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Summary Report: Strength of Single L-headers

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research report

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PREFACE

This report summarizes a previous test program conducted at the NAHB Research Center, and proposes a design methodology for single L-headers under gravity load. The findings provided a basis for the AISI Committee on Framing Standards to establish design options for single L-headers in the AISI *Standard for Cold-Formed Steel Framing – Header Design*.

Research Team
Steel Framing Alliance

Summary Report
Strength of Single L-Headers
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Introduction

Based on a test program performed at the NAHB Research Center (NAHB, 2003), a design methodology is proposed for single L-headers under gravity load. This report briefly summarizes the NAHB test program and presents justification for a proposed design method.

NAHB Test Program

The test specimens were single span assemblies consisting of the top and bottom track, cripple stud, and simulated wall stud. A single L-header was affixed to the top track as illustrated by Figure 1.

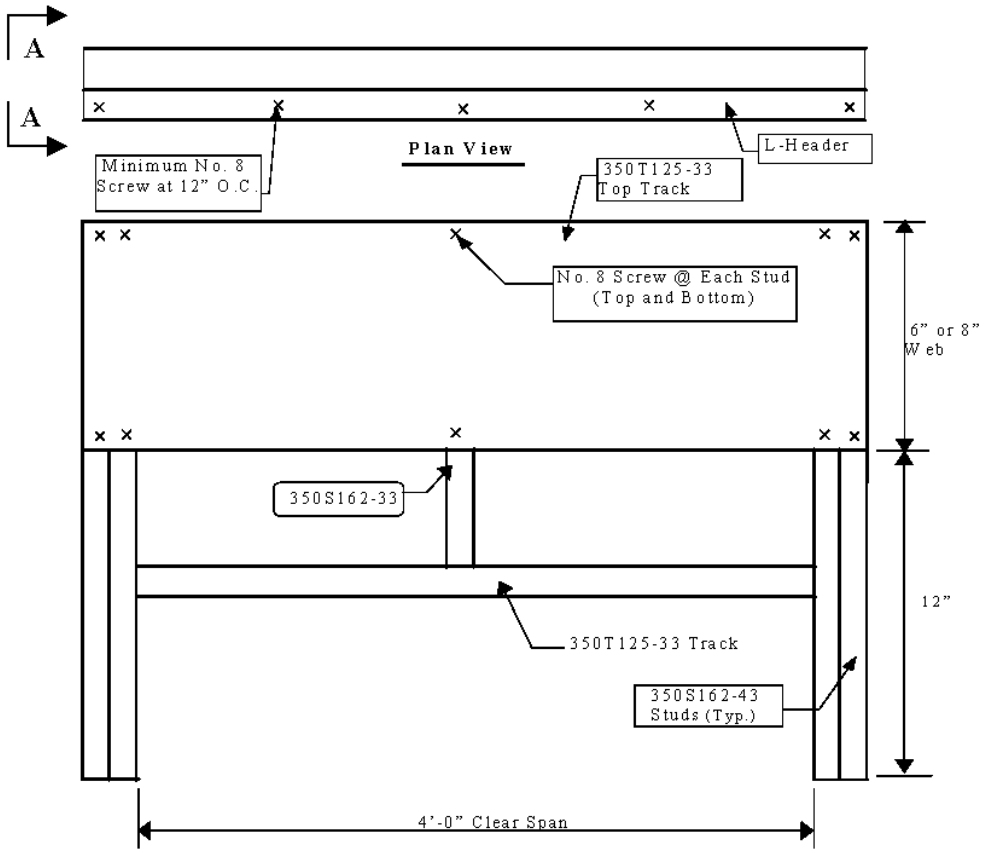

Figure 1 Single L-Header Test Assembly

Using No. 8 self-drilling screws, the L-header was screw attached to both the top track and to each stud as depicted by Figure 1 and Figure 2. Except that only a single L-header was installed, the construction of the tested assemblies met the installation requirements of the Header Standard (AISI, 2001), per Figure A1.1.2 for double L-headers.

