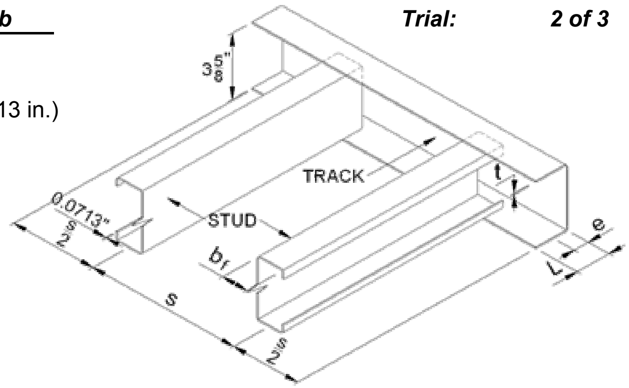
La (in.): 16.5 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 253 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-14-2b*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

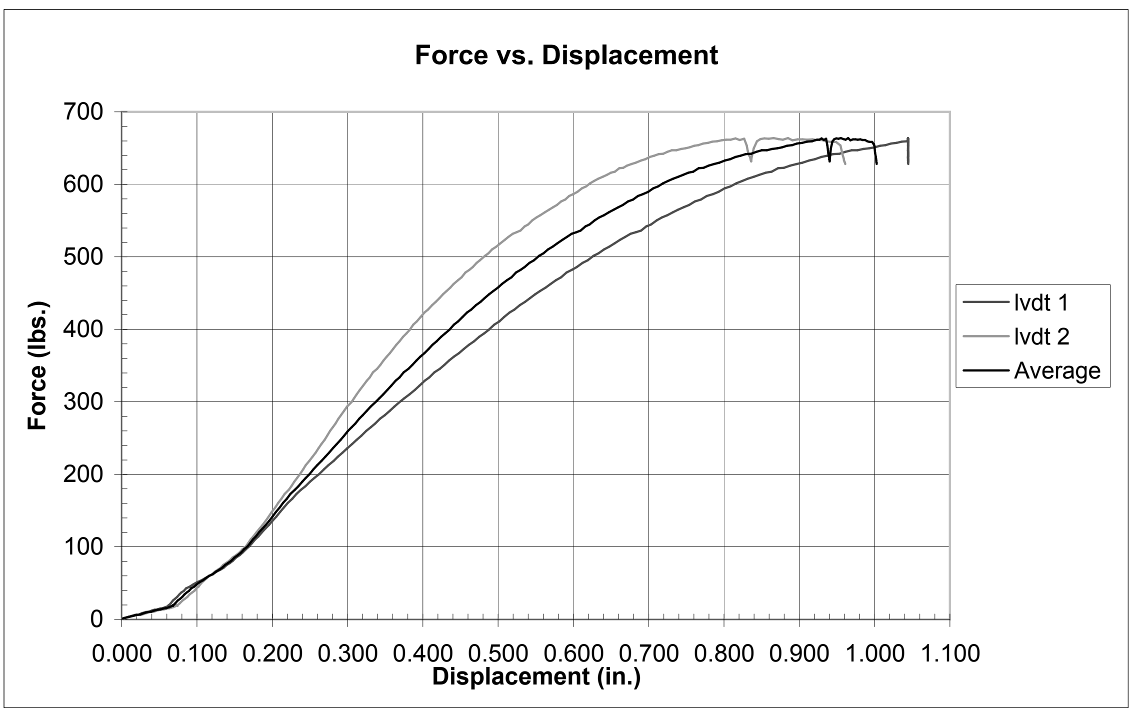
Thickness (in.) 0.0718 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

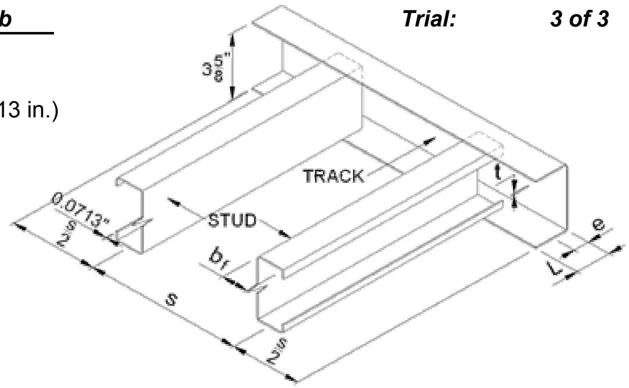
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 275 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-14-3b*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

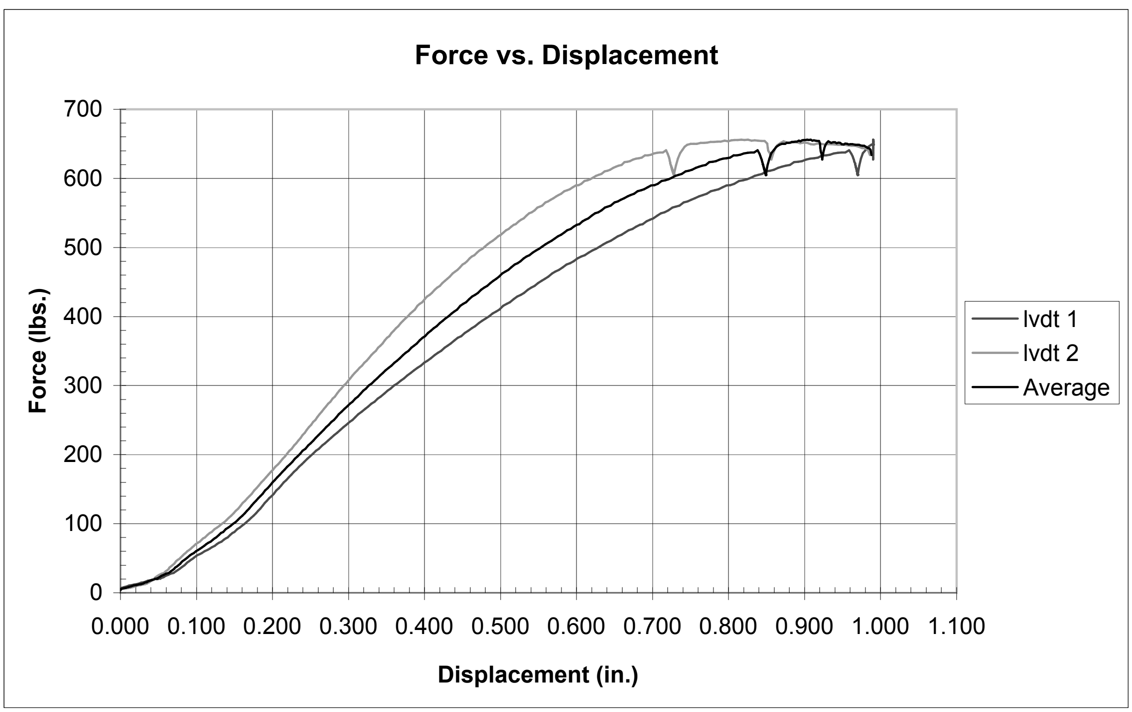
Thickness (in.) 0.0722 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

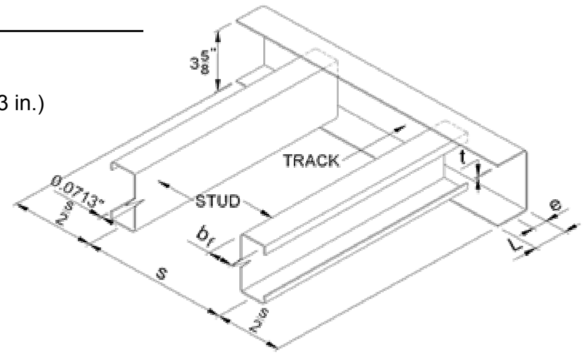
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 408 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***16-10-1-14 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t)	14 gage	(0.0713 in.)
Track Leg Length (L)	3 in.	

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e)	1 in.
Stud Flange Width (bf)	1 5/8 in.
Stud Spacing (s)	16 in.

Fastener Configuration

"a" tests: TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

"b" tests: THREE 1/4 in. dia. bolt w/ steel washers, ONE at specimen center and ONE at 12in. off specimen center (each side)

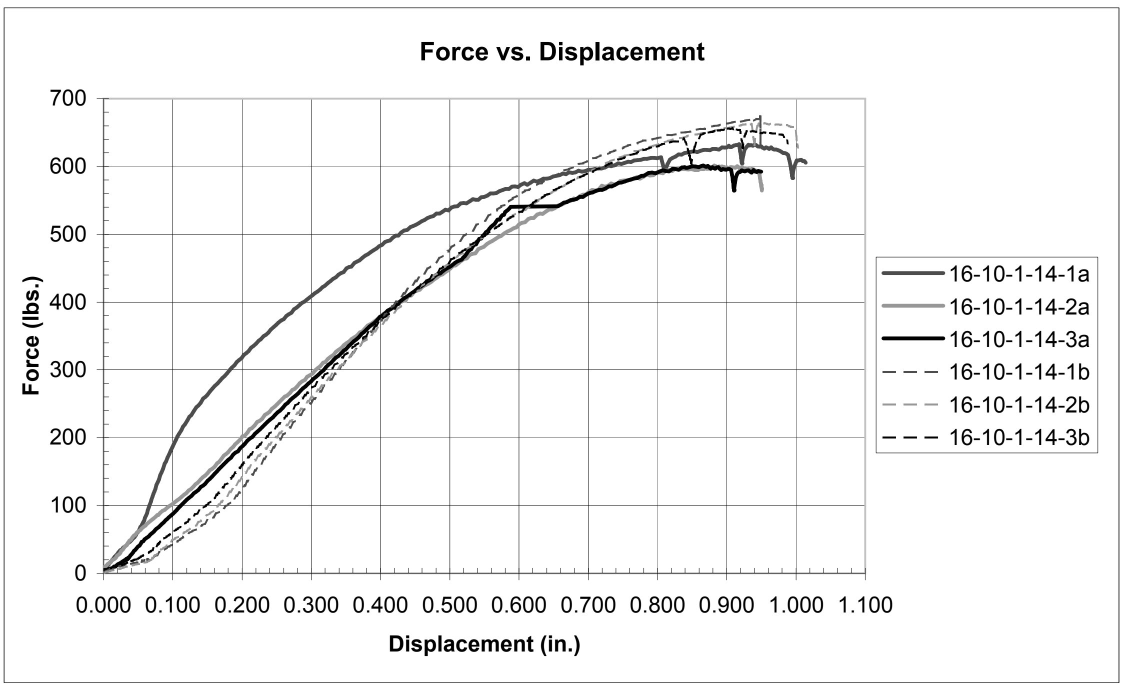
Ram Speed: 0.1 inches in 30 seconds

Maximum Load of Tests:

16-10-1-14-1a	632.96 Lbs.	16-10-1-14-1b	674.21 Lbs.
16-10-1-14-2a	601.48 Lbs.	16-10-1-14-2b	663.97 Lbs.
16-10-1-14-3a	601.17 Lbs.	16-10-1-14-3b	656.14 Lbs.

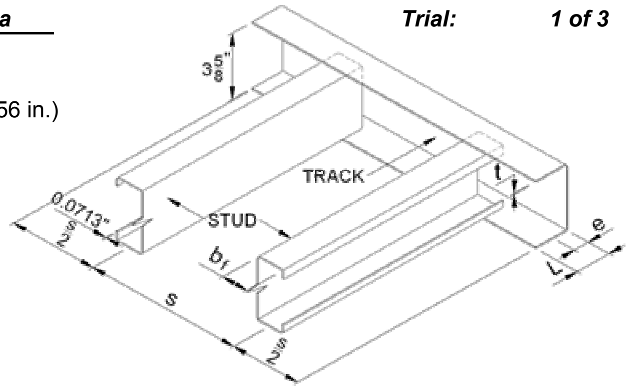
Track Material Property

Yield (ksi)	Test #1	Test #2	Test #3	Average of Tests
	40.9	40.5	40.5	**40.6**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-16-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

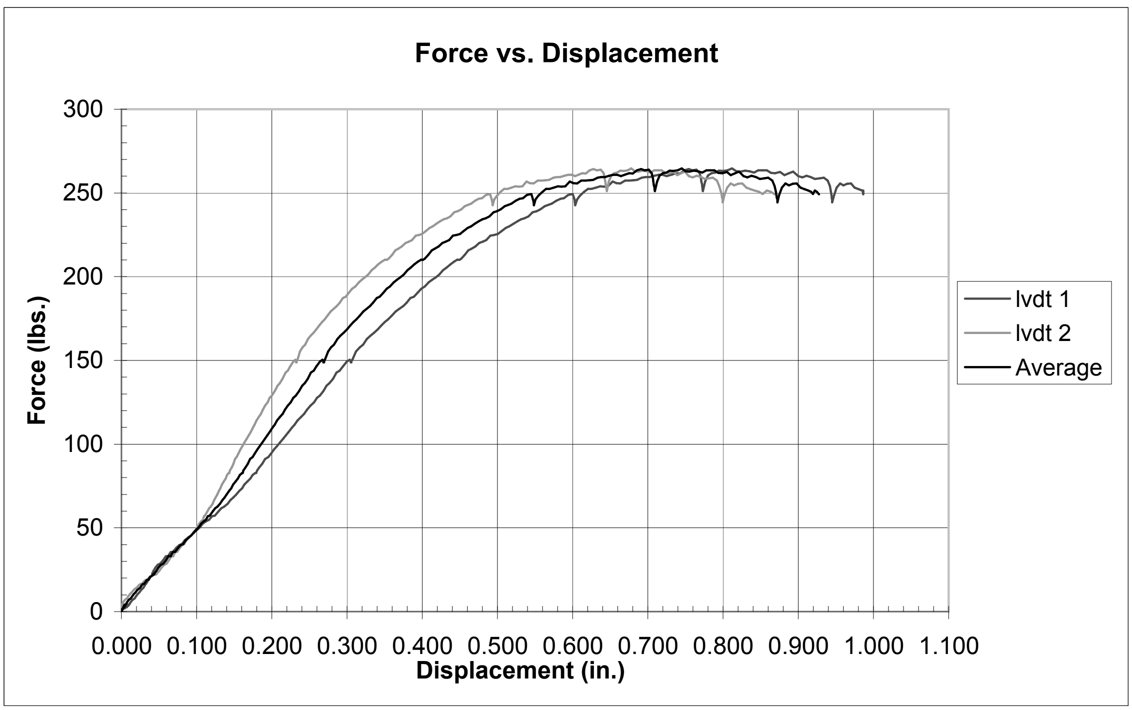
Thickness (in.) 0.0493 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

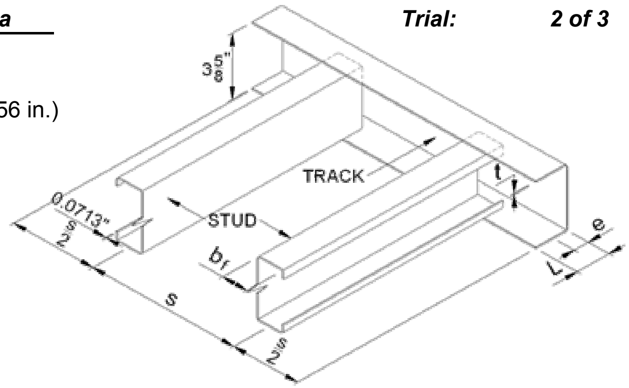
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 332 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-16-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

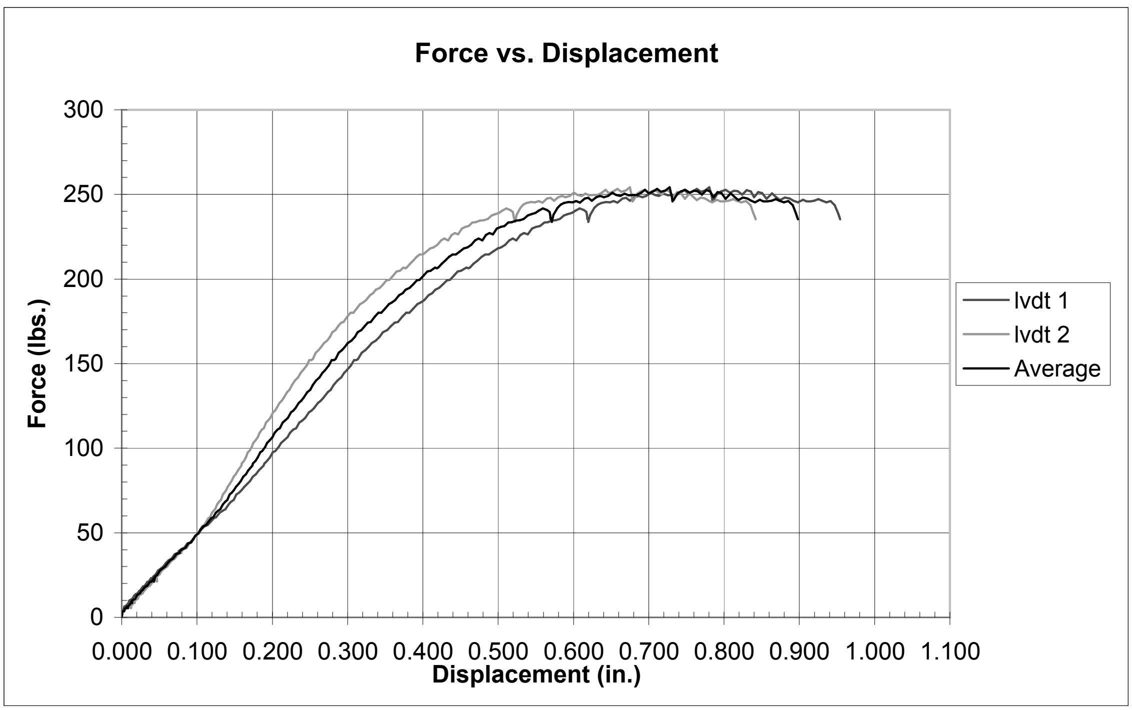
Thickness (in.) 0.0494 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	Average of Tests
23.5	37.9	39.3	**33.6**

Measured Dimensions

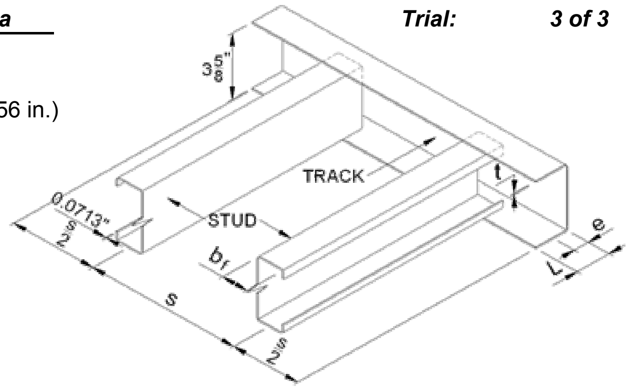
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 263 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-16-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

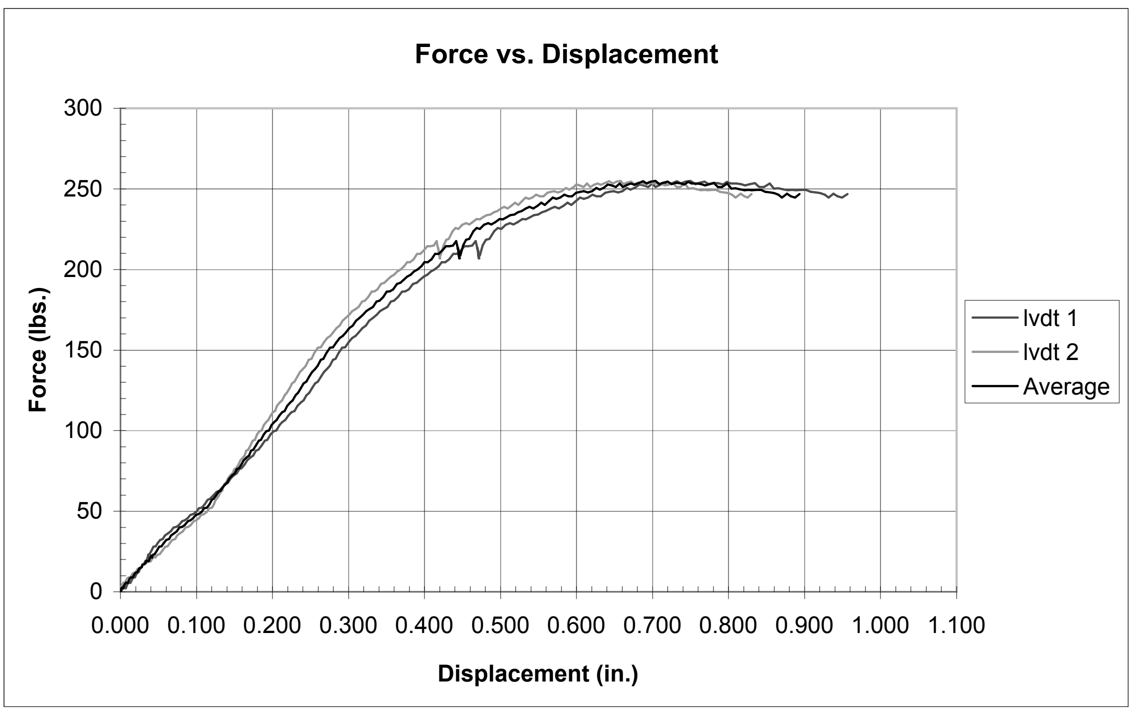
Thickness (in.) 0.0488 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

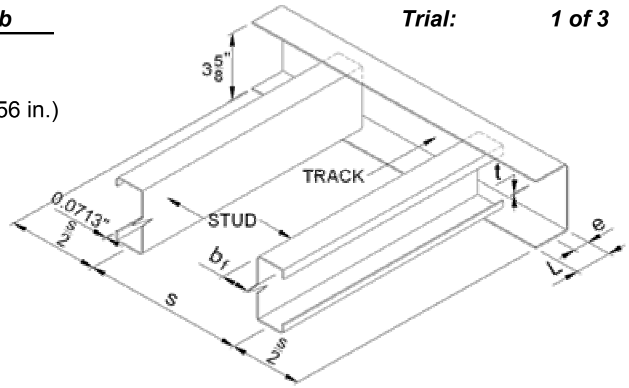
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 274 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-16-1b*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

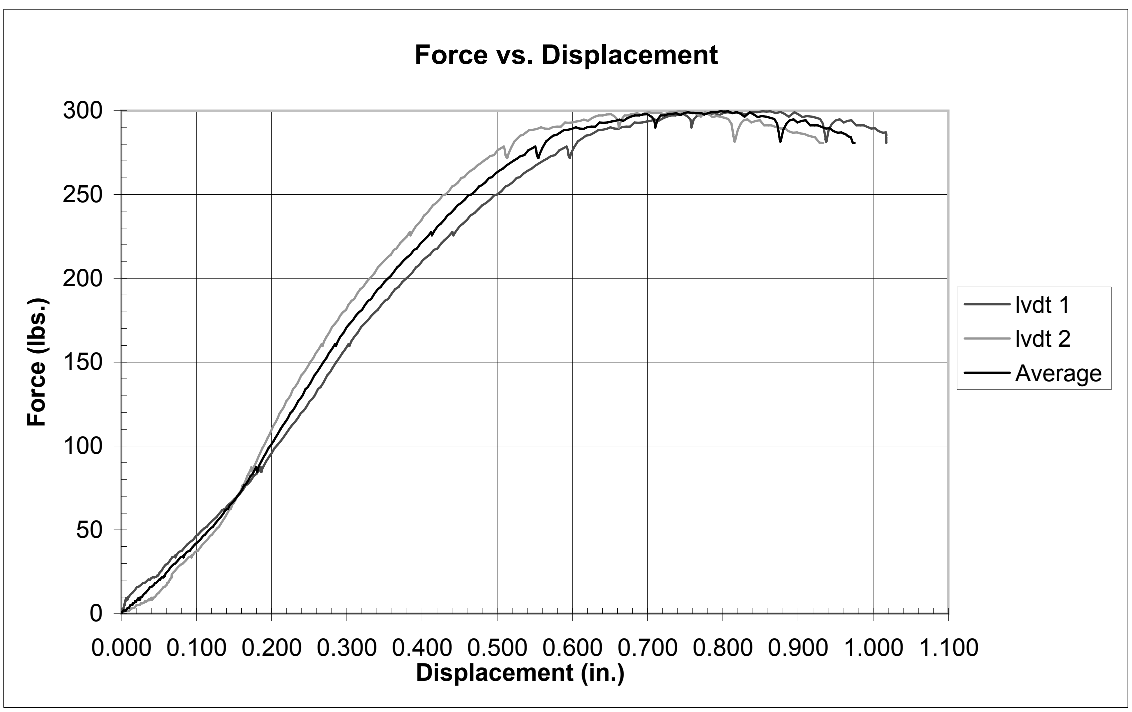
Thickness (in.) 0.0493 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

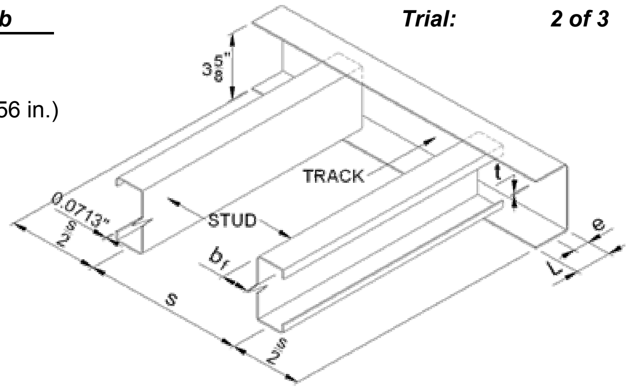
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 401 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-16-2b*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

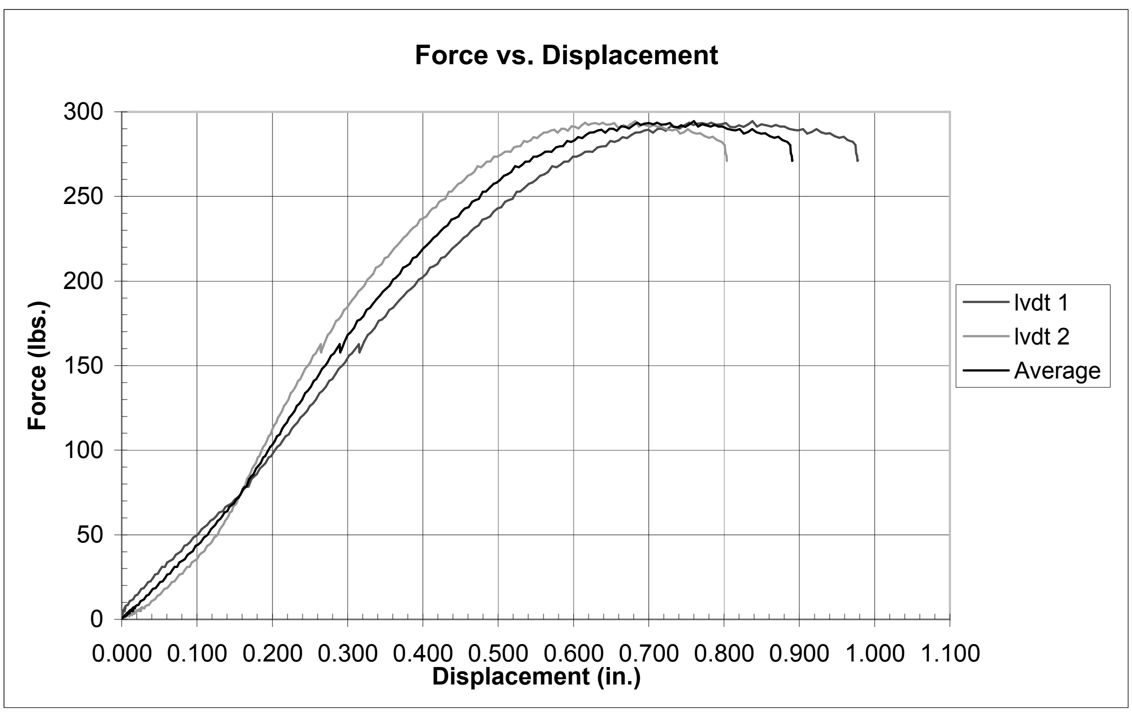
Thickness (in.) 0.0494 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

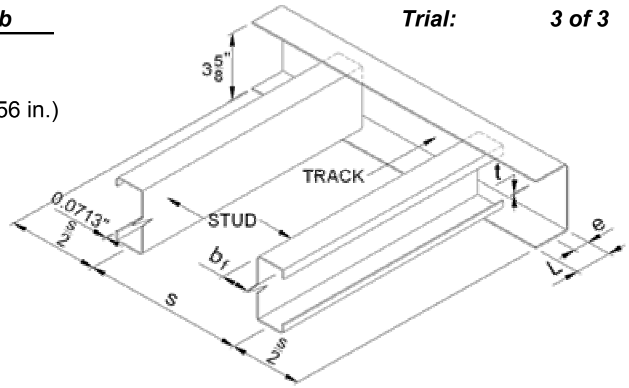
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 271 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-16-3b*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

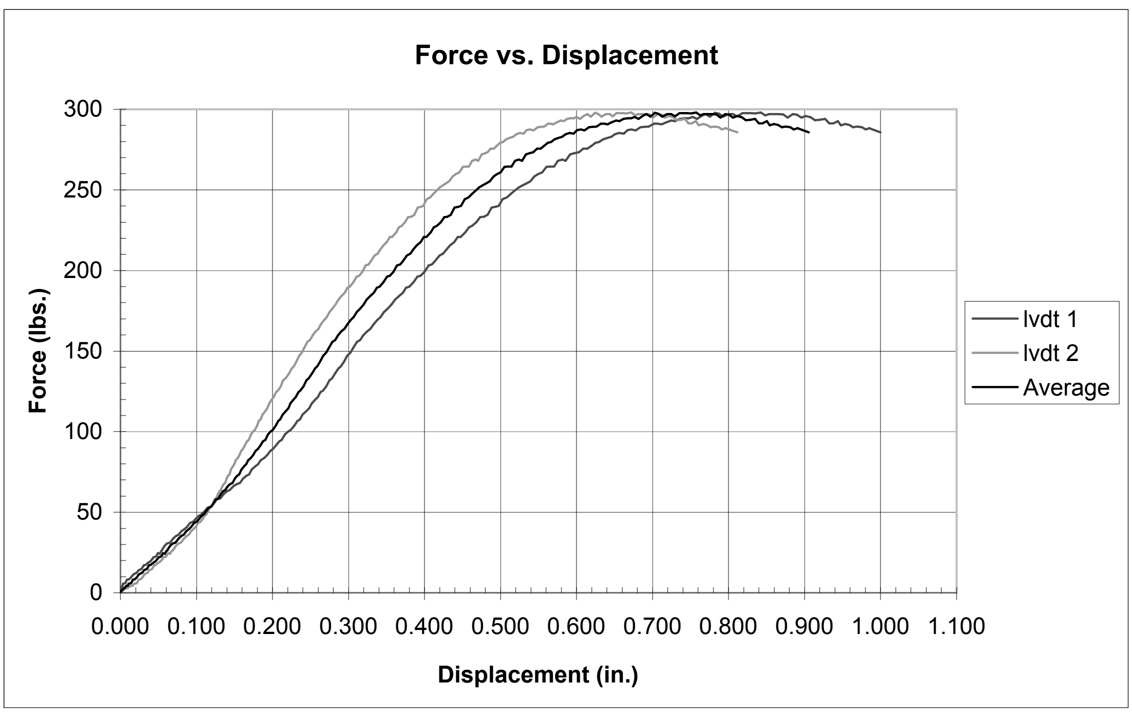
Thickness (in.) 0.0488 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

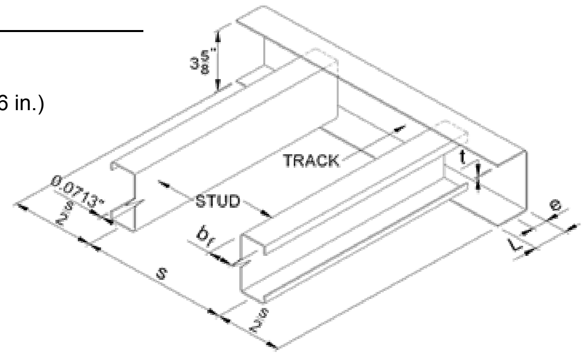
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 237 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***16-10-1-16 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

"a" tests: TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

"b" tests: THREE 1/4 in. dia. bolt w/ steel washers, ONE at specimen center and ONE at 12in. off specimen center (each side)

Ram Speed: 0.1 inches in 30 seconds

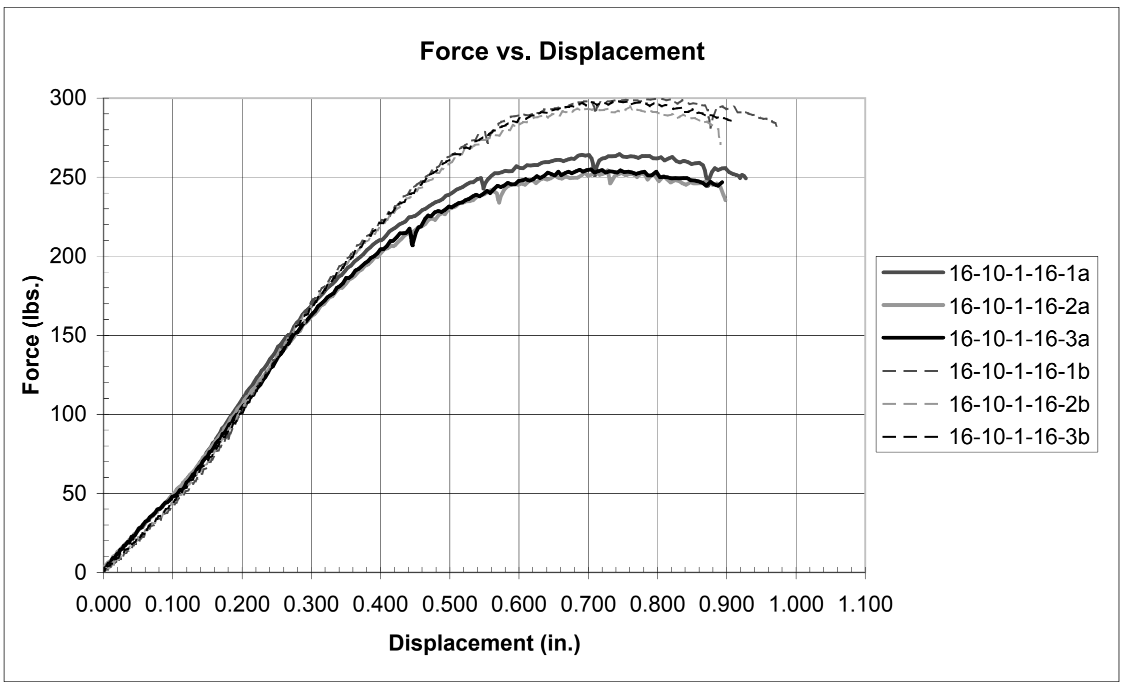
Maximum Load of Tests:

16-10-1-16-1a	264.68 Lbs.	16-10-1-16-1b	299.59 Lbs.
16-10-1-16-2a	254.19 Lbs.	16-10-1-16-2b	294.58 Lbs.
16-10-1-16-3a	254.97 Lbs.	16-10-1-16-3b	298.03 Lbs.

Track Material Property

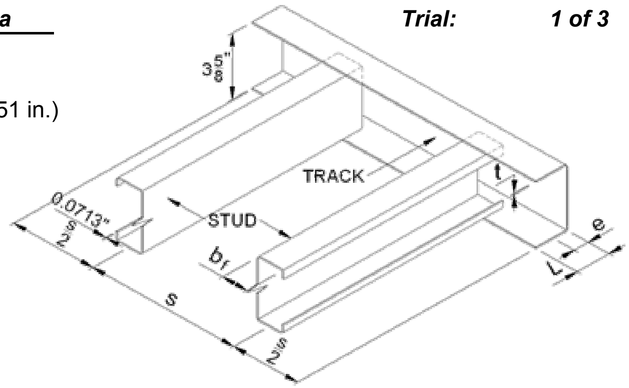
Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-18-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

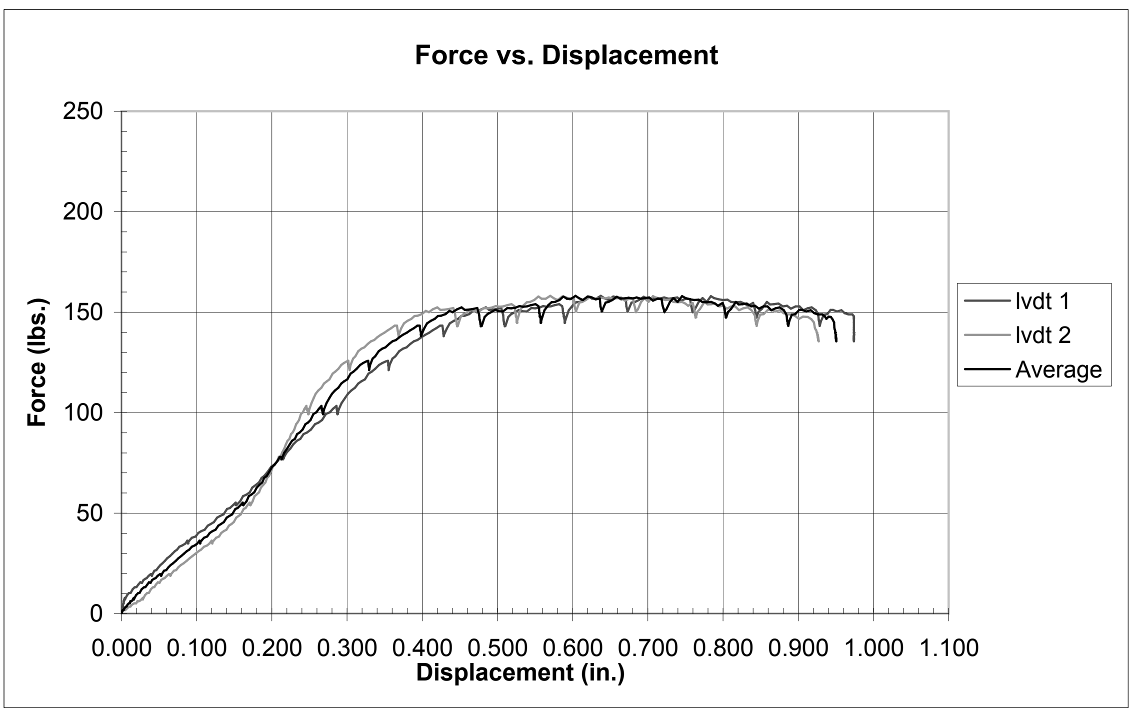
Thickness (in.) 0.0442 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

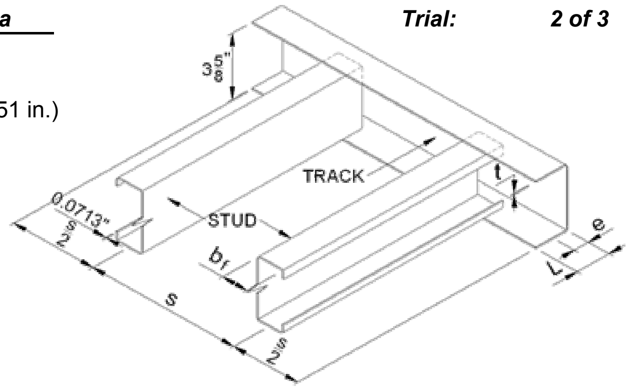
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 428 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-18-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

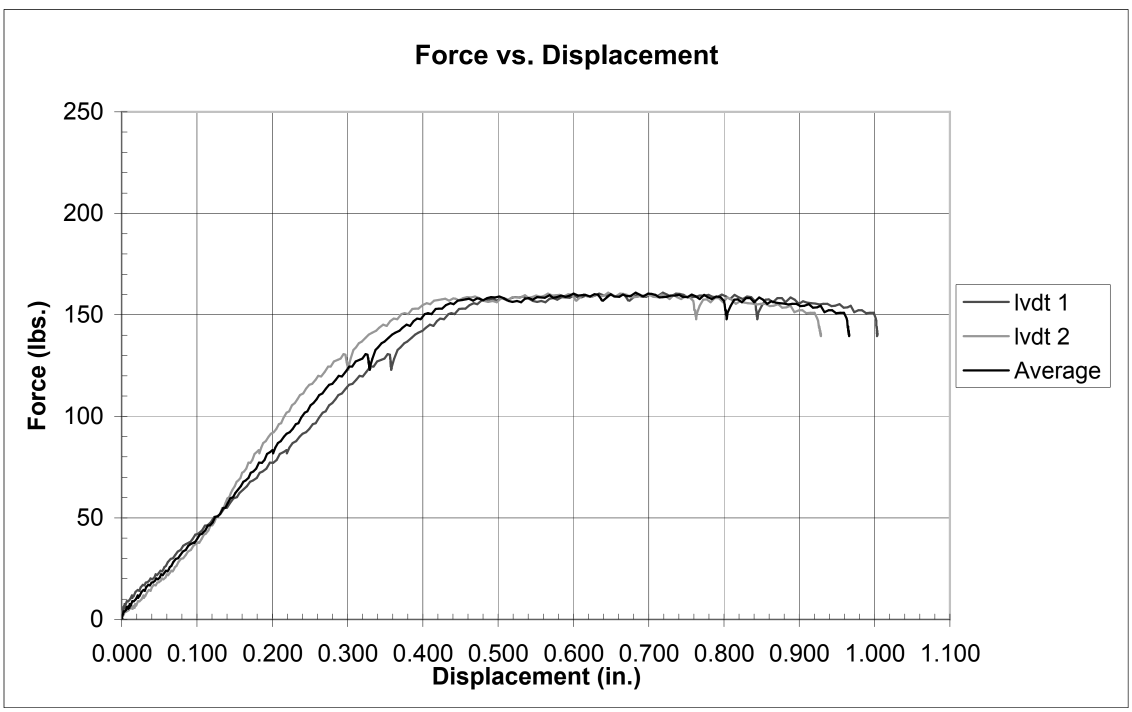
Thickness (in.) 0.0444 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

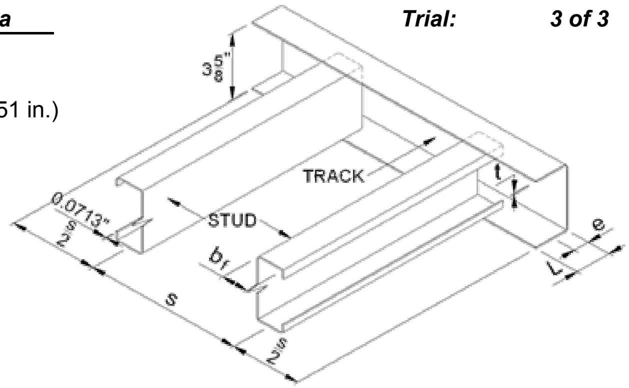
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 344 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-18-3a*** **_Trial:_** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

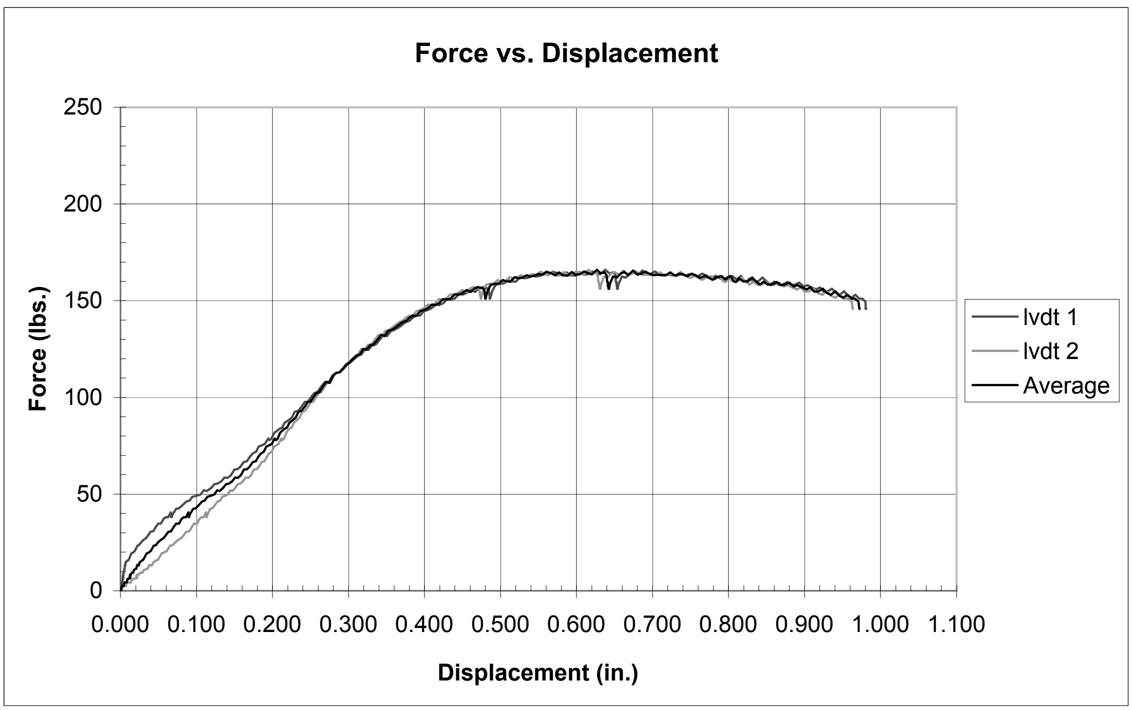
Thickness (in.) 0.0443 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

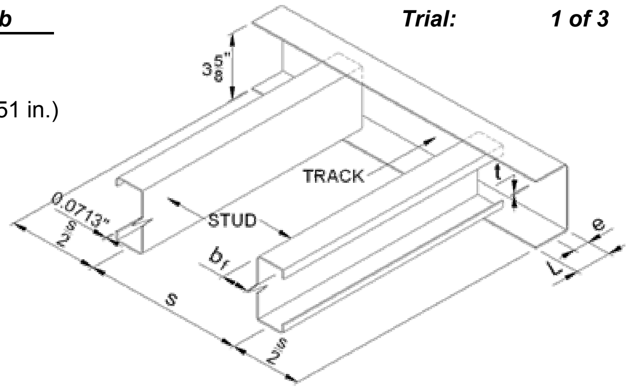
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 304 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-18-1b*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

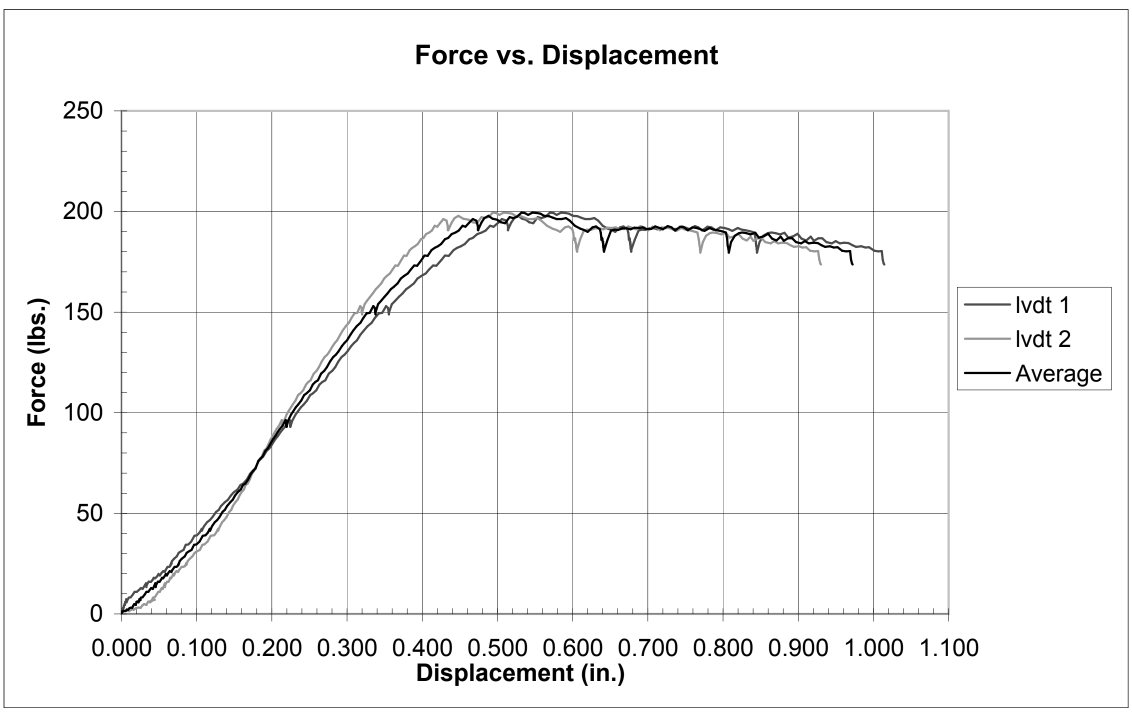
Thickness (in.) 0.0442 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	
23.0	22.8	22.6	

