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

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SCHOOL OF CIVIL ENGINEERING, CORNELL UNIVERSITY
TESTS ON LIGHT BEAMS OF COLD FORMED STEEL

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I. SCOPE OF THIS REPORT

Tension tests were carried out on strip specimens of the steel of which beams 14-3 1/4, 18-3 3/4, 18-5, and 20-3 3/4 are fabricated.

II. METHOD OF TESTING

Tests were carried out on standard tension specimens 1/2 in. wide in the gage portion, 10 in. long between fillets, with 2 in. fillet radius. Permanent elongations were measured between scratches 2 in. apart. In former similar tests only the following quantities had been determined: yield point, ultimate stress, and permanent elongation. However, in recent discussions the question was raised whether the usual value of the modulus of elasticity $E = 29.5$ to 30×10^6 p.s.i. for structural steel also holds for thin sheet steel. Some manufacturers seem to believe that this value may be as low as 26×10^6 for thin sheets. To answer this question a refinement of the testing procedure was introduced which permits the complete stress-strain curve up to the yield point to be obtained. Two 8 in. Berry gages were used, one on either side of the specimen, to exclude the influence of any slight bending that might be present. These Berry gages cannot be set in the usual way in punch marks on thin specimens because the local stress concentration at the marks is likely to produce premature failure. For this reason special clamps were used in these tests which permit mounting of the gages without any injury to the specimens. Because of the high accuracy required for obtaining reliable values for E the gages had to be calibrated in the vertical position used while testing. Two independent calibrations were carried out, one on a special interferometer calibration box generally used

here for calibrating Huggenberger strain gages, and one on a cold rolled steel bar.

III. RESULTS

Table 1

Results of tension tests

No.	Gage	Proportional Limit	Yield Point	Ultimate Strength	E	Elong. in 2"
1	12	24,800	29,600	48,800	32.2 x 10^6	32.5%
2	12	20,900	28,700	47,900	30.2 x 10^6	31.5%
3	12	22,900	29,200	47,800	29.2 x 10^6	35.5%
4	14	22,500	28,900	51,600	29.7 x 10^6	28.5%
5	14	21,000	27,000	50,800	29.4 x 10^6	30.0%
6	14	22,200	28,800	51,000	29.4 x 10^6	--
7	18	27,000	32,100	48,800	29.7 x 10^6	--
8	18	27,500	32,800	49,400	30.6 x 10^6	--
9	18	25,800	32,300	47,800	30.3 x 10^6	--

The value for E of specimen No. 1 is obviously wrong and is probably due to some fault in the setting of the gages. This was the first specimen tested by means of the new test procedure. In the subsequent table 2 this value, therefore, is discarded. Specimen No. 6 broke very close to one of the reference scratch marks so that no reliable value for the permanent elongation could be obtained. All #18 gage specimens broke at the toe of the fillet which prevented establishing of the permanent elongation. The reason for this unusual behavior is not clear. Duplicate tests will be made on specimens with still larger radius of fillet.

Table 2

Average Properties of the Three Steels

Gage	Proportional Limit	Yield Point	Ultimate Strength	E	Elong. in 2"
12	23,200	29,200	48,200	29.7×10^6	33.2%
14	21,900	28,200	51,200	29.5×10^6	29.2%
18	26,800	32,400	48,700	30.2×10^6	--

IV. DISCUSSION

(1) The observed variation of the modulus of elasticity E is seen to be very small and within the range of experimental accuracy. The values obtained are within the range of E for ordinary structural steel. Consequently, these tests did not disclose any difference for E for sheet steel as compared with that of ordinary steel.

(2) The stress-strain curves are not included in this report but are preserved in our files for future reference. These curves disclosed the following peculiarity: Instead of the sharp break usually observed at the yield point of ordinary steel, a rather gradual transition from the straight line portion to the yield value was found in all nine cases. The stress at which the curves began to deviate from the straight line are designated as proportional limit in tables 1 and 2 above. Permanent elongation (gradual yielding) was observed to start at this proportional limit. This peculiar behavior is believed to be due to non-homogeneity of the specimens, the outer layers probably being more affected by rolling and therefore of higher yield strength than the core of the sheets.

V. FUTURE TENSION TESTS

The steels reported on above are the only ones for which control specimens were furnished by the manufacturers. If no such strips are to be sent for the rest of the steel, particularly for the specimens of the Detroit Steel Products Company, specimens will have to be cut out of the undamaged portions of beams and studs after testing. This would increase

considerably the amount of shop work to be done here. In addition it will be hard to tell with any degree of certainty whether a particular portion of the test specimen was unaffected by the preceding testing. For this reason the results obtained on such specimens are less reliable than those cut out of control sheets.