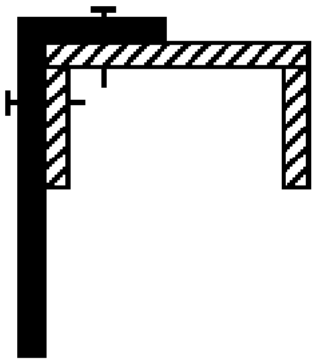

Figure 2 Typical L-Header Attachment to Track

To simulate in-situ loading of the header, each single span assembly was subjected to concentrated load at the mid-span cripple stud (Figure 3). Each assembly was tested to failure.

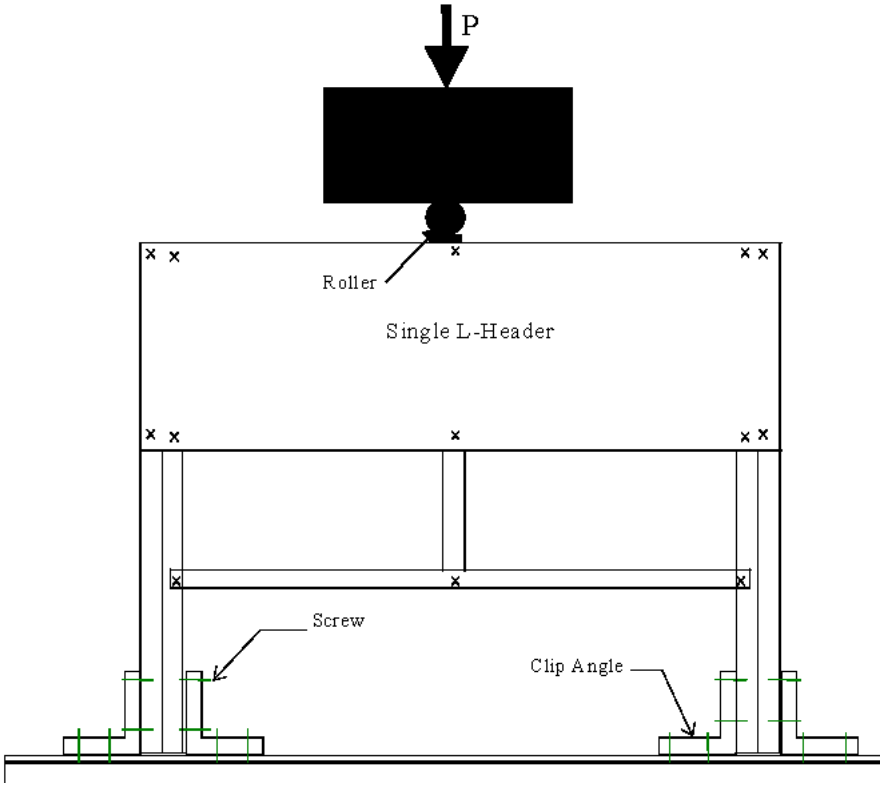

Figure 3 Load Application

Evaluation of Test Data

A total of 18 single L-header assemblies were tested to failure. Material tensile test properties are summarized in Table 1.

Table 1 - Material Tensile Properties for the L-Headers

L-Header (Angle) Designation	Yield Point[1] (psi)	Tensile Strength[1] (psi)	Uncoated Thickness[2] (inch)	Elongation[3] (percent)
600L150-33	36,800	46,100	0.0337	18.5
600L150-33	38,200	45,200	0.0341	18.7
600L150-33	37,500	48,600	0.0340	19.4
600L150-43	41,100	55,300	0.0444	19.6
600L150-43	39,900	54,600	0.0451	21.2
600L150-43	40,500	53,400	0.0448	20.0
600L150-54	53,700	64,600	0.0551	19.5
600L150-54	52,800	67,800	0.0555	19.9
600L150-54	54,100	65,200	0.0546	21.3
800L150-33	36900	48600	0.0339	23.2
800L150-33	37200	45900	0.0335	22.1
800L150-33	37100	46200	0.0336	20.9
800L150-43	39800	56900	0.0439	22.9
800L150-43	38700	58200	0.0441	21.6
800L150-43	40100	55800	0.0440	19.8
800L150-54	56500	69200	0.0540	21.6
800L150-54	54900	67500	0.0541	19.8
800L150-54	53800	68300	0.0541	22.3

For SI: 1 inch = 25.4 mm, 1 psi = 0.0703 kg/cm^2

[1] Yield point and tensile strength shown are based on coupons cut from each sample and tested per ASTM A370 [6].