Measured Dimensions

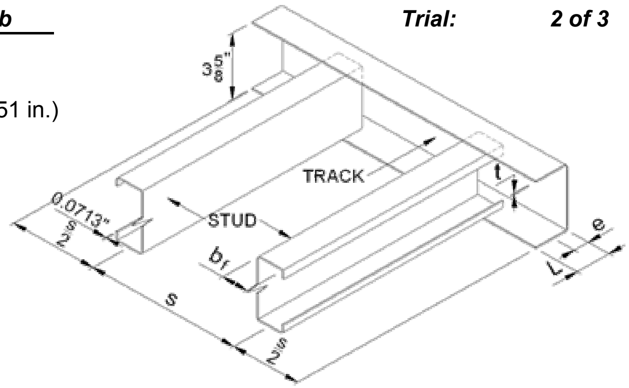
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: **Total Time of Test:** 349 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-18-2b*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

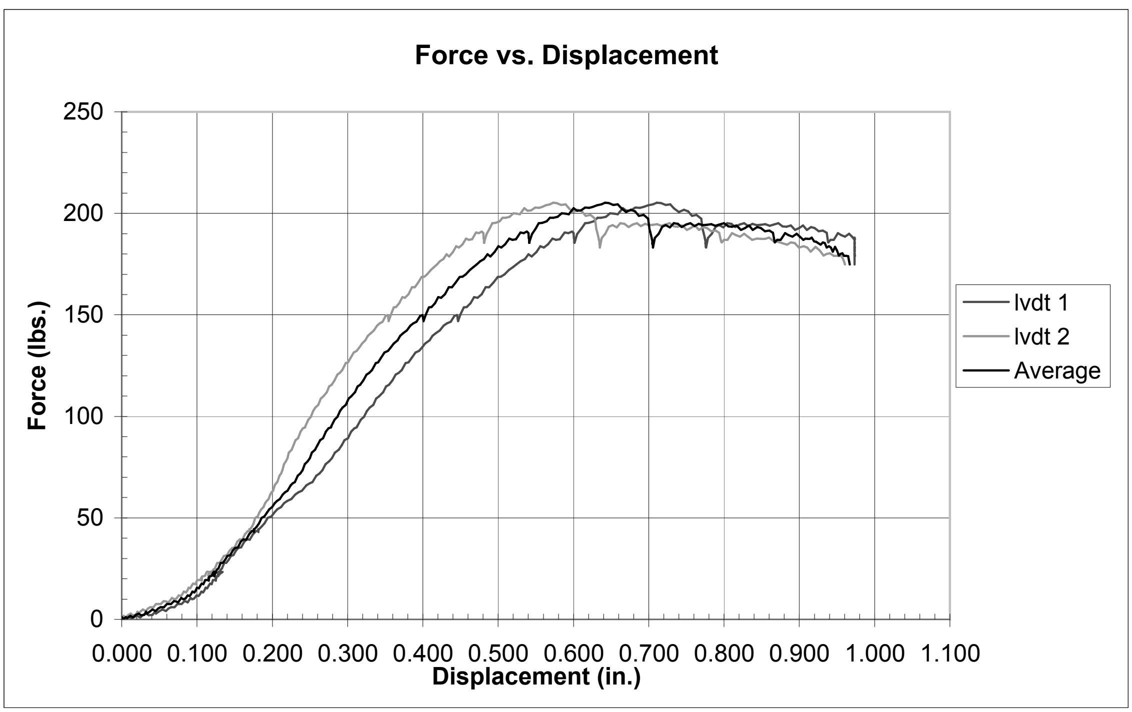
Thickness (in.) 0.0444 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

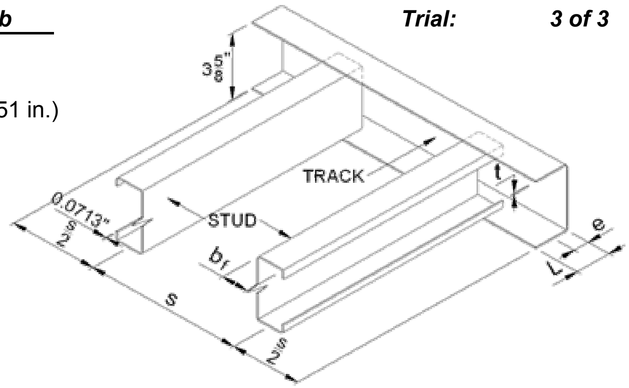
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 324 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-1-18-3b*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

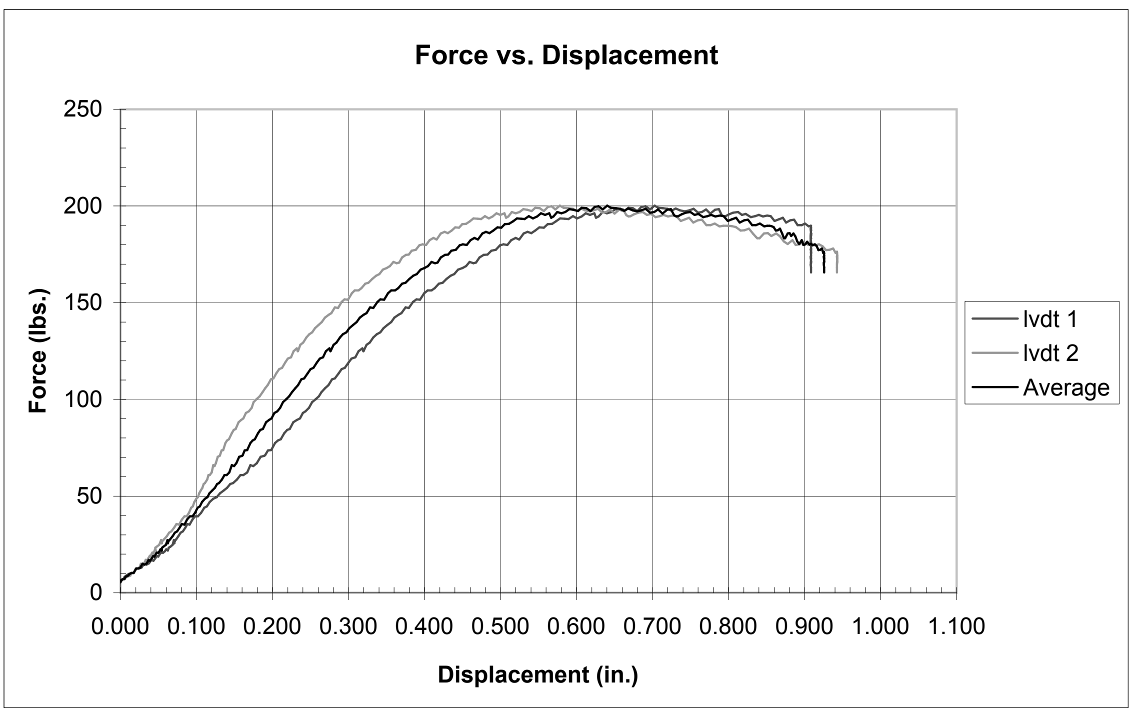
Thickness (in.) 0.0443 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

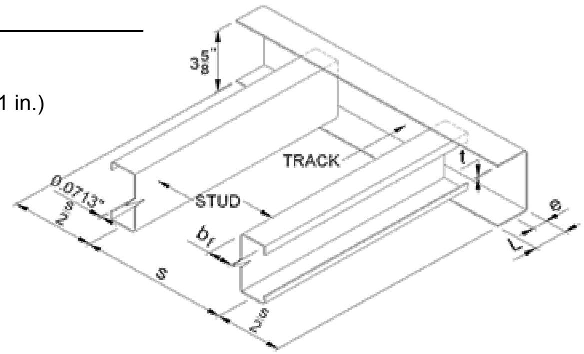
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 277 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***16-10-1-18 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t)	18 gage	(0.0451 in.)
Track Leg Length (L)	3 in.	

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e)	1 in.
Stud Flange Width (bf)	1 5/8 in.
Stud Spacing (s)	16 in.

Fastener Configuration

"a" tests: TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

"b" tests: THREE 1/4 in. dia. bolt w/ steel washers, ONE at specimen center and ONE at 12in. off specimen center (each side)

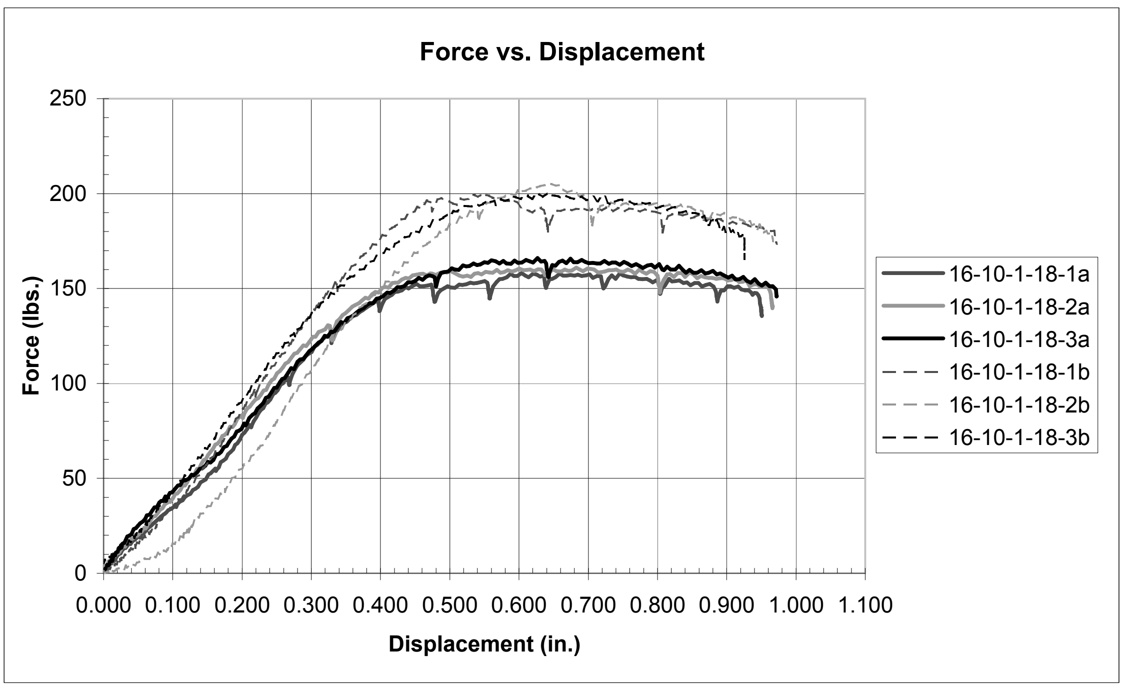
Ram Speed: 0.1 inches in 30 seconds

Maximum Load of Tests:

16-10-1-18-1a	158.18 Lbs.	16-10-1-18-1b	199.51 Lbs.
16-10-1-18-2a	161.00 Lbs.	16-10-1-18-2b	205.30 Lbs.
16-10-1-18-3a	166.01 Lbs.	16-10-1-18-3b	200.13 Lbs.

Track Material Property

	Test #1	Test #2	Test #3	Average of Tests
Yield (ksi)	23.0	22.8	22.6	**22.8**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-14-1a*** **Trial:** ***1 of 3***

Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

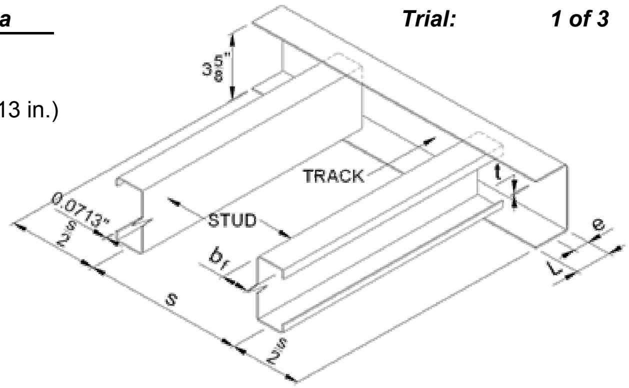
Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.



Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

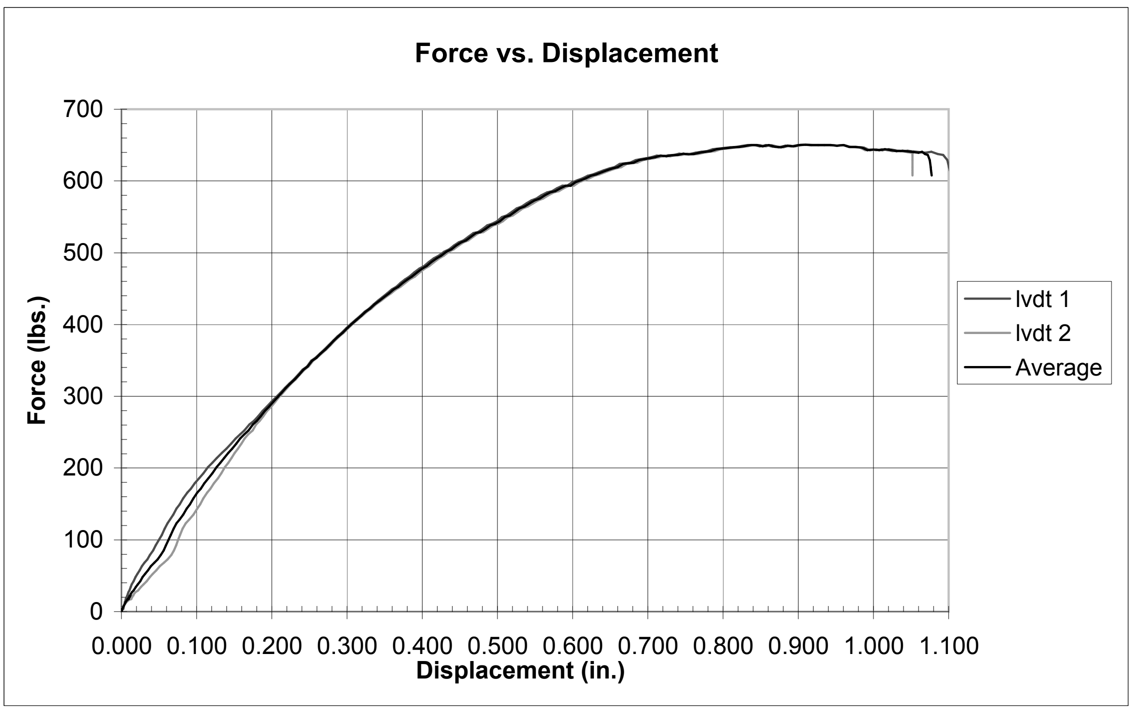
Thickness (in.) 0.0718 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

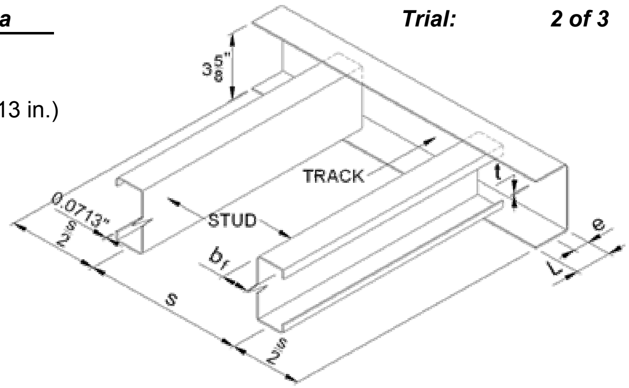
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 216 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-14-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

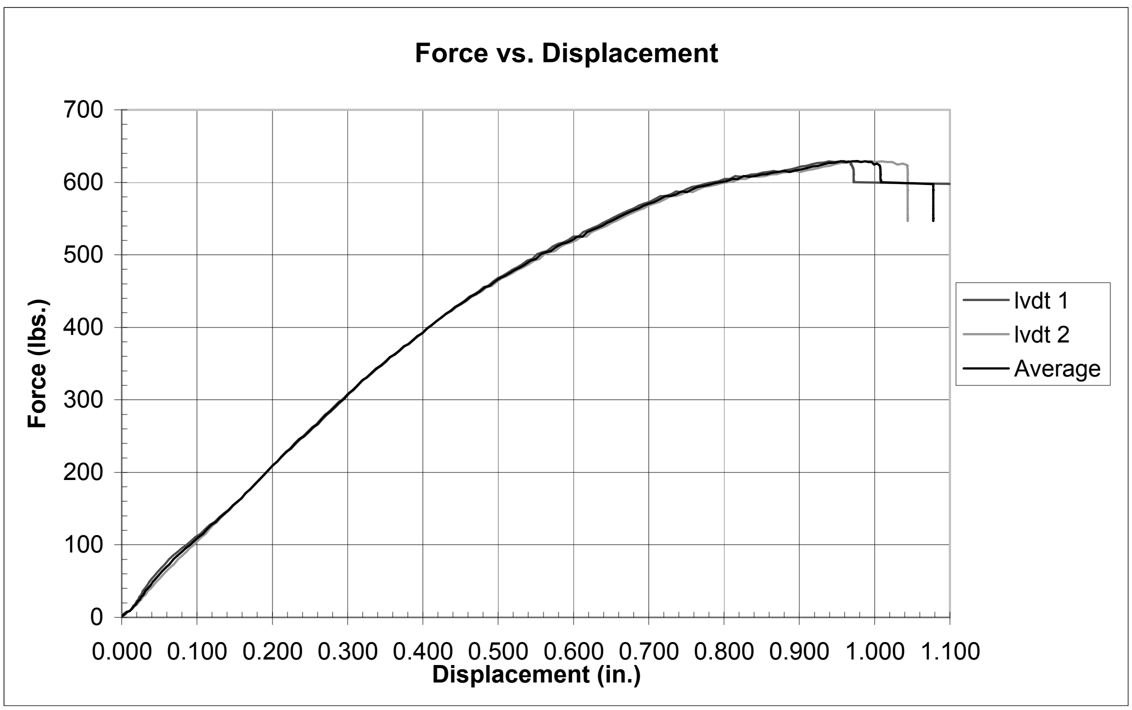
Thickness (in.) 0.0717 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

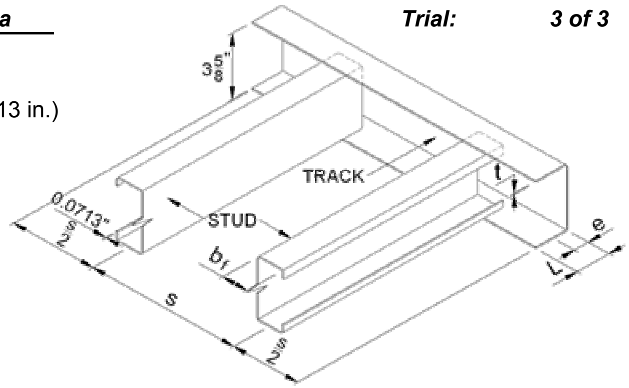
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 231 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-14-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

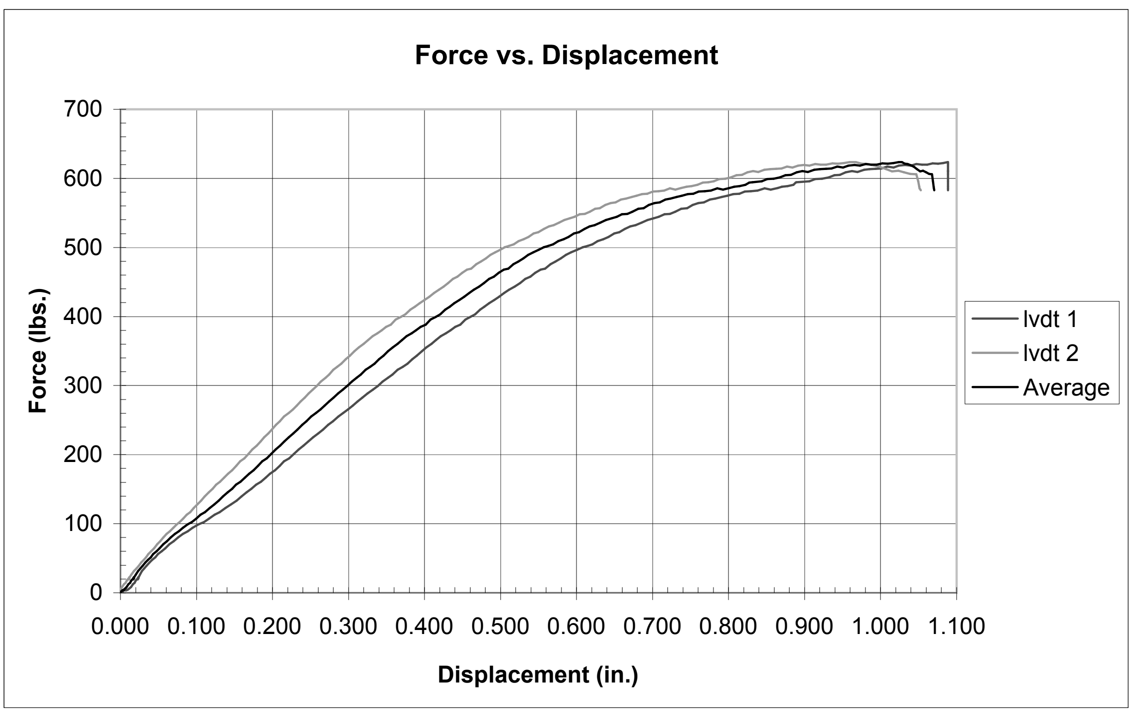
Thickness (in.) 0.0724 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

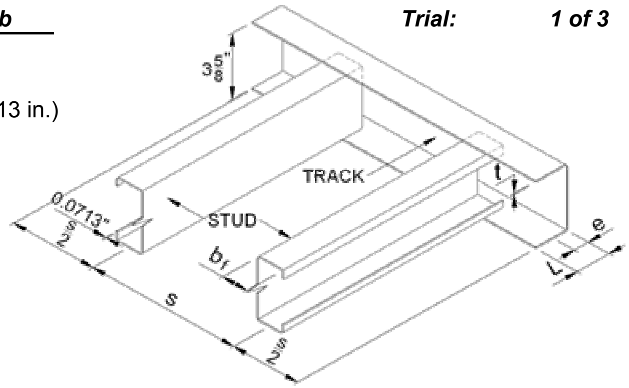
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 218 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-14-1b*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

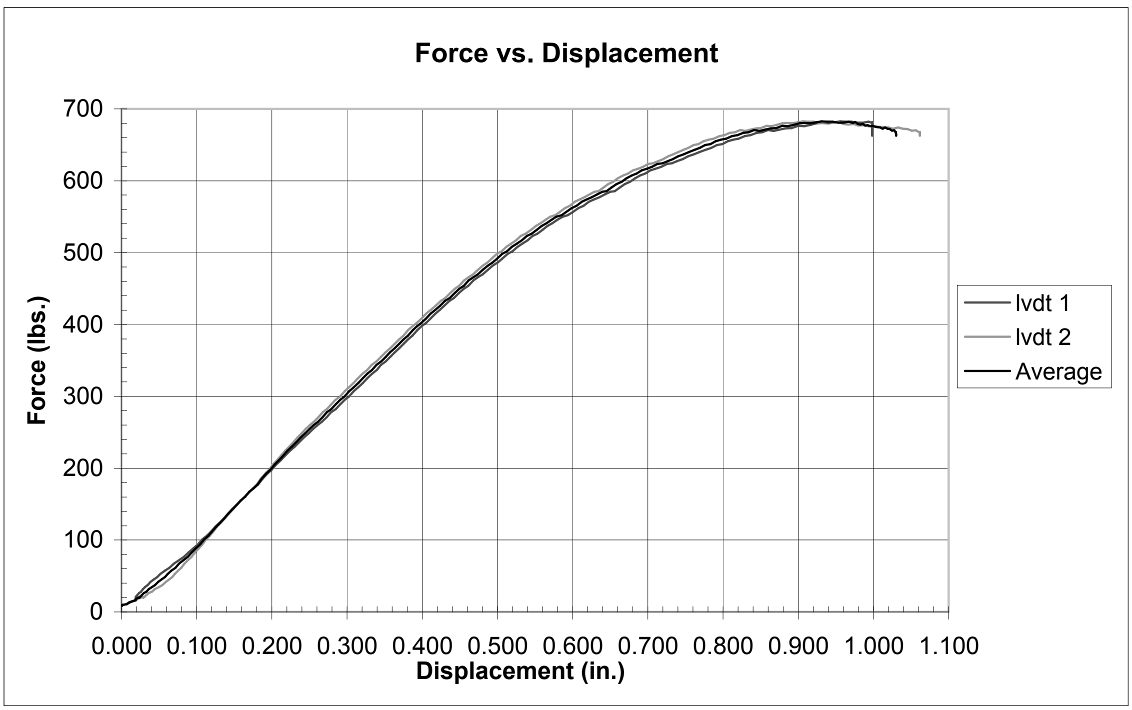
Thickness (in.) 0.0718 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

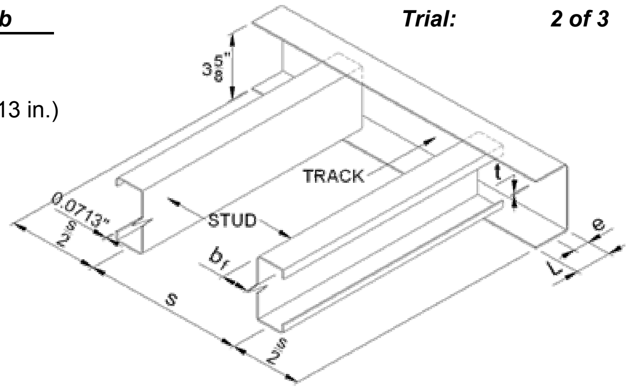
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 218 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-14-2b*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

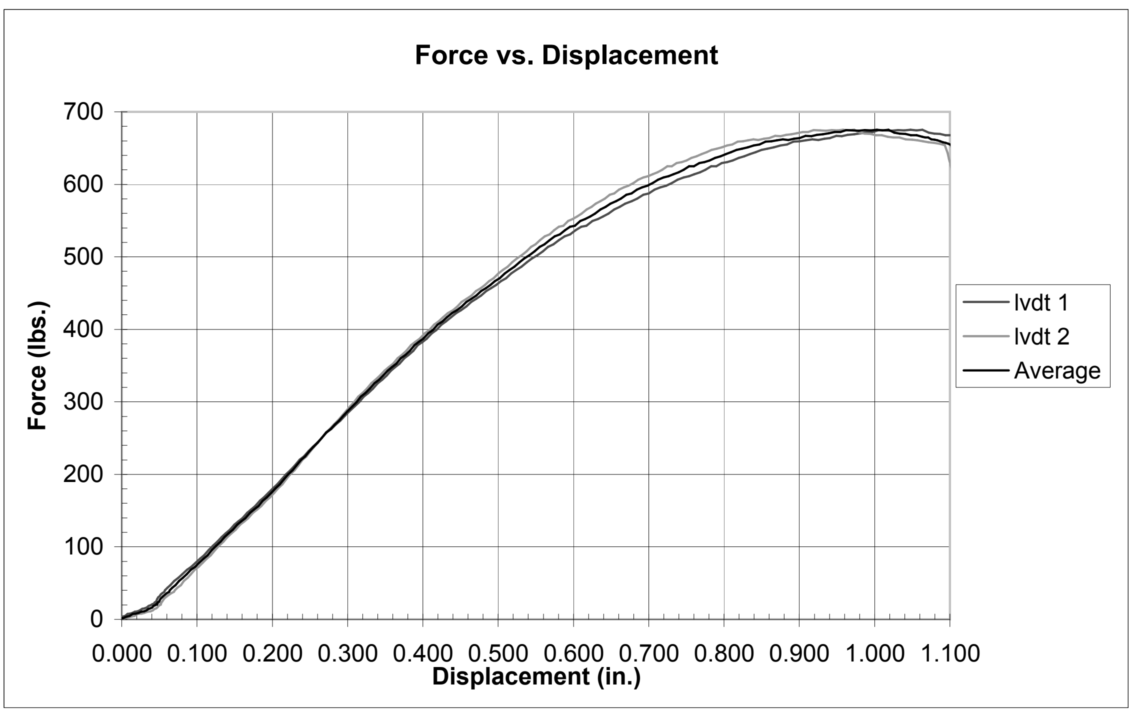
Thickness (in.) 0.0717 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

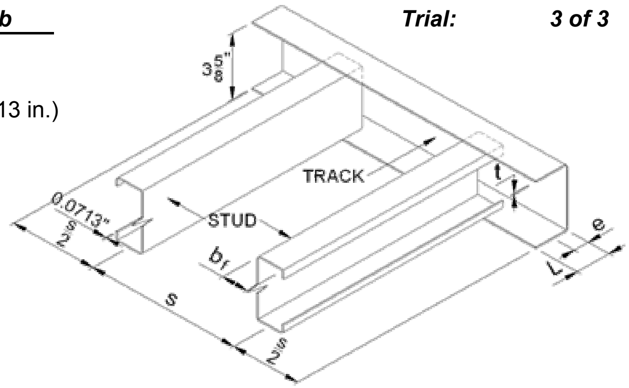
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 233 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-14-3b*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

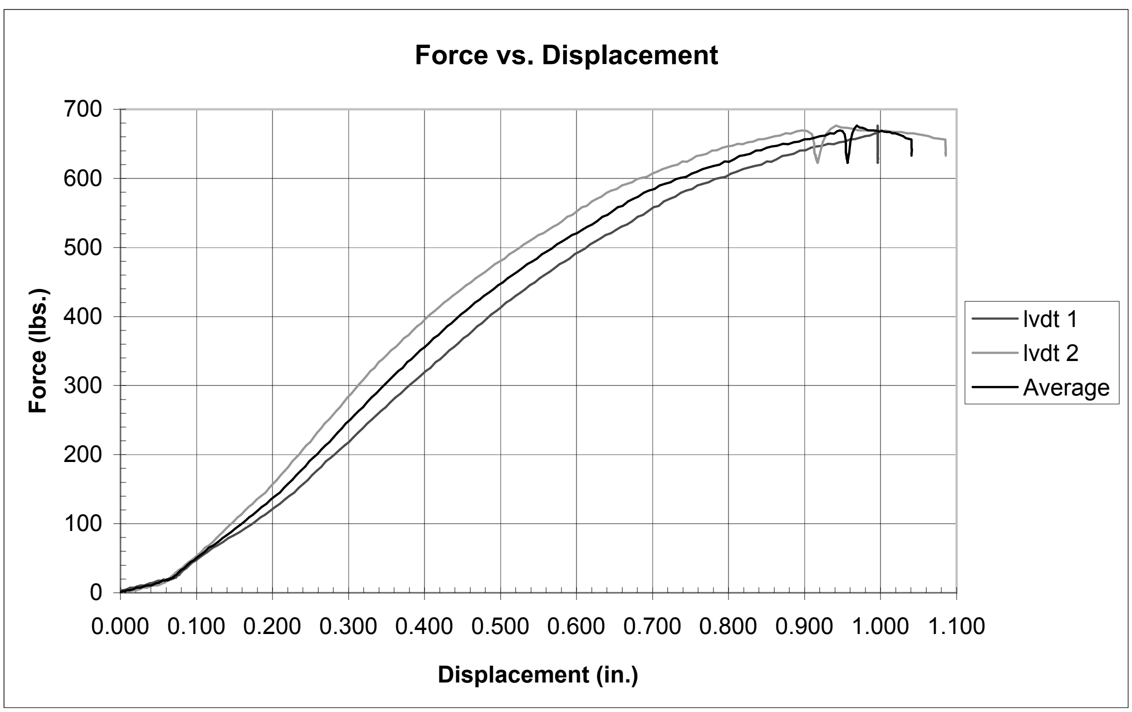
Thickness (in.) 0.0724 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

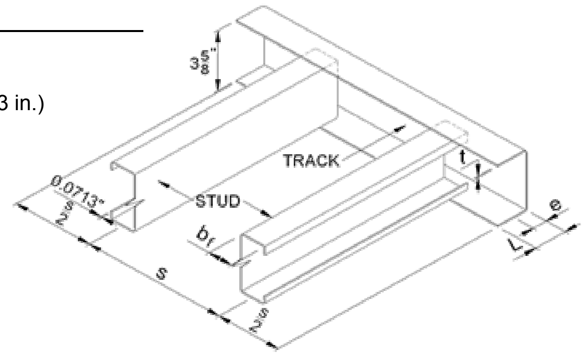
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 312 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***16-10-2-14 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

"a" tests: TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

"b" tests: THREE 1/4 in. dia. bolt w/ steel washers, ONE at specimen center and ONE at 12in. off specimen center (each side)

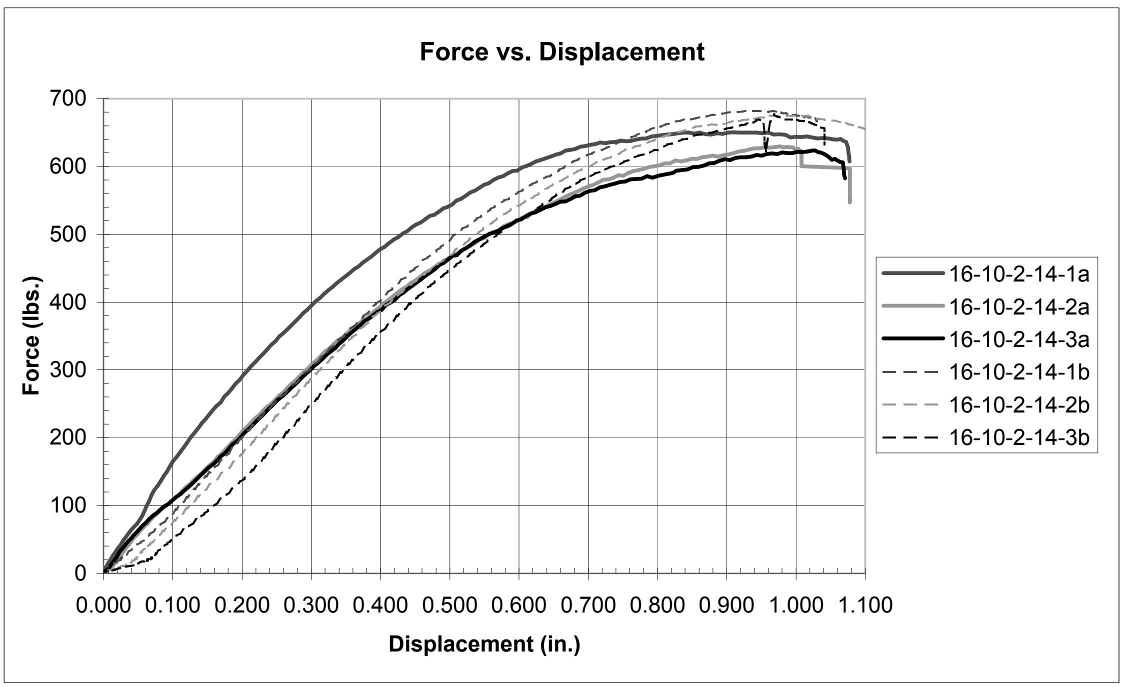
Ram Speed: 0.1 inches in 20 seconds

Maximum Load of Tests:

16-10-2-14-1a	650.35 Lbs.	16-10-2-14-1b	682.45 Lbs.
16-10-2-14-2a	629.52 Lbs.	16-10-2-14-2b	675.40 Lbs.
16-10-2-14-3a	623.72 Lbs.	16-10-2-14-3b	676.19 Lbs.

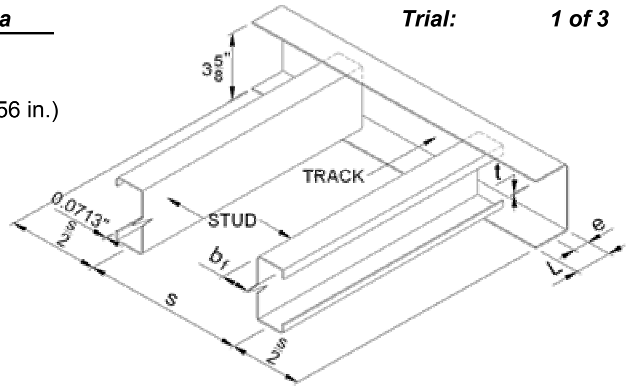
Track Material Property

Yield (ksi)	Test #1	Test #2	Test #3	**Average of Tests**
	40.9	40.5	40.5	**40.6**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-16-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

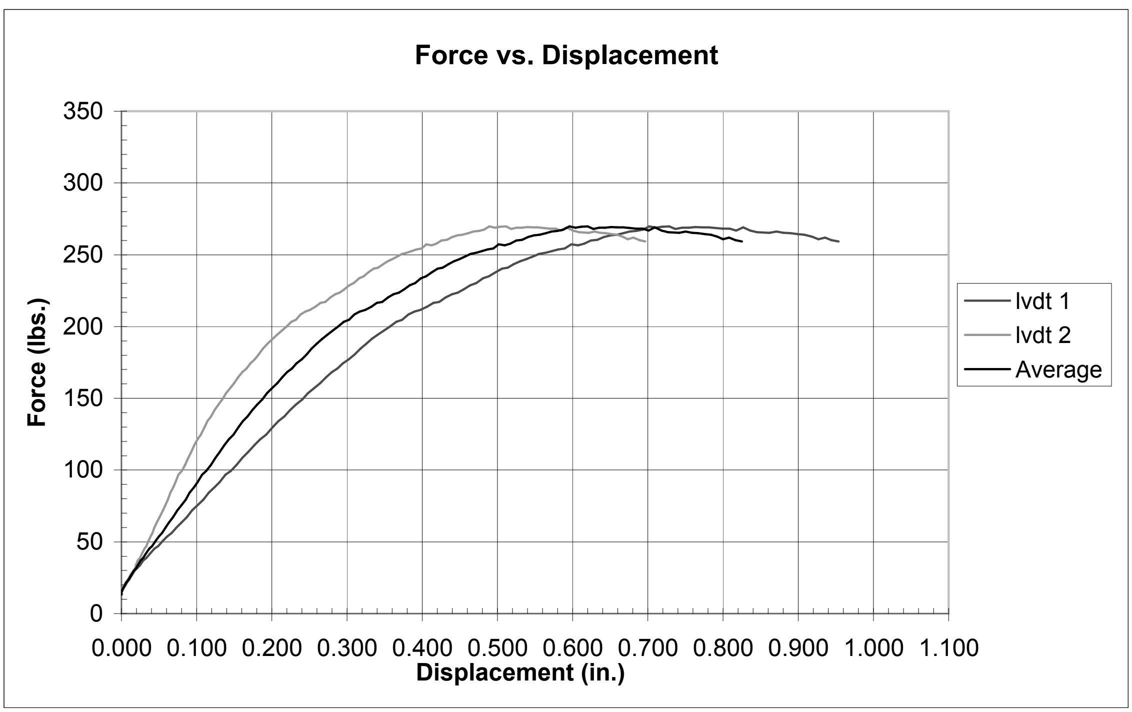
Thickness (in.) 0.0489 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 132 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-16-2a*** **Trial:** ***2 of 3***

Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

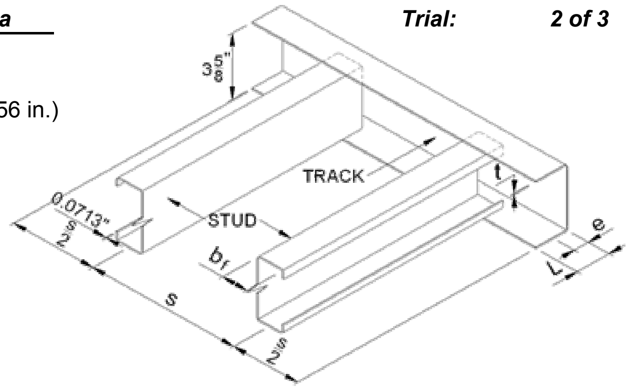
Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.



Track Material Property

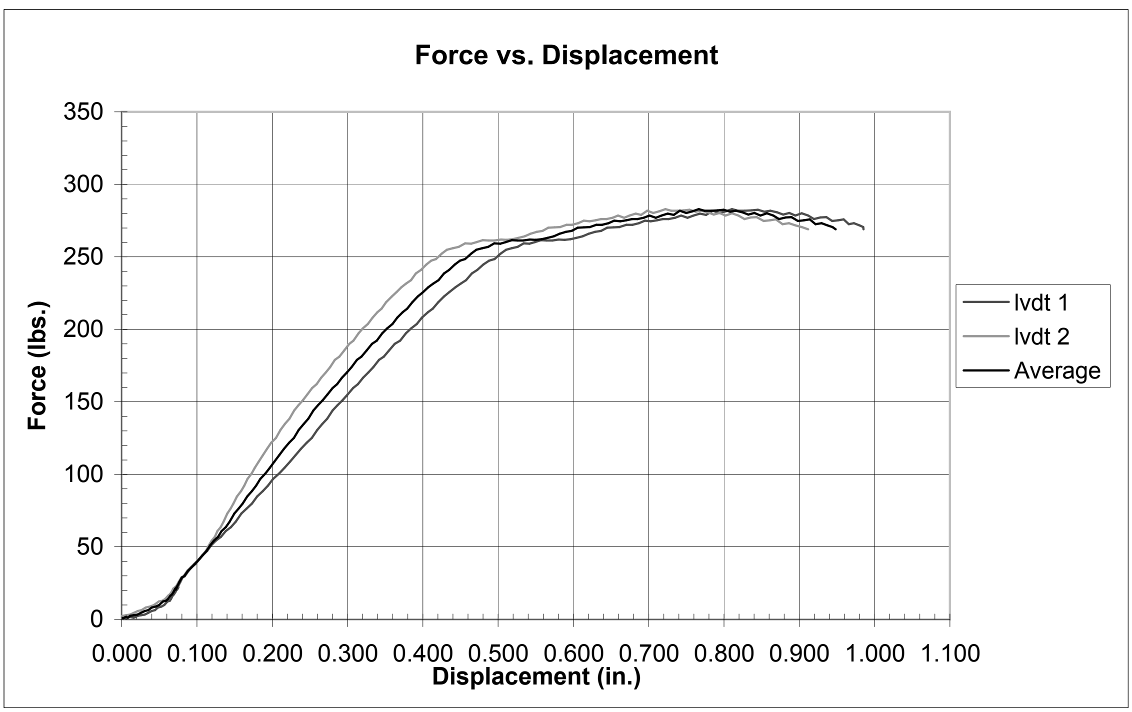
Thickness (in.) 0.0492 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	Average of Tests
23.5	37.9	39.3	**33.6**

Measured Dimensions

La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 169 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-16-3a*** **Trial:** ***3 of 3***

Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

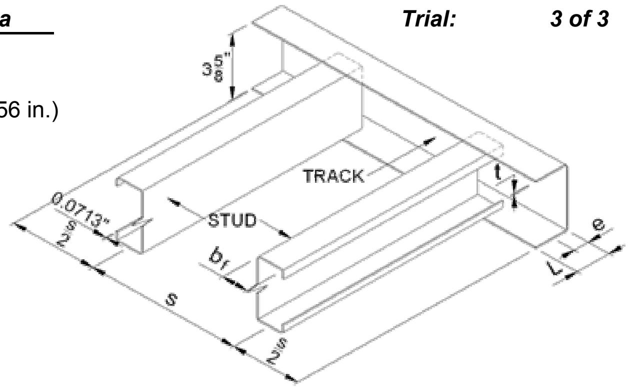
Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.



