



Missouri University of Science and Technology Scholars' Mine

Center for Cold-Formed Steel Structures Library

Wei-Wen Yu Center for Cold-Formed Steel Structures

01 Jan 1945

Cornell University School of Civil Engineering Tests on light beams of cold-formed steel

Cornell University School of Civil Engineering

Follow this and additional works at: https://scholarsmine.mst.edu/ccfss-library



Part of the Structural Engineering Commons

Recommended Citation

Cornell University School of Civil Engineering, "Cornell University School of Civil Engineering Tests on light beams of cold-formed steel" (1945). Center for Cold-Formed Steel Structures Library. 12. https://scholarsmine.mst.edu/ccfss-library/12

This Technical Report is brought to you for free and open access by Scholars' Mine. It has been accepted for inclusion in Center for Cold-Formed Steel Structures Library by an authorized administrator of Scholars' Mine. This work is protected by U. S. Copyright Law. Unauthorized use including reproduction for redistribution requires the permission of the copyright holder. For more information, please contact scholarsmine@mst.edu.

SCHOOL OF CIVIL ENGINEERING, CORNELL UNIVERSITY

TESTS ON LIGHT BEAAS OF COLD FORMED STEEL

FOR THE AMERICAN IRON AND STEEL INSTITUTE

Thirty-ninth Progress Report

January 1945

I. SCOPE OF THIS REPORT

In the Thirty-eighth Progress Report a series of 118 tests was reported on web crippling under concentrated loads. These 118 tests which included 17 representative tests of the Twenty-fifth Progress Report were carried out for web crippling by loads on the span, by simple end reactions, by end reactions with additional loads on top flange, and by reactions of continuous supports with similar additional loads. Two formulas were developed from the entire series of tests which represented, for the two cases (loads on span, and reactions), all test results with satisfactory accuracy.

However, only 8 out of these 118 tests were carried out on single web beams (all others referred to double webs). Therefore, 20 additional tests of single web specimens reported herein are designed to furnish more cvidence on single web beams.

II. METHOD OF TESTING

The specimens, which were cut from undamaged outside portions of old beam specimens, were tested for 4 types of web-crippling as mentioned in the Thirty-eighth Progress Report:

(a) Only 2 specimens of 11 gage were tested to obtain web failure under a concentrated load on the span, because a series of 8 tests (6 of them were for 18 and 14 gages) under the same conditions had been tested and were reported in the Thirty-eighth Report. Six of these eight old late, as mentioned in the Thirty-eighth Report, behaved natisfactority.

However, doubt was expressed on the validity of the two old tests on 11 ga. specimens. On these two specimens high bending stresses obtained on a 36" span were thought to be responsible for the relatively low failure loads (p. 7 of Thirty-eighth Report). For this reason specimens cut from these same beams were tested on a 16" span as were most other specimens of the Thirty-eighth Report. Failure loads obtained were indeed higher than on the longer span and closer to those predicted by the empirical formula. These tests are designated as "web-crippling, span, top flange loading."

- (a) Six (6) specimens were tested in a similar way, but so as to cause failure at the supports. These tests are designated as "web-crippling, reaction, top flange loading".
- (b) Six (6) specimens were tested under direct compression load of the web somewhere along the span (removed from ends). These tests are designated as "web-crippling, span, two-flange loading".
- (c) Six (6) specimens were tested under similar direct compression load, but with loads applied at one end of each specimen. These tests are designated as "web-crippling, reaction, two-flenge loading".

In both "reaction" loadings (b and d, above) the outer edges of the distributing plates were aligned with the ends of the beams. All distributing plates were placed on rockers or rollers so as to obtain continuous contact despite deflection of the specimens.

III. RESULTS

The test results are summarized in table 1 and the graphical representation of the test evaluation is given on drawings 347 to 250.

