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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
FOR THE AMERICAN IRON AND STEEL INSTITUTE

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I. SCOPE OF THIS REPORT

At the present time failure tests are being carried out on the 24 beams series D and E. To date the following beams have been tested: D-18-16-816a and E-18-16-816a and b; E-18-14-816a and b; D-18-14-816a and b; E-18-12-816b; D-18- -816a and b; E-18-18-88a and b; total - 13 beams.

The failure tests on those beams are carried out in a way different from at used heretofore (see section II of this report). As a result very extensive ta are obtained for each of these beams. Since the evaluation of these data ll require considerable time it has been decided to complete the entire series 24 failure tests without interrupting the test work by simultaneous reduction t data obtained. For this reason in the present report no test data are ven and no conclusions drawn.

II. METHOD OF TESTING.

In previous failure tests the observations had been limited to measuring ad and deflection and observing the kind of failure. It was observed however at formation of waves on the top flange, i.e. the beginning of buckling in many ses had started at loads far below the ultimate. The exact time of the first ve forming cannot be observed by simple visual inspection since the first waves e usually so small that they escape observation. For this reason during the esent tests and in addition to the load - deflection observation, strain measure- nts are carried out on the top flange. Eight Huggenberger strain gages are unted on the top flange, four in the longitudinal and four in the transverse di- ction. The gages are mounted in the same way as in previous strain measurements, e. they are set up in pairs, one on the top and one on the bottom surface of the p flange, opposite each other.

It is believed that deviation of the load - strain curve from the straight ne will give a sensitive indication of the first signs of buckling waves. In dition it will be possible to compute the mean stress in the top flange from se strain measurements. It will be remembered that in previous failure tests ly a "nominal stress" has been given, obtained from the flexure formula: stress = However irregularities in the shape of the beam make it impossible to deter- ne S with great accuracy. It is therefore believed that the stress values ob- ined from the present strain readings will at least supplement the data on the ominal ultimate stress".

In setting up the specimens extreme care was taken to avoid any eccentric ading. This effort however in some cases is partly upset by the fact that con-lerable irregularities in the shape of the beams give rise to inevitable eccen-icities.

In former tests the load had been applied over the entire width of the p flange. In some cases this gave rise to local distortion of the top flange th consequent failure directly under the load. In order to avoid such behavior the present tests, a narrow thin steel plate is placed on the top flange direct-over the web at the load points. By means of this plate the load is applied the web as directly as possible. As a result none of the 13 beams tested has iled at the load point.

In testing the twin specimens of each type of beams, one specimen is ested as received, while the inclined stiffeners connecting the web with the bent own portion of the top flange are cut out on the other specimen. It is hoped nat this procedure may shed some light on the question of the necessity of such ateral bracing.

The load is applied in small increments, the magnitude of which depends n the individual beam tested. After each increment the load is reduced again to he small initial load applied at the first reading. Deflection and strain read-ngs are taken at each loading and permanent deflections and strains are observed fter each increment.

The Huggenberger strain gages being very sensitive instruments, it is mpossible to leave them on the specimen up to the ultimate load since they may easily be damaged while failures occur. For this reason the gages are taken off at about 90% of the ultimate load. That can be done with comparative ease since t is usually possible to predict the ultimate load of the beam from its behavior t 70 to 85% of that load (permanent set, wave formation, non-linearity of strain curves etc.)

In addition to these observations the cross-sectional dimensions of each beam are measured as precisely as possible in order to arrive at more exact data concerning I and S than in previous tests.

III. GENERAL BEHAVIOR OF BEAMS IN FAILURE

Although, as mentioned before, no data yet are worked out, it may be of interest to report on the general behavior of the beams in failure.

The 13 beams tested acted in a very regular way; the ultimate load was increasing with decreasing width and increasing thickness, i.e. with increasing stability of the top flange. No great difference has yet been observed between the ultimate loads of the beams with and without inclined flange stiffeners.

Three distinct types of failure have been observed: local short wave buckling of the downstanding part of the top flange; local short wave buckling of the main horizontal part of the top flange; and horizontal bending of the top flange as a whole (loss of lateral stability). In some cases again spot welds failed near the supports. However in all cases this took place at loads consider-ably below the ultimate. It was therefore possible to take those beams out of the testing machine, reweld the bottom flange and carry the tests further to failure in the top flange.

Considerable irregularities in the shape of the beams may in some cases result in an ultimate load sizeably lower than that which would have been obtained if the beams were in better shape. It is hoped that this influence may possibly be analyzed more exactly after the numerical evaluation of the results.