Track Material Property

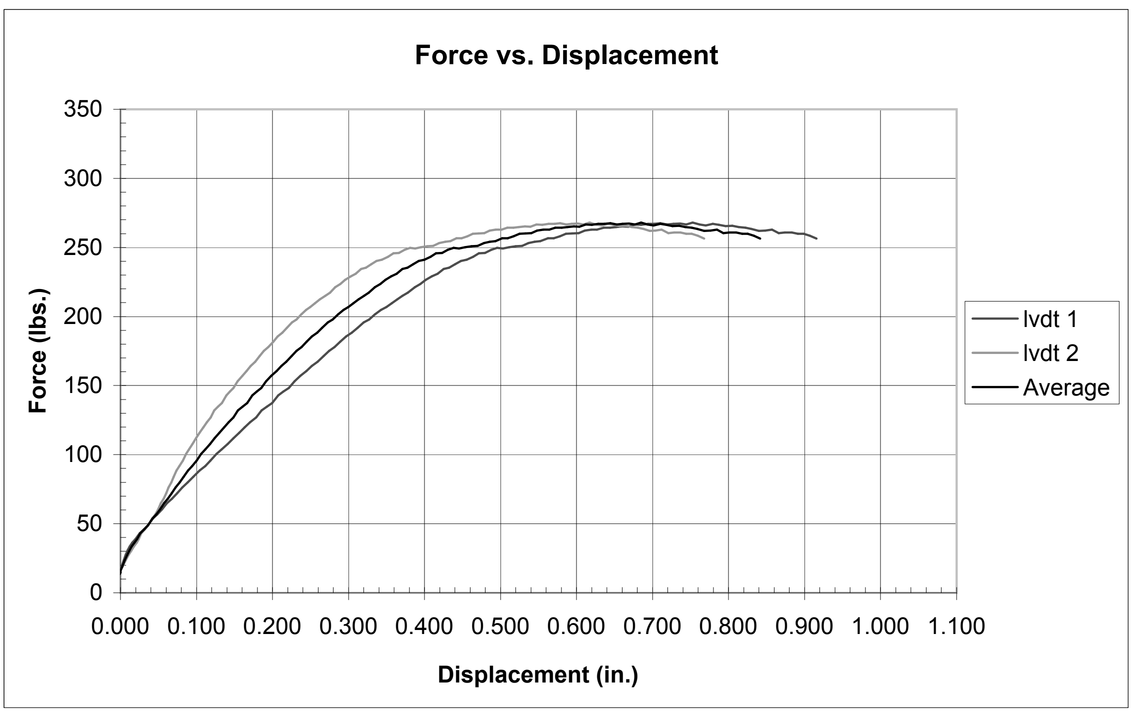
Thickness (in.) 0.0488 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	Average of Tests
23.5	37.9	39.3	**33.6**

Measured Dimensions

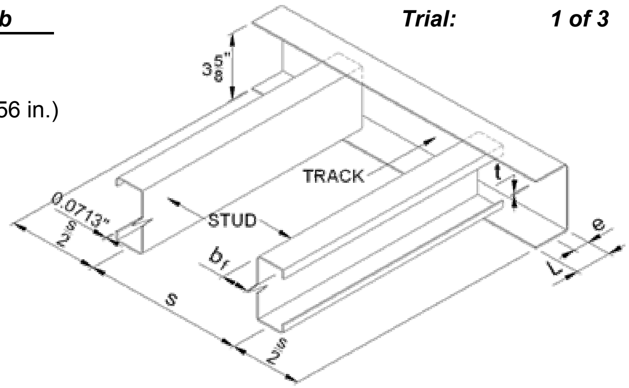
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 132 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-16-1b*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

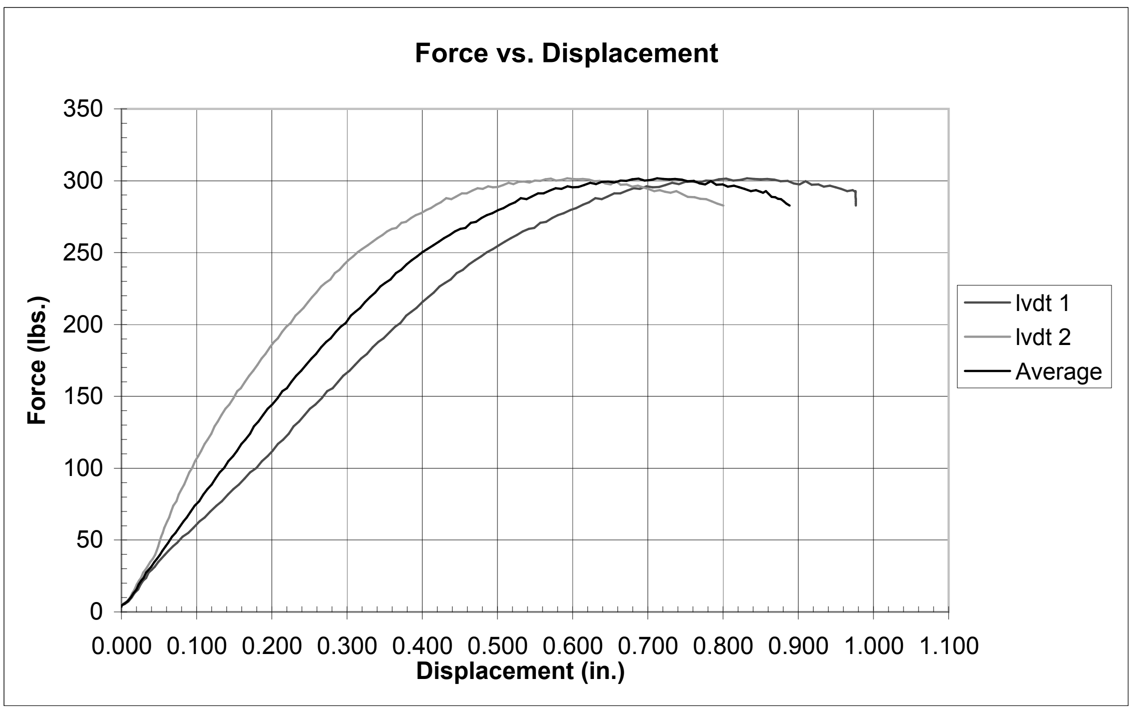
Thickness (in.) 0.0489 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	Average of Tests
23.5	37.9	39.3	**33.6**

Measured Dimensions

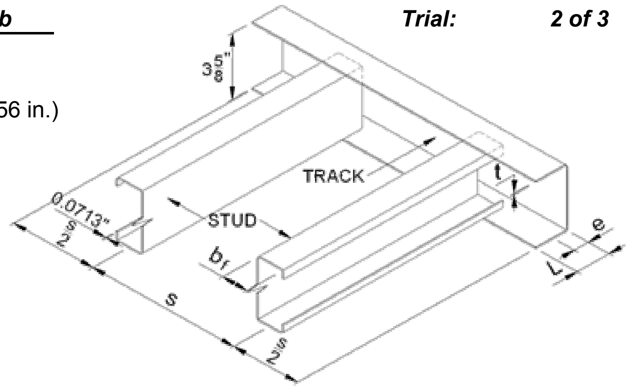
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 151 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-16-2b*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

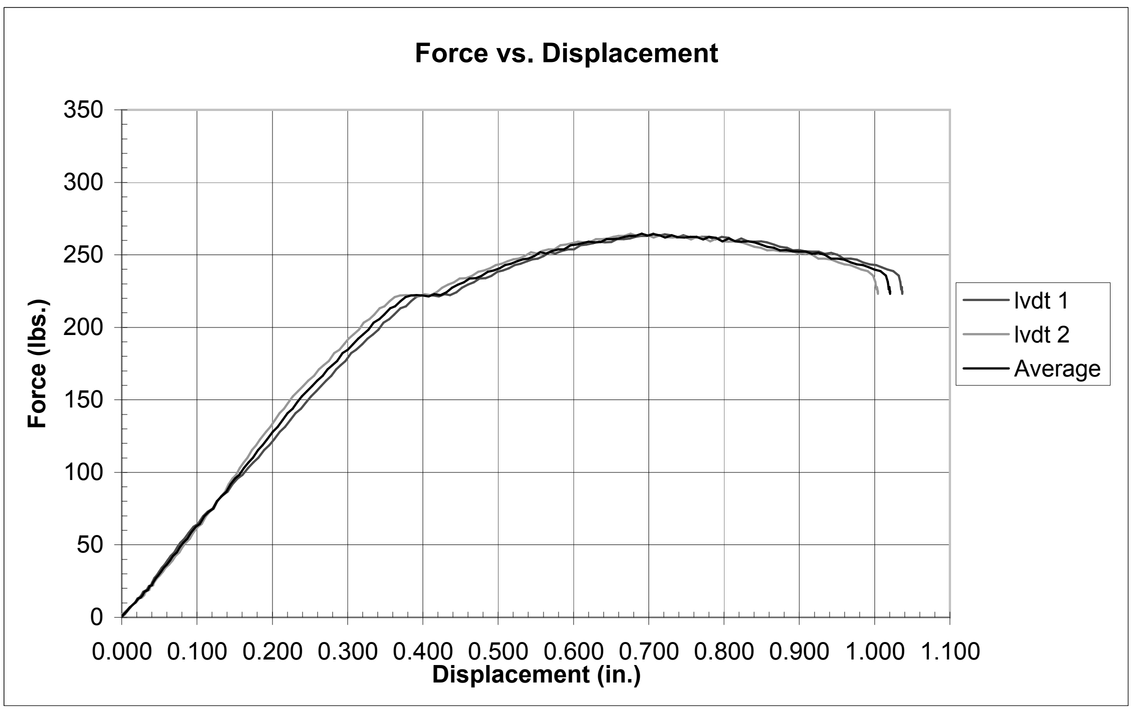
Thickness (in.) 0.0492 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

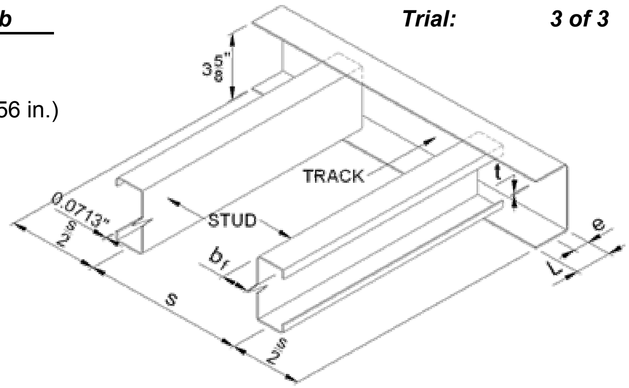
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 180 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-16-3b*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

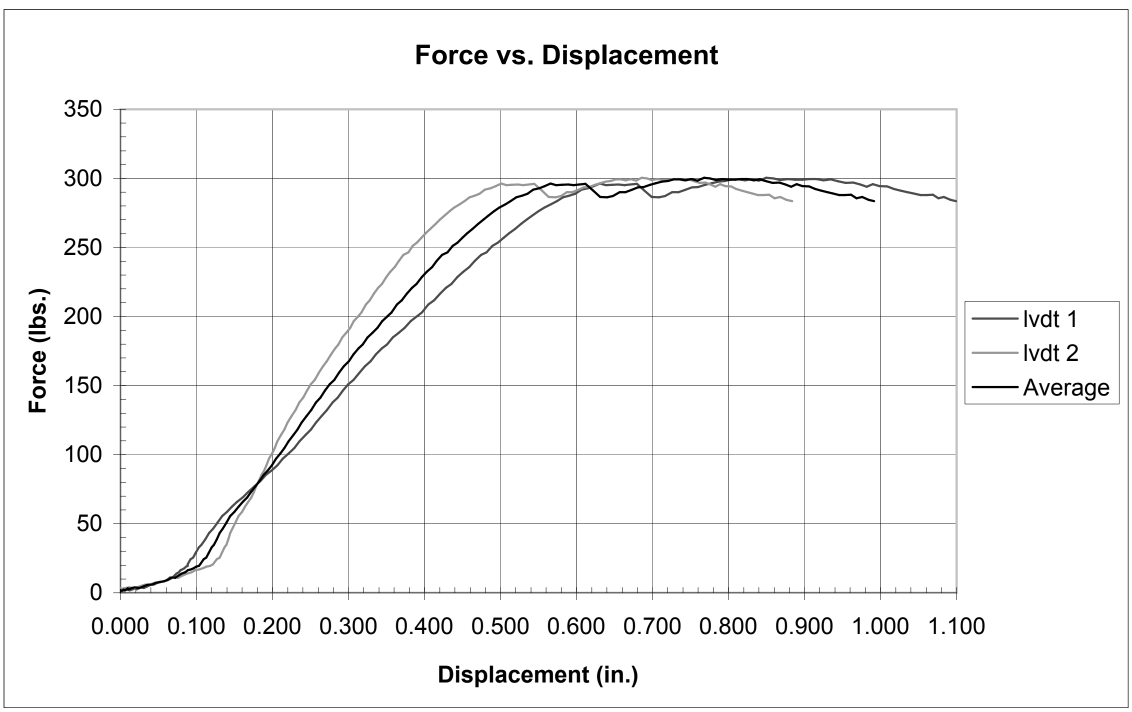
Thickness (in.) 0.0488 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

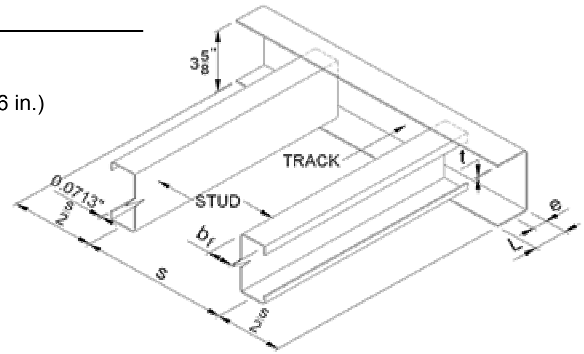
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 168 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***16-10-2-16 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

"a" tests: TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

"b" tests: THREE 1/4 in. dia. bolt w/ steel washers, ONE at specimen center and ONE at 12in. off specimen center (each side)

Ram Speed: 0.1 inches in 20 seconds

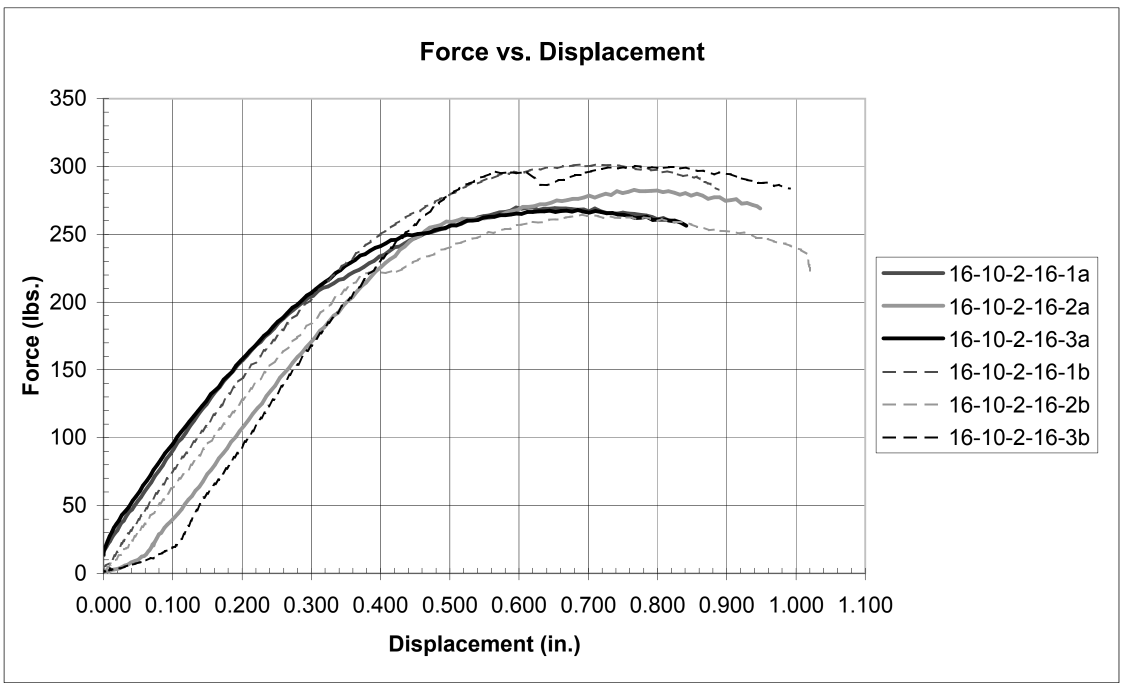
Maximum Load of Tests:

16-10-2-16-1a	269.85 Lbs.	16-10-2-16-1b	301.63 Lbs.
16-10-2-16-2a	282.84 Lbs.	16-10-2-16-2b	264.52 Lbs.
16-10-2-16-3a	267.97 Lbs.	16-10-2-16-3b	300.37 Lbs.

Track Material Property

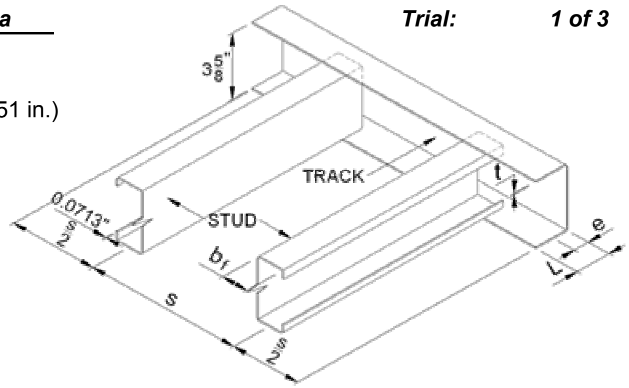
Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-18-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

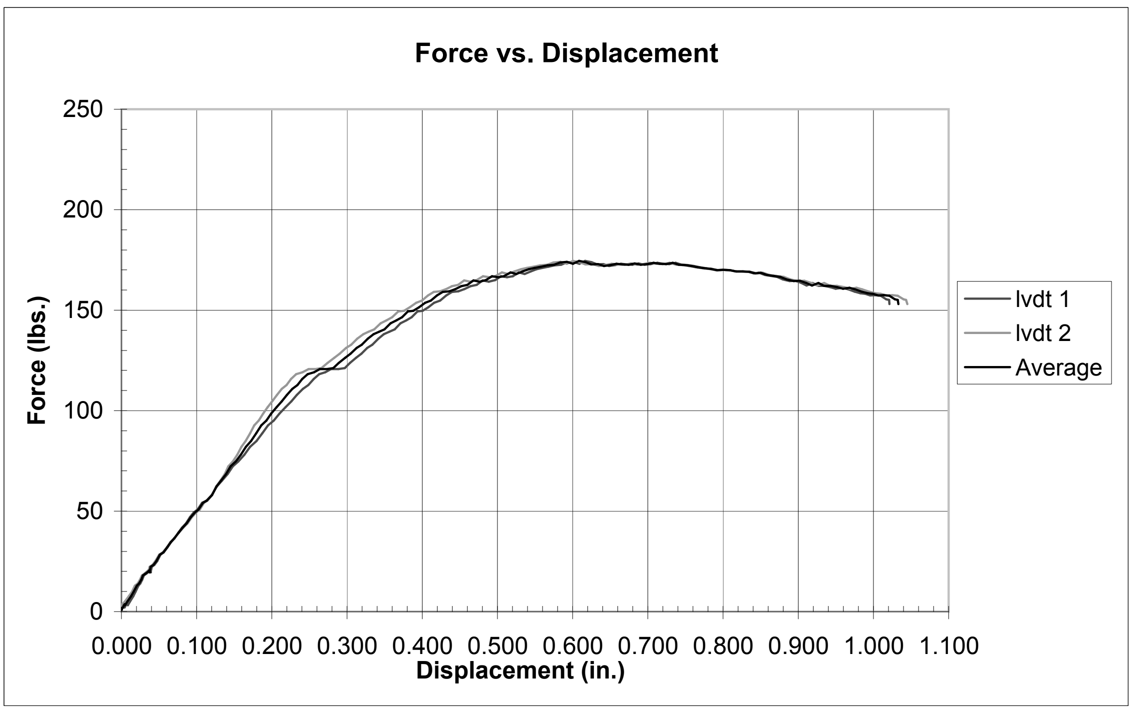
Thickness (in.) 0.0447 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

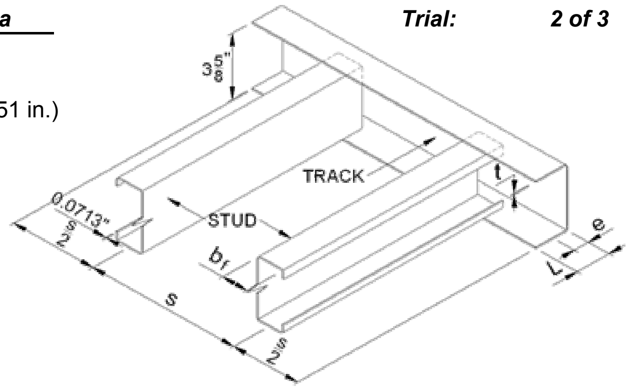
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 162 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-18-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

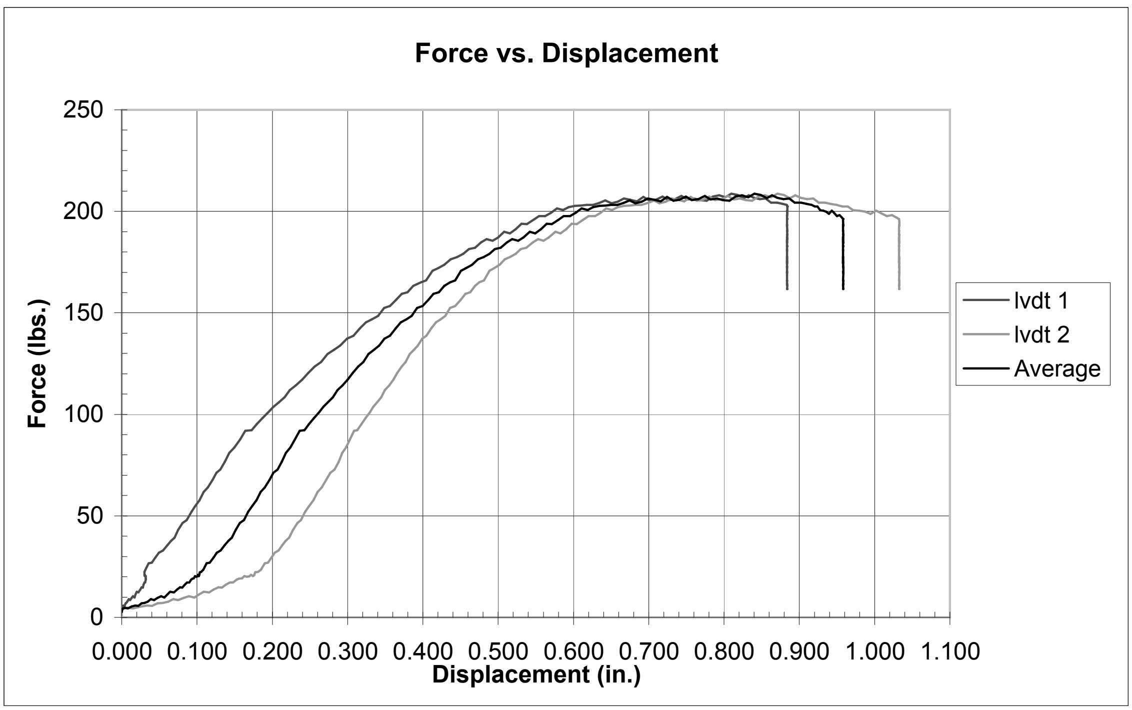
Thickness (in.) 0.0446 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

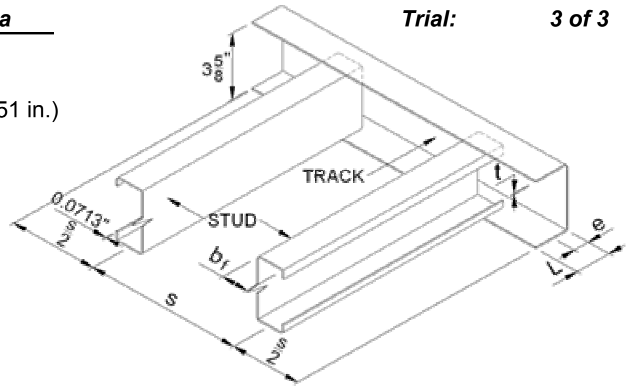
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 215 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-18-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

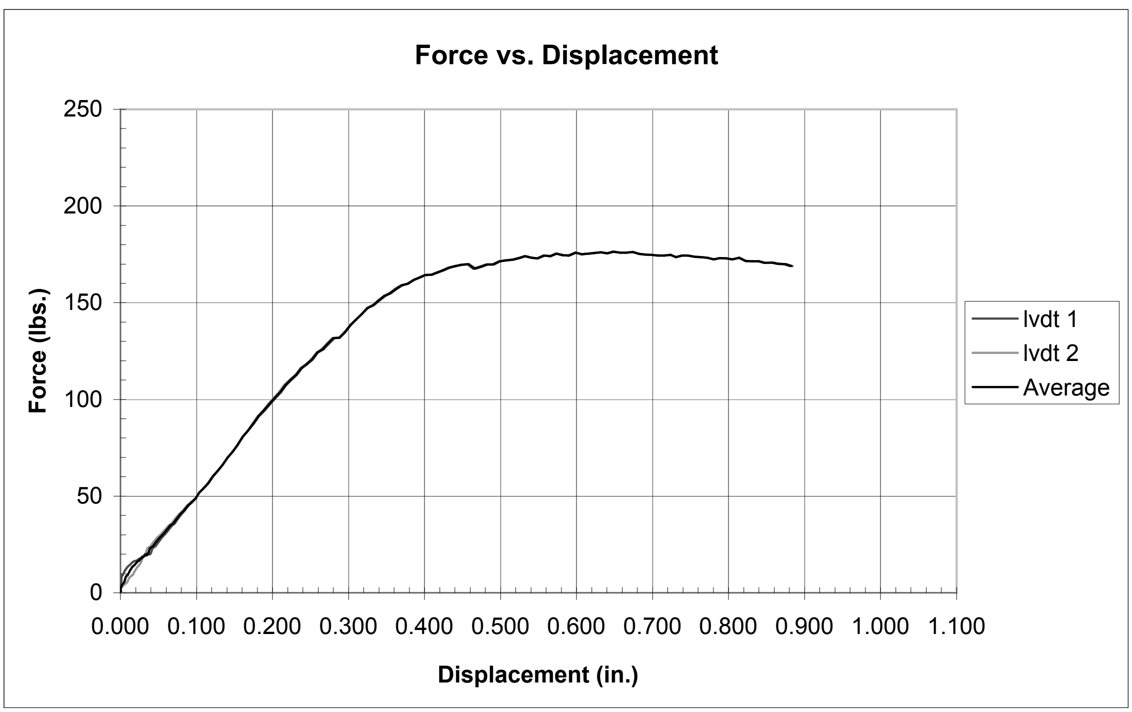
Thickness (in.) 0.0446 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

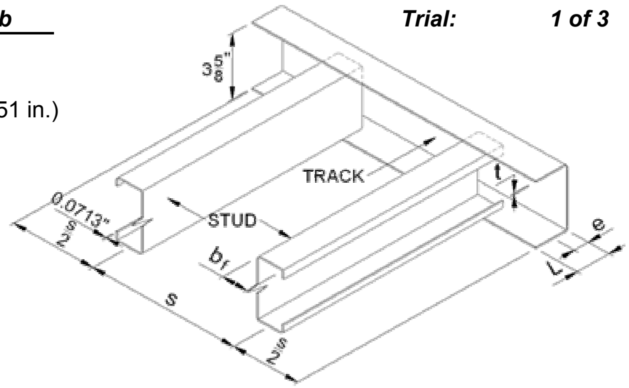
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 160 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-18-1b*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

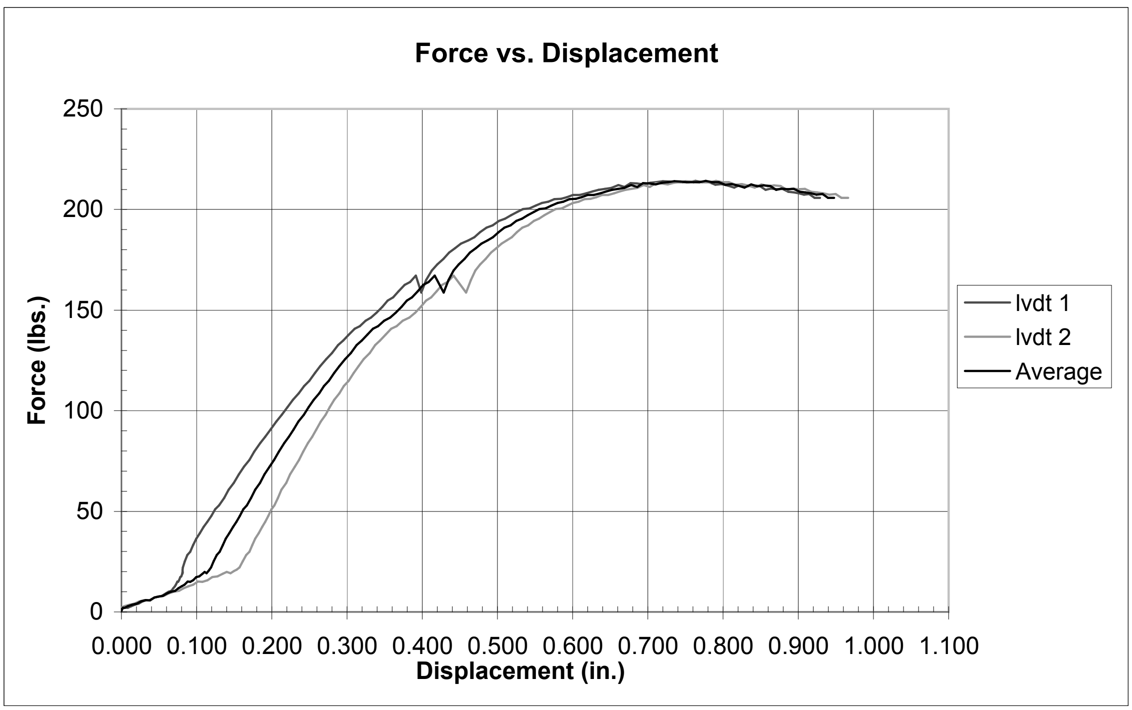
Thickness (in.) 0.0447 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

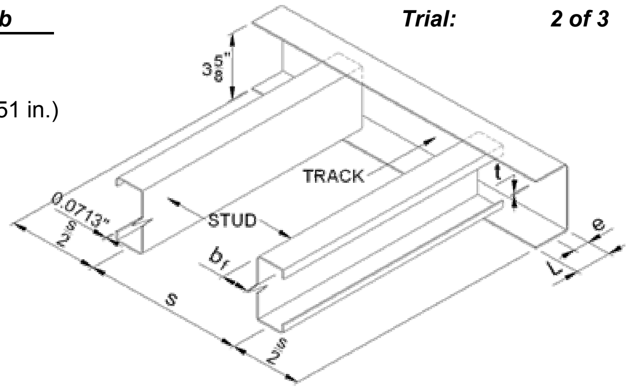
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 156 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-18-2b*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

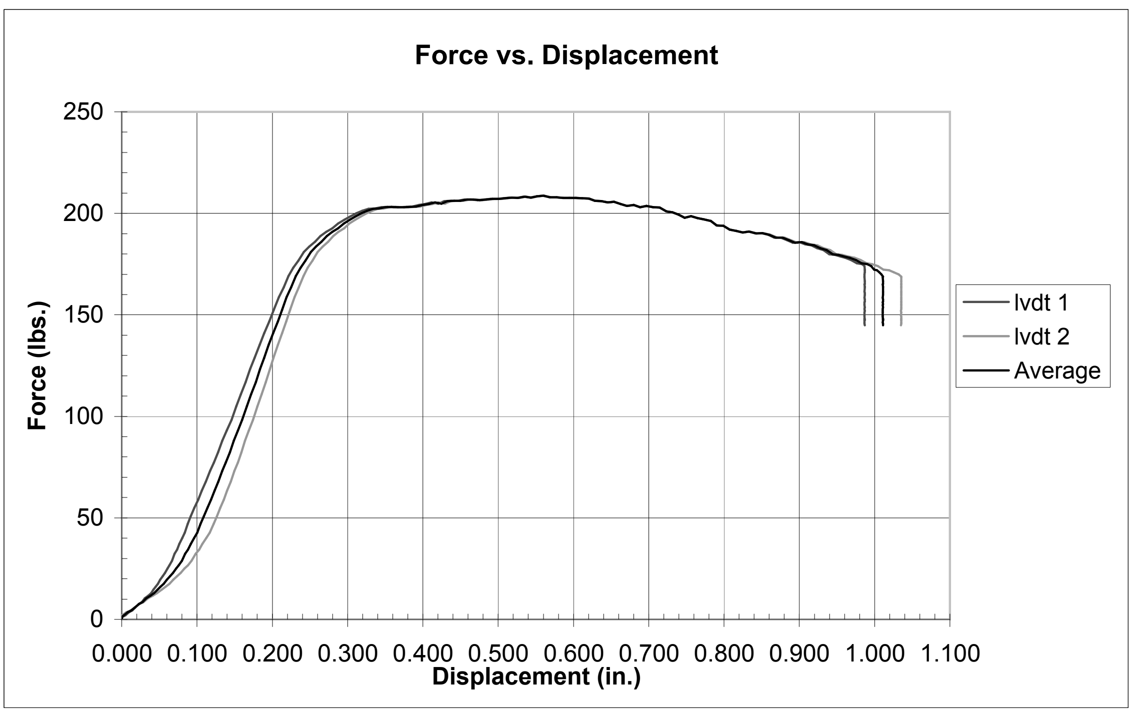
Thickness (in.) 0.0446 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

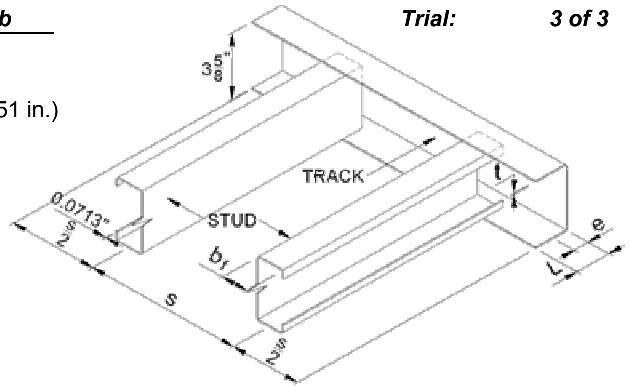
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 208 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***16-10-2-18-3b*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 16 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 12 in. specimen center (each side).

Track Material Property

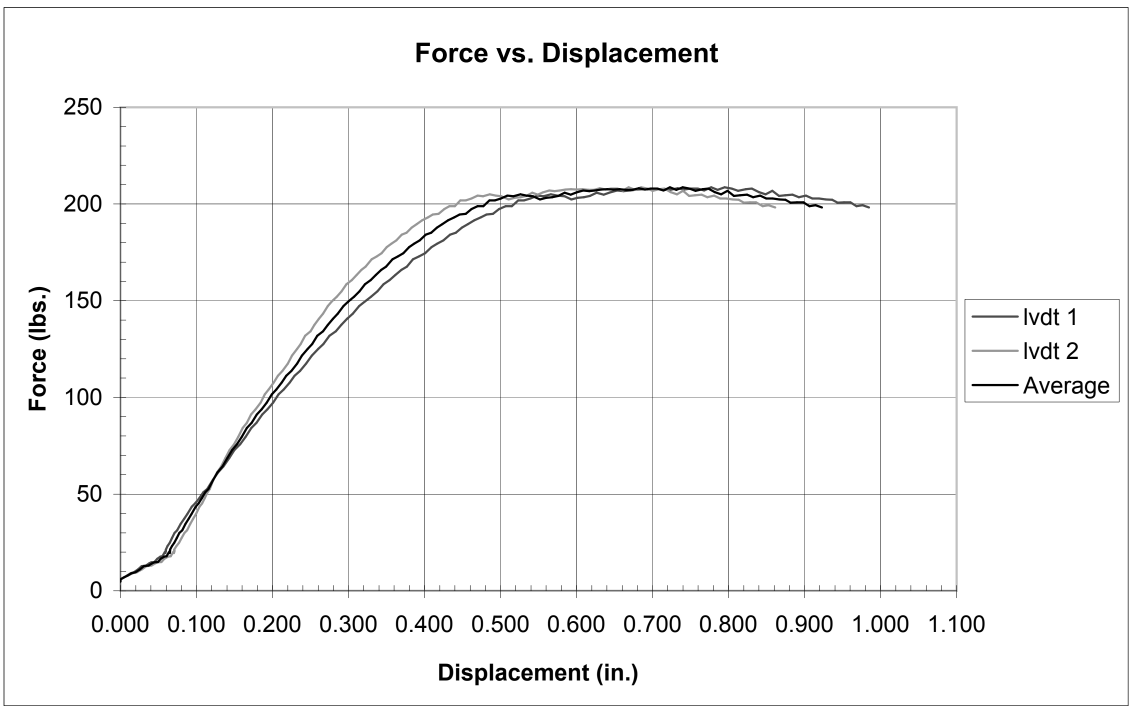
Thickness (in.) 0.0446 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

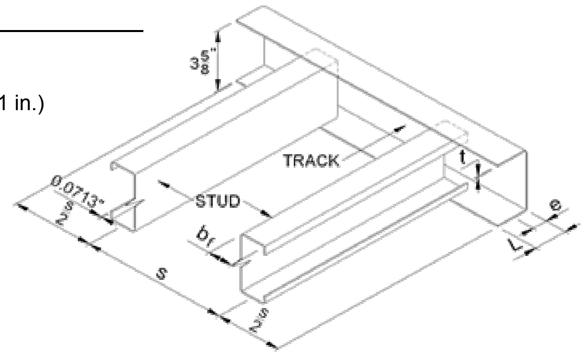
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 152 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***16-10-2-18 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t)	18 gage	(0.0451 in.)
Track Leg Length (L)	3 in.	

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e)	1 in.
Stud Flange Width (bf)	2 1/2 in.
Stud Spacing (s)	16 in.

Fastener Configuration

"a" tests: TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

"b" tests: THREE 1/4 in. dia. bolt w/ steel washers, ONE at specimen center and ONE at 12in. off specimen center (each side)

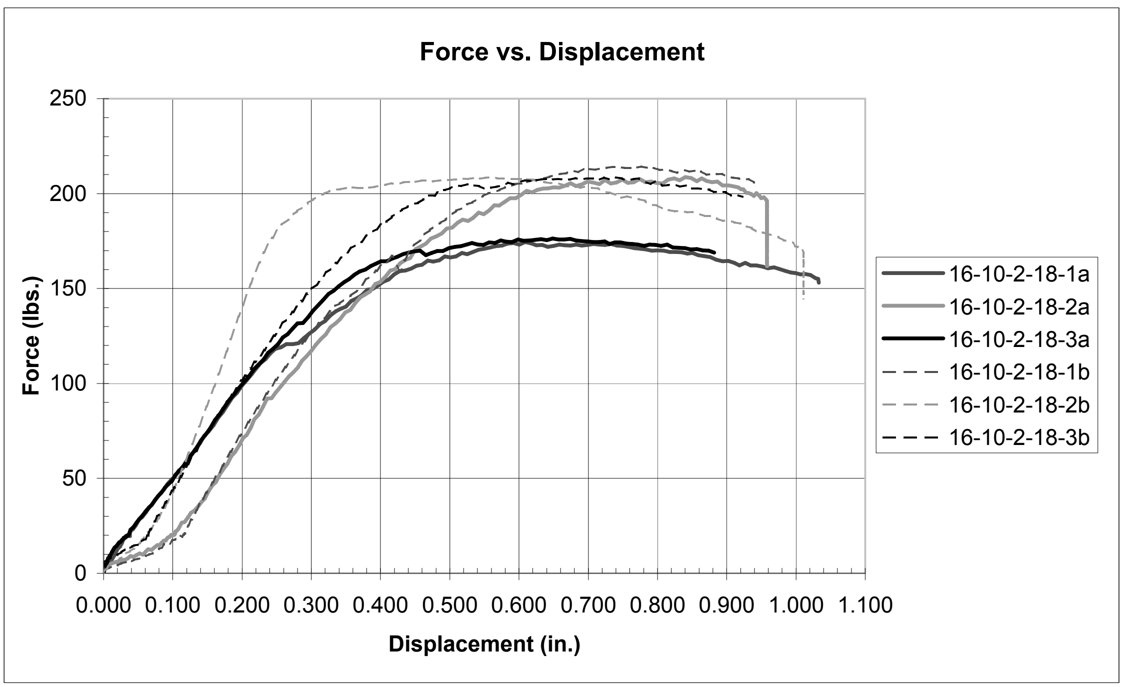
Ram Speed: 0.1 inches in 20 seconds

Maximum Load of Tests:

16-10-2-18-1a	174.46 Lbs.	16-10-2-18-1b	214.22 Lbs.
16-10-2-18-2a	208.74 Lbs.	16-10-2-18-2b	208.74 Lbs.
16-10-2-18-3a	176.34 Lbs.	16-10-2-18-3b	208.58 Lbs.

Track Material Property

	Test #1	Test #2	Test #3	**Average of Tests**
Yield (ksi)	23.0	22.8	22.6	**22.8**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-1-14-1a*** **Trial:** ***1 of 3***

Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

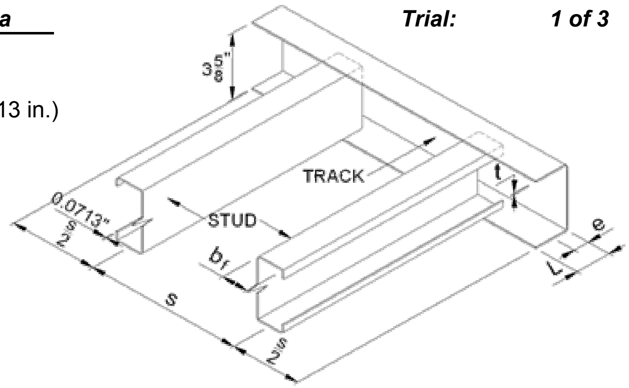
Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.



Track Material Property

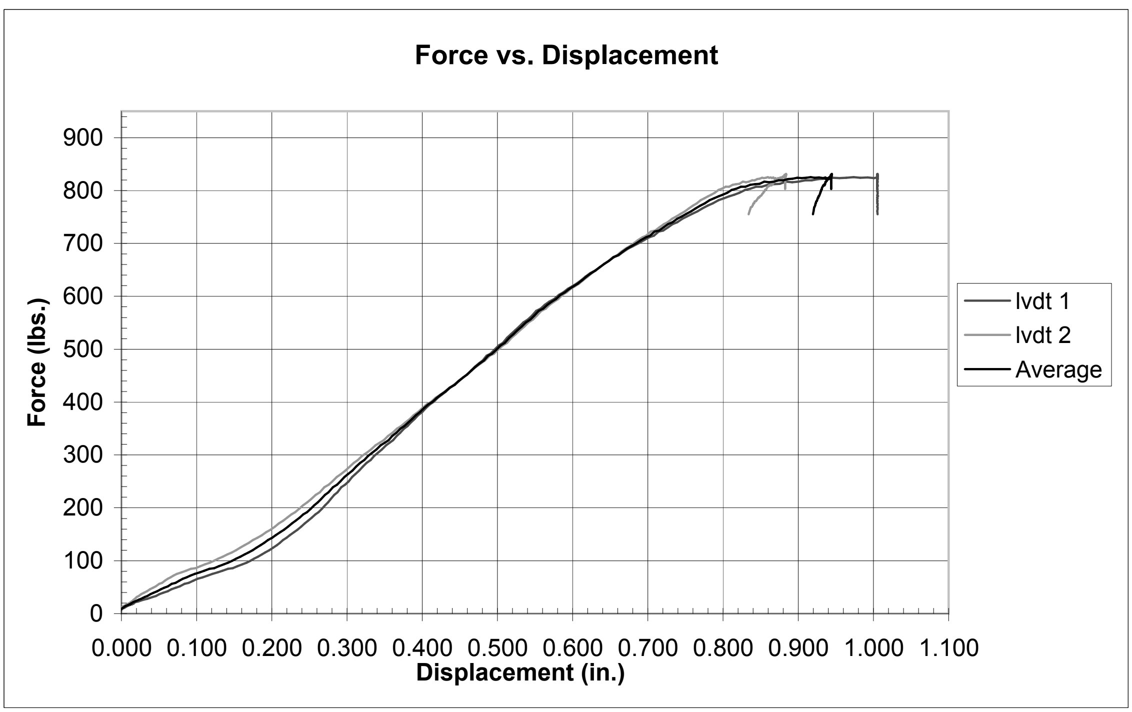
Thickness (in.) 0.0720 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Test (1 & 2)**
37.9	39.3	43.3	**38.6**

Measured Dimensions

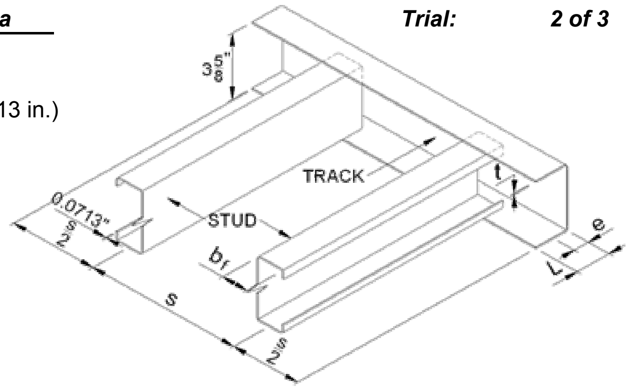
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 292 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-1-14-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

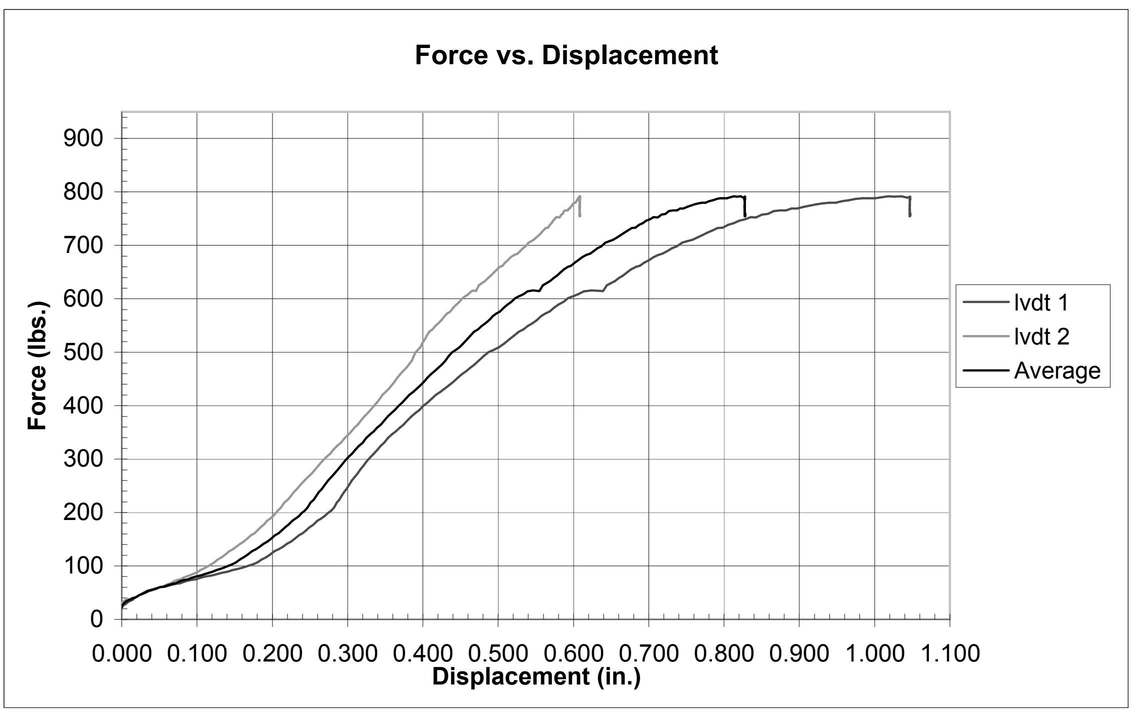
Thickness (in.) 0.0712 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	Average of Test (1 & 2)
37.9	39.3	43.3	**38.6**

Measured Dimensions

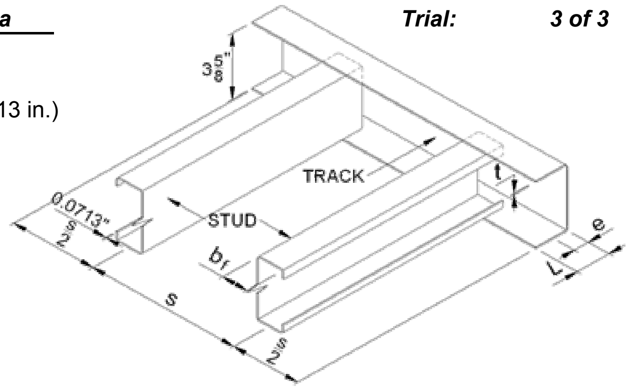
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 230 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-1-14-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

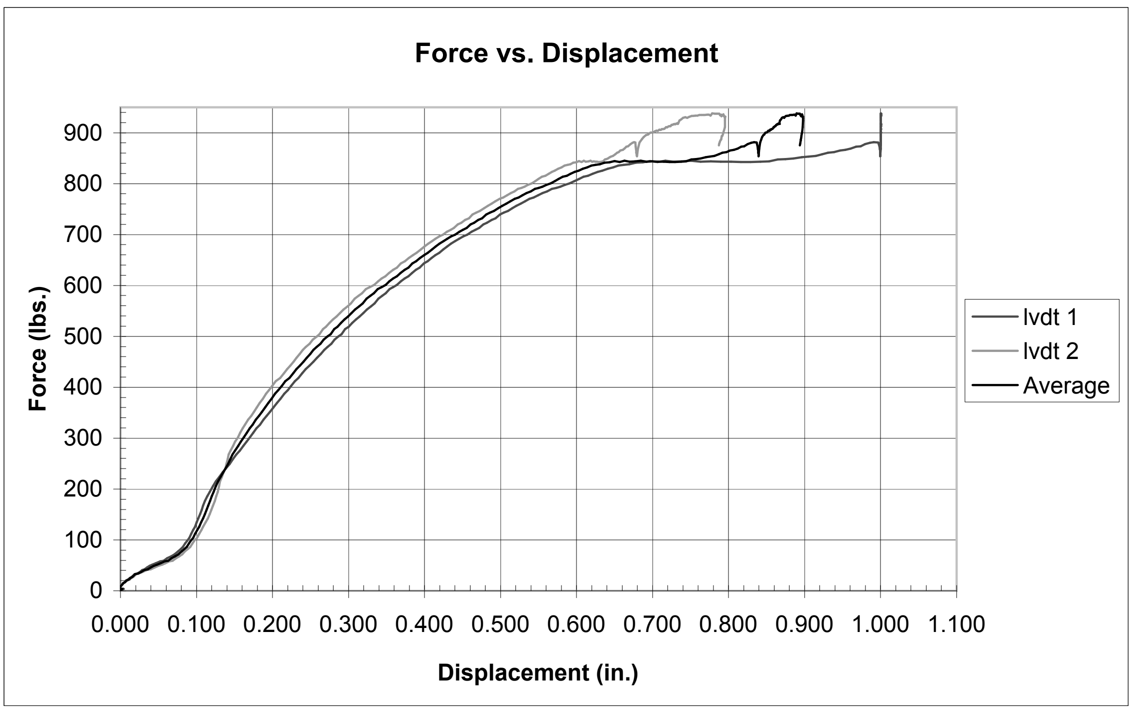
Thickness (in.) 0.0732 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Test (1 & 2)**
37.9	39.3	43.3	**38.6**

Measured Dimensions

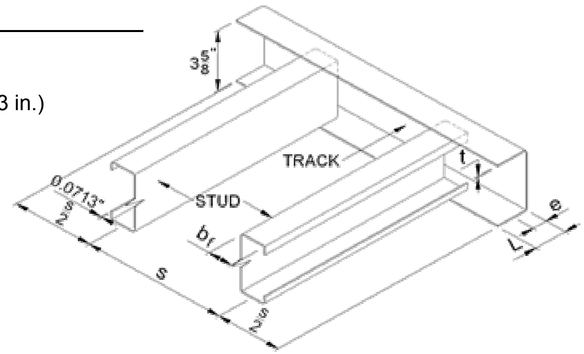
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 310 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***24-05-1-14 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

Ram Speed: 0.1 inches in 20 seconds

Maximum Load of Tests:

24-05-1-14-1a 831.50 Lbs.