[2] Uncoated thickness shown is based on uncoated thickness taken from each sample per ASTM A90 [7].

[3] Tested in accordance with ASTM A370 [6] for a two-inch gauge length.

Each assembly was tested as an assumed simple span beam with a concentrated load at mid-span. The test failure load, P_u, and the corresponding simple span moment is given in Table 2,

$$M_{test} = P_u L/4 \qquad (1)$$

where L = 48 inches.

Using the AISI Specification (AISI, 1999), the elastic section modulus of the effective section calculated at $f = F_y$ in the extreme compression fibers, S_{ec}, was computed for each L-header test assembly. Only the single L-header geometry was considered when computing S_{ec}. The nominal moment capacity, M_{ng}, was computed using Eq. B3.1.1-1 from the 2001 Header Standard (AISI, 2001) as

$$M_{ng} = S_{ec} F_y \qquad (2)$$

where F_y = yield point as given in Table 1.

Table 2 - Test and Analysis Results

Section	Fy ksi	Sec in3	Mng in-kips	Pu kips	Mtest in-kips	Mtest/Mn
600L150-33	36.8	0.285	10.49	1.87	22.44	2.140
600L150-33	38.2	0.288	11.00	1.89	22.67	2.060
600L150-33	37.5	0.287	10.76	1.70	20.41	1.897
600L150-43	41.1	0.398	16.36	2.02	24.22	1.480
600L150-43	39.9	0.410	16.36	2.18	26.16	1.599
600L150-43	40.5	0.406	16.44	2.34	28.12	1.710
600L150-54	53.7	0.509	27.33	2.81	33.74	1.235
600L150-54	52.8	0.516	27.24	2.91	34.88	1.280
600L150-54	54.1	0.503	27.21	2.81	33.71	1.239
800L150-33	36.9	0.400	14.76	2.19	26.28	1.780
800L150-33	37.2	0.383	14.25	2.20	26.42	1.855
800L150-33	37.1	0.387	14.36	2.26	27.17	1.892
800L150-43	39.8	0.642	25.55	2.81	33.72	1.320
800L150-43	38.7	0.647	25.04	2.77	33.22	1.327
800L150-43	40.1	0.643	25.78	2.93	35.20	1.365
800L150-54	56.5	0.797	45.03	3.19	38.26	0.850
800L150-54	54.9	0.801	43.97	3.13	37.60	0.855
800L150-54	53.8	0.803	43.20	3.34	40.03	0.927
					Mean	1.489
					Std. Dev.	0.400
					COV	0.2689

Conclusion

Based on the computed ratios of M_{test}/M_{ng} listed in Table 2, Equation 2 (Eq. B3.1.1-1 from the 2001 Header Standard) is an acceptable relationship for evaluating the gravity moment capacity of the single L-header assemblies tested, except for the 8 inch deep 54-mil L-headers which did not achieve design strength. The design methodology should be adjusted to reflect this observed behavior. Using the provision of Chapter F1 of the AISI specification, $\Omega = 1.67$ and $\varphi = 0.90$. These are the same factors prescribed in the 2001 Header Standard (AISI, 2001) for the design of double L-headers.

As with previously tested double L-headers, neither pure shear or combined bending and shear were failure modes in the test program. Also, web crippling and combined bending and web crippling are precluded from occurring because of the requirement that concentrated load applications occur at cripple stud locations.

Recommendation

The 2001 Header Standard (AISI, 2001) should be revised to incorporate single L-headers within the ranges tested.

References

AISI (1999), Specification for the Design of Cold-Formed Steel Structural Members, 1996 Edition with 1999 Supplement, American Iron and Steel Institute, Washington, D.C.

AISI (2001), Standard for Cold-Formed Steel Framing – Header Design, American Iron and Steel Institute, Washington, D.C.

NAHB (2003), "Testing of Steel Single L-Headers", U.S. Department of Housing and Urban Development, Washington, D.C.

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