Table 1
Results of Web Crippling Tests
-single web specimens-

•	_			Fe	ilure Loads,	lb. (per v	veb)
	syp	t	b	Span	Reaction	Span	Reaction
Beam	p.s.i.	in.	in.	top fl.	top fl.	two fl.	two fl.
03a	32,200	.0463	1	•		1,600	880
	•		2.5	•	•	1,660	920
-03b	-32,200	.0463	1		1,130		
030	32,200	.0463	2.5	₫ a ,	1,275		
NZa	35,800	.0757	1			6,200	٤,450
•			2.5			6,750	3,060
NEb	- 35,800	.0757	1		3,600		
N3c	35,800	.0757	2.5		4,075		
K3a	37,600	.1250	l		-	12,900	6,800
4	·		2.5			14,600	7,500
KZb	37,600	.1230	1		7,125		•
	·		2.5		10,325		
K3đ	37,600	.1230	1	10,500		-	
	-		2.5	12,900			

IV. EVALUATION

In the manner as discussed under the same heading in the Thirty-eighth Report, the following same two equations were used: For span crippling, both top flange and two-flange loading:

$$P_{ult} = (15 + 2.25 \sqrt{b/t}) t^2 s_{vp}$$

For reaction crippling, both top flange and two flange loading:

$$P_{ult} = (10 + 1.25 \sqrt{b/t}) t^2 s_{yp}$$

The straight lines representing these equations are plotted on all four drawings. It is seen that the test points scatter within satisfactory limits around these lines.

Again, in order to show quantitatively the accuracy of these formulas for these 20 tests, the four tables below have been computed. These tables contain the actual failure loads, the failure loads computed from the above formulae, and the percentage of deviation for the tests.

Table 2

Comparison of Empirical and Computed Failure Loads

Span, Top Flange Loading

				$P_{\mathbf{W}}$	$P_{\mathbf{v}_{l}}$	
Beem	s yp	t	ď	test	formula	Ą.
KZd	37,600	.1230	1	10,500	13,500	- 22.2
Kad	37,600	.1230	2.5	12,900	16,500	8.18

In this table:

syp = yield point

t = sheet thickness

b = width of bearing.

 P_{w} = ultimate test load, per web

P_{w formula} = ultimate load computed from formula given in Thirty-eighth

Report

% = percentage of deviation = 100 (Pw test - Pw form) /Pw form

The mean deviation of P_{w} test from P_{w} form for these two tests is - 22%, as compared with - 36% obtained in the old long-span tests on the same specimens.

Table 3

Comparison of Empirical and Computed Failure Loads

Reaction, Top Flange Loading

Beam	s _. Ур	t	ь	Pw test	Pw form	<u>g</u> ;
03b	32,200	.0463	1	1,130	1,080	+ 4.6
03e	32,200	.0463	2.5	1,275	1,310	- 2.7
N3b	35,800	.0757	1	3,600	2,960	+ 21.6
N3c	35,800	.0757	2.5	4,070	3,490	+ 16.6
K3b	37,600	.1230	. 1	7,125	7,560	- 5.7
-K2c	37,600	.1230	2.5	10,325	8,740	+ 18.1

The mean deviation is + 8.7%, the mean positive deviation is + 15.2%, the mean negative deviation is - 4.2%.

Table 4

Comparison of Empirical and Computed Failure Loads

Span, Two-Flange Loading

	s			Ø	D	
Beam	УР	t	b	w test	Fw form	<u> </u>
03a	32,200	.0463	1	1,600	2,050	- 22.0
03a	32,200	.0463	2.5	1,960	2,670	- 26.6
N3a	35,800	.0757	1	6,260	5,450	+ 13.7
N3a	35,800	.0757	2.5	6,750	6,850	- 1.5
КЗа	37,600	.1230).	12,900	13,150	- 4.5
KZa	37,600	.1220	2.5	14,600	16,500	- 11.5

The mean deviation is - 8.7%, the mean positive deviation is + 13.7%, the mean negative deviation is - 13.2%.

Table 5

Comparison of Empirical and Computed Failure Loads

Reaction, Two-Flange Loading

Beam	s yp	t	ъ	P _{w test}	P w form	%
'03a	32,200	.0463	1	88 9	1,080	- 18,5
03a	32,200	.0463	2.5	9&0	1,310	- 29.8
N3a	35,800	.0757	1	2,450	2,960	- 17.2
·N3a	35,800	.0757	2.5	3,060	3,490	- 12.3
K5a	37,600	.1230	1	6,800	7,560	- 10.1
K3a	37,600	.1230	2.5	7,500	8,740	- 14.2

The mean deviation is - 17.0%.

V. OBSERVATIONS

- (1) All #11 gage specimens failed by distortion of the part of the web directly under the load. The distortion, semicircular in shape, was strictly localized, usually spreading not further than one third of the depth of the beam from the loaded flange into the web.
- (2) Under "top flange loading" all three #14 gage specimens failed by istortion locally of the part of the web directly under the load; while the rest of the three #14 gage specimens under "two flange loading" failed

aue to bulging of the entire web from top to bottom directly at the loaded portion.