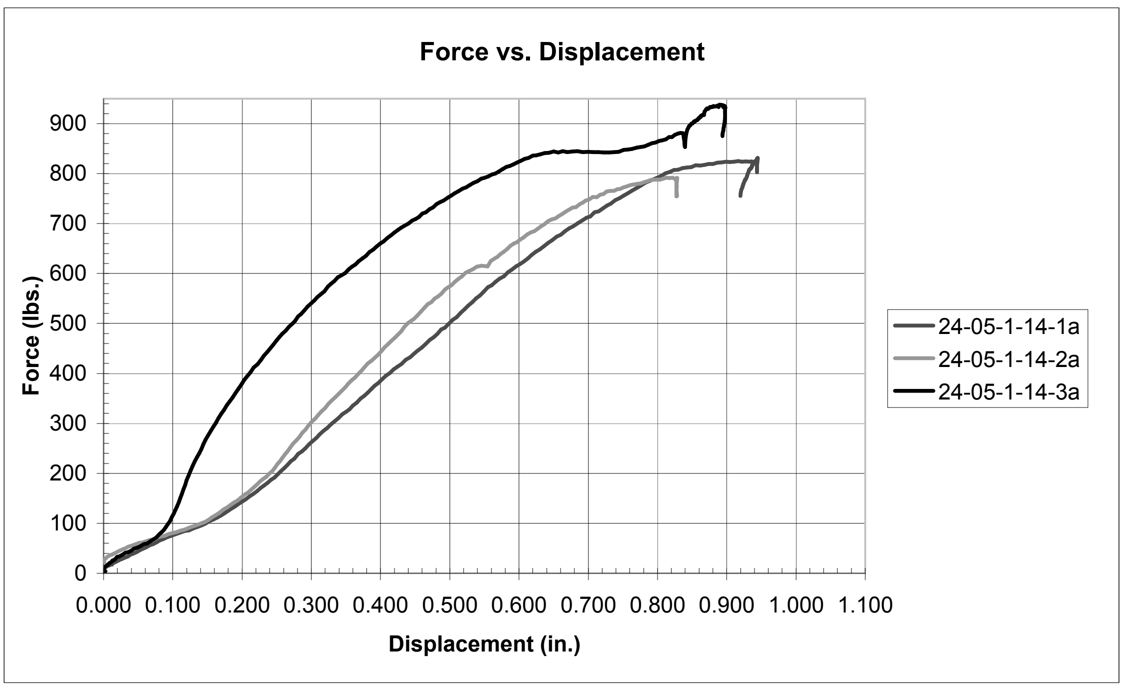
24-05-1-14-2a 792.06 Lbs.

24-05-1-14-3a 937.89 Lbs.

Track Material Property

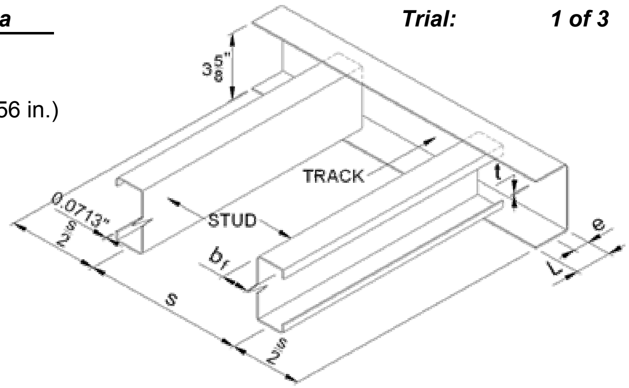
Yield (ksi)

Test #1	Test #2	Test #3	**Average of Test (1 & 2)**
37.9	39.3	43.3	**38.6**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-1-16-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

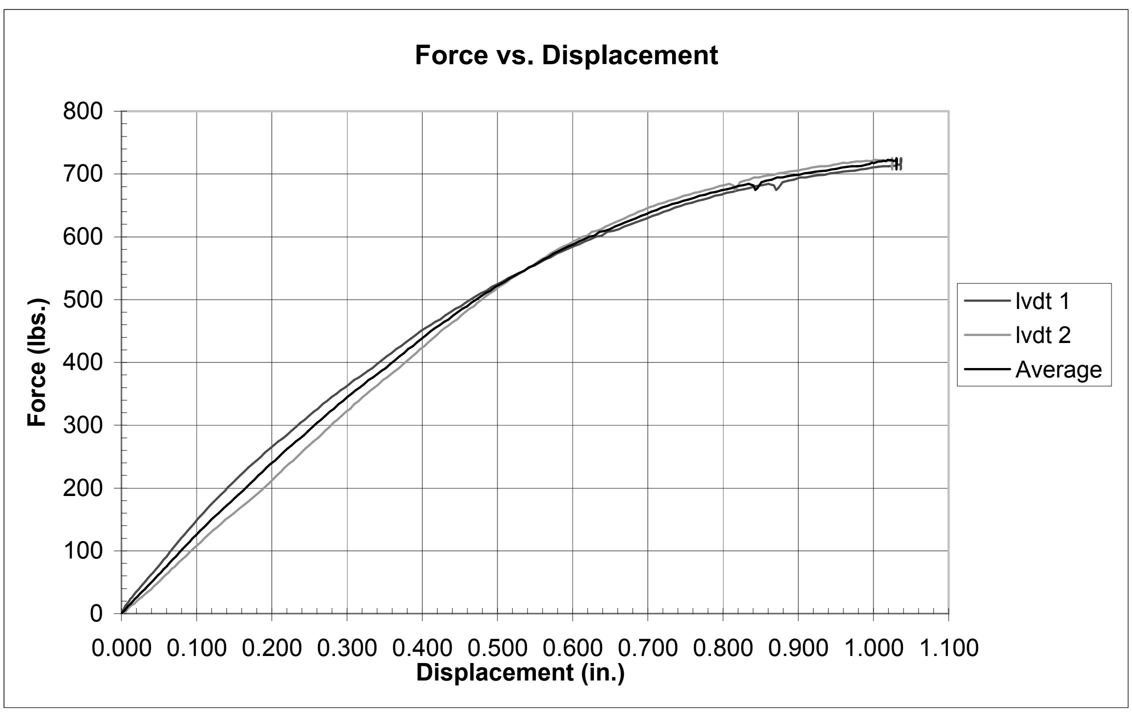
Thickness (in.) 0.0583 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
44.3	45.9	43.2	**44.5**

Measured Dimensions

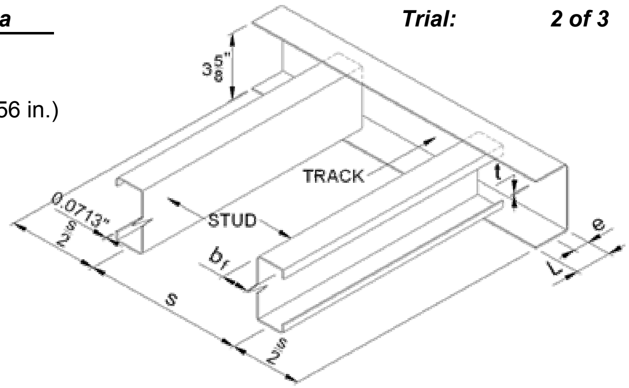
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 255 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-1-16-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

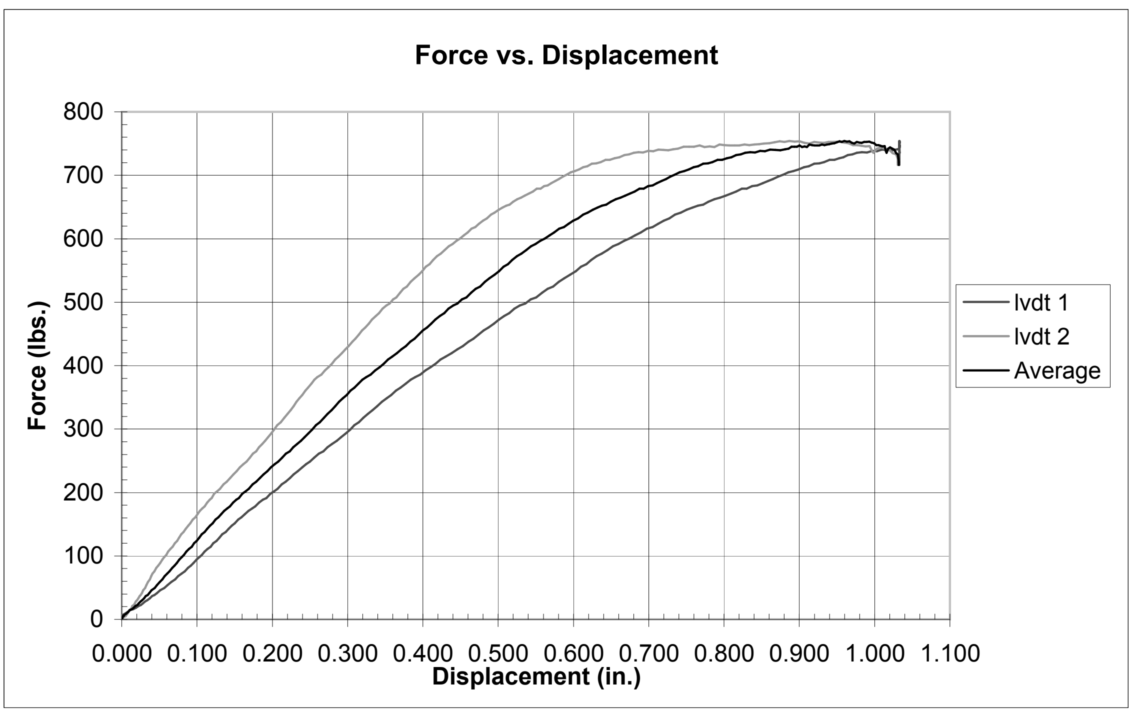
Thickness (in.) 0.0592 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
44.3	45.9	43.2	**44.5**

Measured Dimensions

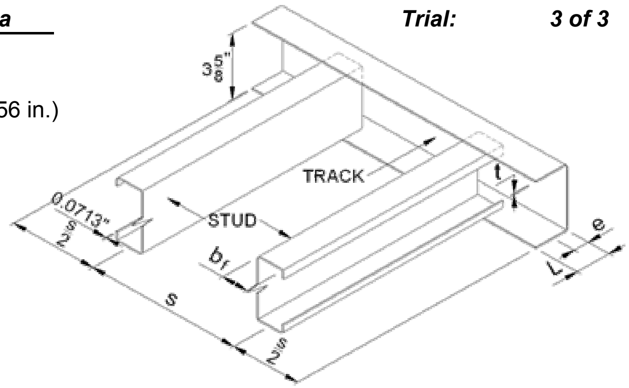
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 238 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-1-16-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

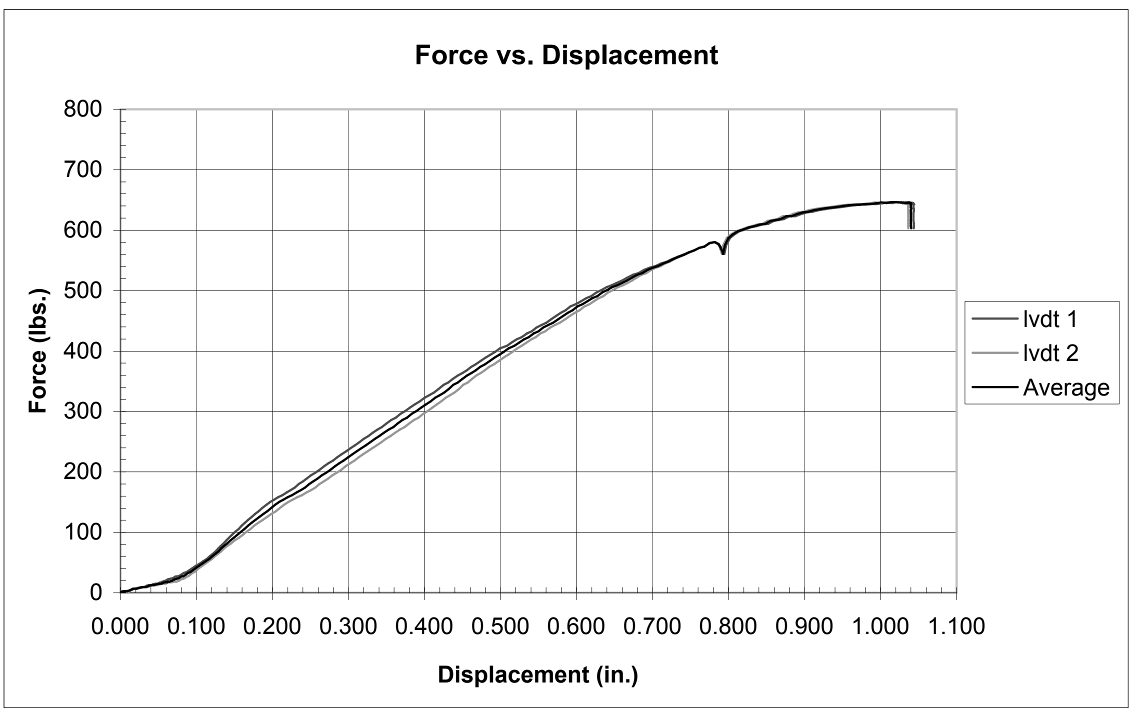
Thickness (in.) 0.0586 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	Average of Tests
44.3	45.9	43.2	**44.5**

Measured Dimensions

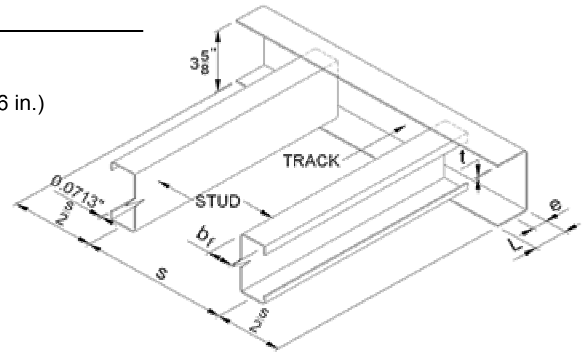
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 252 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***24-05-1-16 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t)	16 gage	(0.0556 in.)
Track Leg Length (L)	2 in.	

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e)	0.5 in.
Stud Flange Width (bf)	1 5/8 in.
Stud Spacing (s)	24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

Ram Speed: 0.1 inches in 20 seconds

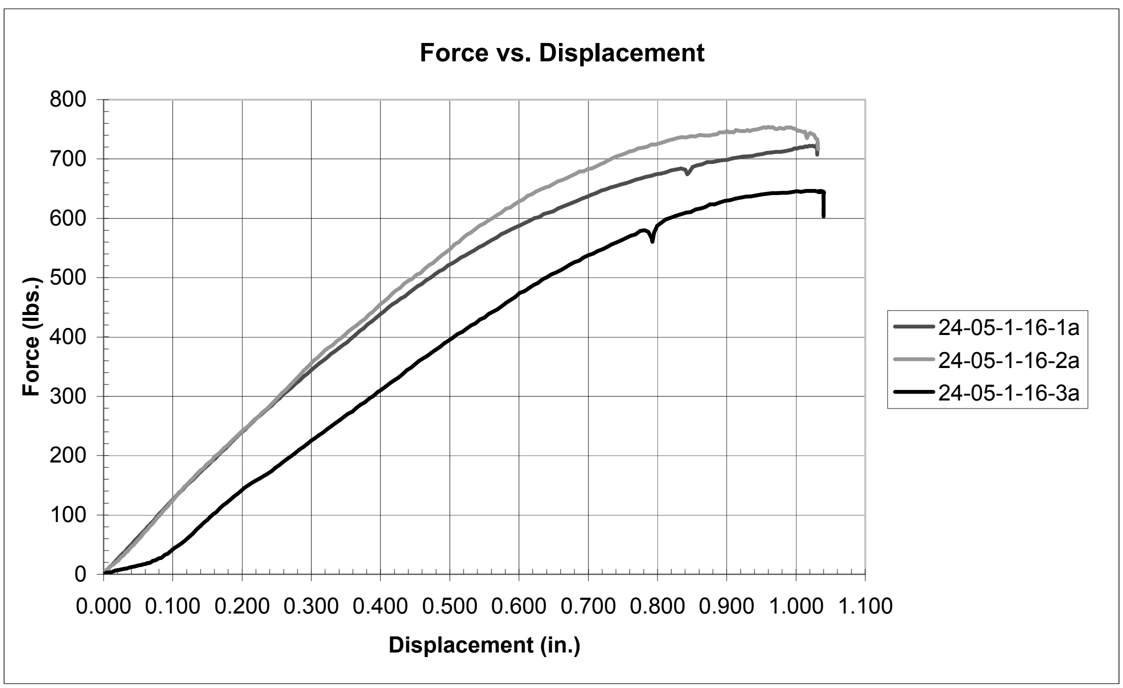
Maximum Load of Tests:

24-05-1-16-1a	725.01 Lbs.
24-05-1-16-2a	753.89 Lbs.
24-05-1-16-3a	646.32 Lbs.

Track Material Property

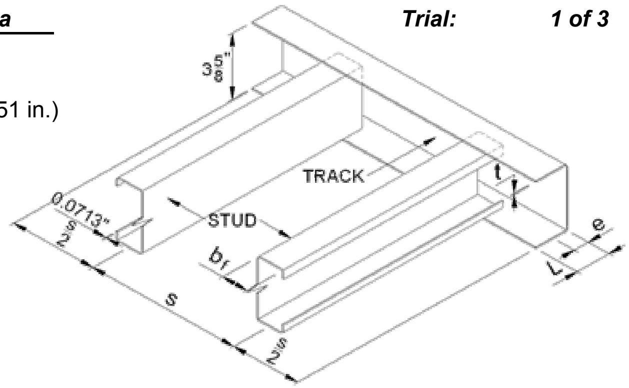
Yield (ksi)

Test #1	Test #2	Test #3	Average of Tests
44.3	45.9	43.2	**44.5**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-1-18-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

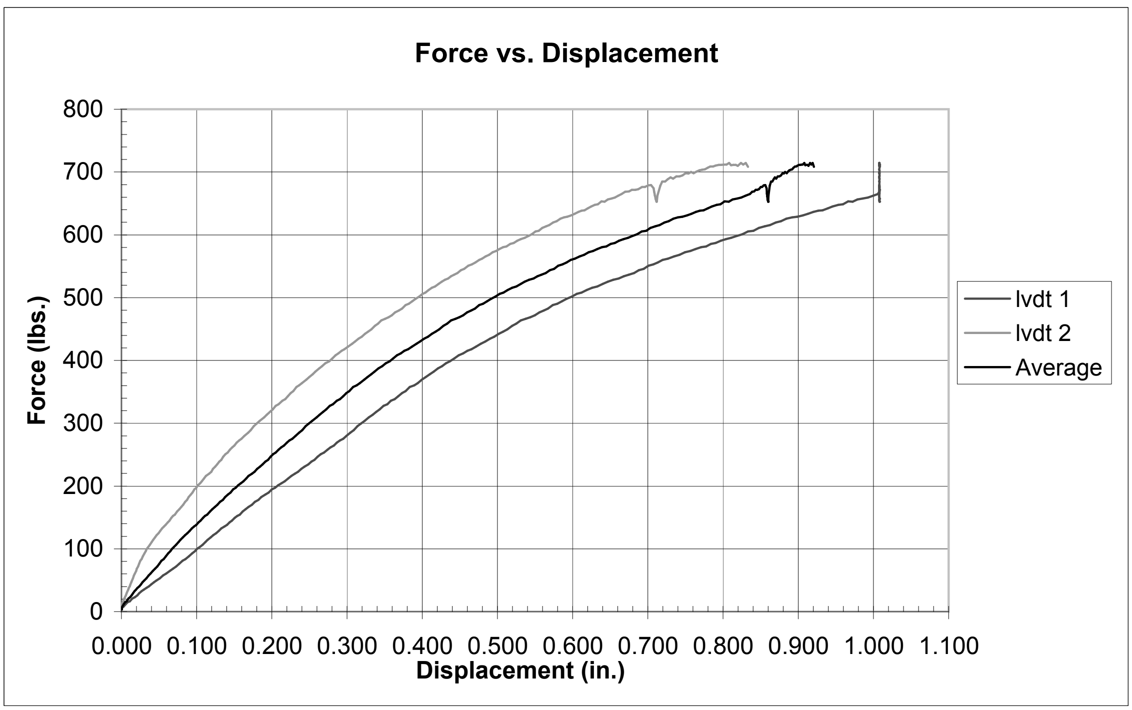
Thickness (in.) 0.0466 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.4	39.6	38.2	**39.4**

Measured Dimensions

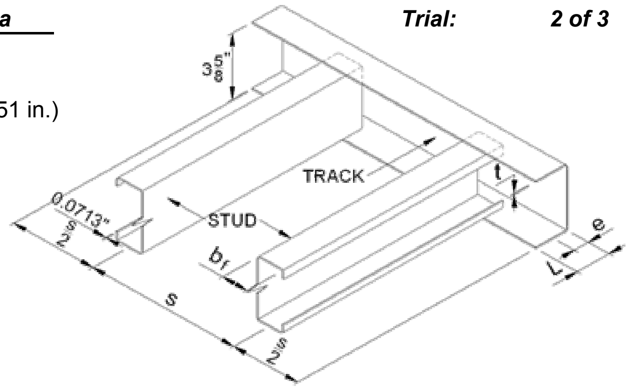
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 264 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-1-18-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

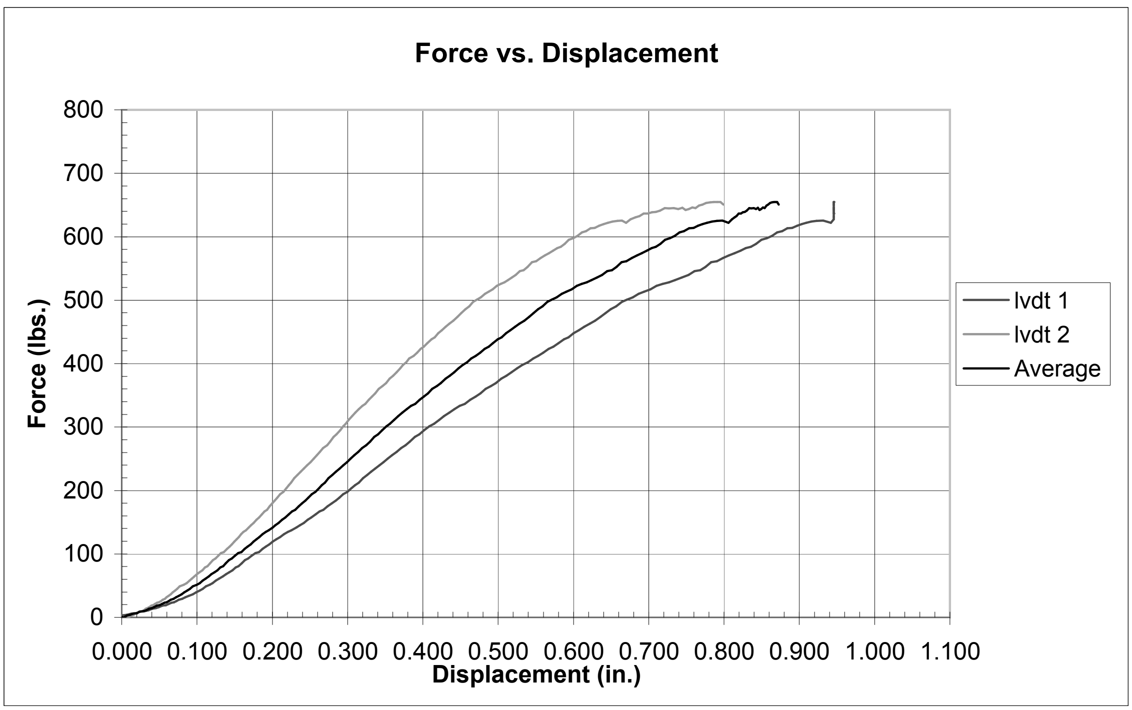
Thickness (in.) 0.0463 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.4	39.6	38.2	**39.4**

Measured Dimensions

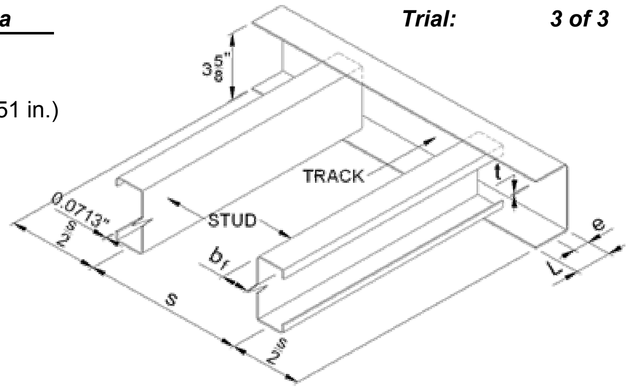
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 206 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-1-18-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

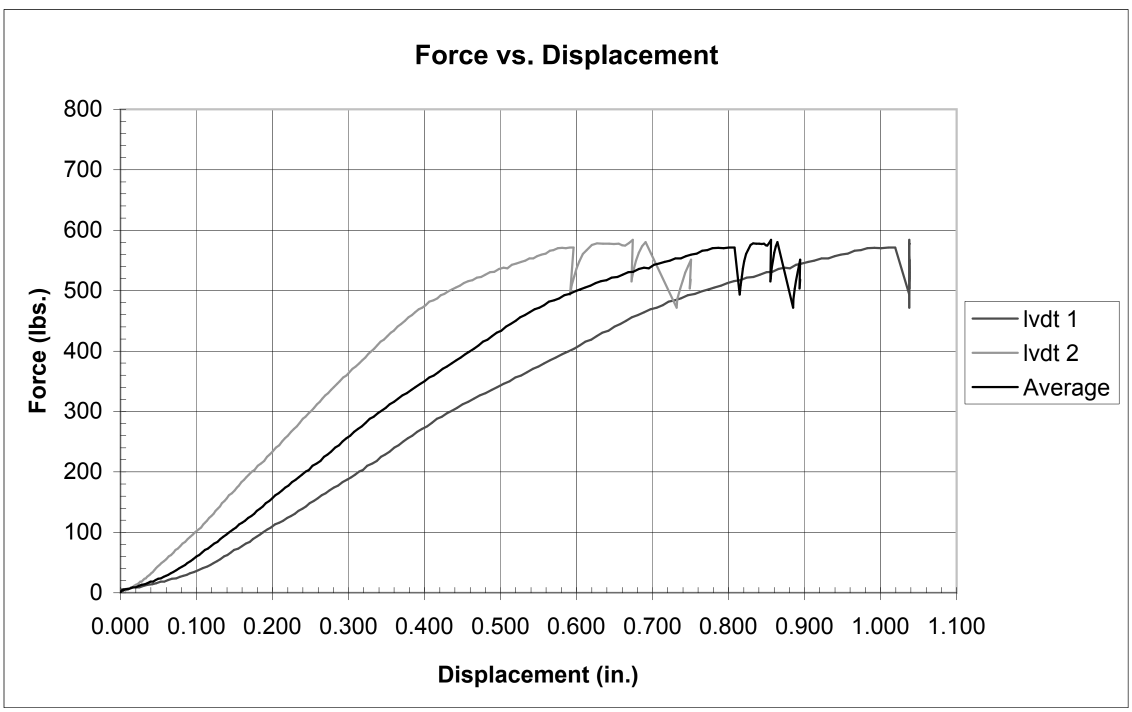
Thickness (in.) 0.0497 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.4	39.6	38.2	**39.4**

Measured Dimensions

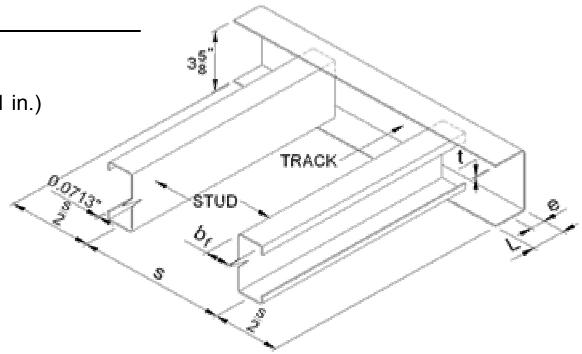
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 200 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***24-05-1-18 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

Ram Speed: 0.1 inches in 20 seconds

Maximum Load of Tests:

24-05-1-18-1a 714.31 Lbs.

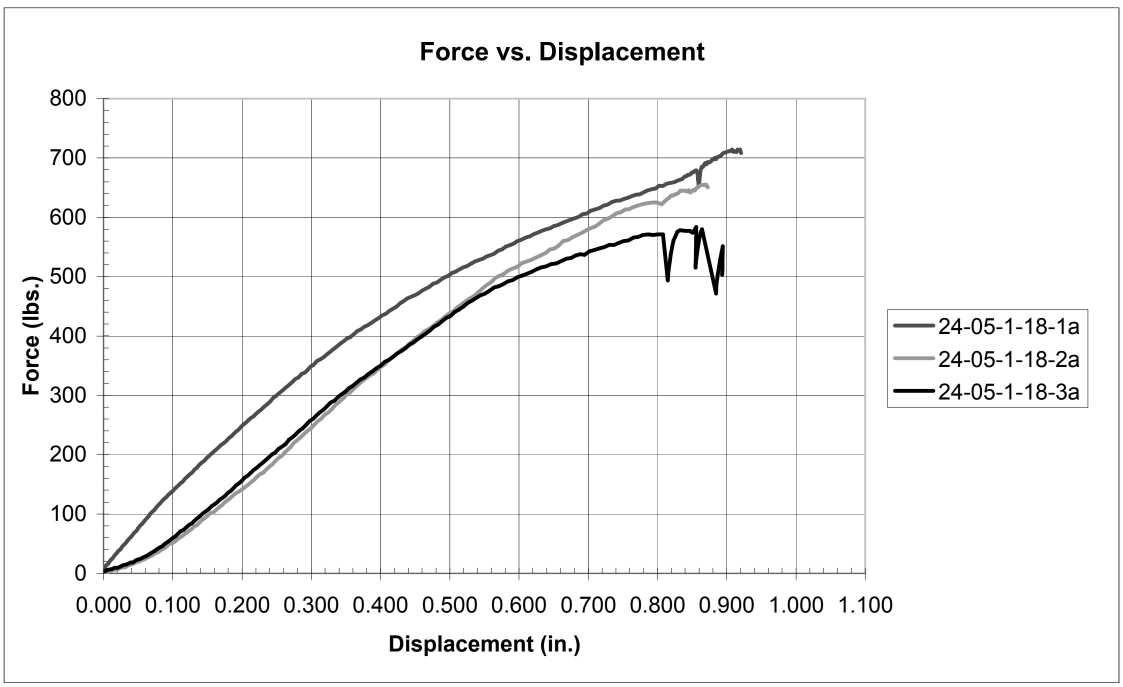
24-05-1-18-2a 654.73 Lbs.

24-05-1-18-3a 583.84 Lbs.

Track Material Property

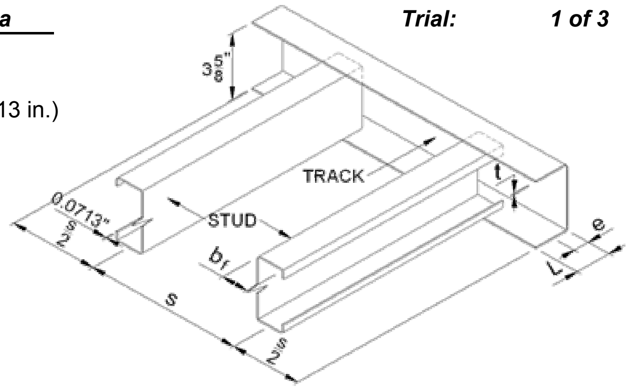
Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.4	39.6	38.2	**39.4**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-2-14-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

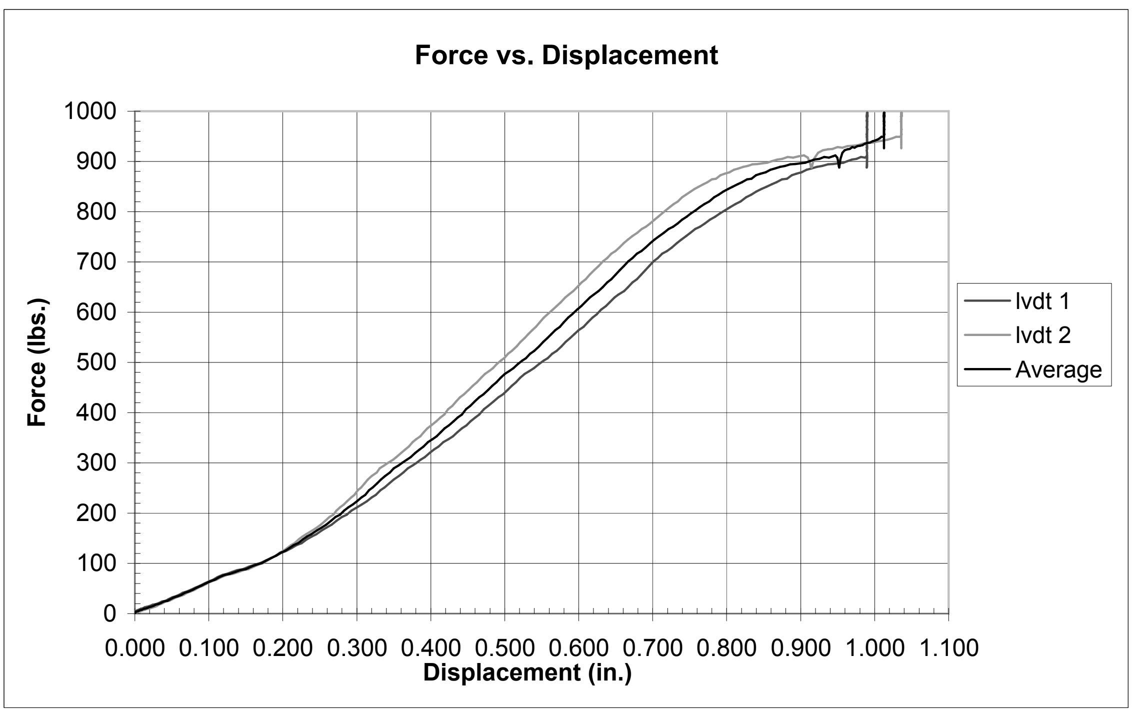
Thickness (in.) 0.0727 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Test (1 & 2)**
37.9	39.3	43.3	**38.6**

Measured Dimensions

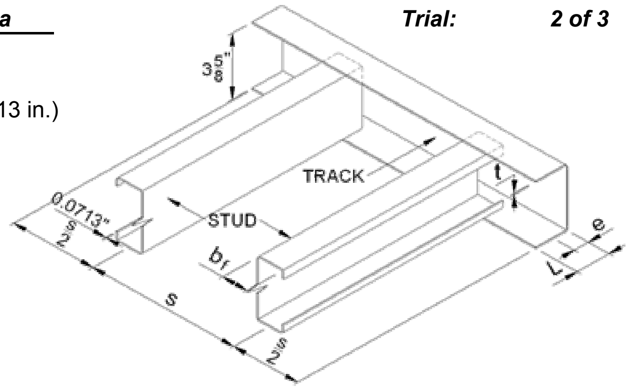
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 316 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-2-14-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

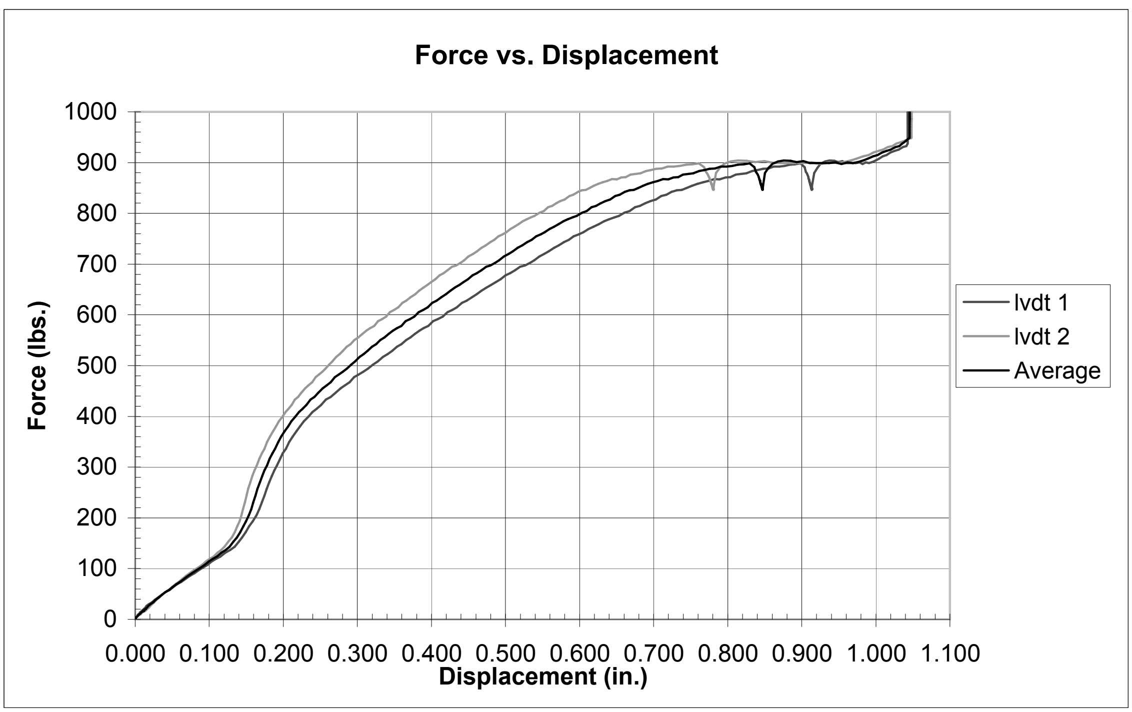
Thickness (in.) 0.0715 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Test (1 & 2)**
37.9	39.3	43.3	**38.6**

Measured Dimensions

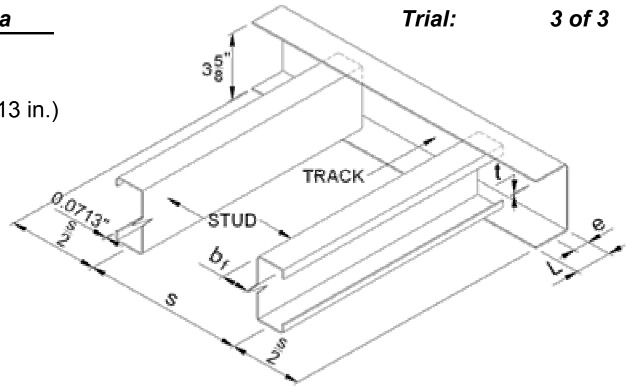
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 383 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-2-14-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

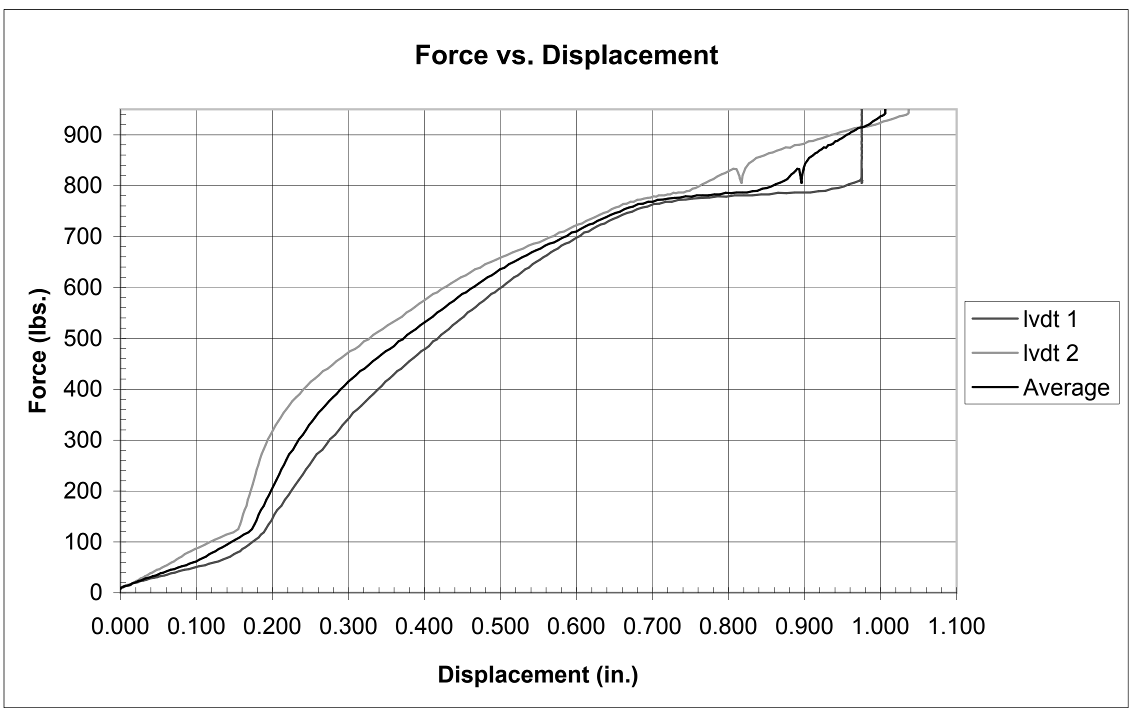
Thickness (in.) 0.0721 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Test (1 & 2)**
37.9	39.3	43.3	**38.6**

Measured Dimensions

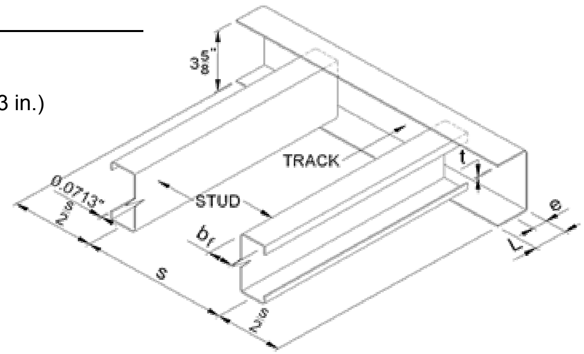
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 334 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***24-05-2-14 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

Ram Speed: 0.1 inches in 20 seconds

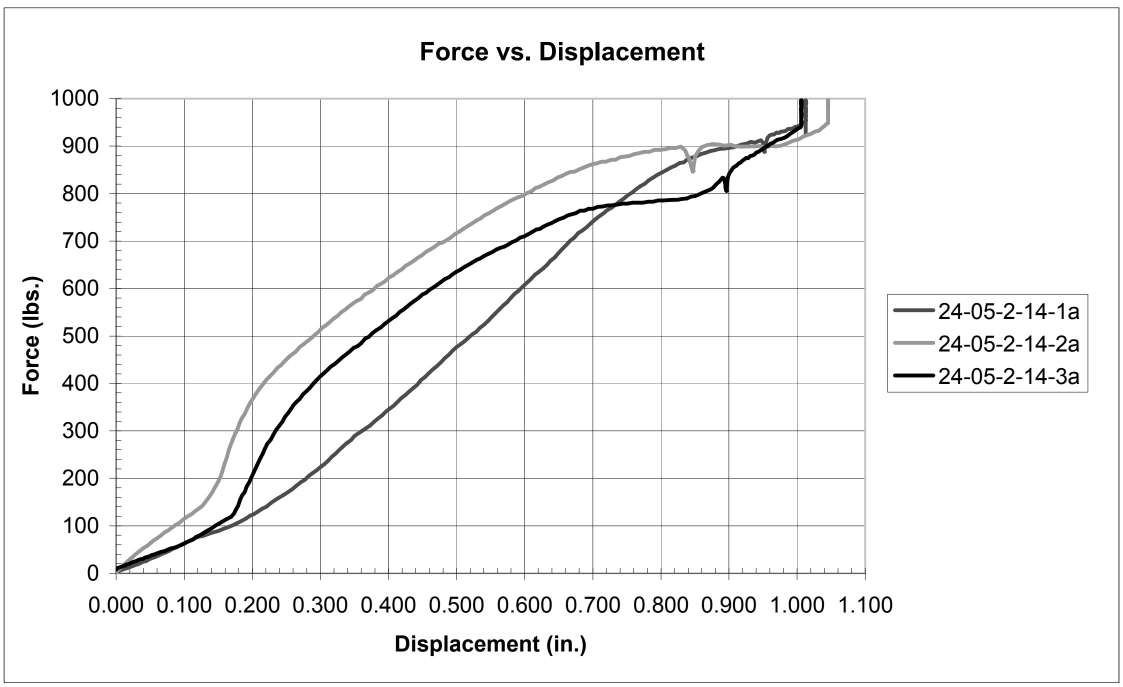
Maximum Load of Tests:

24-05-2-14-1a	997.05	Lbs.
24-05-2-14-2a	1036.79	Lbs.
24-05-2-14-3a	997.50	Lbs.

Track Material Property

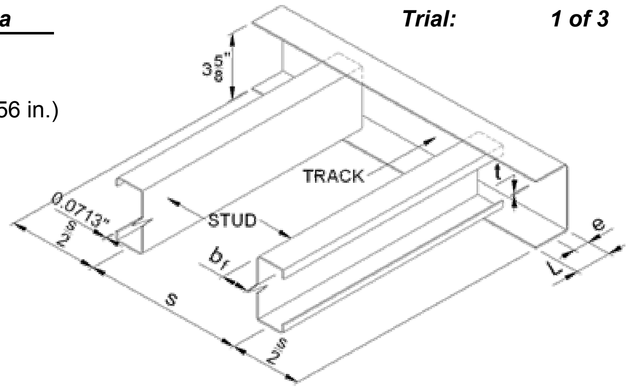
Yield (ksi)

Test #1	Test #2	Test #3	**Average of Test (1 & 2)**
37.9	39.3	43.3	**38.6**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-2-16-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

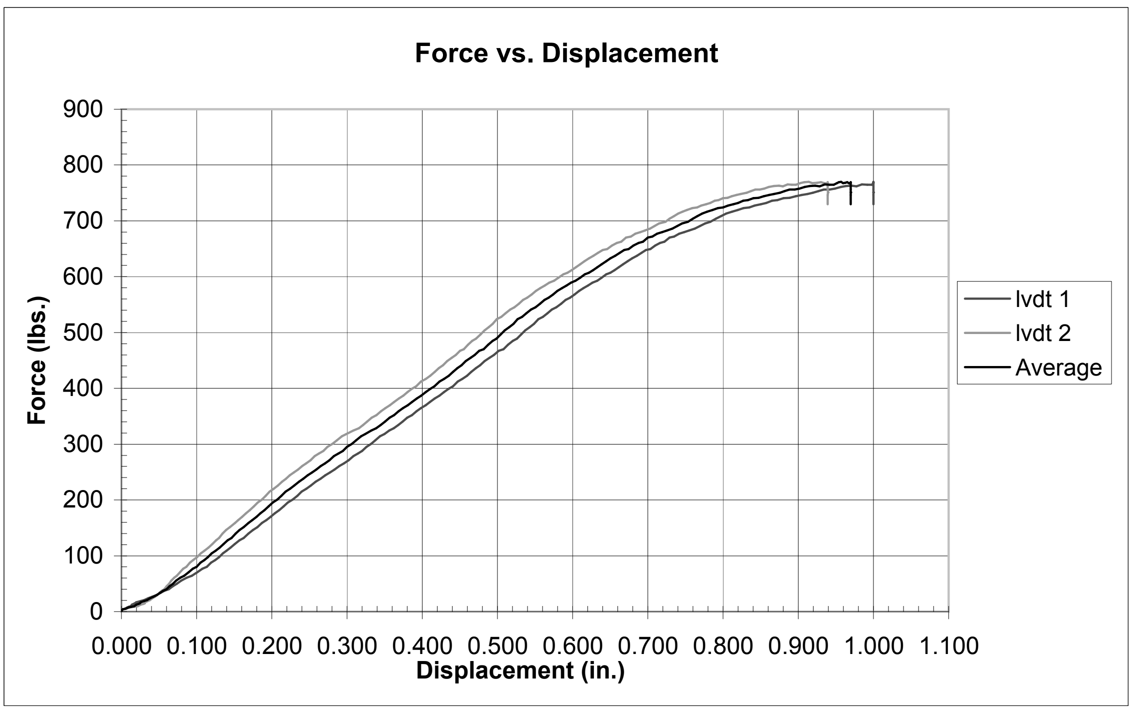
Thickness (in.) 0.0596 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	Average of Tests
44.3	45.9	43.2	**44.5**

Measured Dimensions

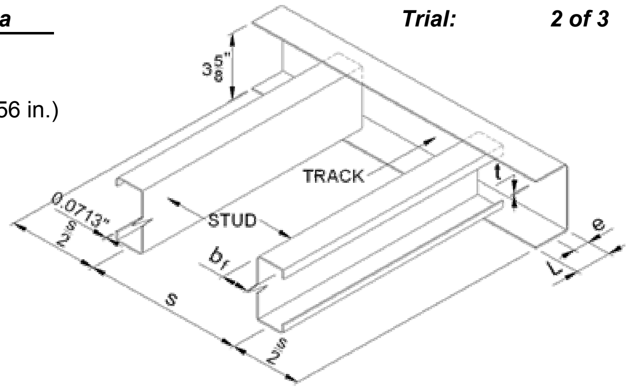
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 188 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-2-16-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

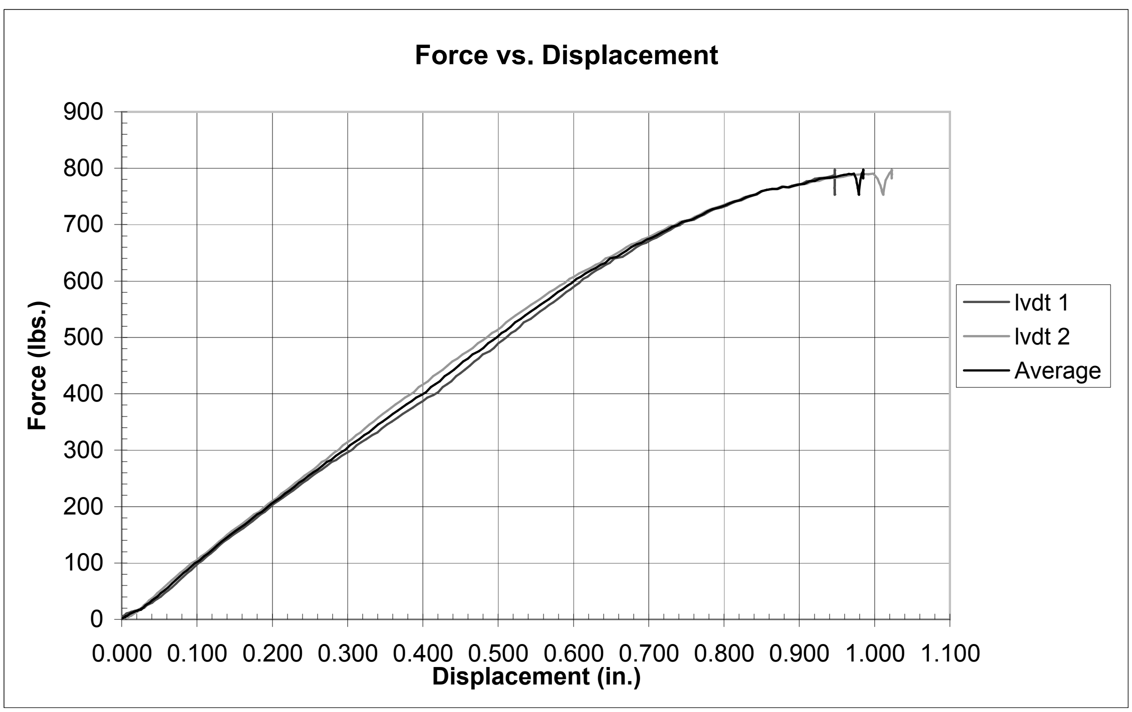
Thickness (in.) 0.0582 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
44.3	45.9	43.2	**44.5**

Measured Dimensions

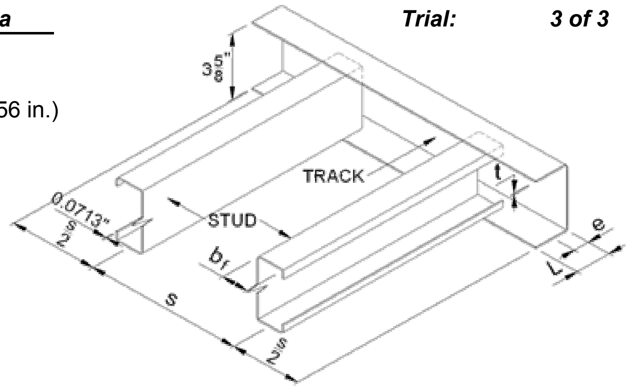
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 239 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-2-16-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

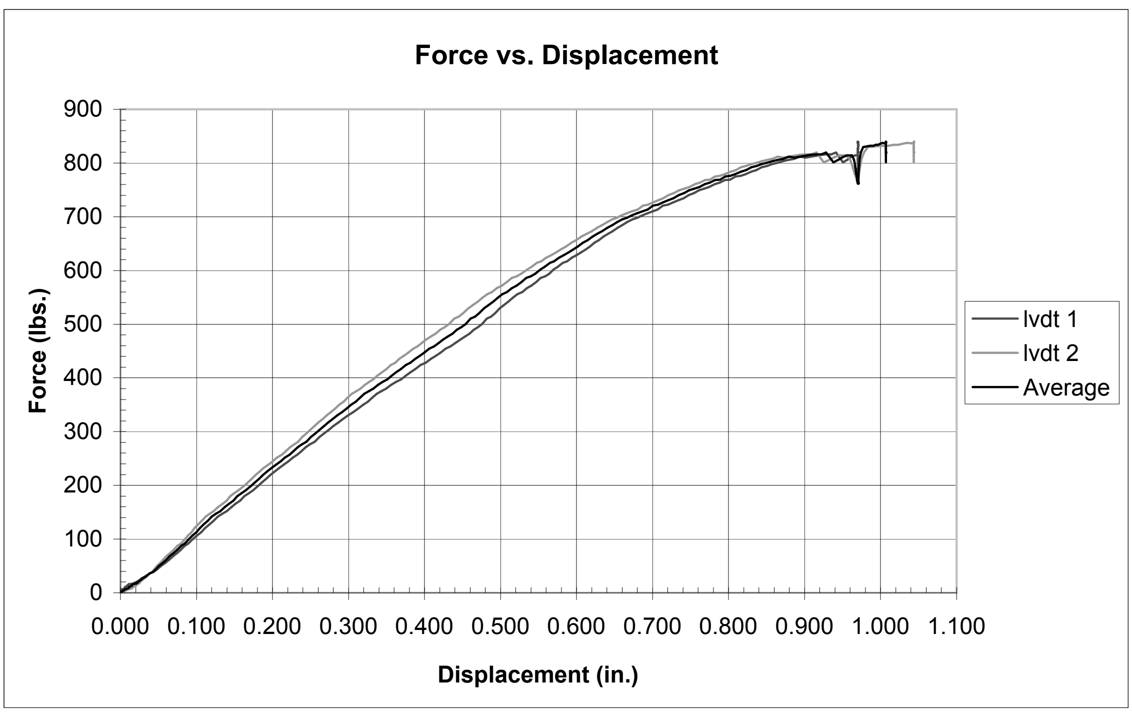
Thickness (in.) 0.0588 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
44.3	45.9	43.2	**44.5**

Measured Dimensions

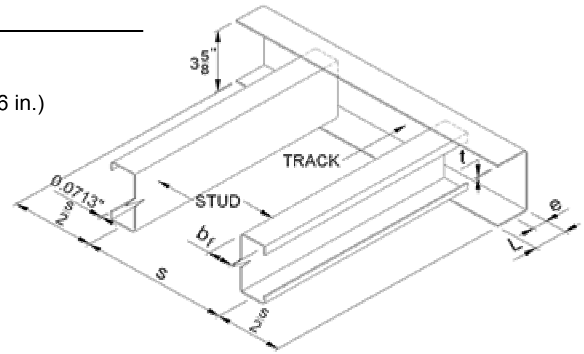
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 333 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***24-05-2-16 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t)	16 gage	(0.0556 in.)
Track Leg Length (L)	2 in.	

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e)	0.5 in.
Stud Flange Width (bf)	2 1/2 in.
Stud Spacing (s)	24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

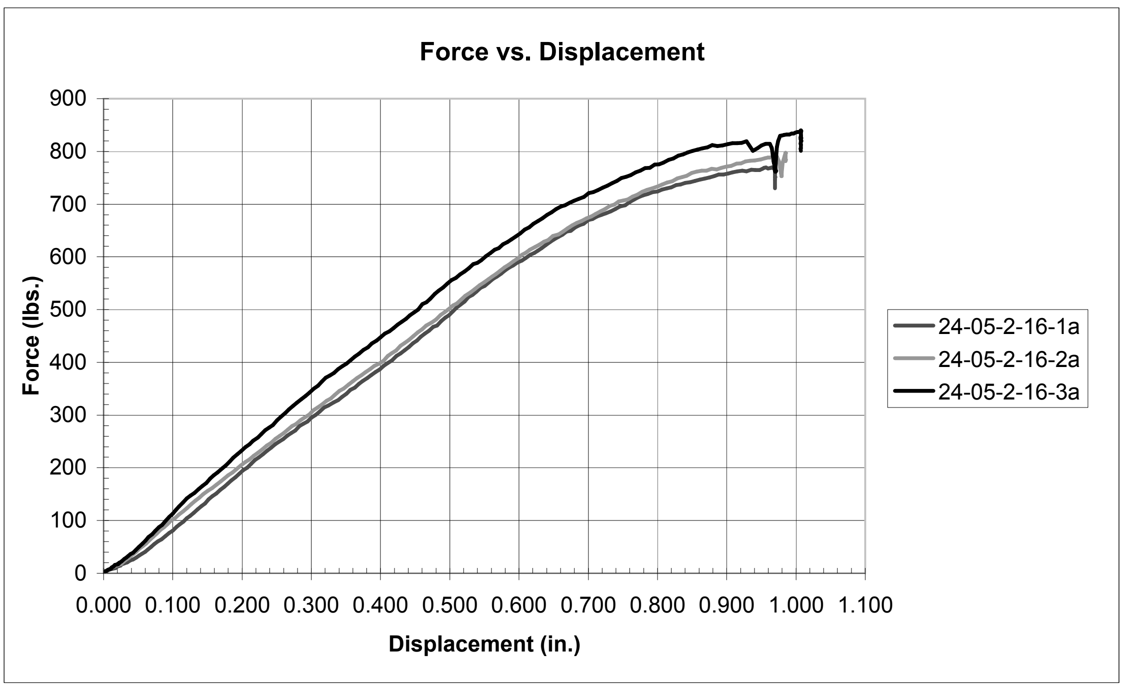
Ram Speed: 0.1 inches in 20 seconds

Maximum Load of Tests:

24-05-2-16-1a	769.65 Lbs.
24-05-2-16-2a	797.38 Lbs.
24-05-2-16-3a	839.66 Lbs.

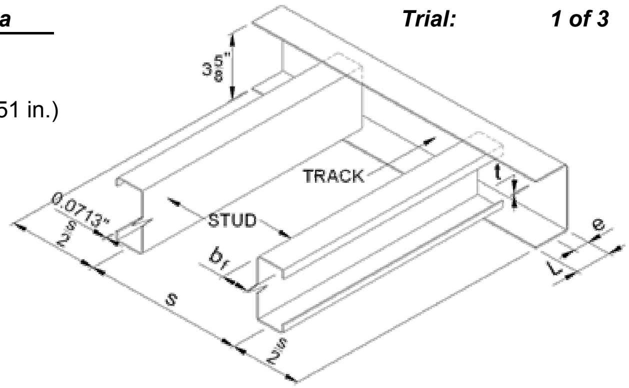
Track Material Property

	Test #1	Test #2	Test #3	**Average of Tests**
Yield (ksi)	44.3	45.9	43.2	**44.5**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-2-18-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

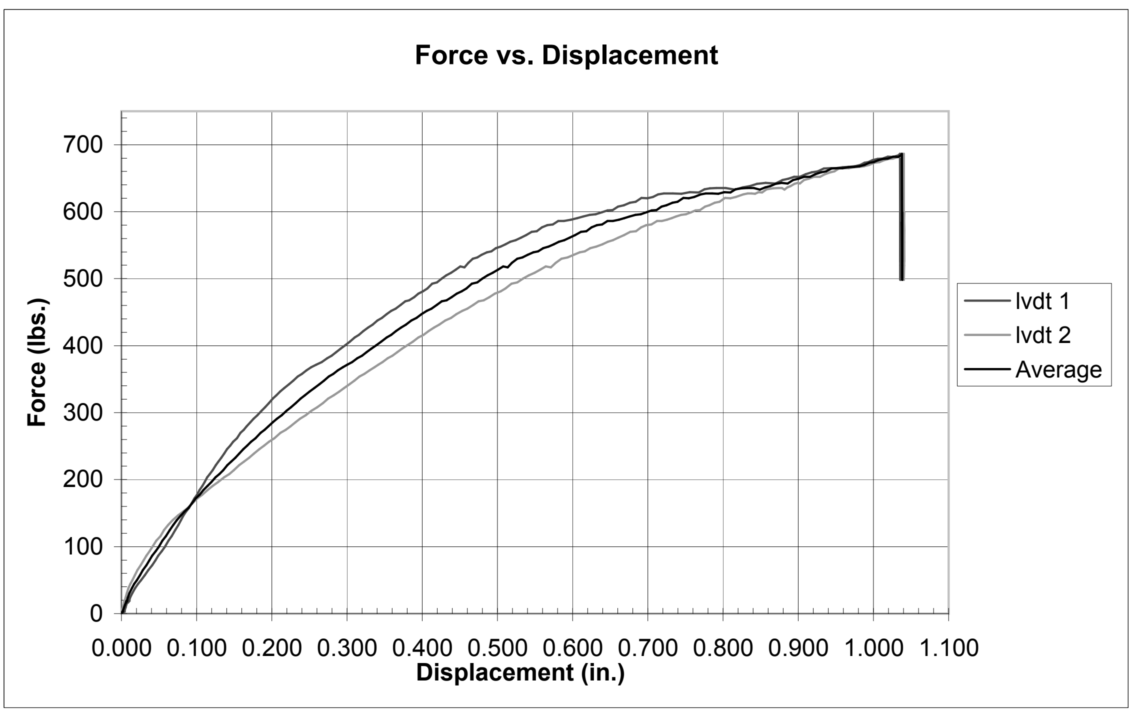
Thickness (in.) 0.0484 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.4	39.6	38.2	**39.4**

Measured Dimensions

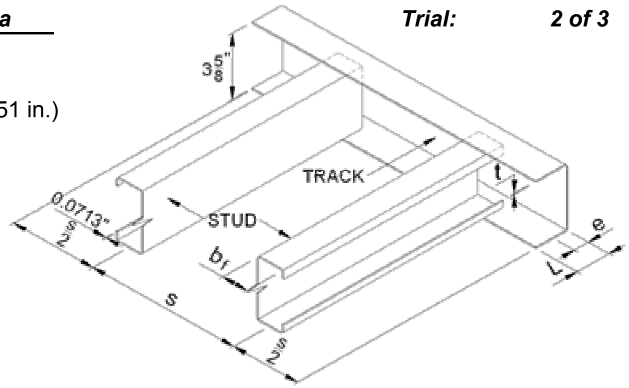
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 206 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-2-18-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

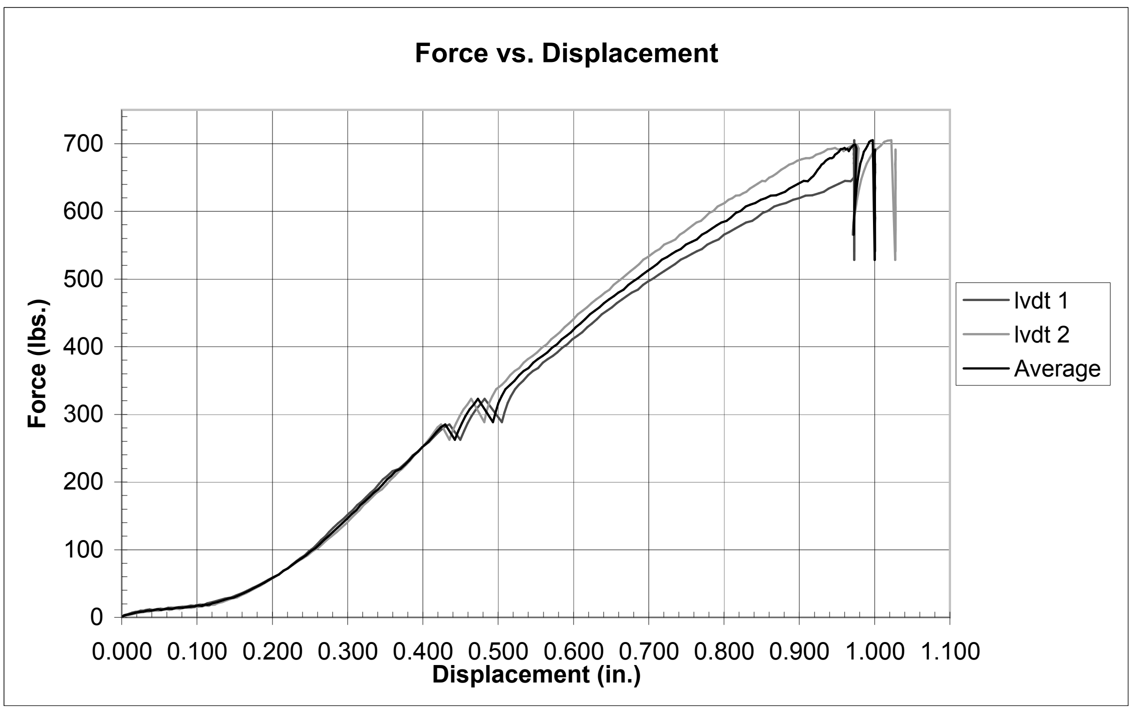
Thickness (in.) 0.0482 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.4	39.6	38.2	**39.4**

Measured Dimensions

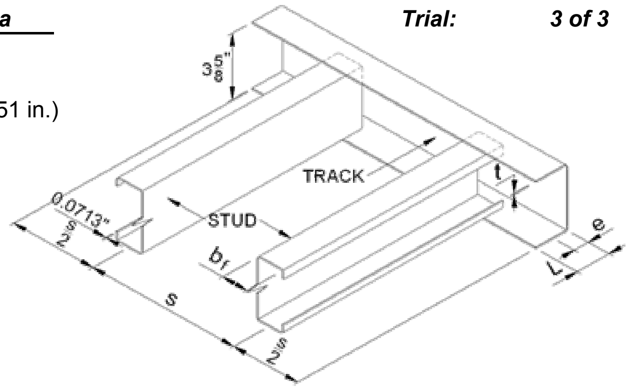
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 222 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-05-2-18-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

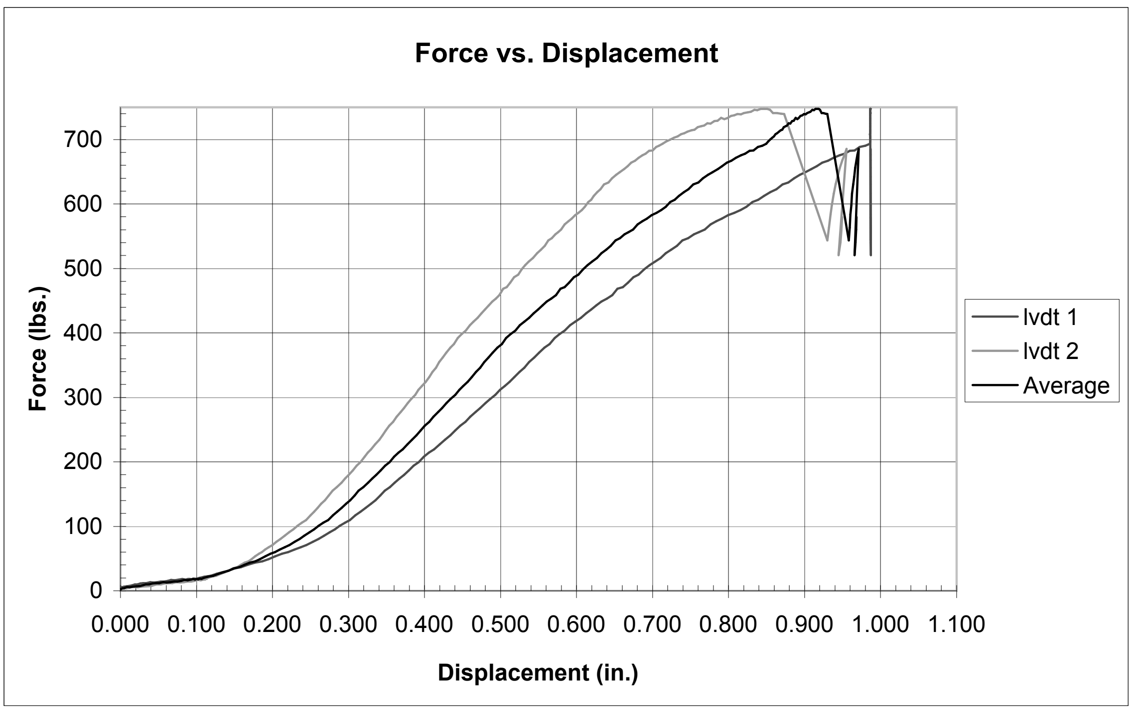
Thickness (in.) 0.0481 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.4	39.6	38.2	**39.4**

Measured Dimensions

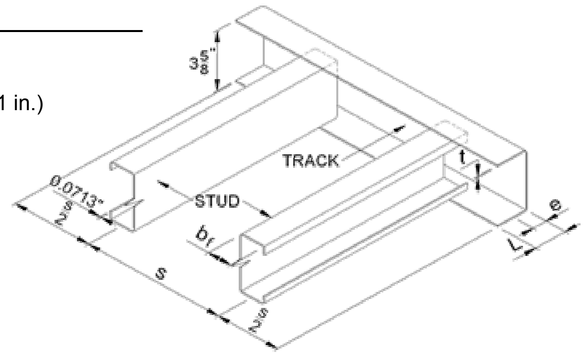
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 213 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***24-05-2-18 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 2 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 0.5 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

Ram Speed: 0.1 inches in 20 seconds

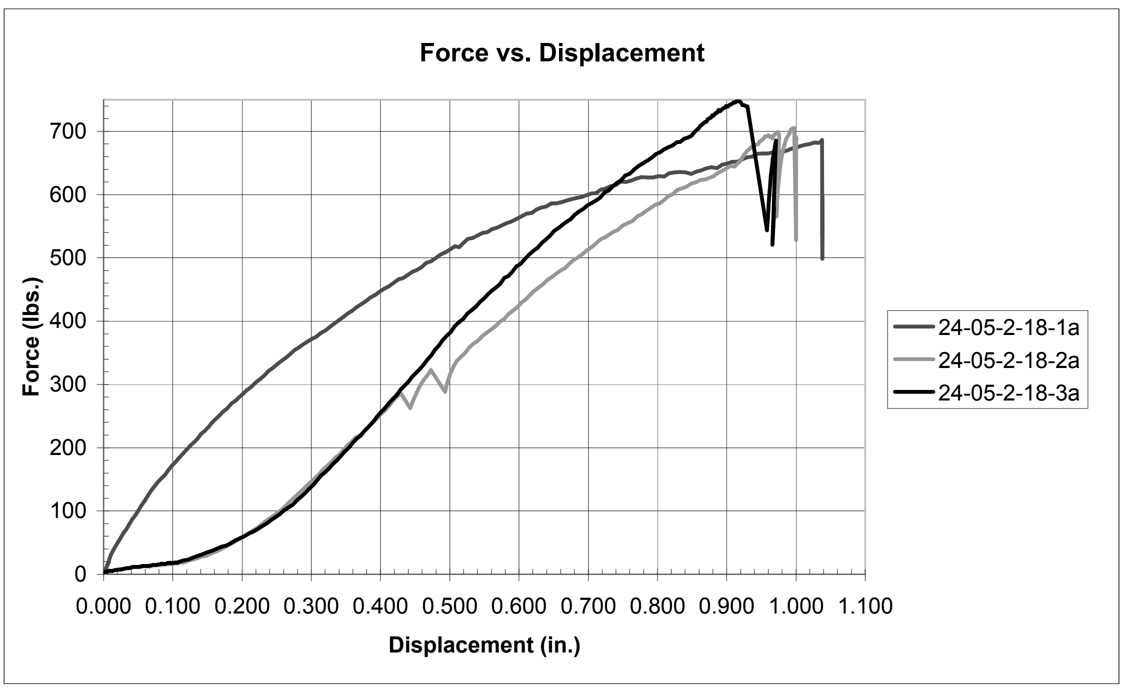
Maximum Load of Tests:

24-05-2-18-1a	686.35 Lbs.
24-05-2-18-2a	705.29 Lbs.
24-05-2-18-3a	747.61 Lbs.

Track Material Property

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.4	39.6	38.2	**39.4**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-14-1a*** **Trial:** ***1 of 3***

Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

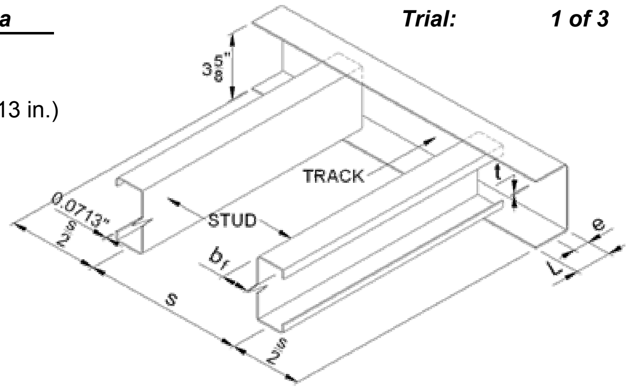
Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.



Track Material Property

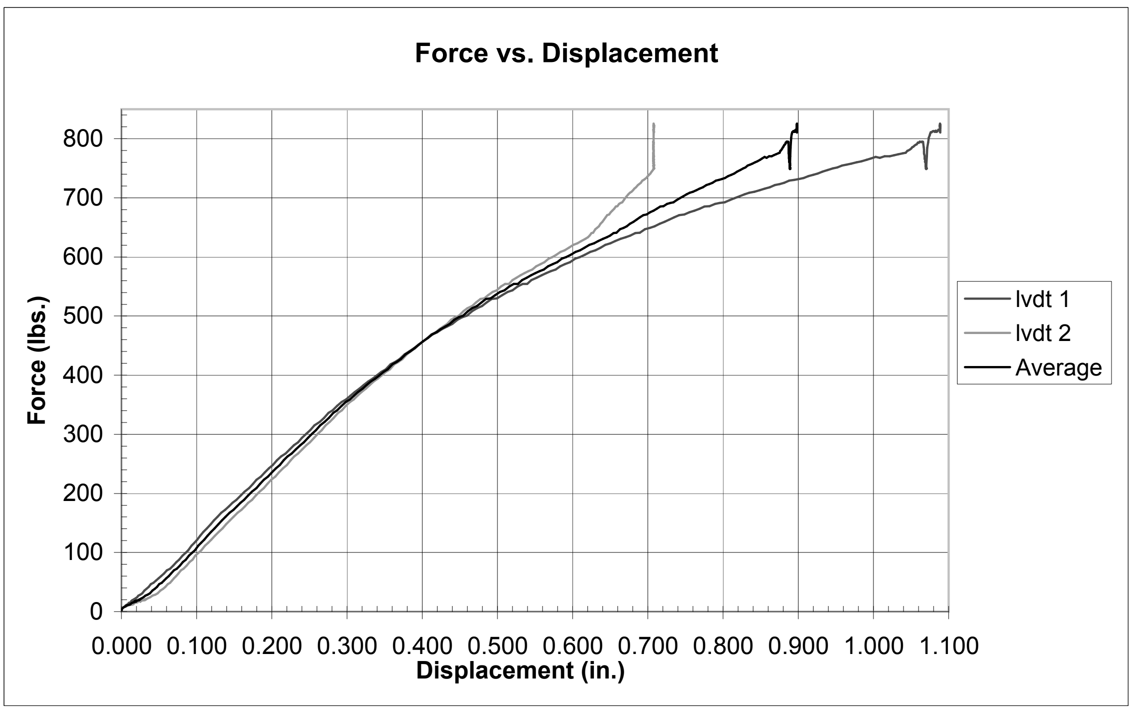
Thickness (in.) 0.0719 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

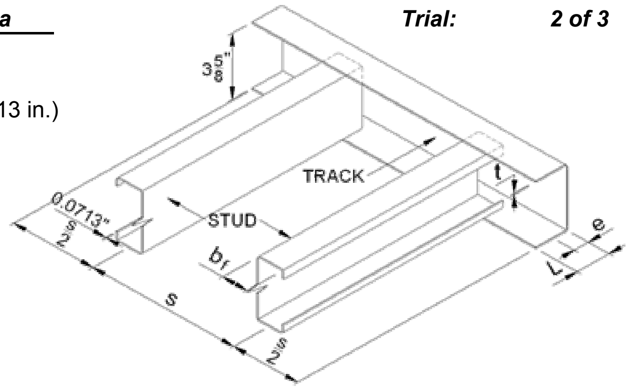
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 462 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-14-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

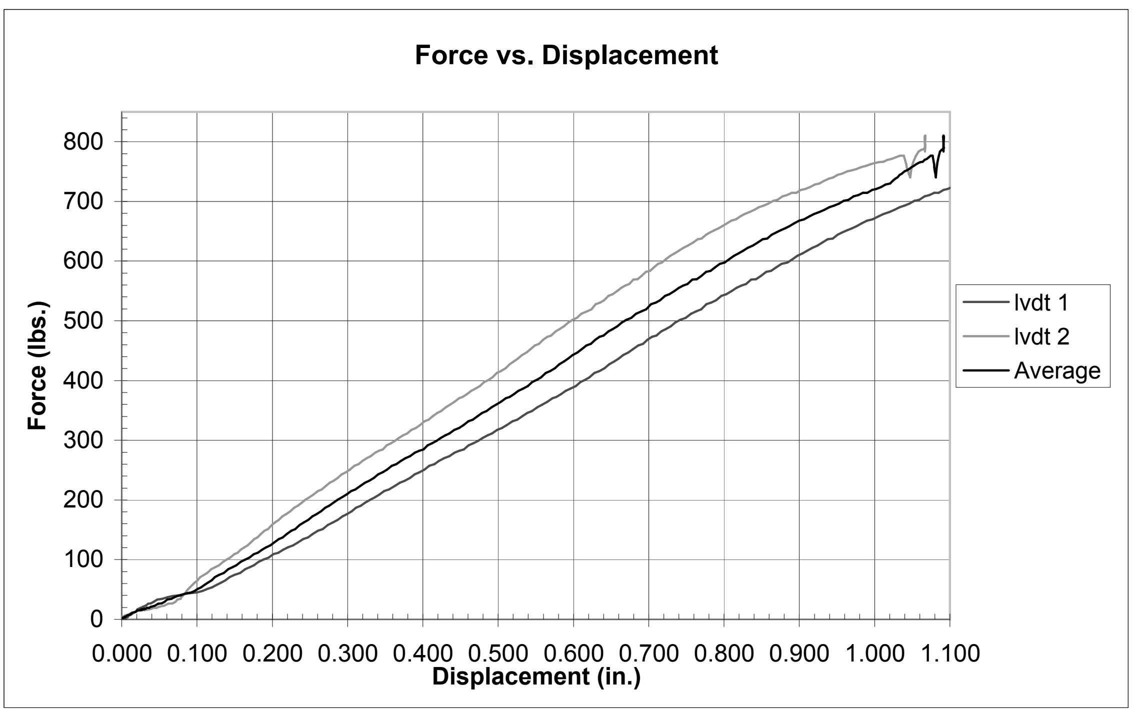
Thickness (in.) 0.0716 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	Average of Tests
40.9	40.5	40.5	**40.6**

Measured Dimensions

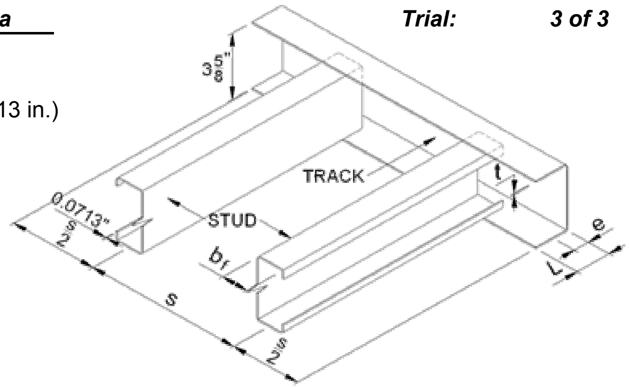
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 313 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-14-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

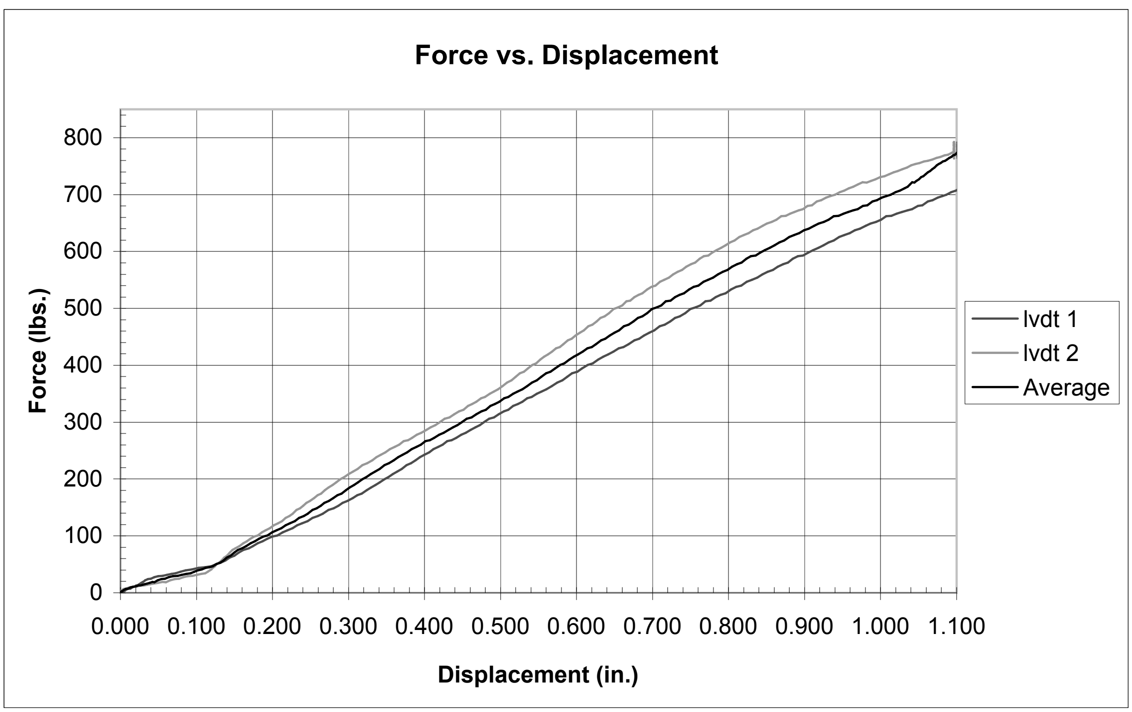
Thickness (in.) 0.0714 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

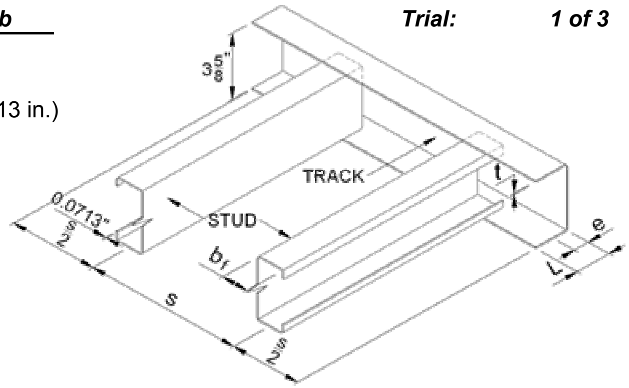
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 275 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-14-1b*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

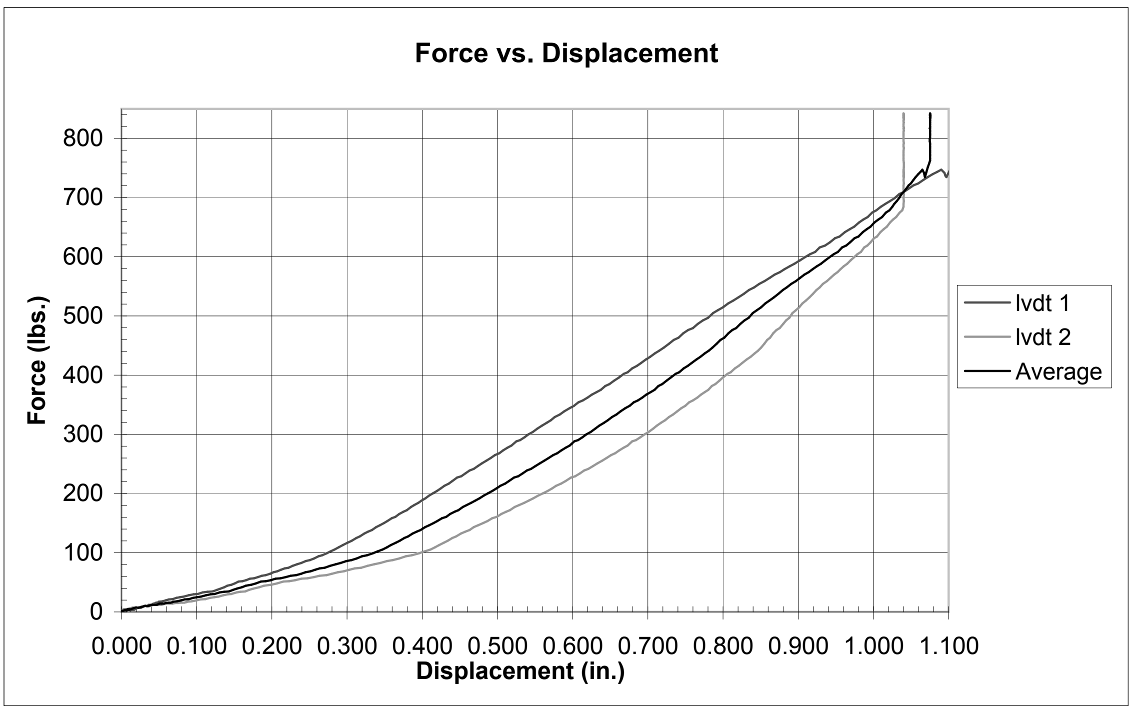
Thickness (in.) 0.0719 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

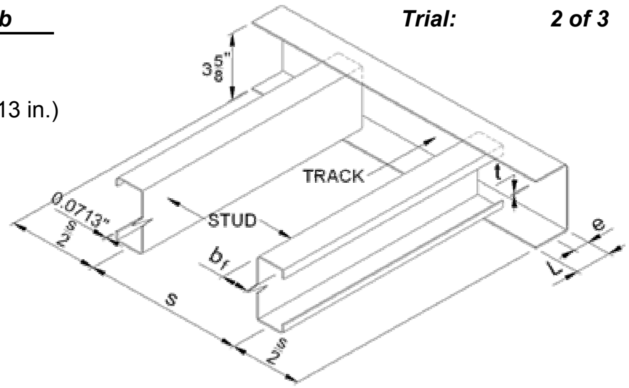
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 303 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-14-2b*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

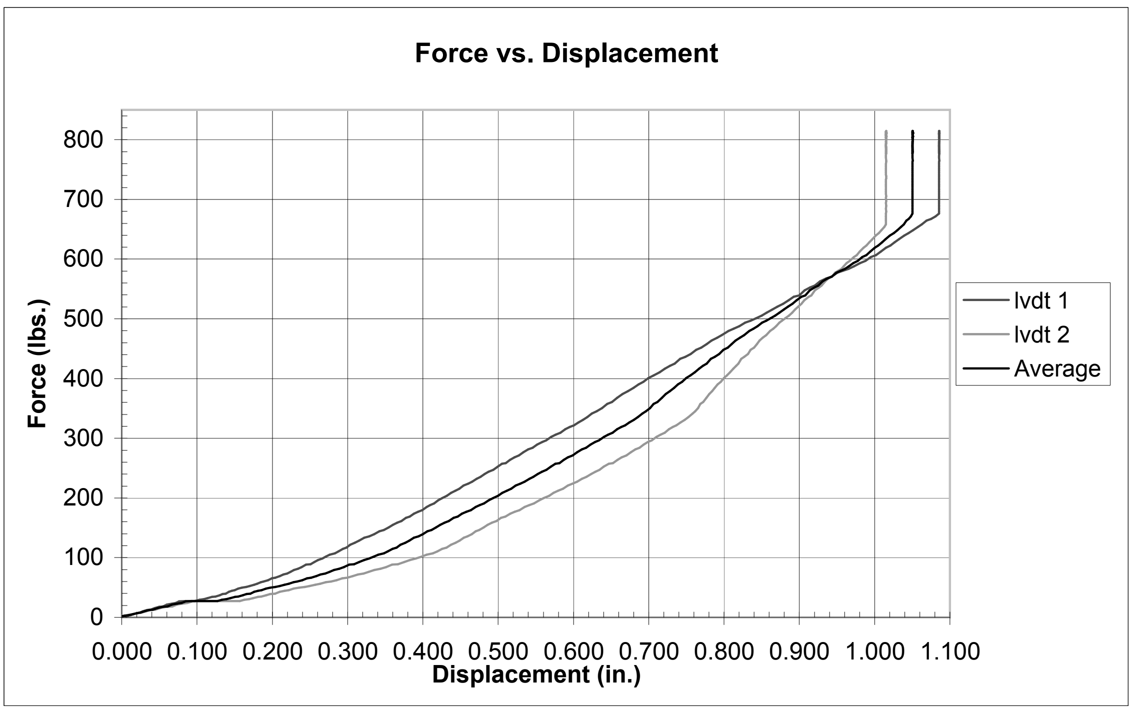
Thickness (in.) 0.0716 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

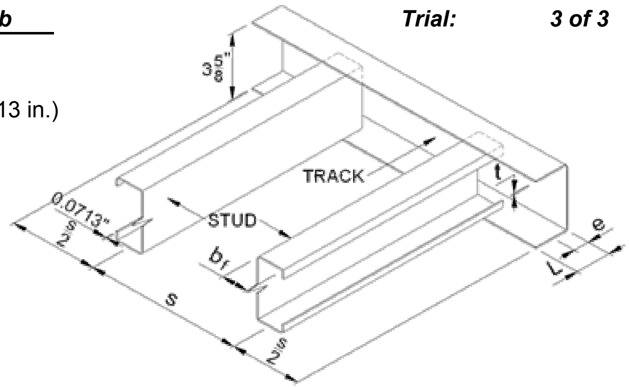
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 298 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-14-3b*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

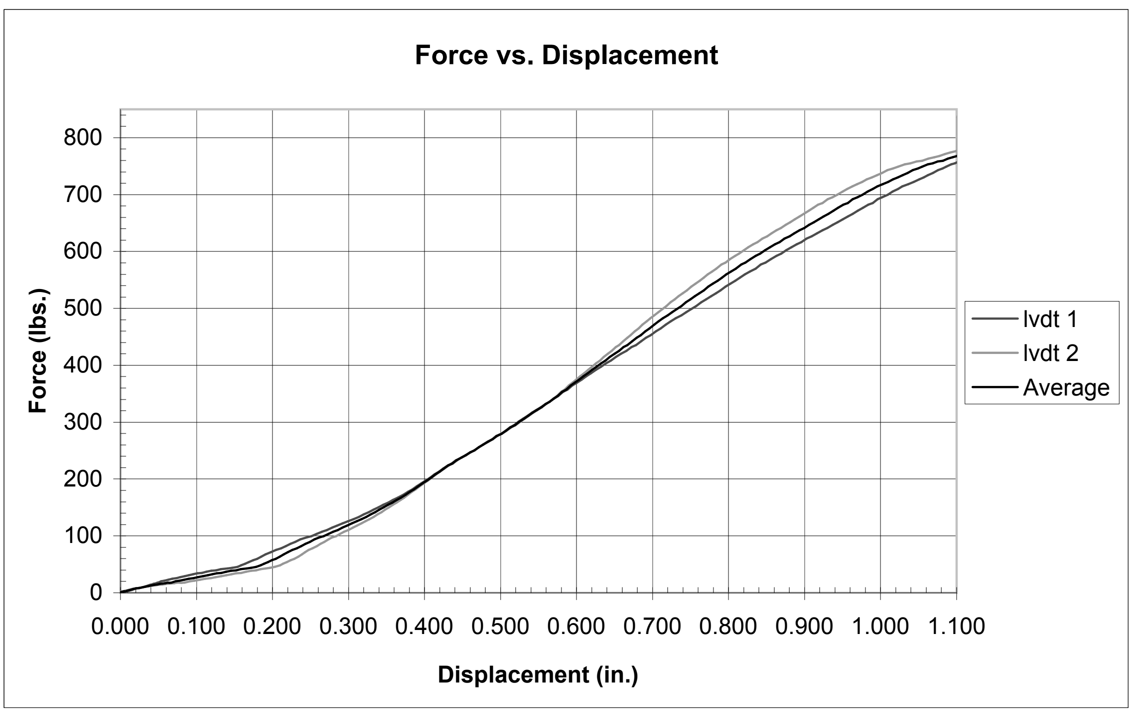
Thickness (in.) 0.0714 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

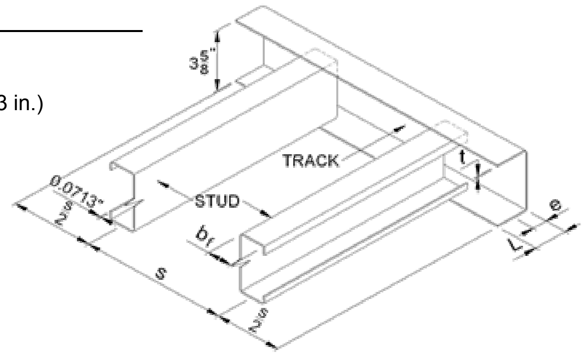
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 334 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***24-10-1-14 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

"a" tests: TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

"b" tests: THREE 1/4 in. dia. bolt w/ steel washers, ONE at specimen center and ONE at 20in. off specimen center (each side)

Ram Speed: 0.1 inches in 20 seconds

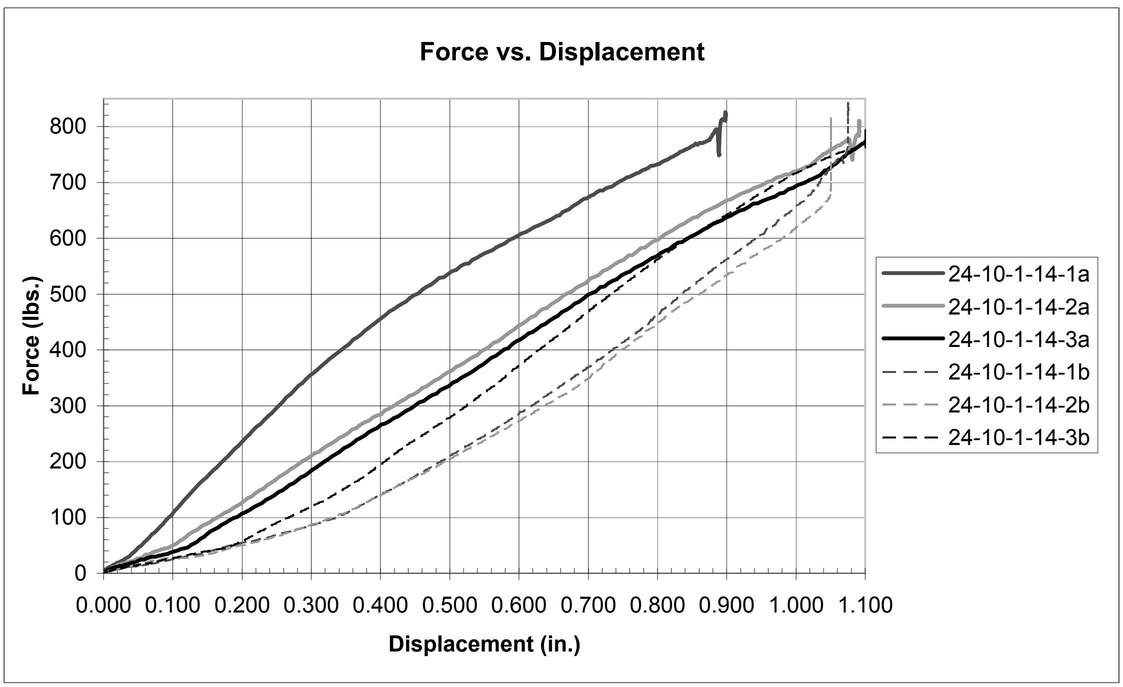
Maximum Load of Tests:

24-10-1-14-1a	825.75 Lbs.	24-10-1-14-1b	842.35 Lbs.
24-10-1-14-2a	810.40 Lbs.	24-10-1-14-2b	814.63 Lbs.
24-10-1-14-3a	792.55 Lbs.	24-10-1-14-3b	837.50 Lbs.