- (3) All six #18 gage specimens failed due to bulging of the entire web from top to bottom under the loaded portion.
- (4) In most of the tests for heavier gage (#11 gage here), distortion occurred not only in the web but also in the loaded flanges directly under the loaded area.

VI. SUMMARY

- (1) A total of 20 tests of single web specimens on web crippling by local loading was carried out.
- (2) Tests were carried out by loads on the span, by simple end reaction, by end reaction with additional loads on the top flange, and by
 reactions of continuous supports with similar additional loads.
- (3) It was found that the two formulae which had been developed in the Thirty-eighth Progress Report could be used for single web specimens with sufficient accuracy. The amount of scattering of the results of these tests as compared with the data of the formula is about the same as on the double web tests of the Thirty-eighth Report, and is more than amply covered by the factor of safety of 2.5 used in the Design Specifications.

			• • •		S- 4 . 4		٠.		-	-			347
						HILE E				.,		(10)=	
A CONTRACTOR OF THE PARTY OF TH													
			HIME	illa:					in part			1	
													= 11:11
		H, Strift										II-)	
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	-Hilli					Hitif						H. I	
		Eth.H										NF 1	
											1		
- Control													
THE WALL		11111										Annym it	
	HARA	. 21.4	Jan He	7.1 1 T			THE LE				ere Friid		
Section to		TO LAK		4 17									
3 0				A CLASS			47 117			. 14 1			3
~ \$		THE STATE			217.,1	Y	to all a bon.				12 57 27		111111111
7 3	The same of the same				per par	- X		1277 (327)					
0													11.75 11.75
3		33 135			han burar	autilieri autilieri							3
7 9	12.00												
			17328	A [3] (****)			1	*	723.1 .	7. Trans.		andra Augustai	7.11. 11
	1	1,177,74				- 4 - 2							
V. V.			1		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	******			######################################				
- 14 - 0		1 1 1 1 1 1					147				p.a p.a. 1		
200					HHI								
	Nini			<u>1</u> 1.		1		1-1-11:11					
_				7***!	111111111		1						777
							7	10000	*				
			14.14.14				1	<u> </u>		11 .11		, ` , ' 7 ; '	
	<u> </u>							1-1	11. 1				
			1				1	1.	111 11 11		1		
								m \		1		latin esti.	
		1 1 1						1			<u> </u>		
The second secon				1					1				
									1		1 1 1	1 1112	
				1 1 1									
				- 1 1 1				1	1				;;
			7	11.0					1				
	773,25							1 1			1 1 1		E CONTRACTOR
22. 1		• • • • • • • •	0/2	5	Þ.		5	1	3		2	1 2 2	\$
1							y	1					

1) _	, :		Ĺ				·		 					N	EB			214	75	IN	3		5	PA	W	,							;; -··		
) - : : : - : : : : : : : : : : : : : : :												70	0		F- 6	AI	19	E	1.2	اعرن	P	N	7										
D/		,		•															1000年								1111										
7 6	- 5γ	7																																			
50					7	+												1.51	1		4 4 4						1							100		100	
					7 1		1.11														1											,					
+0		 		- F-									12.								# 1 m											n					
																								*													
30.			-				11.1				ومسيا	1	t	5	ZP	سلسل		نسبسه	X		1							141A		×							
						1/1	5.	3	1	7 1	0/	×							*	112									F,								
-20			سيسر	P		1			17.																												
			,														7.7									76		111								13	
-70																					1							1					†:::				
									7												11.5													10.01			
<i>- 0</i>	1								-	į			3												5				,		.5				V	b/	2

<u>.</u>		1.1		111	.					::			Vi	E	63	1		121	9//	Δ	G.		RE	Ac	11	26	1 .11	:17.	1	1:.		: :	: 1		:		
		1::):											7	54,2	Ď.	F	G.	4		Z) <i>(</i> 1	d)	77									::					
								1				1-1	- T.									1						1	77:1 17:1 17:1								
			3																											1							
4	Syp					#						111														1											
200										1																											
								::::																				-								1 2 2 2	
																																			E		
+											, 2	5~	7										3														
		P		10	+	. 2	51	10	t	7	×		-117	×				* *											¥								
70								1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1				1				11.																					
	1	1 . '																	1.1.																7		
	4					F.1		71 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7												•			1								(1) A	2		V			
				.]					, 7.		.F.																										