Track Material Property

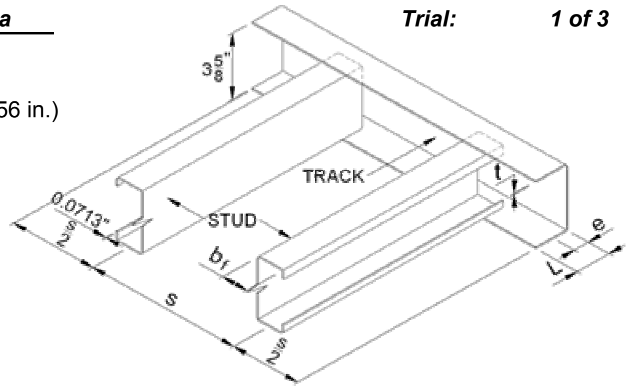
Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-16-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

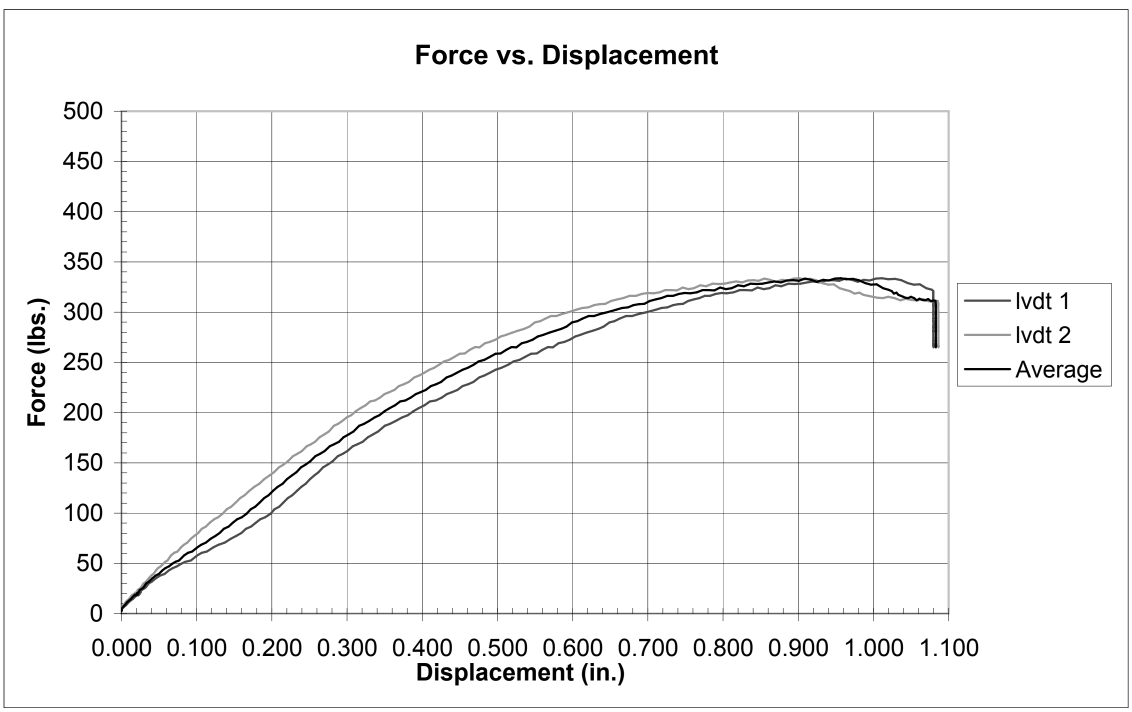
Thickness (in.) 0.0492 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	Average of Tests
23.5	37.9	39.3	**33.6**

Measured Dimensions

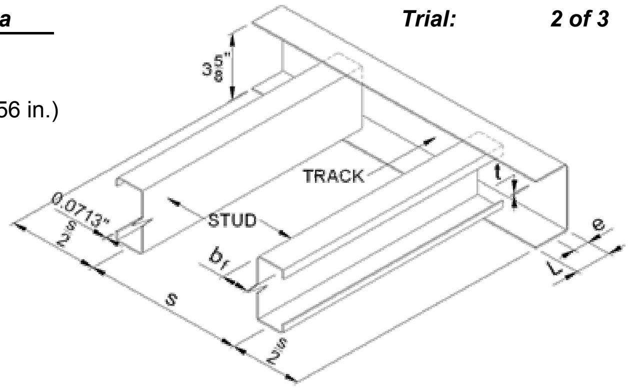
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 244 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-16-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

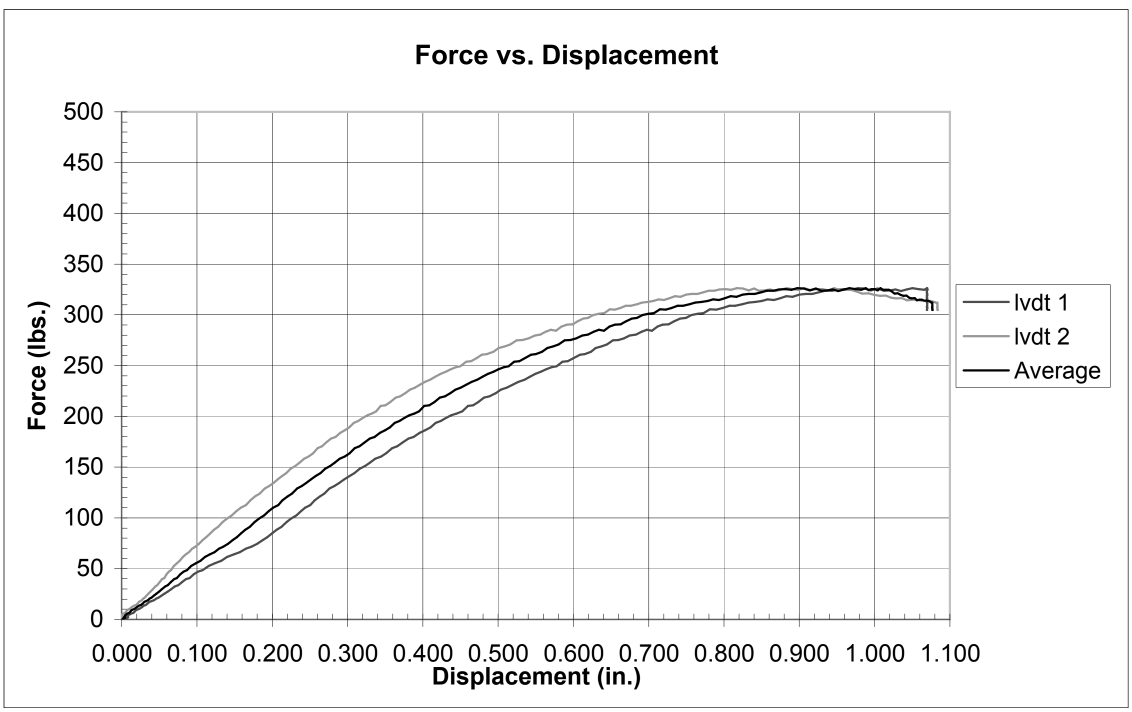
Thickness (in.) 0.0490 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

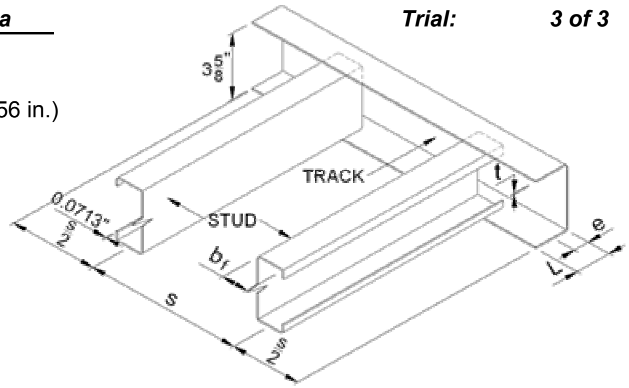
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 210 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-16-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

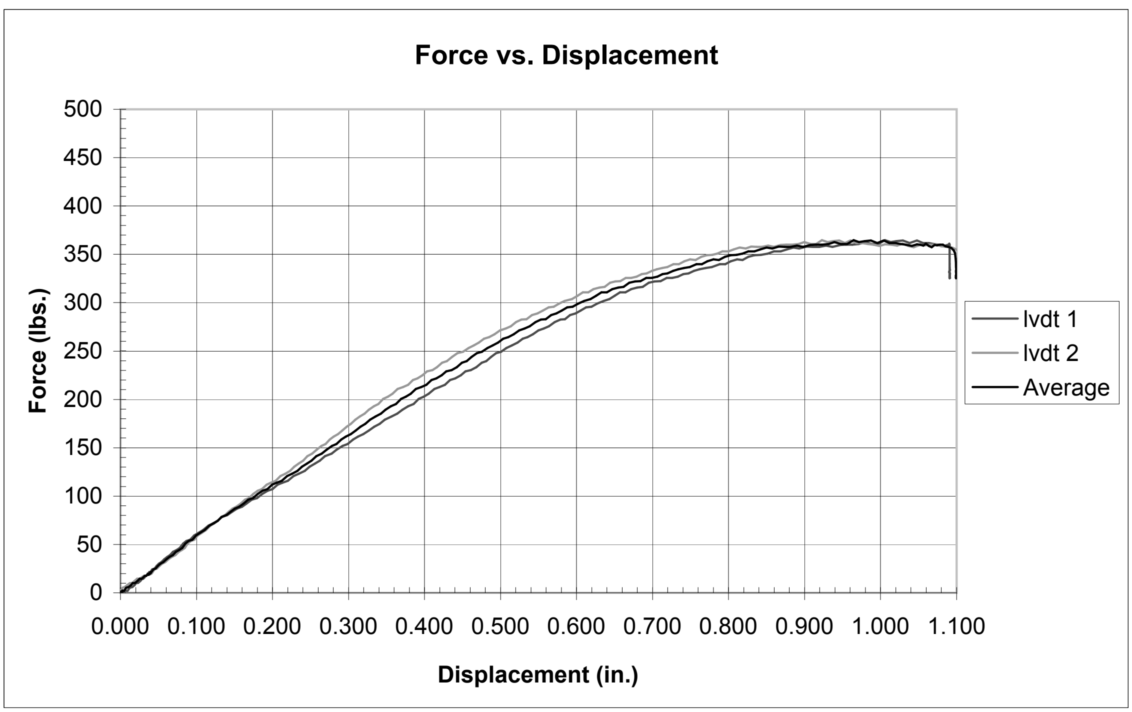
Thickness (in.) 0.0492 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

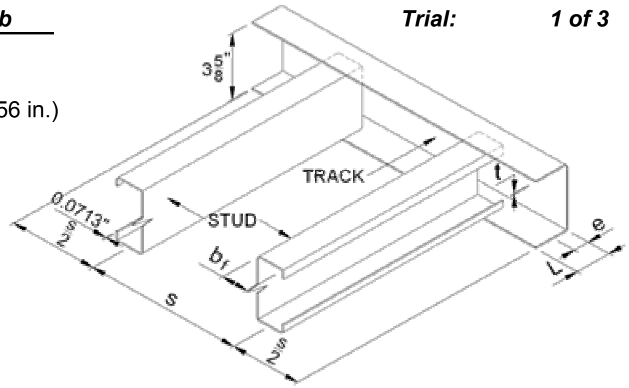
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 256 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-16-1b*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

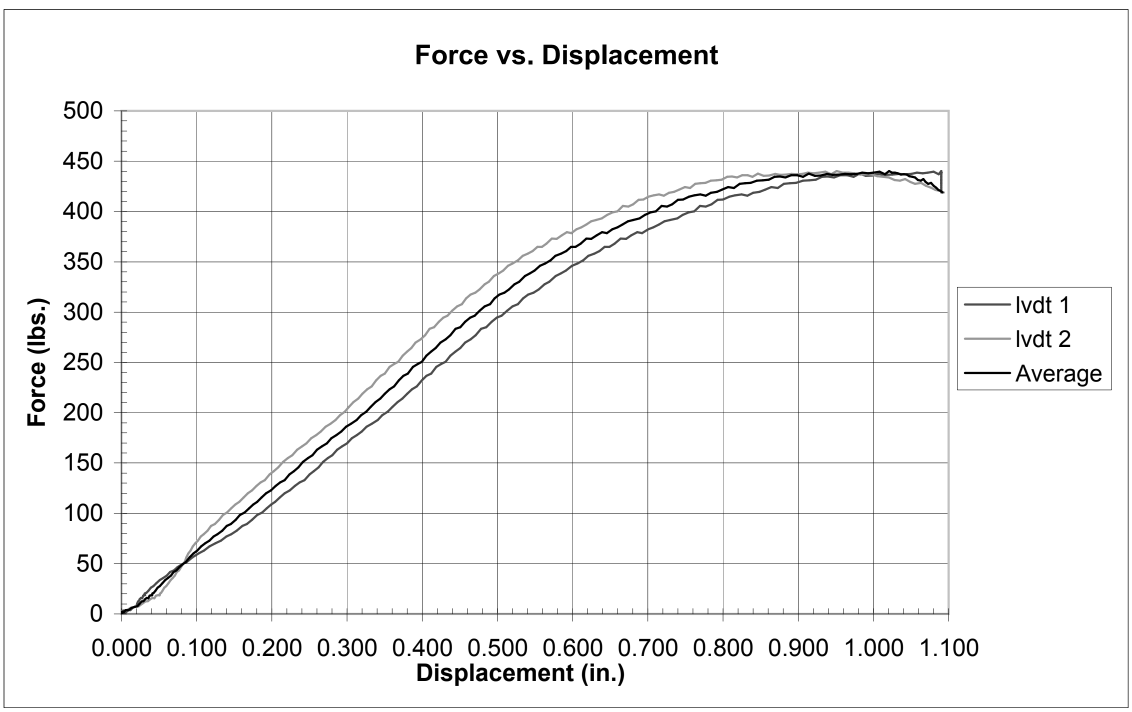
Thickness (in.) 0.0492 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

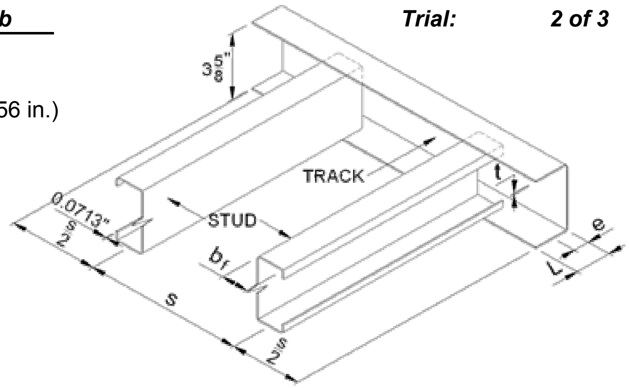
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 214 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-16-2b*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

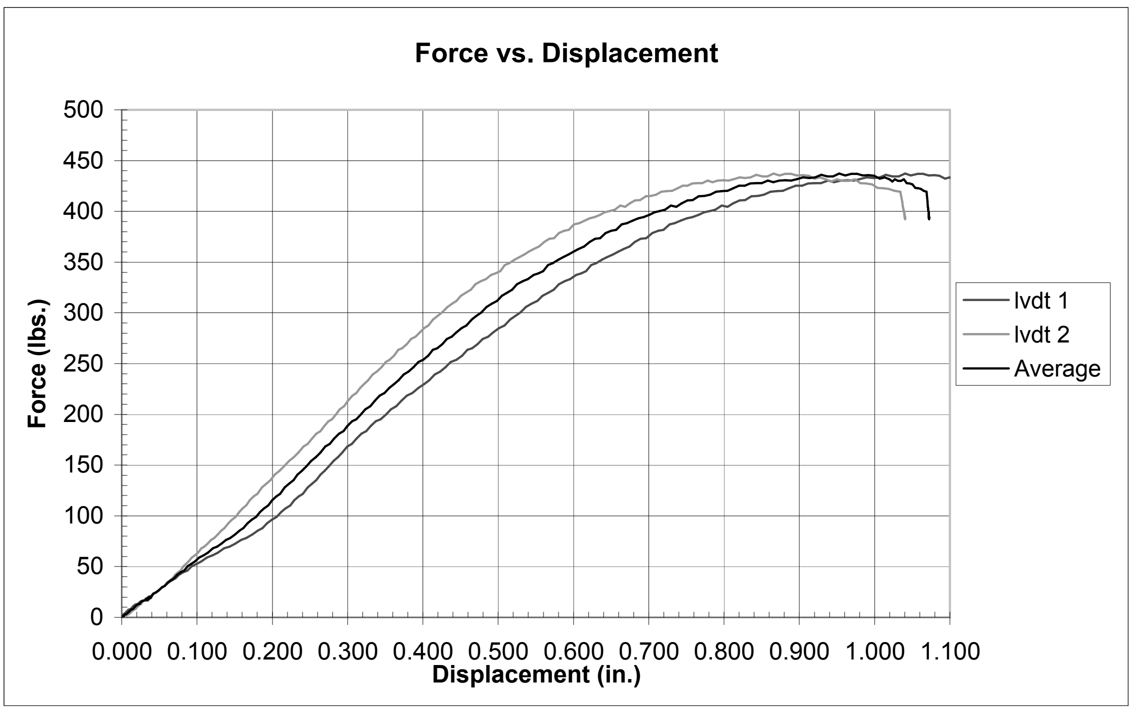
Thickness (in.) 0.0490 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

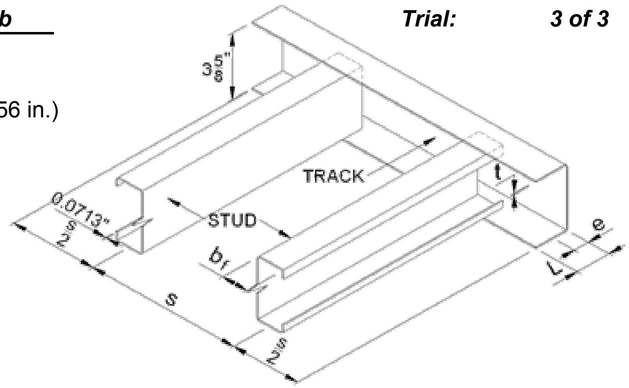
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 237 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-16-3b*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

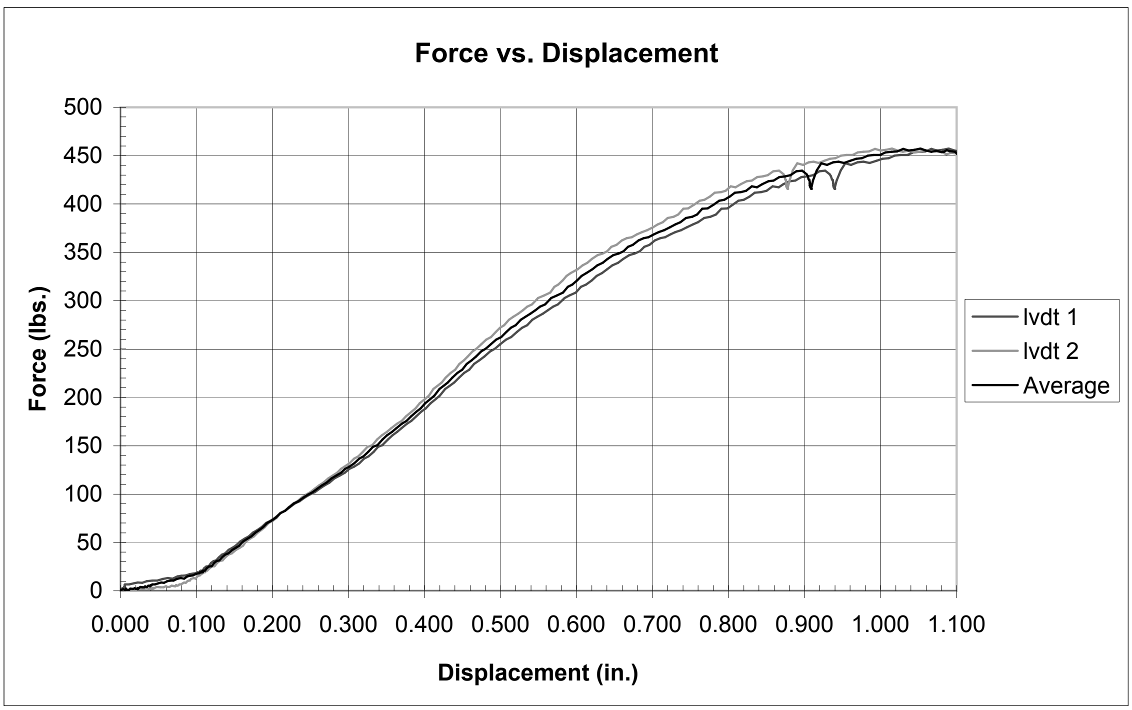
Thickness (in.) 0.0492 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

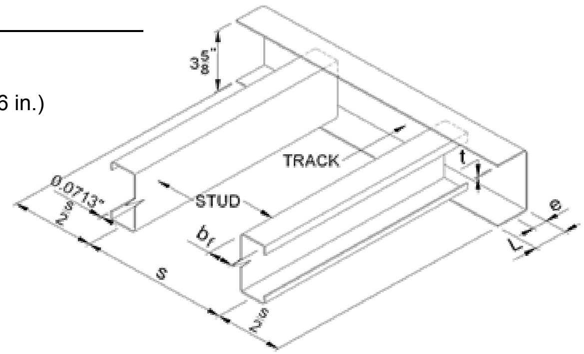
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 332 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***24-10-1-16 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t)	16 gage	(0.0556 in.)
Track Leg Length (L)	3 in.	

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e)	1 in.
Stud Flange Width (bf)	1 5/8 in.
Stud Spacing (s)	24 in.

Fastener Configuration

"a" tests: TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

"b" tests: THREE 1/4 in. dia. bolt w/ steel washers, ONE at specimen center and ONE at 20in. off specimen center (each side)

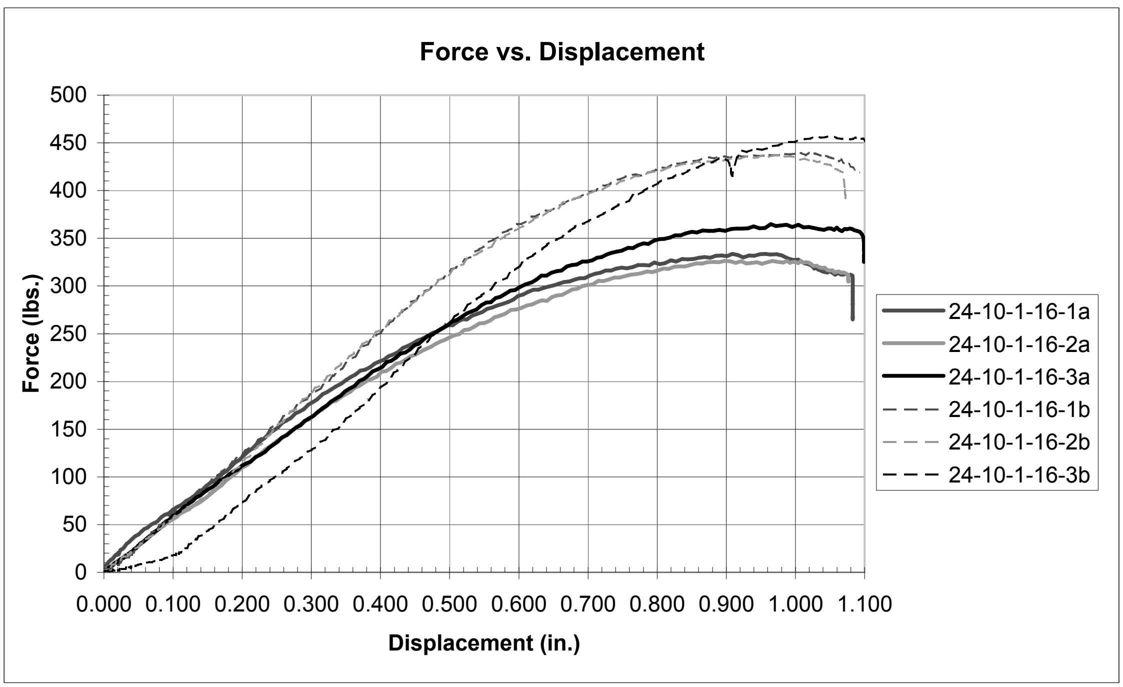
Ram Speed: 0.1 inches in 20 seconds

Maximum Load of Tests:

24-10-1-16-1a	333.72 Lbs.	24-10-1-16-1b	440.18 Lbs.
24-10-1-16-2a	326.36 Lbs.	24-10-1-16-2b	437.21 Lbs.
24-10-1-16-3a	364.72 Lbs.	24-10-1-16-3b	457.24 Lbs.

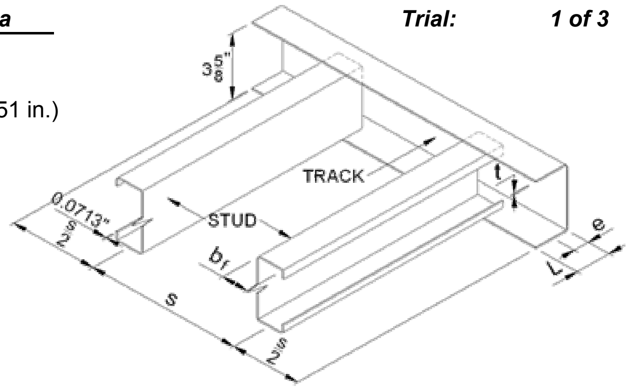
Track Material Property

	Test #1	Test #2	Test #3	**Average of Tests**
Yield (ksi)	23.5	37.9	39.3	**33.6**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-18-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

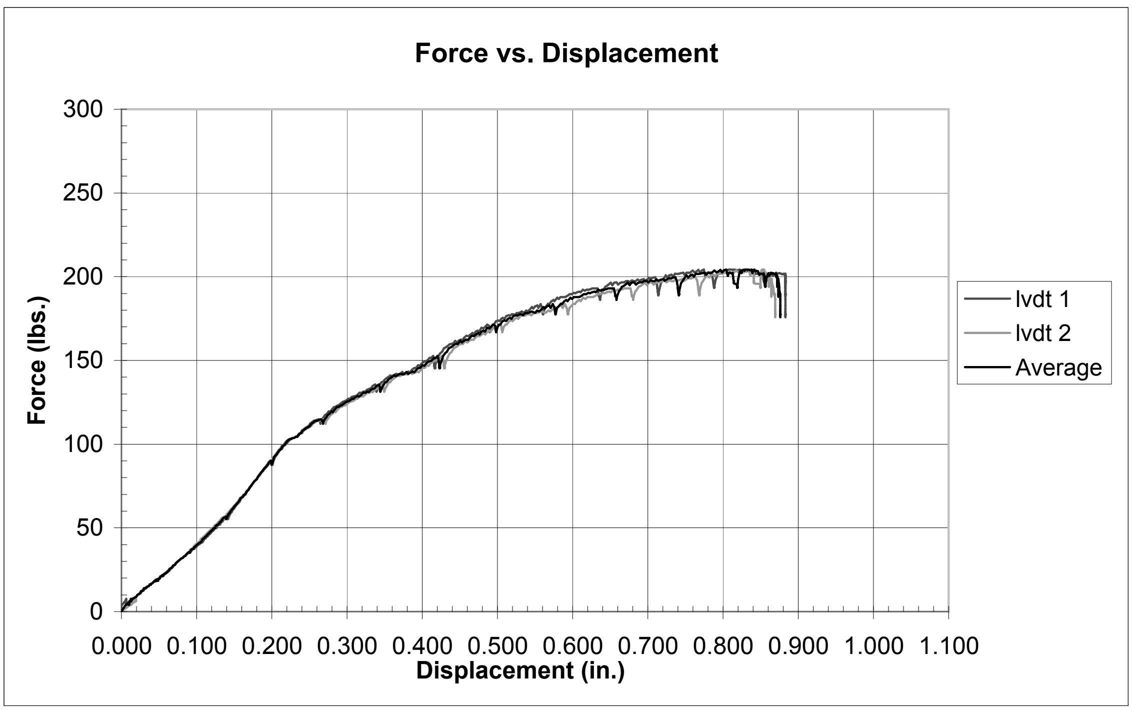
Thickness (in.) 0.0440 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

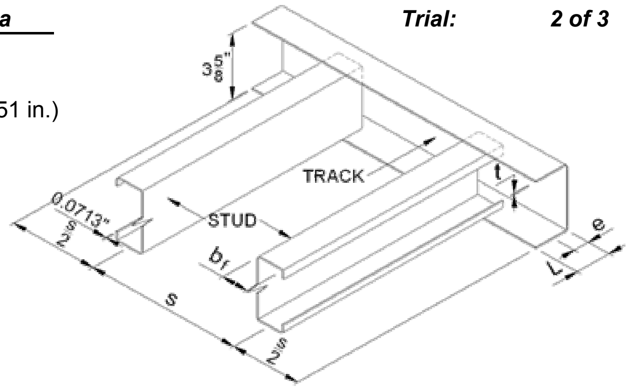
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 1123 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-18-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

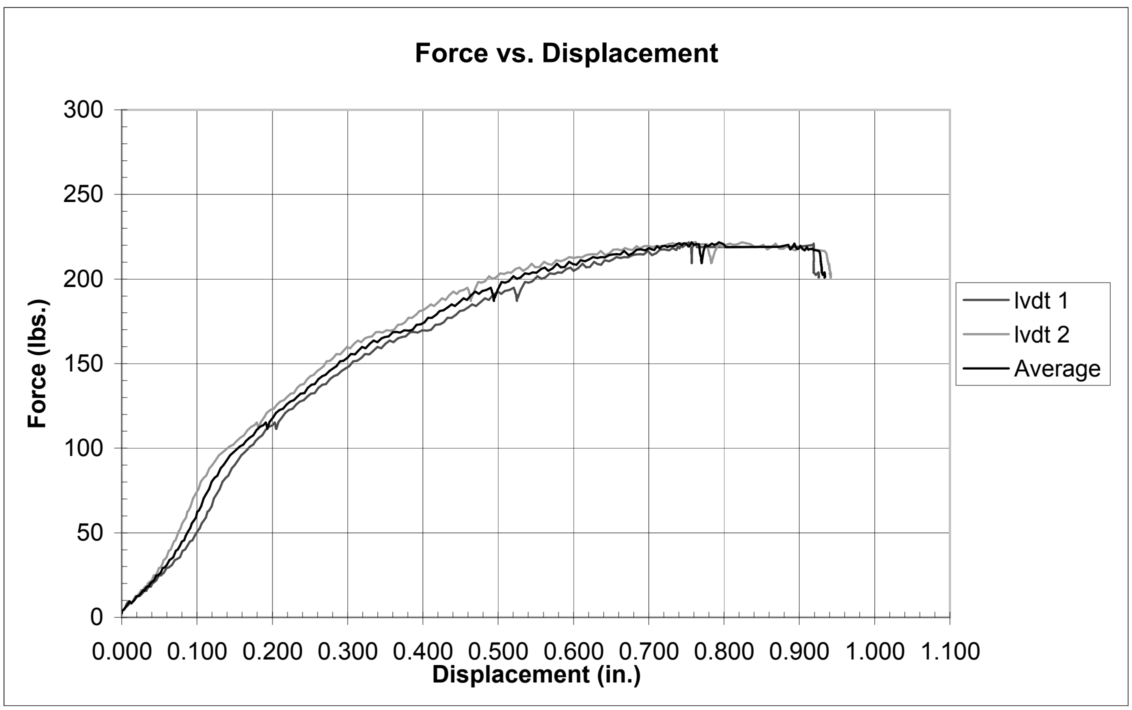
Thickness (in.) 0.0445 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

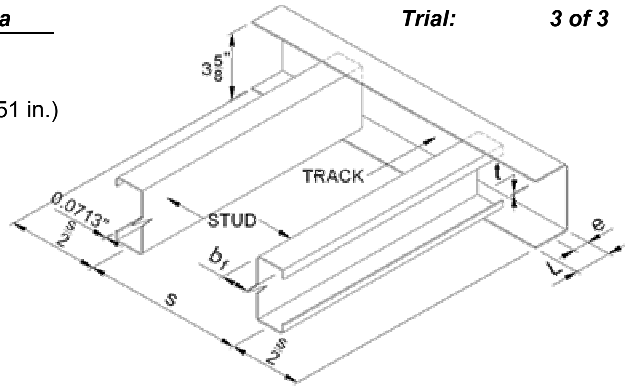
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 303 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-18-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

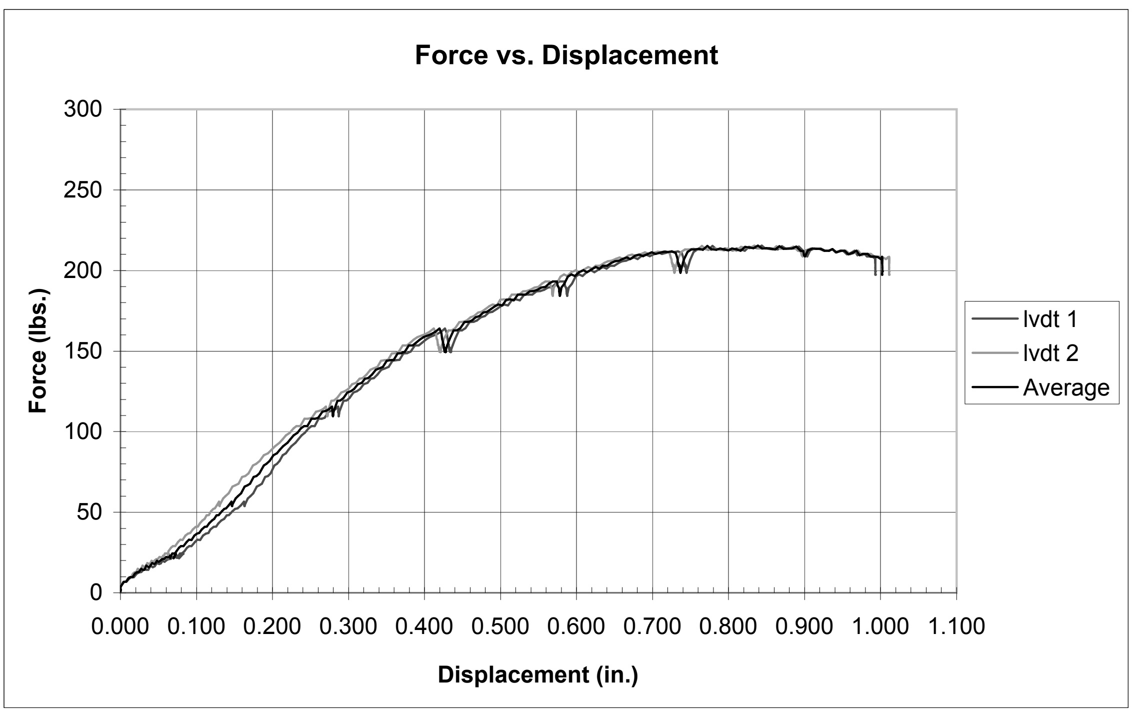
Thickness (in.) 0.0443 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

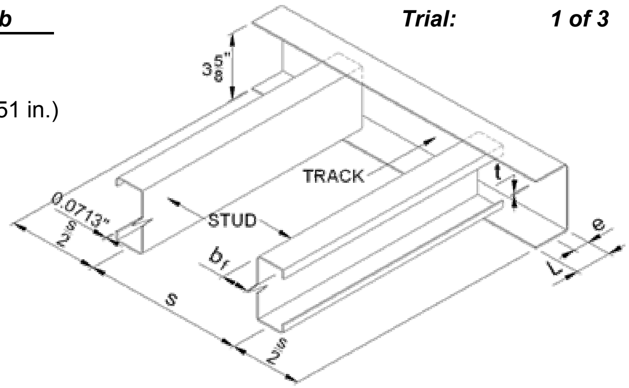
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 423 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-18-1b*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

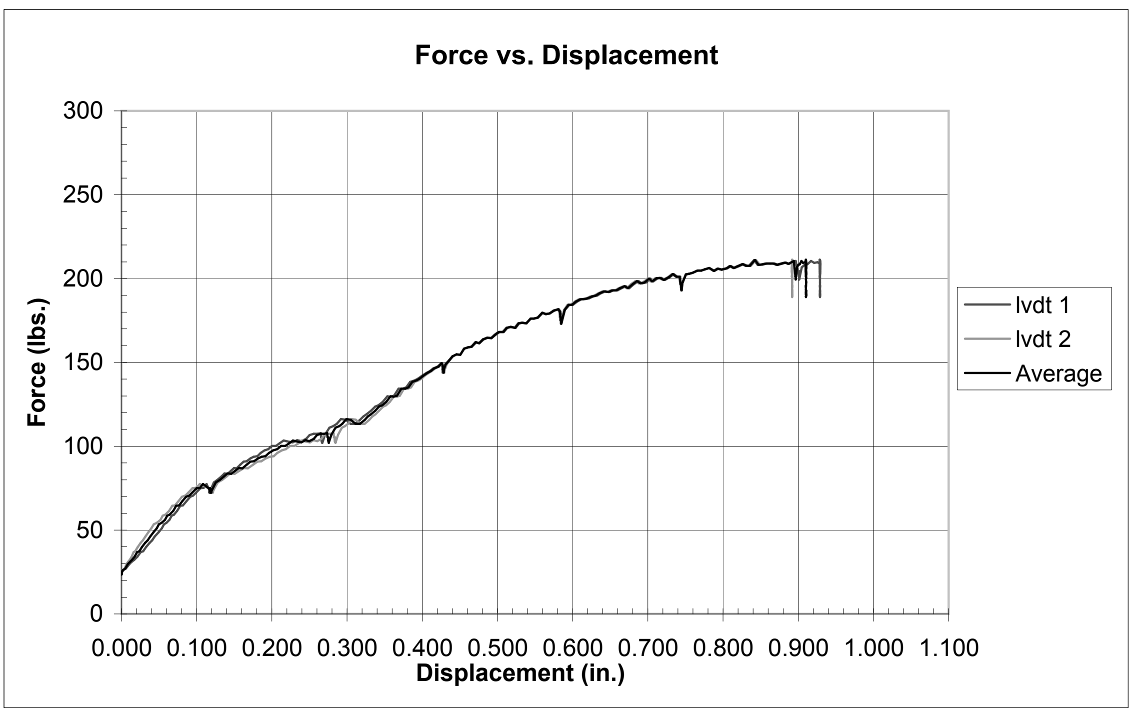
Thickness (in.) 0.0440 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

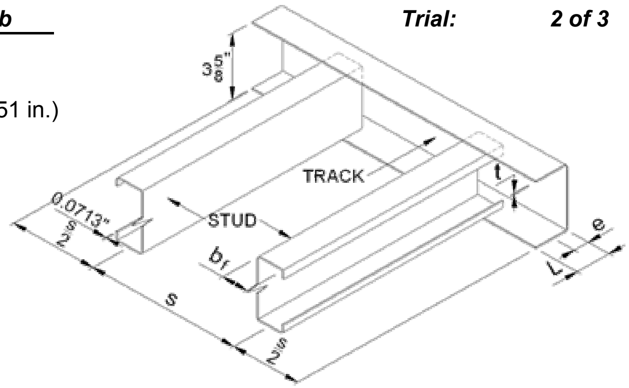
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 465 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-18-2b*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

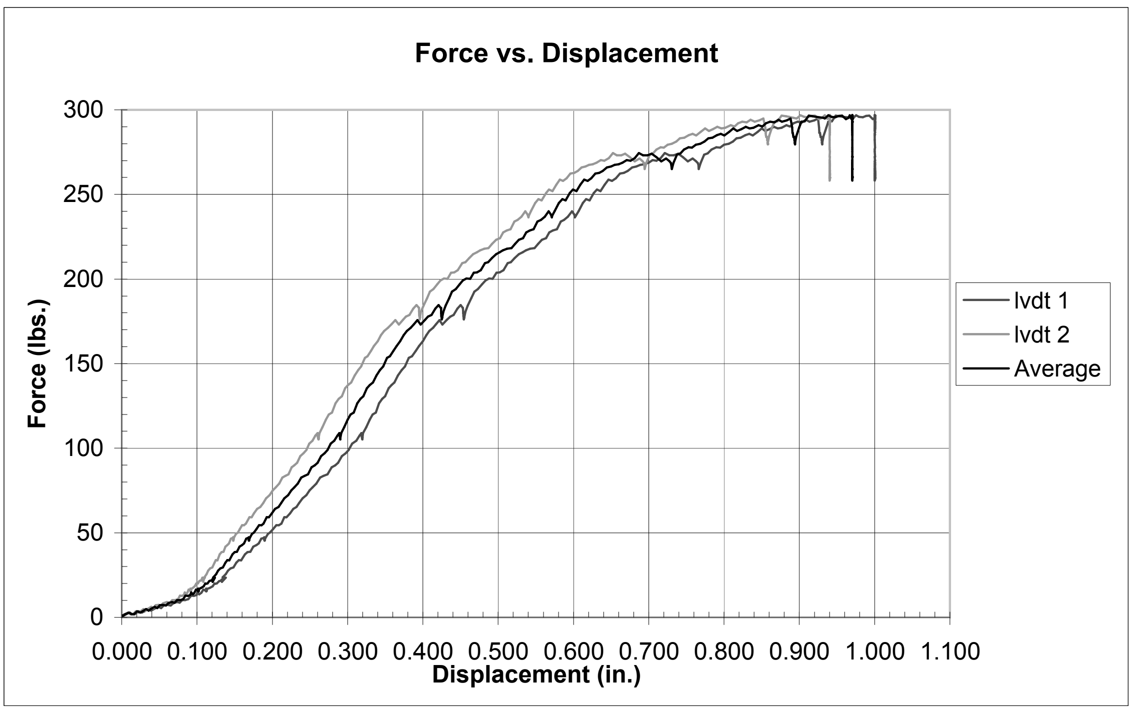
Thickness (in.) 0.0445 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

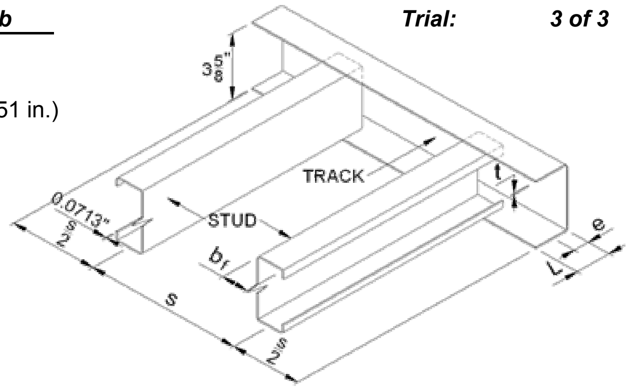
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 534 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-1-18-3b*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

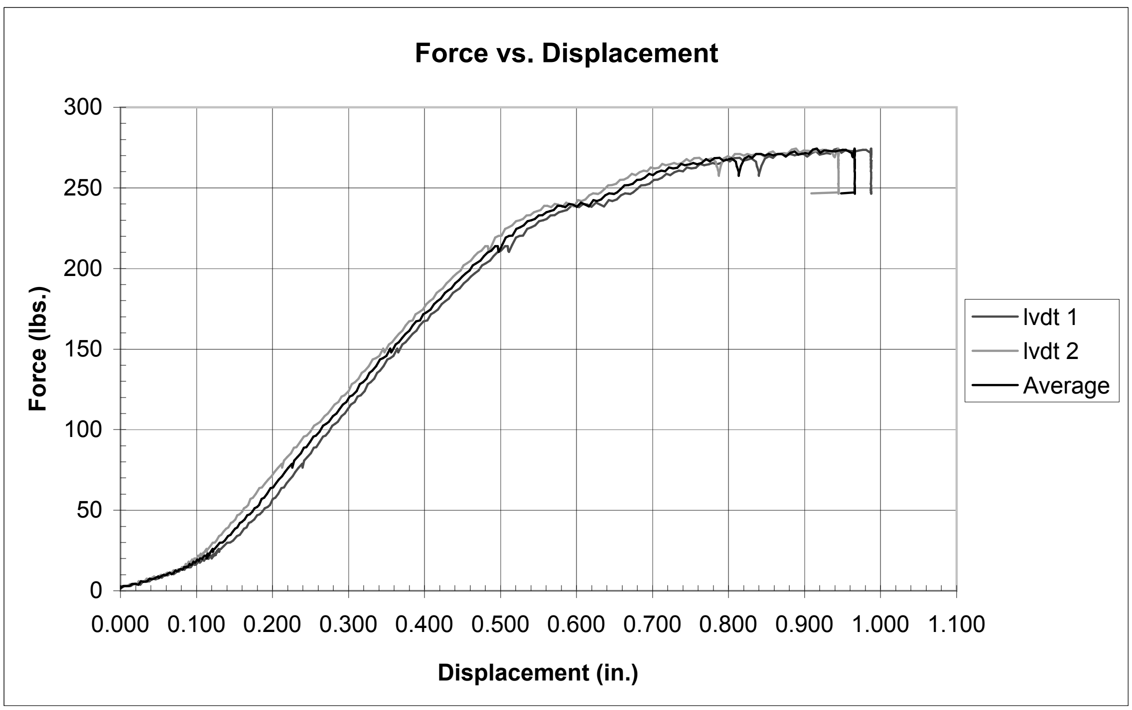
Thickness (in.) 0.0443 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

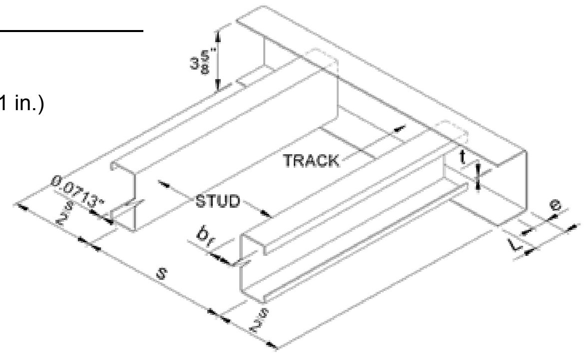
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 345 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***24-10-1-18 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 1 5/8 in.

Stud Spacing (s) 24 in.

Fastener Configuration

"a" tests: TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

"b" tests: THREE 1/4 in. dia. bolt w/ steel washers, ONE at specimen center and ONE at 20in. off specimen center (each side)

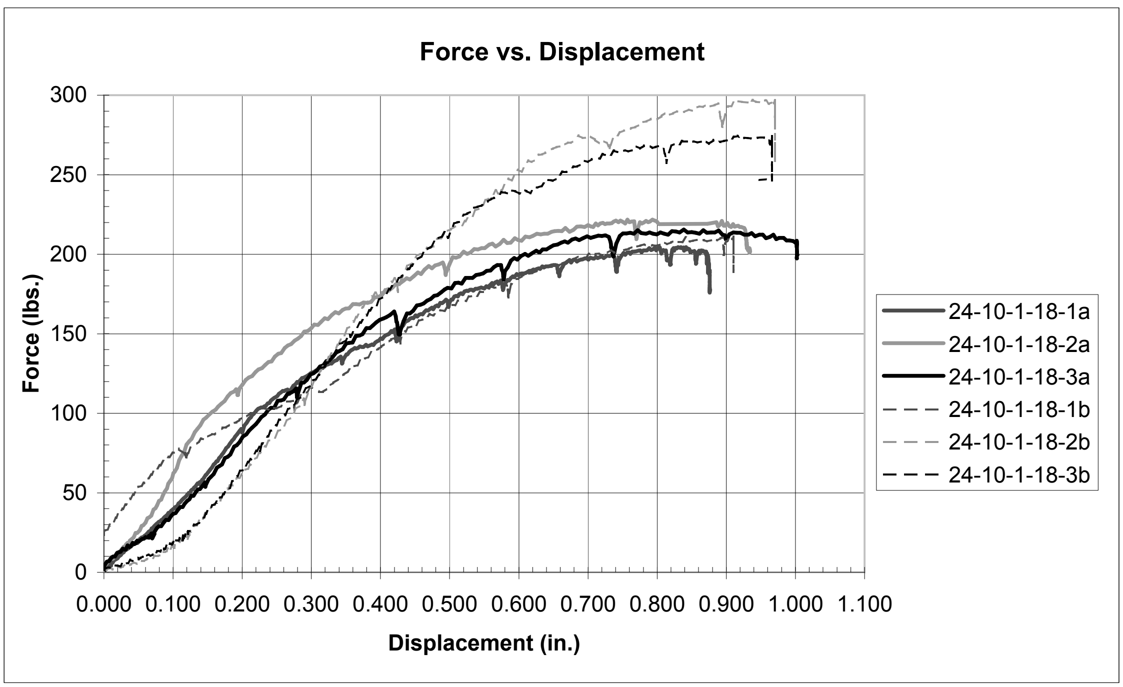
Ram Speed: 0.1 inches in 30 seconds

Maximum Load of Tests:

24-10-1-18-1a	204.36 Lbs.	24-10-1-18-1b	211.25 Lbs.
24-10-1-18-2a	221.73 Lbs.	24-10-1-18-2b	297.02 Lbs.
24-10-1-18-3a	215.47 Lbs.	24-10-1-18-3b	274.48 Lbs.

Track Material Property

	Test #1	Test #2	Test #3	**Average of Tests**
Yield (ksi)	23.0	22.8	22.6	**22.8**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-14-1a*** **Trial:** ***1 of 3***

Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

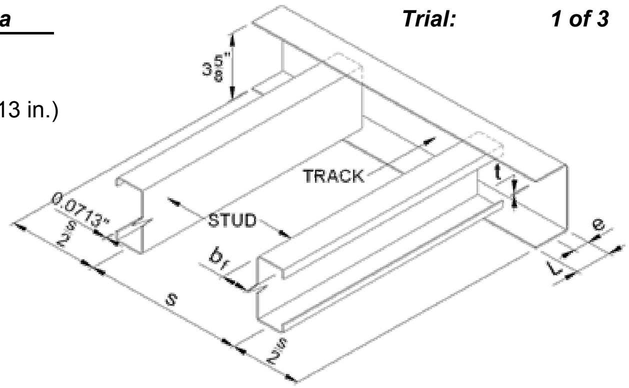
Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.



Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

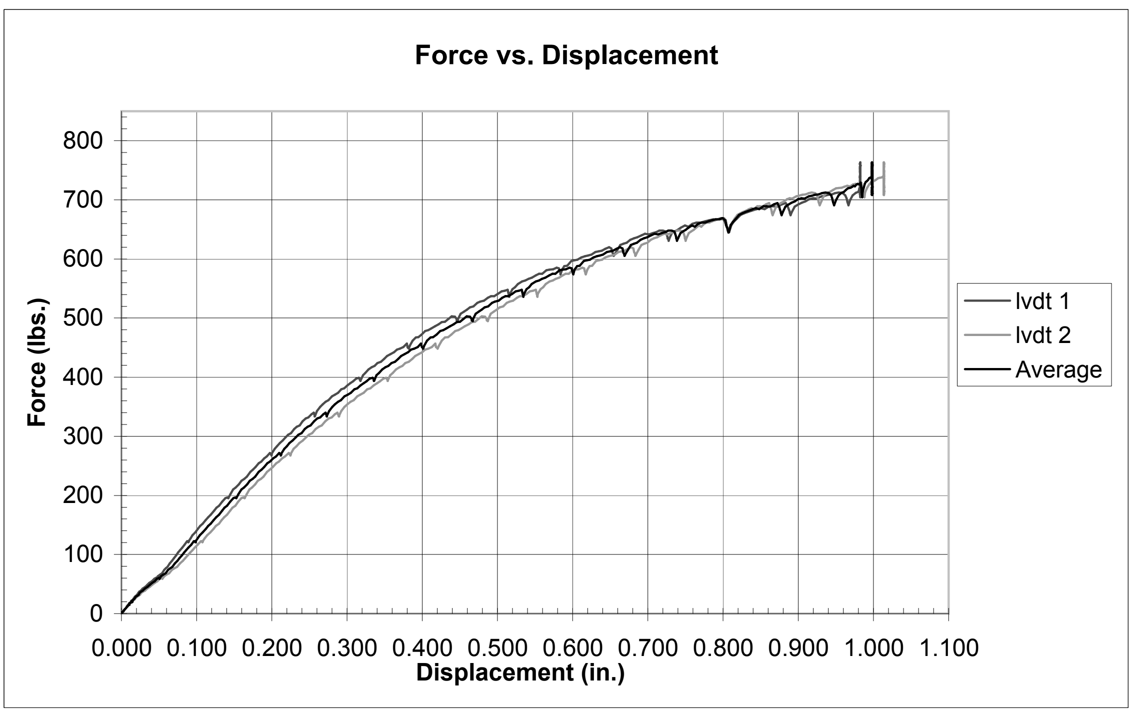
Thickness (in.) 0.0718 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	Average of Tests
40.9	40.5	40.5	**40.6**

Measured Dimensions

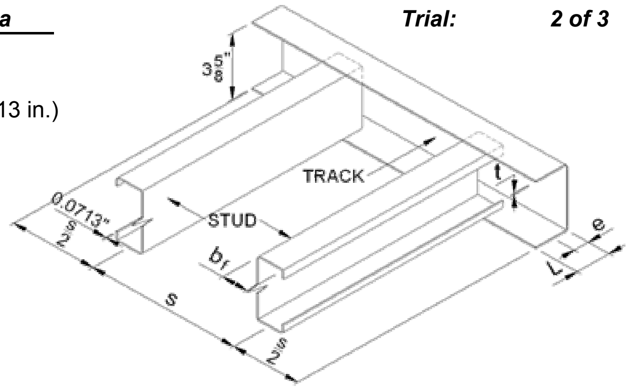
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 812 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-14-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

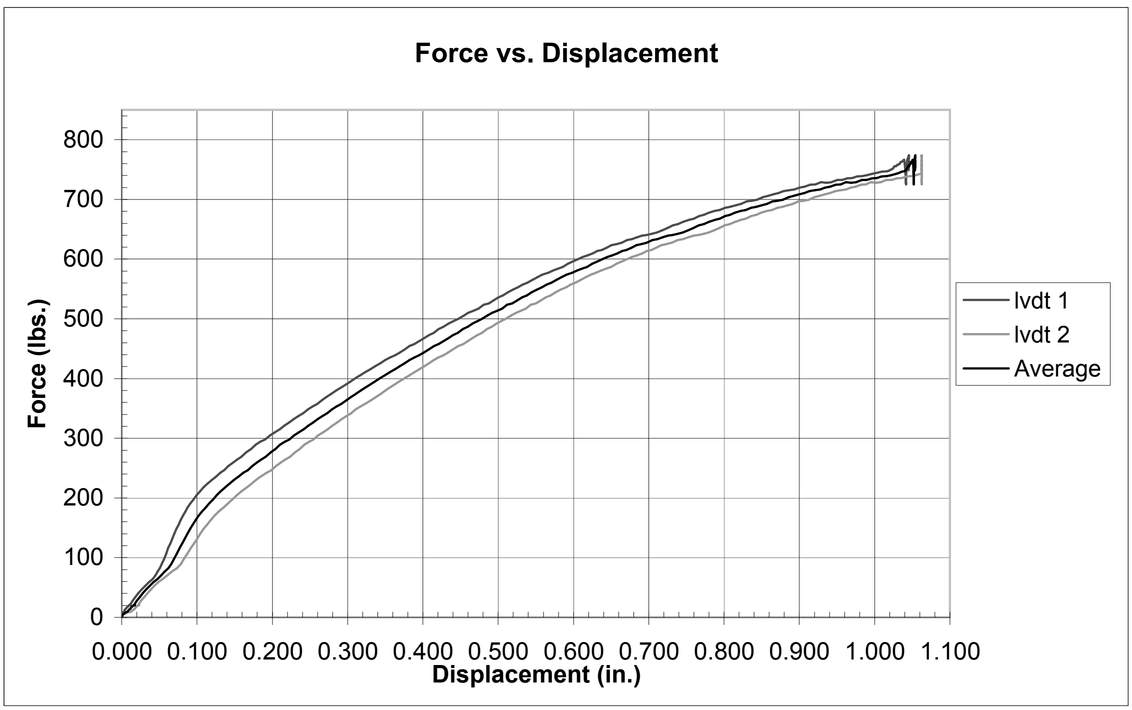
Thickness (in.) 0.0716 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

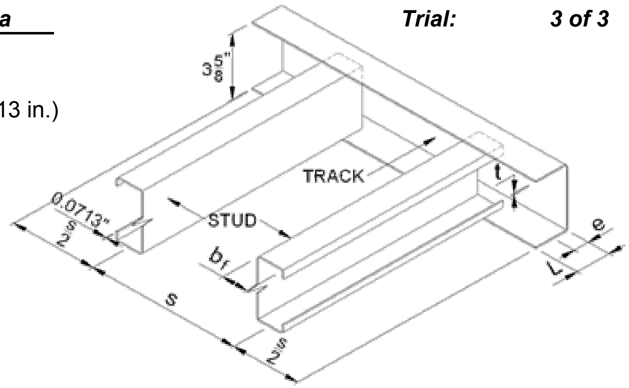
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 283 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-14-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

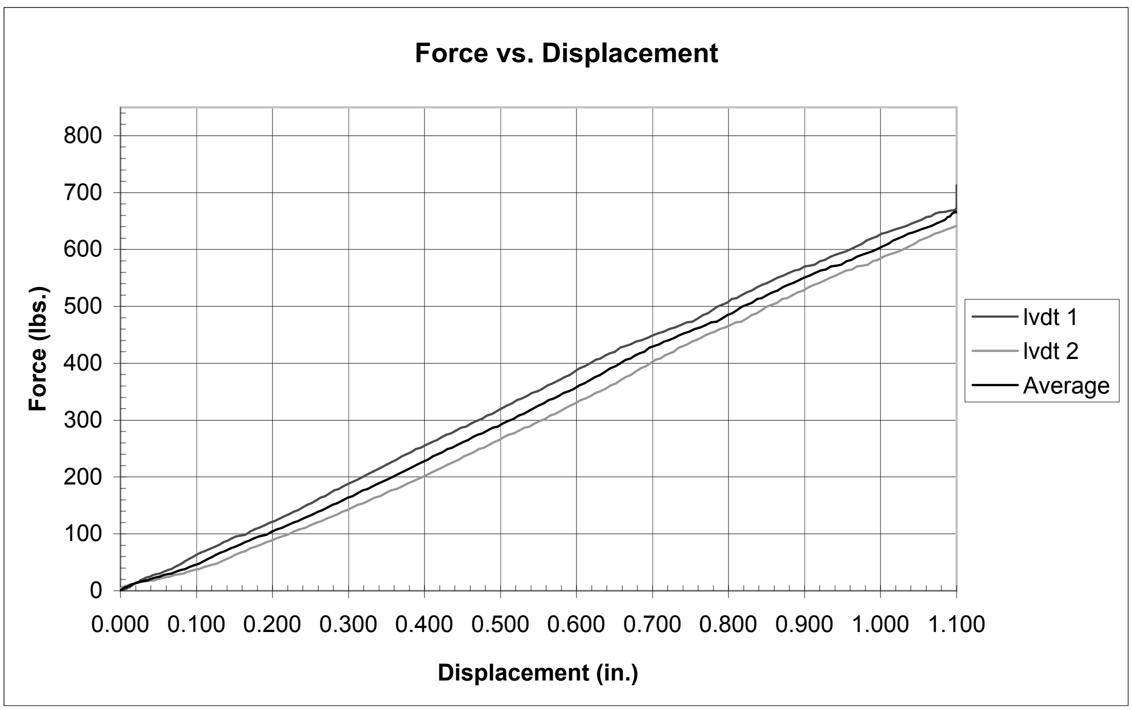
Thickness (in.) 0.0714 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	Average of Tests
40.9	40.5	40.5	**40.6**

Measured Dimensions

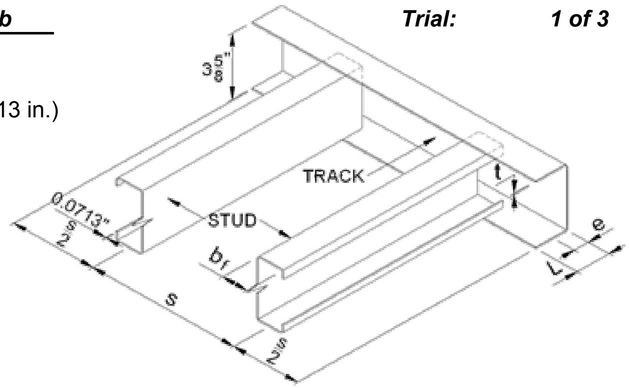
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 283 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-14-1b*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

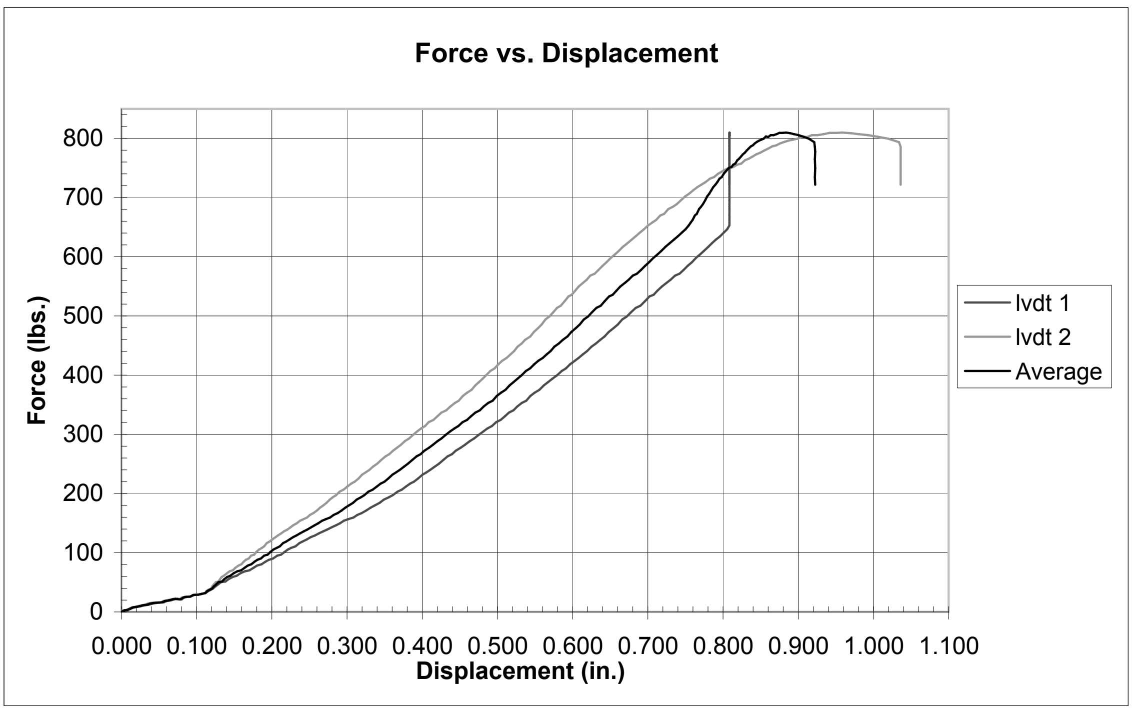
Thickness (in.) 0.0718 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

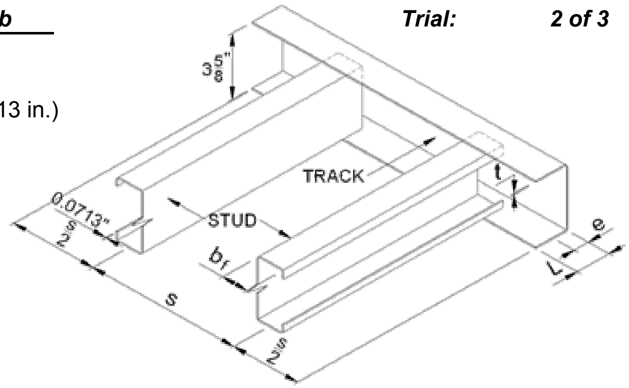
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 222 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-14-2b*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

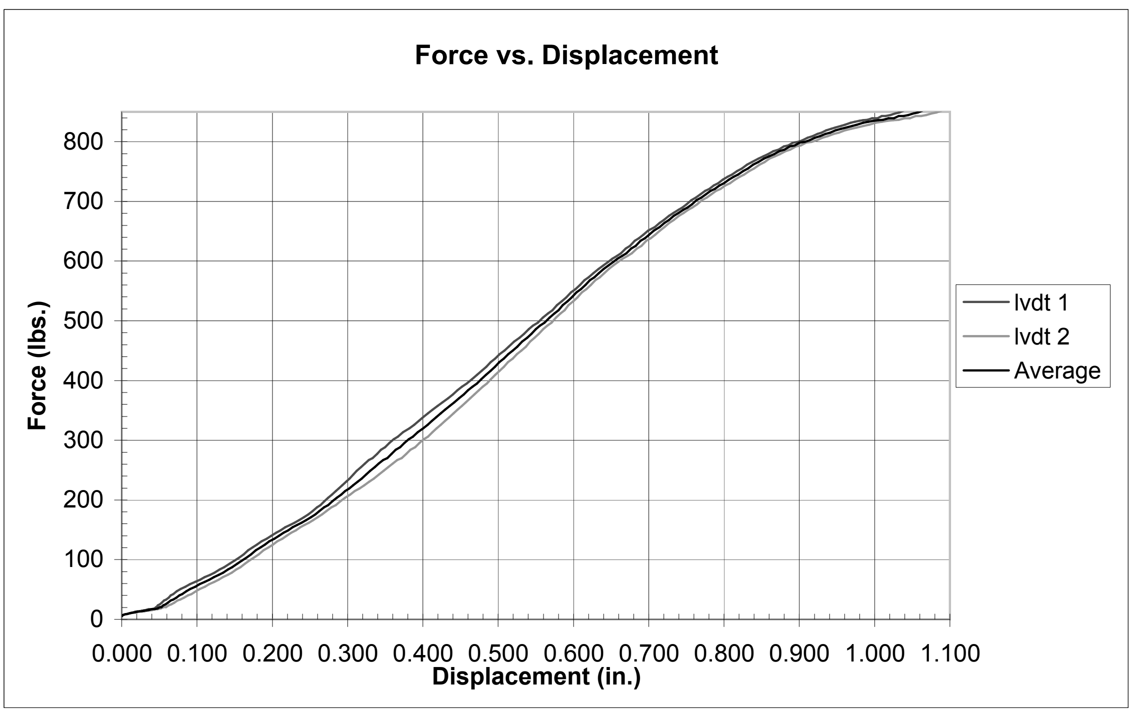
Thickness (in.) 0.0716 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

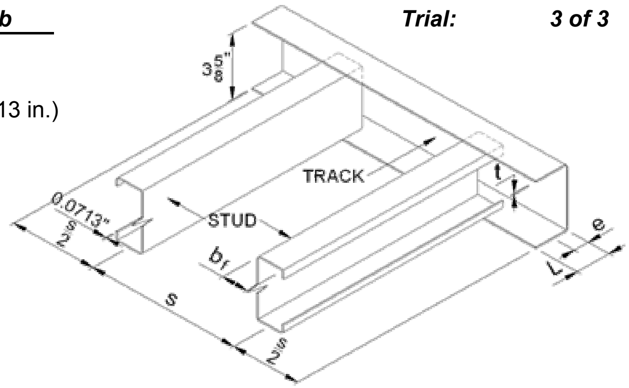
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 315 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-14-3b*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

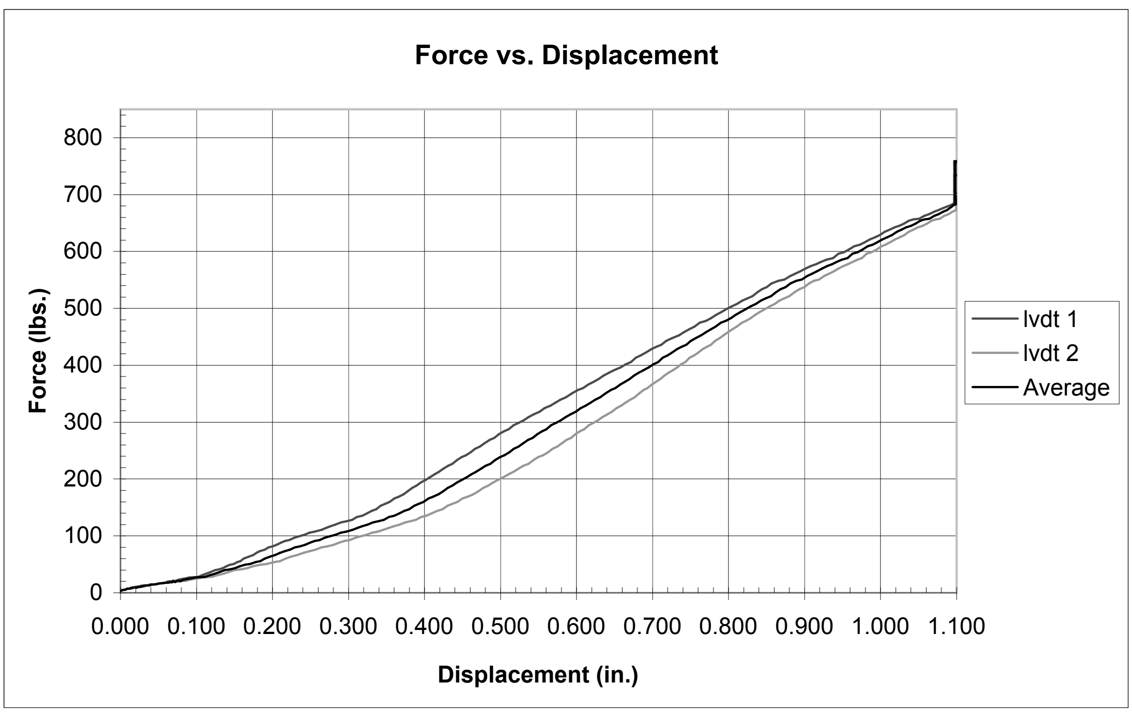
Thickness (in.) 0.0714 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
40.9	40.5	40.5	**40.6**

Measured Dimensions

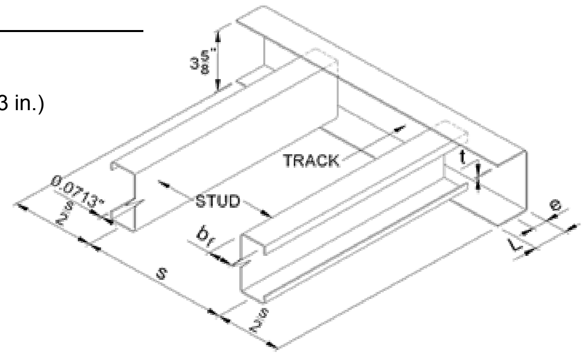
La (in.): 16 Lf (in.): 47 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 20 seconds **Total Time of Test:** 357 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***24-10-2-14 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t) 14 gage (0.0713 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

"a" tests: TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

"b" tests: THREE 1/4 in. dia. bolt w/ steel washers, ONE at specimen center and ONE at 20in. off specimen center (each side)

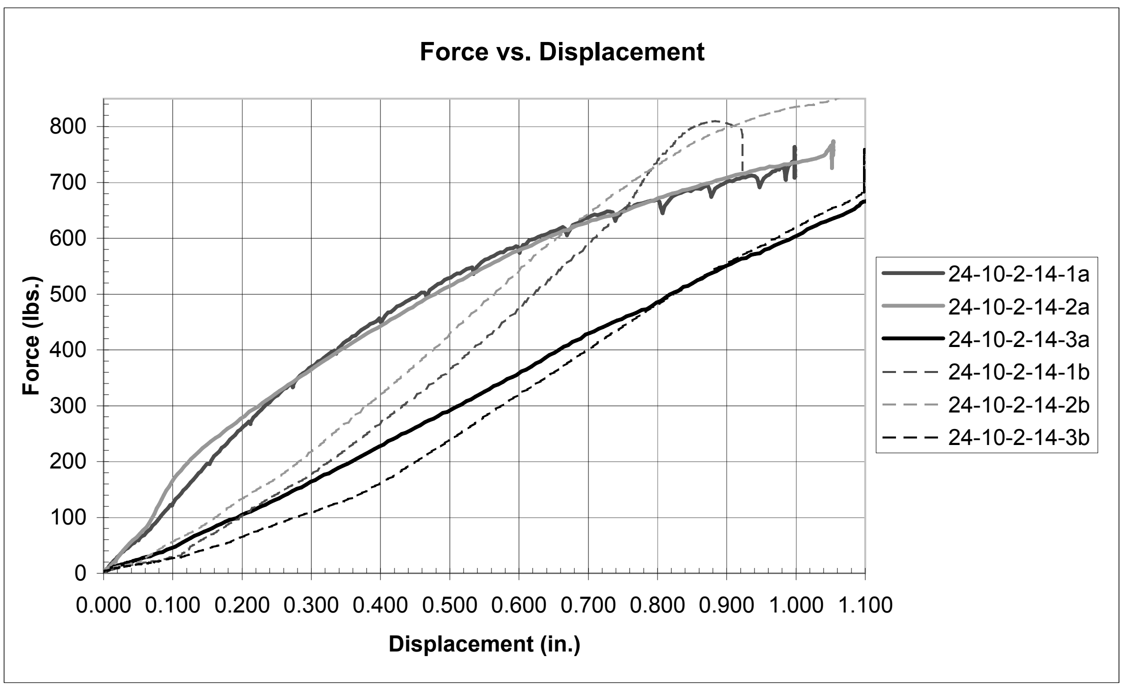
Ram Speed: 0.1 inches in 20 seconds

Maximum Load of Tests:

24-10-2-14-1a	763.22 Lbs.	24-10-2-14-1b	810.05 Lbs.
24-10-2-14-2a	773.73 Lbs.	24-10-2-14-2b	903.86 Lbs.
24-10-2-14-3a	712.53 Lbs.	24-10-2-14-3b	759.05 Lbs.

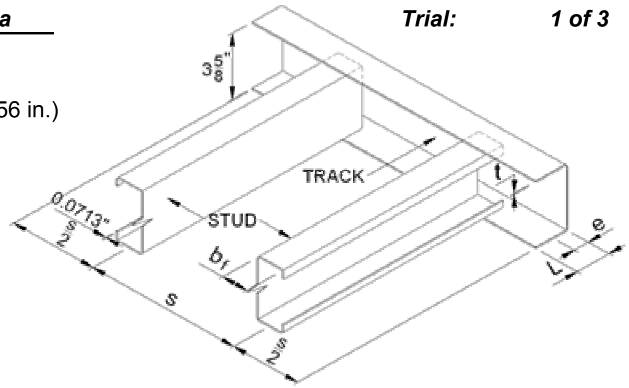
Track Material Property

Yield (ksi)	Test #1	Test #2	Test #3	**Average of Tests**
	40.9	40.5	40.5	**40.6**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-16-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

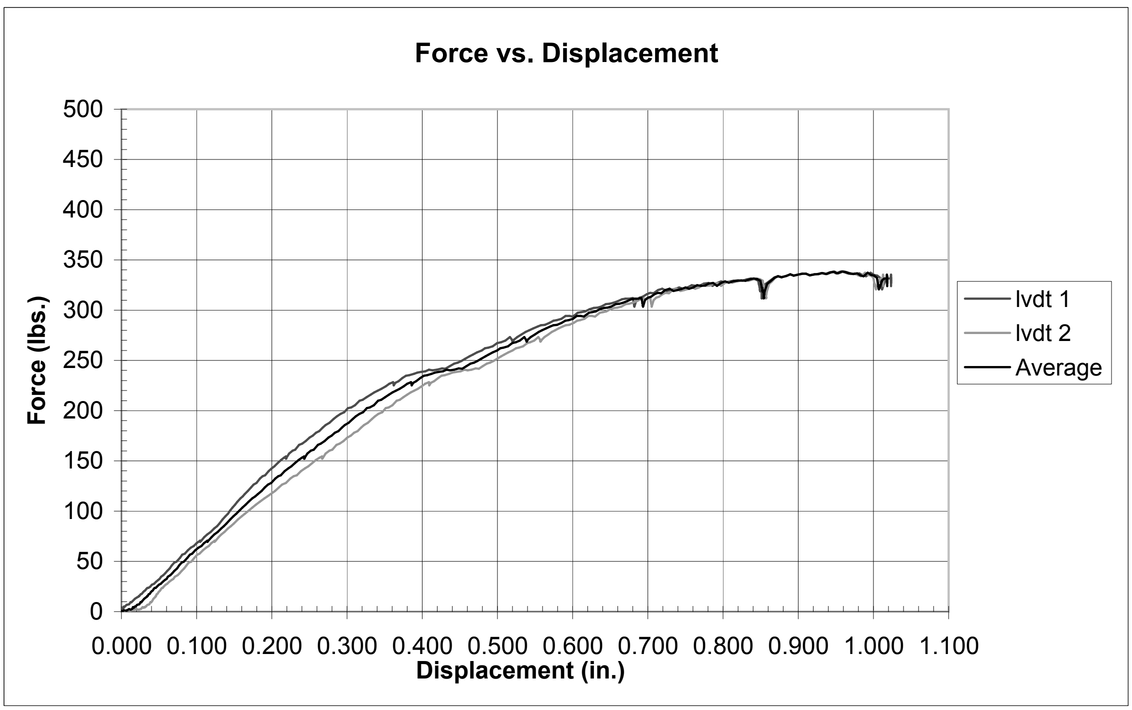
Thickness (in.) 0.0489 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

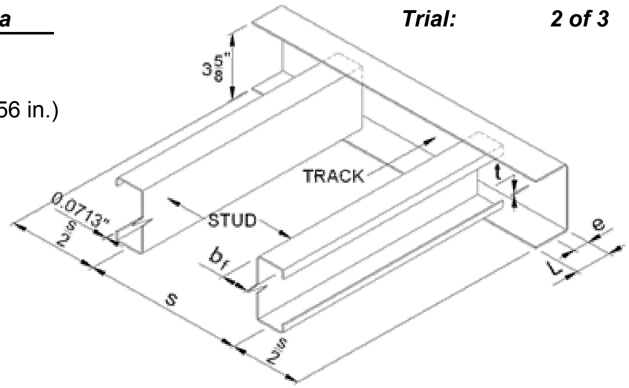
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 358 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-16-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

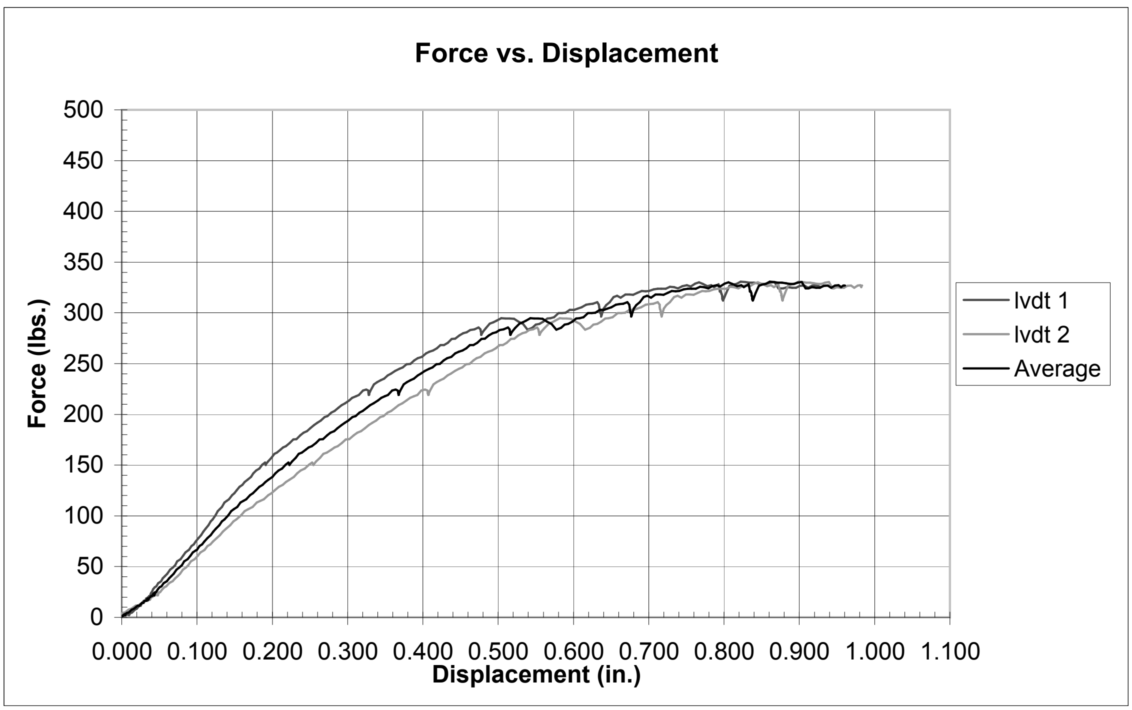
Thickness (in.) 0.0490 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

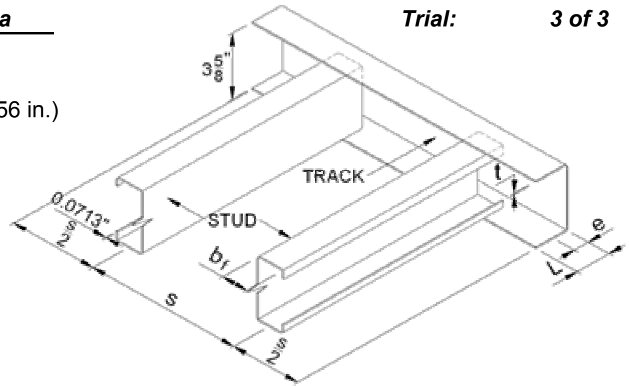
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 313 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-16-3a*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

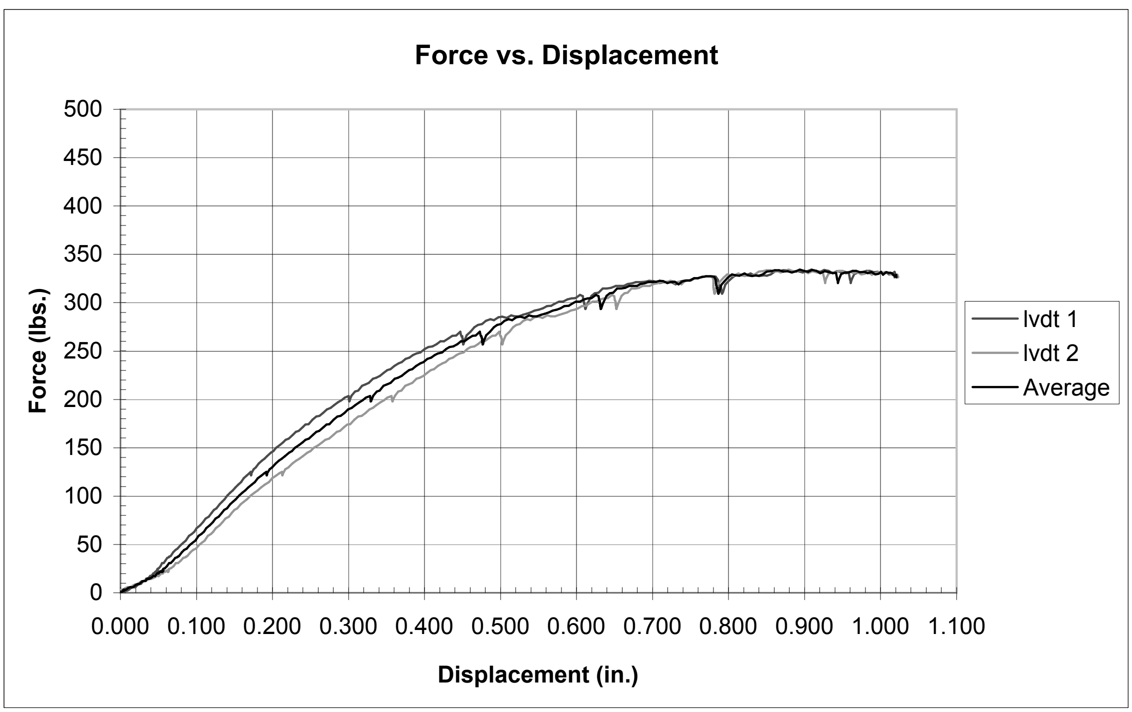
Thickness (in.) 0.0489 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

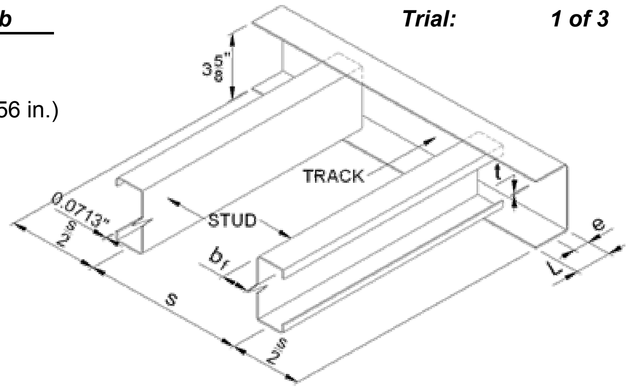
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 383 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-16-1b*** **_Trial:_** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

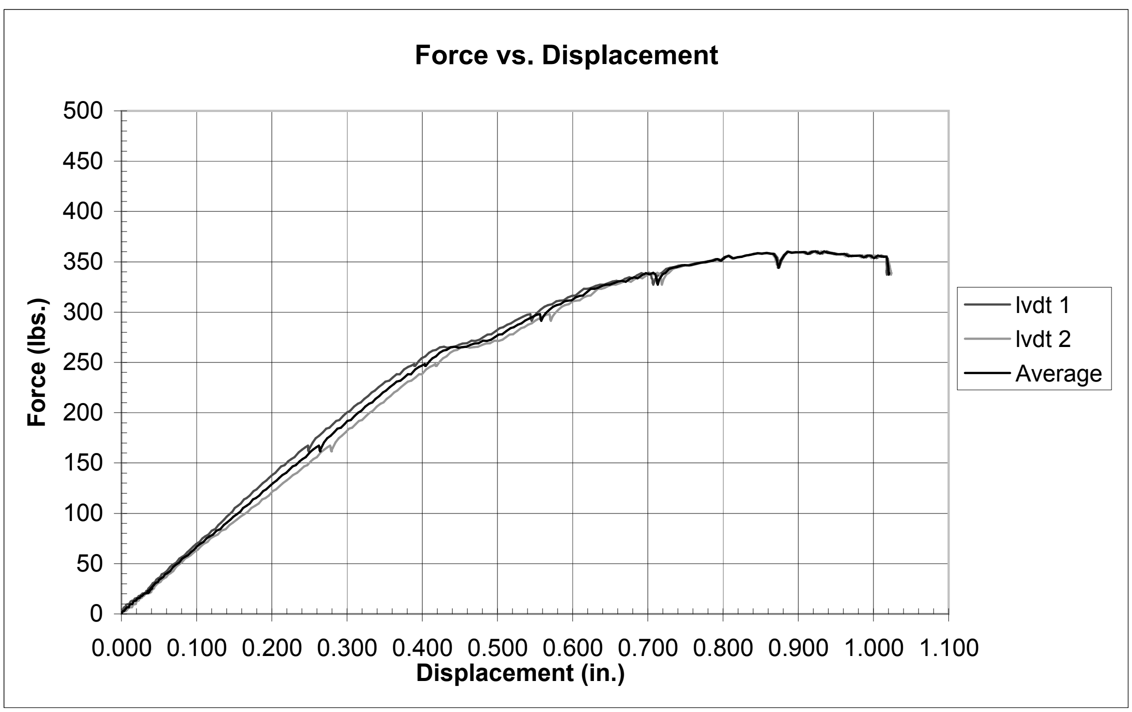
Thickness (in.) 0.0489 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

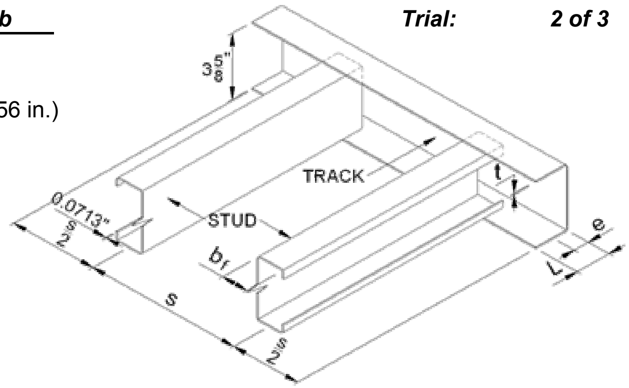
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 317 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-16-2b*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

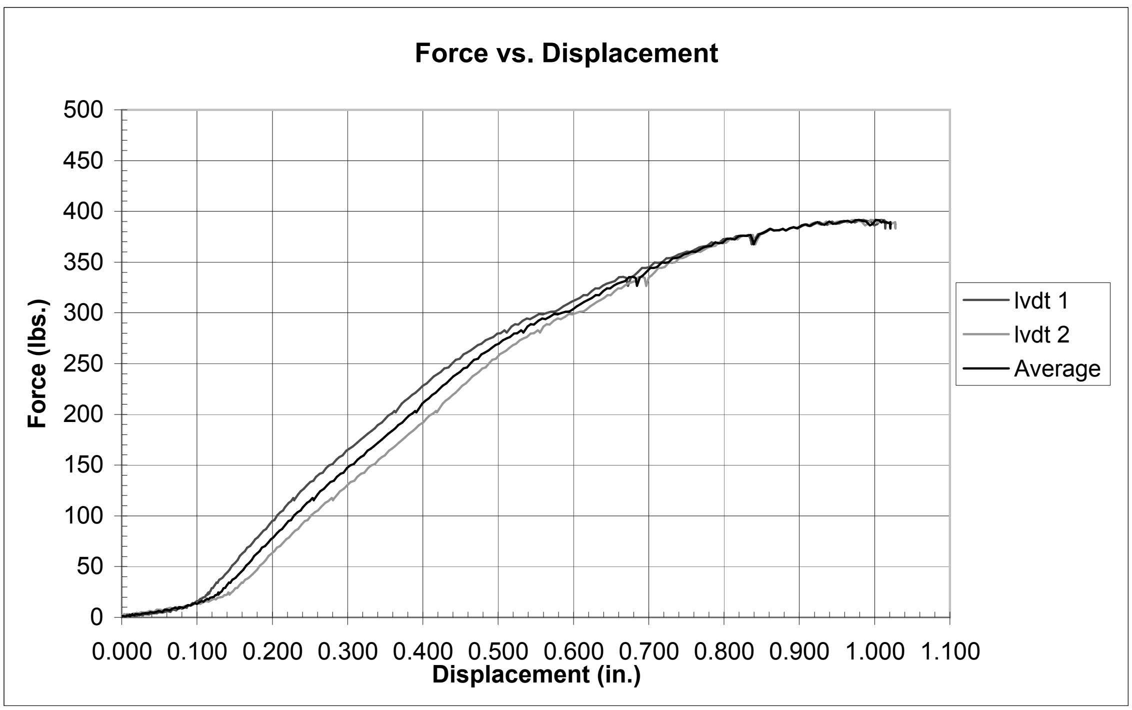
Thickness (in.) 0.0490 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 308 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-16-3b*** **Trial:** ***3 of 3***

Track Properties (3 5/8" depth)

Track Thickness (t) 16 gage (0.0556 in.)

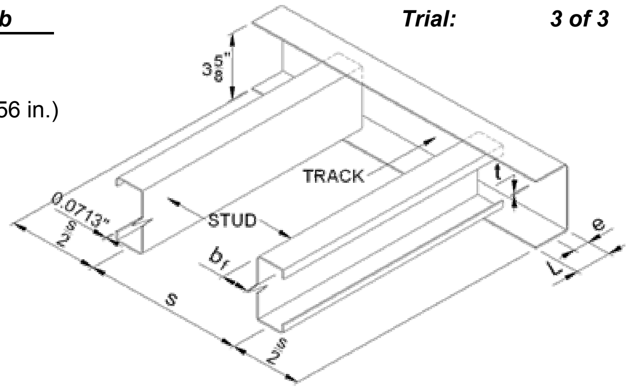
Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.



Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

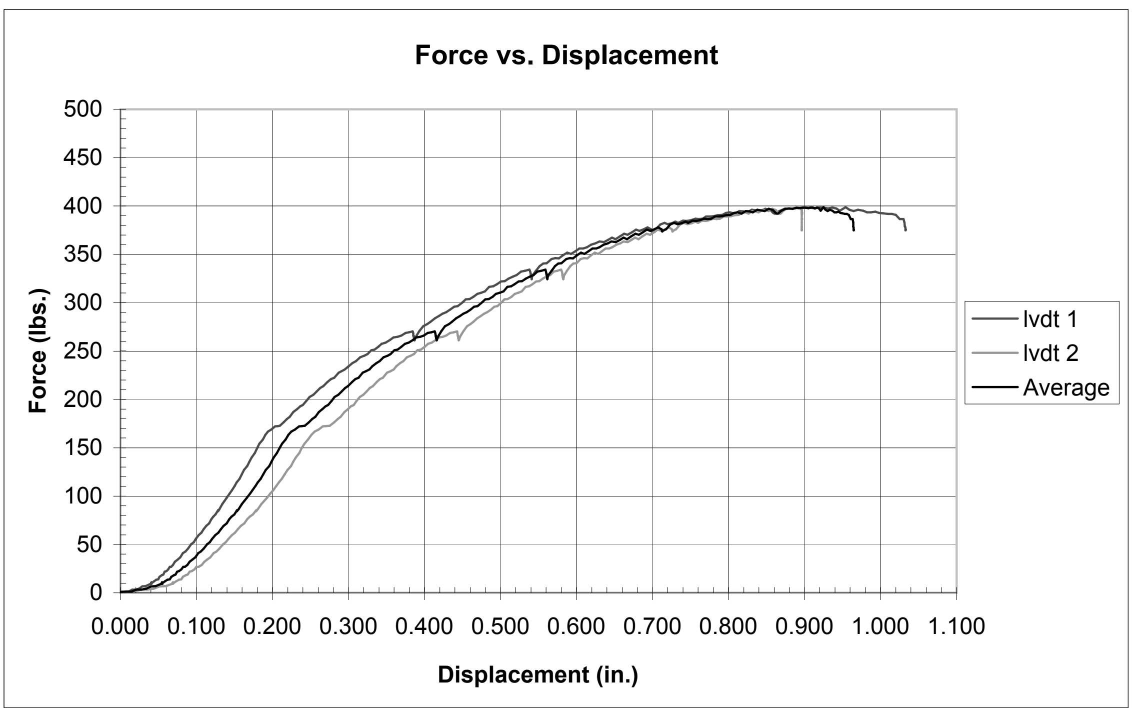
Thickness (in.) 0.0489 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.5	37.9	39.3	**33.6**

Measured Dimensions

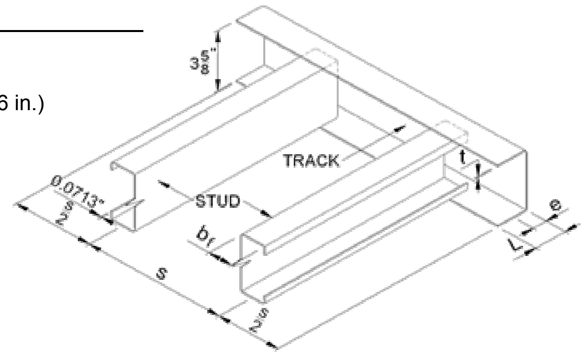
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 302 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***24-10-2-16 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t)	16 gage	(0.0556 in.)
Track Leg Length (L)	3 in.	

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e)	1 in.
Stud Flange Width (bf)	2 1/2 in.
Stud Spacing (s)	24 in.

Fastener Configuration

"a" tests: TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

"b" tests: THREE 1/4 in. dia. bolt w/ steel washers, ONE at specimen center and ONE at 20in. off specimen center (each side)

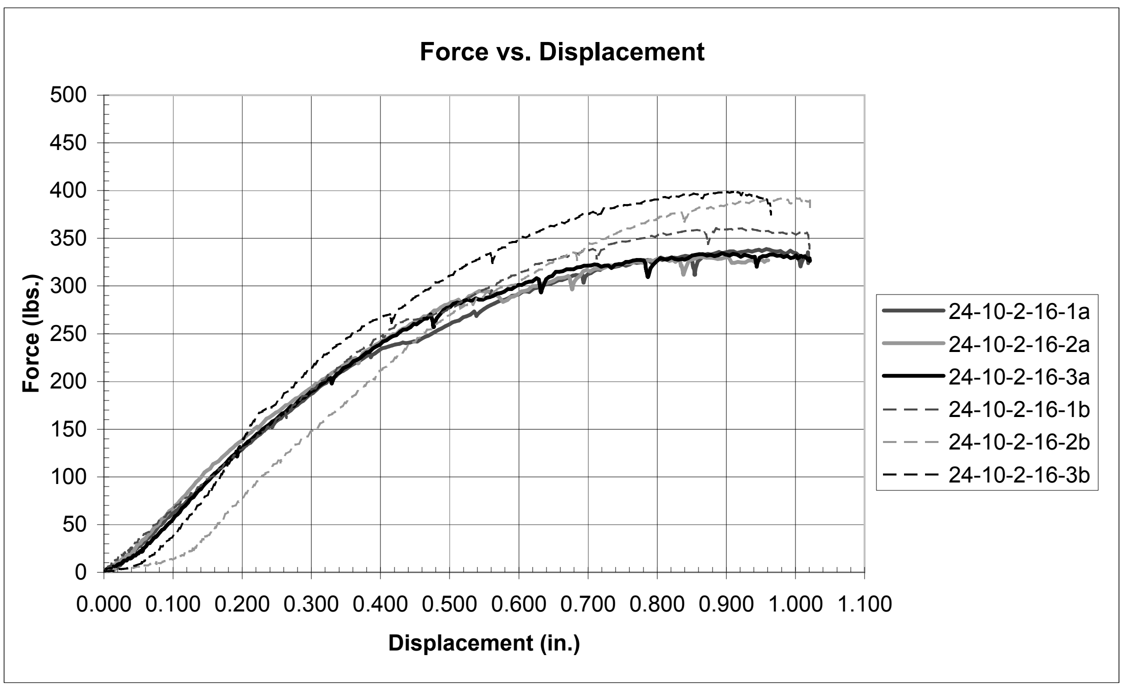
Ram Speed: 0.1 inches in 30 seconds

Maximum Load of Tests:

24-10-2-16-1a	338.57 Lbs.	24-10-2-16-1b	360.49 Lbs.
24-10-2-16-2a	330.75 Lbs.	24-10-2-16-2b	391.65 Lbs.
24-10-2-16-3a	334.35 Lbs.	24-10-2-16-3b	398.69 Lbs.

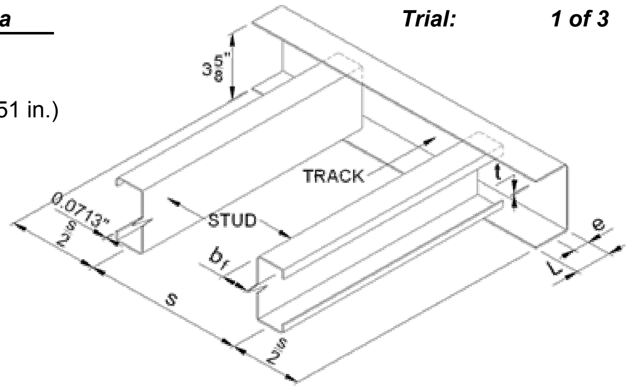
Track Material Property

Yield (ksi)	Test #1	Test #2	Test #3	Average of Tests
	23.5	37.9	39.3	**33.6**



SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-18-1a*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

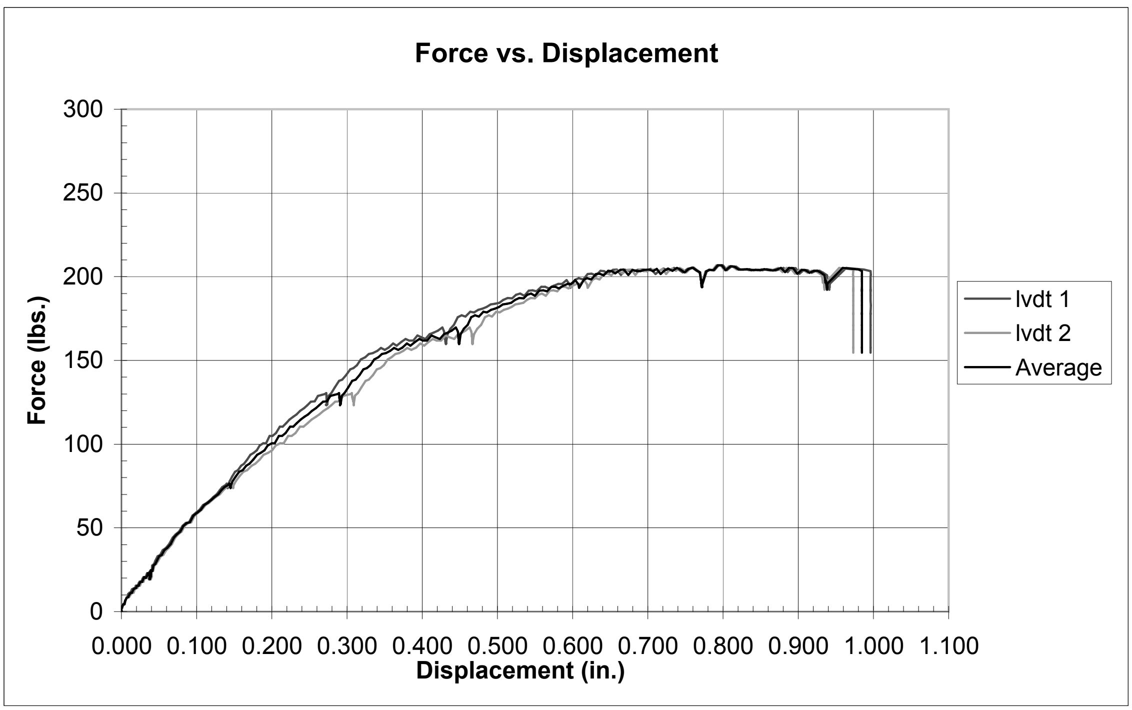
Thickness (in.) 0.0447 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

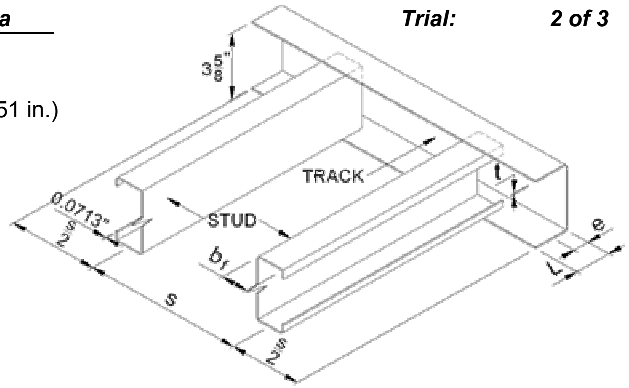
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 442 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-18-2a*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.

Track Material Property

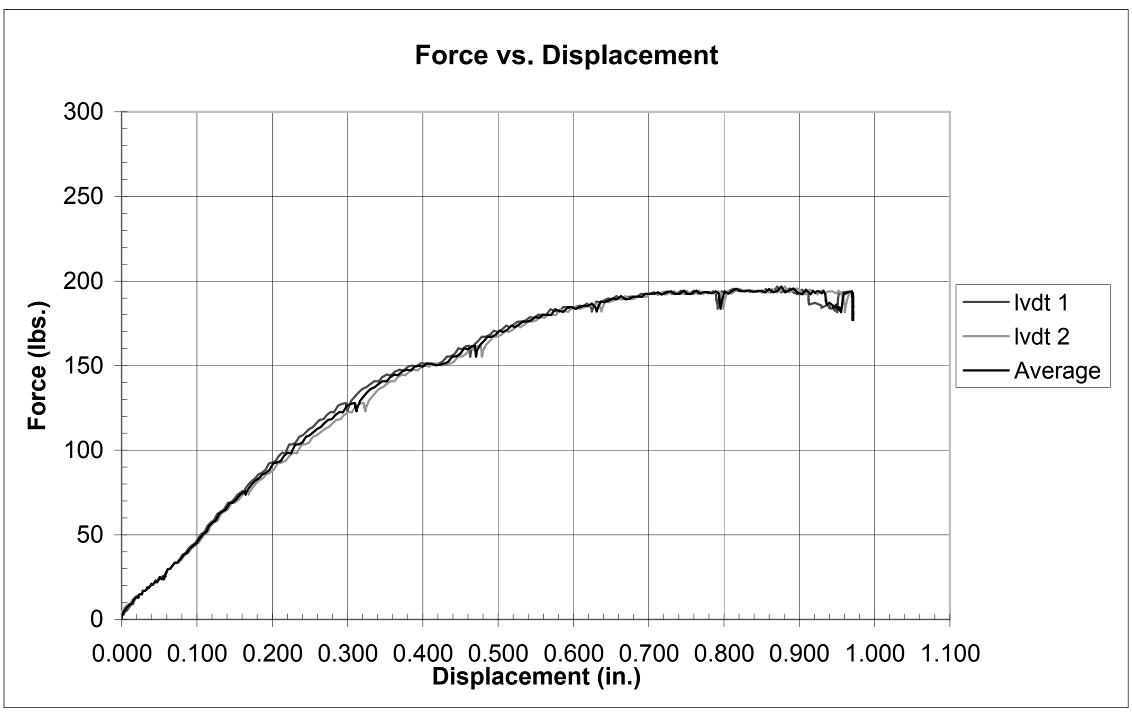
Thickness (in.) 0.0443 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 370 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-18-3a*** **Trial:** ***3 of 3***

Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

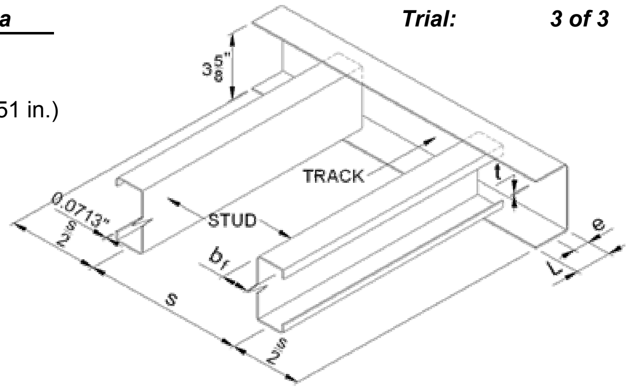
Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

TWO 1/4 in. dia. bolt w/ steel washers,
ONE at each stud location.



Track Material Property

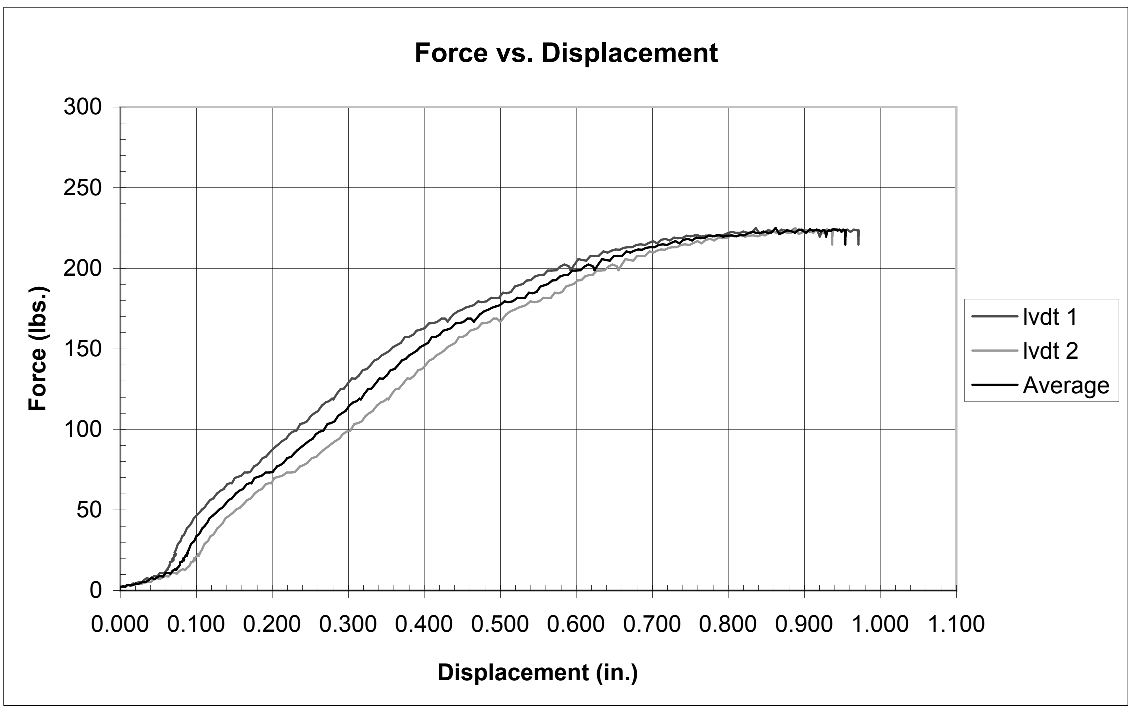
Thickness (in.) 0.0441 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	Average of Tests
23.0	22.8	22.6	**22.8**

Measured Dimensions

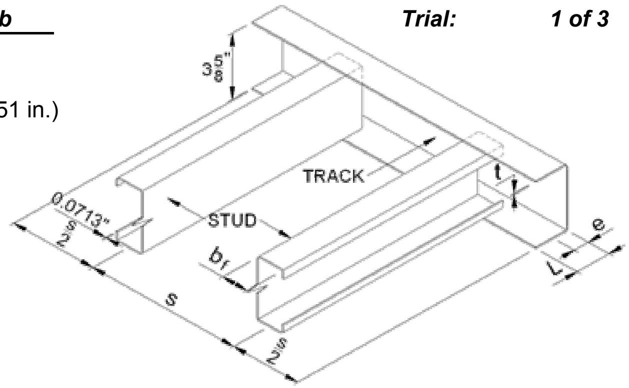
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 257 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-18-1b*** **Trial:** ***1 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

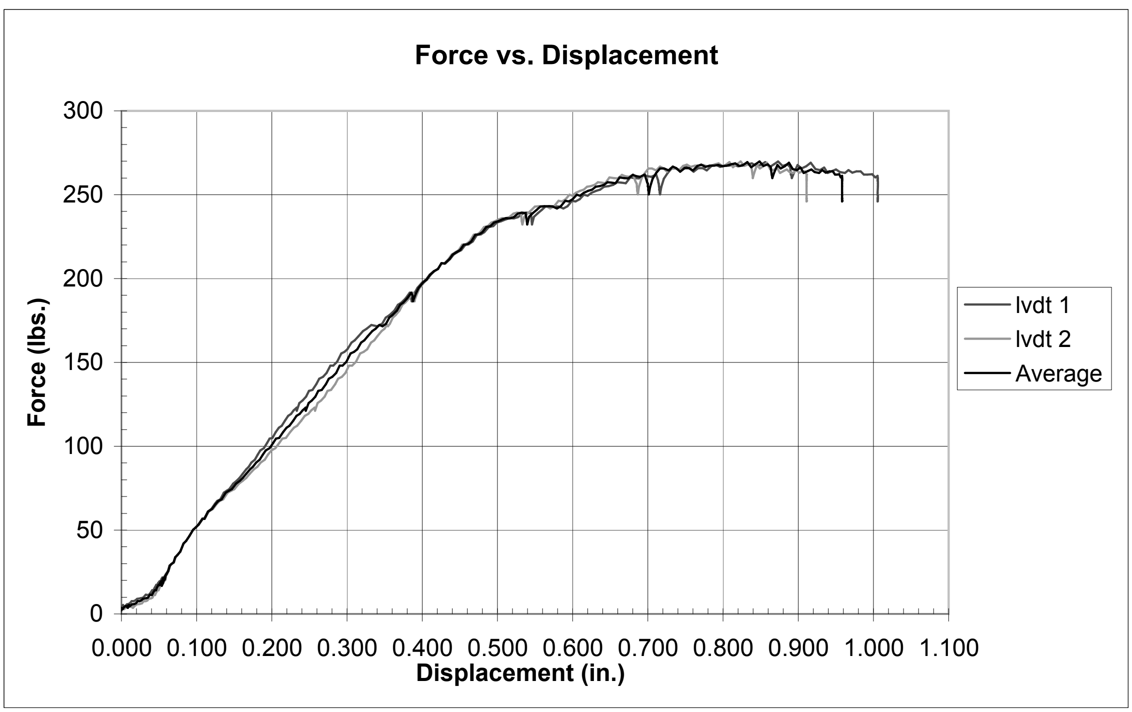
Thickness (in.) 0.0447 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

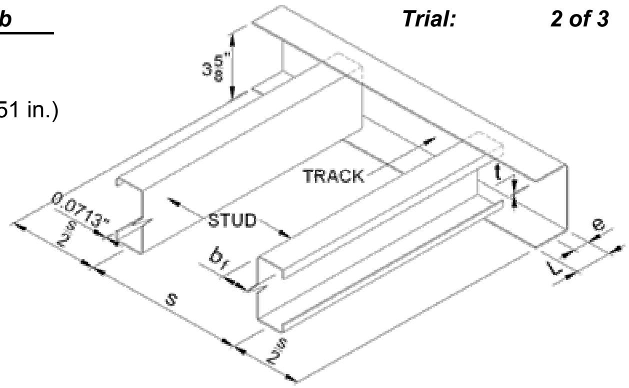
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 299 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-18-2b*** **Trial:** ***2 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

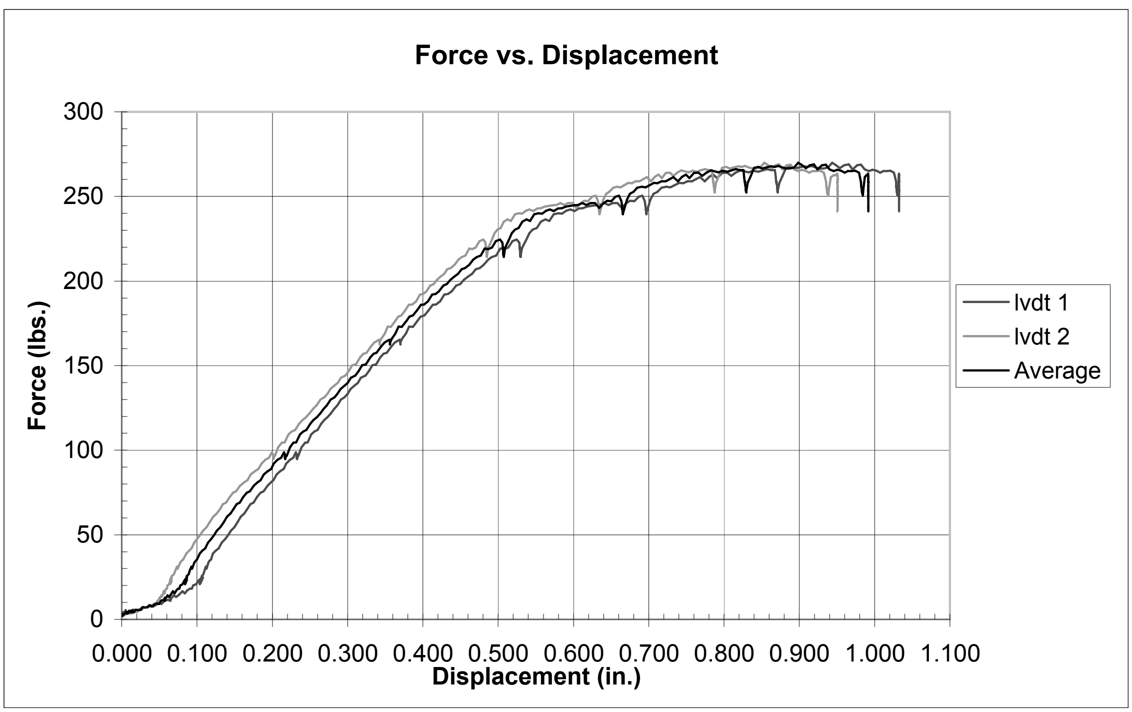
Thickness (in.) 0.0443 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

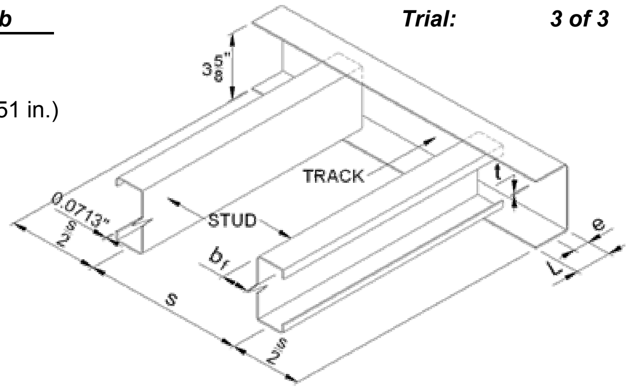
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 415 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimen: ***24-10-2-18-3b*** **Trial:** ***3 of 3***



Track Properties (3 5/8" depth)

Track Thickness (t) 18 gage (0.0451 in.)

Track Leg Length (L) 3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e) 1 in.

Stud Flange Width (bf) 2 1/2 in.

Stud Spacing (s) 24 in.

Fastener Configuration

THREE 1/4 in. dia. bolt w/ steel washers,
ONE at specimen center and
ONE at 20 in. specimen center (each side).

Track Material Property

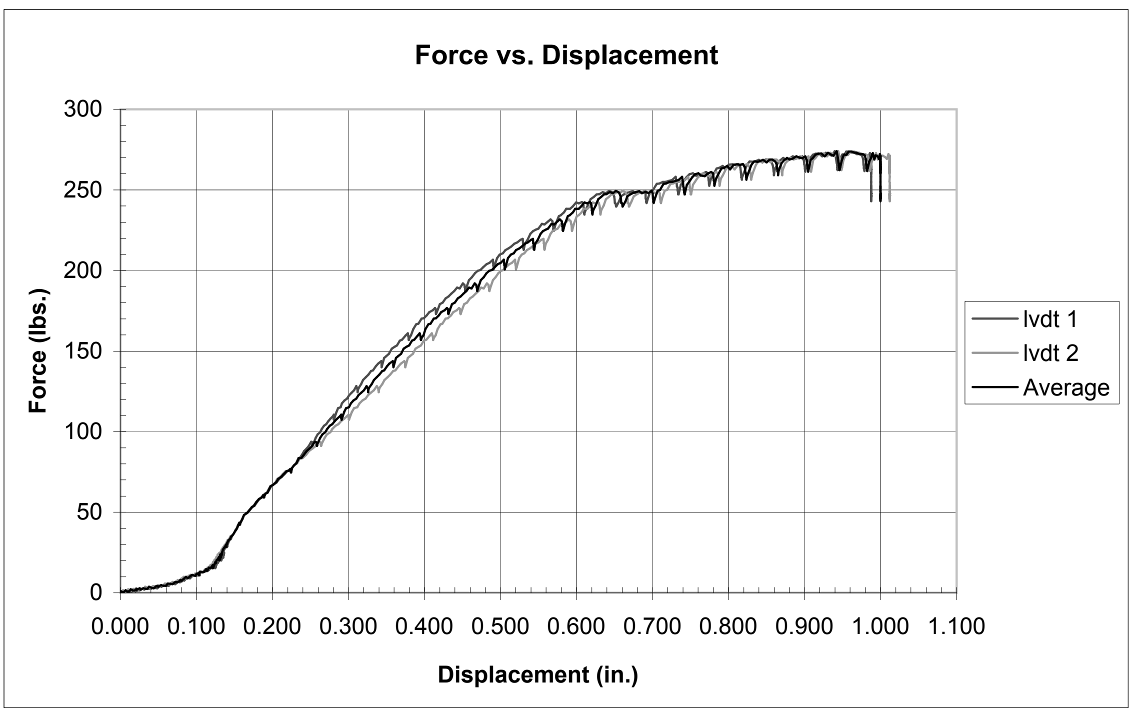
Thickness (in.) 0.0441 (Measured)

Yield (ksi)

Test #1	Test #2	Test #3	**Average of Tests**
23.0	22.8	22.6	**22.8**

Measured Dimensions

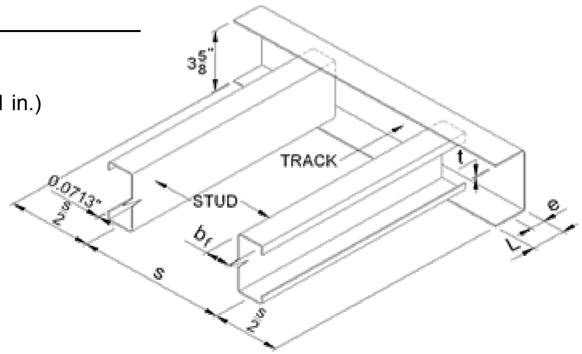
La (in.): 16 Lf (in.): 47.5 (See Test Setup Drawing)



Ram Speed: 0.1 inches in 30 seconds **Total Time of Test:** 832 seconds

SLIP TRACK TEST DATA (MSOE 2001)

Specimens: ***24-10-2-18 Summary***



Track Properties (3 5/8" depth)

Track Thickness (t)	18 gage (0.0451 in.)
Track Leg Length (L)	3 in.

Stud Properties (3 5/8" depth) 14 gage

Slip Gap (e)	1 in.
Stud Flange Width (bf)	2 1/2 in.
Stud Spacing (s)	24 in.

Fastener Configuration

"a" tests: TWO 1/4 in. dia. bolt w/ steel washers, ONE at each stud location.

"b" tests: THREE 1/4 in. dia. bolt w/ steel washers, ONE at specimen center and ONE at 20in. off specimen center (each side)

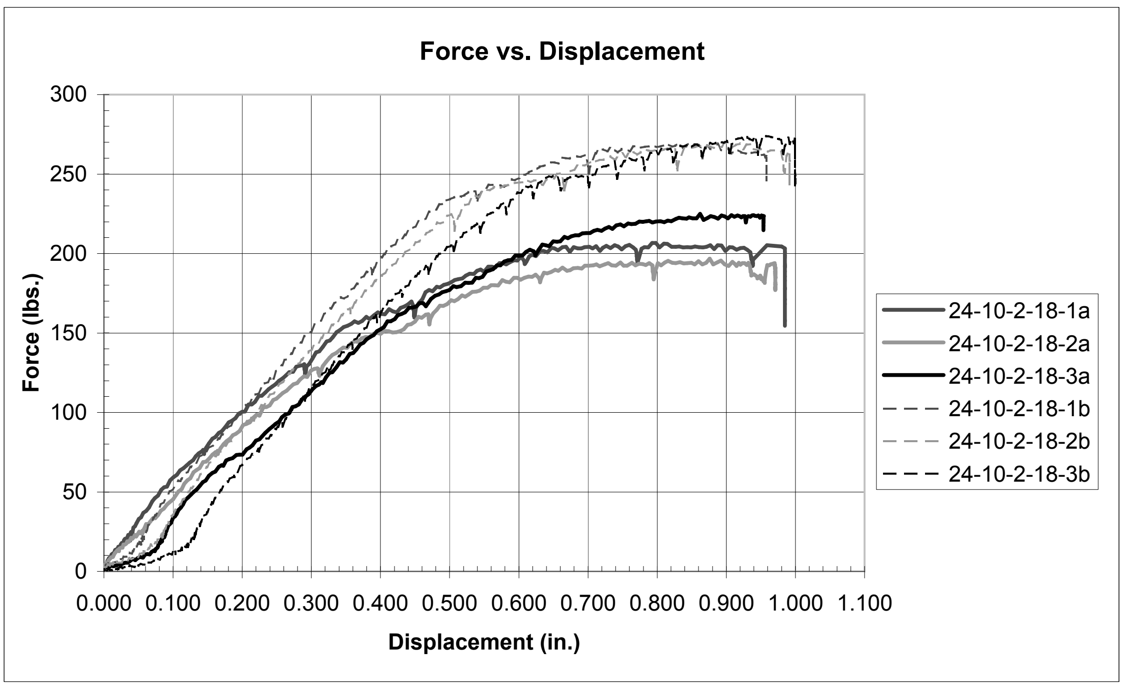
Ram Speed: 0.1 inches in 30 seconds

Maximum Load of Tests:

24-10-2-18-1a	206.71 Lbs.	24-10-2-18-1b	269.78 Lbs.
24-10-2-18-2a	196.69 Lbs.	24-10-2-18-2b	269.94 Lbs.
24-10-2-18-3a	224.86 Lbs.	24-10-2-18-3b	274.01 Lbs.

Track Material Property

	Test #1	Test #2	Test #3	**Average of Tests**
Yield (ksi)	23.0	22.8	22.6	**22.8**



APPENDIX C

Summary of MSOE Slip-Track Test Results

Table C-1 — MSOE Test Results for Test "a".

Specimen Name	Track Thickness t (in.)	Track Leg Length L (in.)	Slip Gap e (in.)	Stud Spacing S (in.)	Stud Flange Width b_f (in.)	F_y (ksi)	P_{test} (lbs)
16-05-1-14-1a	0.0709	2	0.5	16	1.625	38.6	811.93
16-05-1-14-2a	0.0709	2	0.5	16	1.625	38.6	853.66
16-05-1-14-3a	0.0709	2	0.5	16	1.625	38.6	721.44
						Average	**795.68**
						Standard Deviation	**67.59**
						Coefficient of Variation	**8.50%**
16-05-1-16-1a	0.0568	2	0.5	16	1.625	44.5	601.24
16-05-1-16-2a	0.0568	2	0.5	16	1.625	44.5	600.17
16-05-1-16-3a	0.0568	2	0.5	16	1.625	44.5	569.15
						Average	**590.19**
						Standard Deviation	**18.23**
						Coefficient of Variation	**3.09%**
16-05-1-18-1a	0.0464	2	0.5	16	1.625	39.4	430.61
16-05-1-18-2a	0.0464	2	0.5	16	1.625	39.4	504.40
16-05-1-18-3a	0.0464	2	0.5	16	1.625	39.4	437.48
						Average	**457.50**
						Standard Deviation	**40.76**
						Coefficient of Variation	**8.91%**
24-05-1-14-1a	0.0709	2	0.5	24	1.625	38.6	831.50
24-05-1-14-2a	0.0709	2	0.5	24	1.625	38.6	792.06
24-05-1-14-3a	0.0709	2	0.5	24	1.625	38.6	937.89
						Average	**853.82**
						Standard Deviation	**75.43**
						Coefficient of Variation	**8.83%**
24-05-1-16-1a	0.0568	2	0.5	24	1.625	44.5	725.01
24-05-1-16-2a	0.0568	2	0.5	24	1.625	44.5	753.89
24-05-1-16-3a	0.0568	2	0.5	24	1.625	44.5	646.32
						Average	**708.41**
						Standard Deviation	**55.68**
						Coefficient of Variation	**7.86%**
24-05-1-18-1a	0.0464	2	0.5	24	1.625	39.4	714.31
24-05-1-18-2a	0.0464	2	0.5	24	1.625	39.4	654.73
24-05-1-18-3a	0.0464	2	0.5	24	1.625	39.4	583.84
						Average	**650.96**
						Standard Deviation	**65.32**
						Coefficient of Variation	**10.03%**
16-05-2-14-1a	0.0709	2	0.5	16	2.5	38.6	870.48
16-05-2-14-2a	0.0709	2	0.5	16	2.5	38.6	900.13
16-05-2-14-3a	0.0709	2	0.5	16	2.5	38.6	865.43
						Average	**878.68**
						Standard Deviation	**18.75**
						Coefficient of Variation	**2.13%**
16-05-2-16-1a	0.0568	2	0.5	16	2.5	44.5	643.11
16-05-2-16-2a	0.0568	2	0.5	16	2.5	44.5	624.01
16-05-2-16-3a	0.0568	2	0.5	16	2.5	44.5	657.81
						Average	**641.64**
						Standard Deviation	**16.95**
						Coefficient of Variation	**2.64%**

16-05-2-18-1a	0.0464	2	0.5	16	2.5	39.4	556.65
16-05-2-18-2a	0.0464	2	0.5	16	2.5	39.4	486.22
16-05-2-18-3a	0.0464	2	0.5	16	2.5	39.4	518.30
						Average	**520.39**
						Standard Deviation	**35.26**
						Coefficient of Variation	**6.78%**
24-05-2-14-1a	0.0709	2	0.5	24	2.5	38.6	997.05
24-05-2-14-2a	0.0709	2	0.5	24	2.5	38.6	1036.79
24-05-2-14-3a	0.0709	2	0.5	24	2.5	38.6	997.50
						Average	**1010.45**
						Standard Deviation	**22.81**
						Coefficient of Variation	**2.26%**
24-05-2-16-1a	0.0568	2	0.5	24	2.5	44.5	769.65
24-05-2-16-2a	0.0568	2	0.5	24	2.5	44.5	797.38
24-05-2-16-3a	0.0568	2	0.5	24	2.5	44.5	839.66
						Average	**802.23**
						Standard Deviation	**35.25**
						Coefficient of Variation	**4.39%**
24-05-2-18-1a	0.0464	2	0.5	24	2.5	39.4	686.35
24-05-2-18-2a	0.0464	2	0.5	24	2.5	39.4	705.29
24-05-2-18-3a	0.0464	2	0.5	24	2.5	39.4	747.61
						Average	**713.08**
						Standard Deviation	**31.37**
						Coefficient of Variation	**4.40%**
16-10-1-14-1a	0.0713	3	1.0	16	1.625	40.6	632.96
16-10-1-14-2a	0.0713	3	1.0	16	1.625	40.6	601.48
16-10-1-14-3a	0.0713	3	1.0	16	1.625	40.6	601.17
						Average	**611.87**
						Standard Deviation	**18.27**
						Coefficient of Variation	**2.99%**
16-10-1-16-1a	0.0466	3	1.0	16	1.625	33.6	264.68
16-10-1-16-2a	0.0466	3	1.0	16	1.625	33.6	254.19
16-10-1-16-3a	0.0466	3	1.0	16	1.625	33.6	254.97
						Average	**257.95**
						Standard Deviation	**5.84**
						Coefficient of Variation	**2.27%**
16-10-1-18-1a	0.0440	3	1.0	16	1.625	22.8	158.18
16-10-1-18-2a	0.0440	3	1.0	16	1.625	22.8	161.00
16-10-1-18-3a	0.0440	3	1.0	16	1.625	22.8	166.01
						Average	**161.73**
						Standard Deviation	**3.96**
						Coefficient of Variation	**2.45%**
24-10-1-14-1a	0.0713	3	1.0	24	1.625	40.6	825.75
24-10-1-14-2a	0.0713	3	1.0	24	1.625	40.6	810.40
24-10-1-14-3a	0.0713	3	1.0	24	1.625	40.6	792.55
						Average	**809.57**
						Standard Deviation	**16.62**
						Coefficient of Variation	**2.05%**
24-10-1-16-1a	0.0466	3	1.0	24	1.625	33.6	333.72
24-10-1-16-2a	0.0466	3	1.0	24	1.625	33.6	326.36
24-10-1-16-3a	0.0466	3	1.0	24	1.625	33.6	364.72
						Average	**341.60**
						Standard Deviation	**20.36**
						Coefficient of Variation	**5.96%**
24-10-1-18-1a	0.0440	3	1.0	24	1.625	22.8	204.36

24-10-1-18-2a	0.0440	3	1.0	24	1.625	22.8	221.73
24-10-1-18-3a	0.0440	3	1.0	24	1.625	22.8	215.47
						Average	**213.85**
						Standard Deviation	**8.80**
						Coefficient of Variation	**4.11%**
16-10-2-14-1a	0.0713	3	1.0	16	2.5	40.6	650.35
16-10-2-14-2a	0.0713	3	1.0	16	2.5	40.6	629.52
16-10-2-14-3a	0.0713	3	1.0	16	2.5	40.6	623.72
						Average	**634.53**
						Standard Deviation	**14.00**
						Coefficient of Variation	**2.21%**
16-10-2-16-1a	0.0466	3	1.0	16	2.5	33.6	269.85
16-10-2-16-2a	0.0466	3	1.0	16	2.5	33.6	282.84
16-10-2-16-3a	0.0466	3	1.0	16	2.5	33.6	267.97
						Average	**273.55**
						Standard Deviation	**8.10**
						Coefficient of Variation	**2.96%**
16-10-2-18-1a	0.0440	3	1.0	16	2.5	22.8	174.46
16-10-2-18-2a	0.0440	3	1.0	16	2.5	22.8	208.74
16-10-2-18-3a	0.0440	3	1.0	16	2.5	22.8	176.34
						Average	**186.52**
						Standard Deviation	**19.27**
						Coefficient of Variation	**10.33%**
24-10-2-14-1a	0.0713	3	1.0	24	2.5	40.6	763.22
24-10-2-14-2a	0.0713	3	1.0	24	2.5	40.6	773.73
24-10-2-14-3a	0.0713	3	1.0	24	2.5	40.6	712.53
						Average	**749.83**
						Standard Deviation	**32.72**
						Coefficient of Variation	**4.36%**
24-10-2-16-1a	0.0466	3	1.0	24	2.5	33.6	338.57
24-10-2-16-2a	0.0466	3	1.0	24	2.5	33.6	330.75
24-10-2-16-3a	0.0466	3	1.0	24	2.5	33.6	334.35
						Average	**334.56**
						Standard Deviation	**3.92**
						Coefficient of Variation	**1.17%**
24-10-2-18-1a	0.0440	3	1.0	24	2.5	22.8	206.71
24-10-2-18-2a	0.0440	3	1.0	24	2.5	22.8	196.69
24-10-2-18-3a	0.0440	3	1.0	24	2.5	22.8	224.86
						Average	**209.42**
						Standard Deviation	**14.28**
						Coefficient of Variation	**6.82%**

Table C-2 — MSOE Test Results for Test "b".

Specimen Name	Track Thickness t (in.)	Track Leg Length L (in.)	Slip Gap e (in.)	Stud Spacing S (in.)	Stud Flange Width b_f (in.)	F_y (ksi)	P_{test} (lbs)
16-10-1-14-1b	0.0713	3	1.0	16	1.625	40.6	674.21
16-10-1-14-2b	0.0713	3	1.0	16	1.625	40.6	663.97
16-10-1-14-3b	0.0713	3	1.0	16	1.625	40.6	656.14
						Average	**664.77**
						Standard Deviation	**9.06**
						Coefficient of Variation	**1.36%**
16-10-1-16-1b	0.0466	3	1.0	16	1.625	33.6	299.59
16-10-1-16-2b	0.0466	3	1.0	16	1.625	33.6	294.58
16-10-1-16-3b	0.0466	3	1.0	16	1.625	33.6	298.03
						Average	**297.40**
						Standard Deviation	**2.56**
						Coefficient of Variation	**0.86%**
16-10-1-18-1b	0.0440	3	1.0	16	1.625	22.8	199.51
16-10-1-18-2b	0.0440	3	1.0	16	1.625	22.8	205.30
16-10-1-18-3b	0.0440	3	1.0	16	1.625	22.8	200.13
						Average	**201.65**
						Standard Deviation	**3.18**
						Coefficient of Variation	**1.58%**
24-10-1-14-1b	0.0713	3	1.0	24	1.625	40.6	842.35
24-10-1-14-2b	0.0713	3	1.0	24	1.625	40.6	814.63
24-10-1-14-3b	0.0713	3	1.0	24	1.625	40.6	837.50
						Average	**831.49**
						Standard Deviation	**14.80**
						Coefficient of Variation	**1.78%**
24-10-1-16-1b	0.0466	3	1.0	24	1.625	33.6	440.18
24-10-1-16-2b	0.0466	3	1.0	24	1.625	33.6	437.21
24-10-1-16-3b	0.0466	3	1.0	24	1.625	33.6	457.24
						Average	**444.88**
						Standard Deviation	**10.81**
						Coefficient of Variation	**2.43%**
24-10-1-18-1b	0.0440	3	1.0	24	1.625	22.8	211.25
24-10-1-18-2b	0.0440	3	1.0	24	1.625	22.8	297.02
24-10-1-18-3b	0.0440	3	1.0	24	1.625	22.8	274.48
						Average	**260.91**
						Standard Deviation	**44.47**
						Coefficient of Variation	**17.04%**
16-10-2-14-1b	0.0713	3	1.0	16	2.5	40.6	682.45
16-10-2-14-2b	0.0713	3	1.0	16	2.5	40.6	675.40
16-10-2-14-3b	0.0713	3	1.0	16	2.5	40.6	676.19
						Average	**678.01**
						Standard Deviation	**3.86**
						Coefficient of Variation	**0.57%**
16-10-2-16-1b	0.0466	3	1.0	16	2.5	33.6	301.63
16-10-2-16-2b	0.0466	3	1.0	16	2.5	33.6	264.52
16-10-2-16-3b	0.0466	3	1.0	16	2.5	33.6	300.37
						Average	**288.84**
						Standard Deviation	**21.07**
						Coefficient of Variation	**7.29%**

16-10-2-18-1b	0.0440	3	1.0	16	2.5	22.8	214.22
16-10-2-18-2b	0.0440	3	1.0	16	2.5	22.8	208.74
16-10-2-18-3b	0.0440	3	1.0	16	2.5	22.8	208.58
						Average	**210.51**
						Standard Deviation	**3.21**
						Coefficient of Variation	**1.52%**
24-10-2-14-1b	0.0713	3	1.0	24	2.5	40.6	810.05
24-10-2-14-2b	0.0713	3	1.0	24	2.5	40.6	903.86
24-10-2-14-3b	0.0713	3	1.0	24	2.5	40.6	759.05
						Average	**824.32**
						Standard Deviation	**73.45**
						Coefficient of Variation	**8.91%**
24-10-2-16-1b	0.0466	3	1.0	24	2.5	33.6	360.49
24-10-2-16-2b	0.0466	3	1.0	24	2.5	33.6	391.65
24-10-2-16-3b	0.0466	3	1.0	24	2.5	33.6	398.69
						Average	**383.61**
						Standard Deviation	**20.33**
						Coefficient of Variation	**5.30%**
24-10-2-18-1b	0.0440	3	1.0	24	2.5	22.8	269.78
24-10-2-18-2b	0.0440	3	1.0	24	2.5	22.8	269.94
24-10-2-18-3b	0.0440	3	1.0	24	2.5	22.8	274.01
						Average	**271.25**
						Standard Deviation	**2.40**
						Coefficient of Variation	**0.88%**

Table C-3 — University of Missouri-Rolla Test Results.

Specimen No.	Track Thickness t (in.)	Track Leg Length L (in.)	Slip Gap e (in.)	Stud Spacing s (in.)	Stud Flange Width b_f (in.)	F_y (ksi)	P_{test} (lbs)
1	0.052	2	0.125	18	1.625	46.7	933
2	0.052	2	0.125	18	1.625	46.7	950
Specimen name: (UMR: 18-01-1-16)						**Average**	**941.5**
3	0.052	2	0.5	12	1.625	46.7	850
4	0.052	2	0.5	12	1.625	46.7	850
Specimen name: (UMR: 12-05-1-16)						**Average**	**850**
5	0.052	2	0.5	18	1.625	46.7	750
6	0.052	2	0.5	18	1.625	46.7	750
Specimen name: (UMR: 18-05-1-16)						**Average**	**750**
7	0.052	2	0.75	12	1.625	46.7	483
8	0.052	2	0.75	12	1.625	46.7	550
Specimen name: (UMR: 12-07-1-16)						**Average**	**516.5**
9	0.052	2	0.75	18	1.625	46.7	683
10	0.052	2	0.75	18	1.625	46.7	650
Specimen name: (UMR: 18-07-1-16)						**Average**	**666.5**
11	0.052	2	1.25	12	1.625	46.7	317
12	0.052	2	1.25	12	1.625	46.7	367
Specimen name: (UMR: 12-12-1-16)						**Average**	**342**
13	0.052	2	1.25	18	1.625	46.7	367
14	0.052	2	1.25	18	1.625	46.7	350
Specimen name: (UMR: 18-12-1-16)						**Average**	**358.5**