01 Jul 1942

School of Civil Engineering Tests of light beams of cold formed steel for the American Iron & Steel Inst.

Cornell University School of Civil Engineering

SCHOOL OF CIVIL ENGINEERING
TESTS OF LIGHT BEAMS OF COLD FORMED STEEL
FOR
THE AMERICAN IRON & STEEL INST.

Twenty-sixth Progress Report
July, 1942

I. SCOPE OF THIS REPORT

Six beams of the new series with unstiffened top flanges have been tested; viz., two specimens each of beams 12-3, 18-3 3/4, and 20-3 3/4. (The first number in this designation gives the gage thickness, the second the half-width of the top flange).

This report contains only the data of the tests. The evaluation of the test results will be carried out after a larger number of beams have been tested.

II. GRAPHICAL REPRESENTATION OF RESULTS

Drawing 232 gives the load deflection curves for beams 12-3-1 and 2

Drawing 233 gives the load deflection curves for beams 18-3 3/4-1 and 2

Drawing 234 gives the load deflection curves for beams 20-3 3/4-1 and 2

Drawing 235 gives the load strain curves for beam 12-3-2

Drawing 236 gives the load strain curves for beam 18-3 3/4-2

III. METHOD OF TESTING

The beams were tested in the same manner as those of the preceding series. They were supported laterally at the load points and at the supports in order to insure failure of the top flange without twist or other disturbance.

On the first beam of each type only load-deflection readings were taken. On the second beam of each type Huggenberger gages were used in addition. One pair (H_1 and H_2) was mounted at a distance of 0.9 in. from the web, H_1 on the top surface and H_2 on the bottom surface of the top flange. The other pair, (H_3 and H_4), was mounted 0.5 in. from the outer edge of the top flange, H_3 on the top surface and H_4 on the bottom surface.

IV. RESULTS

The ultimate load of each beam is given on the corresponding load-deflection diagram. It is seen that the ultimate loads obtained on twin beams agree very well for 18-3 3/4. For beam 12-3 the difference in ultimate loads of twin specimens is about 9%; for beams 20-3 3/4 this difference is about 11%. However, the lower value for 20-3 3/4 is likely to be due to the fact that no cover plates were used on this beam, whereas such plates were welded to the load and support points of all other beams. Since the plates had not been furnished by the manufacturer, they were made up from stock available here. However, this stock was not sufficient to provide the last one of the beams with cover plates. This beam failed very close to one of the loading points despite 1/4 in. distributing plates inserted between the loading device and the top flange, but not welded to the latter. It appears, therefore, that, in order to obtain uniform results, the use of welded-on distributing plates is essential.

On beam 12-3-2 the points on the load deflection curve corresponding to a load of 4500 and 5500 lb. are seen to be off the curve. This is due to the deflection wire having come in contact with one of the electric wires supplying the vibrators on the Huggenberger gages. These two points, therefore, should not be considered.

On beams 18-3 3/4 and 20-3 3/4 waves in the top flange developed at the very lowest loads without, however, impairing the carrying capacity of the beam. This is in agreement with the findings of the tests on beams with stiffened flanges which proved that wave buckling of compression flanges occurred long before failure. It proves once more that the critical buckling stress of thin flanges is of no consequence and that a proper account of the strength can be obtained only from an approach like that used for evaluating the ultimate strength of stiffened flanges, on which the proposed design specifications are based.

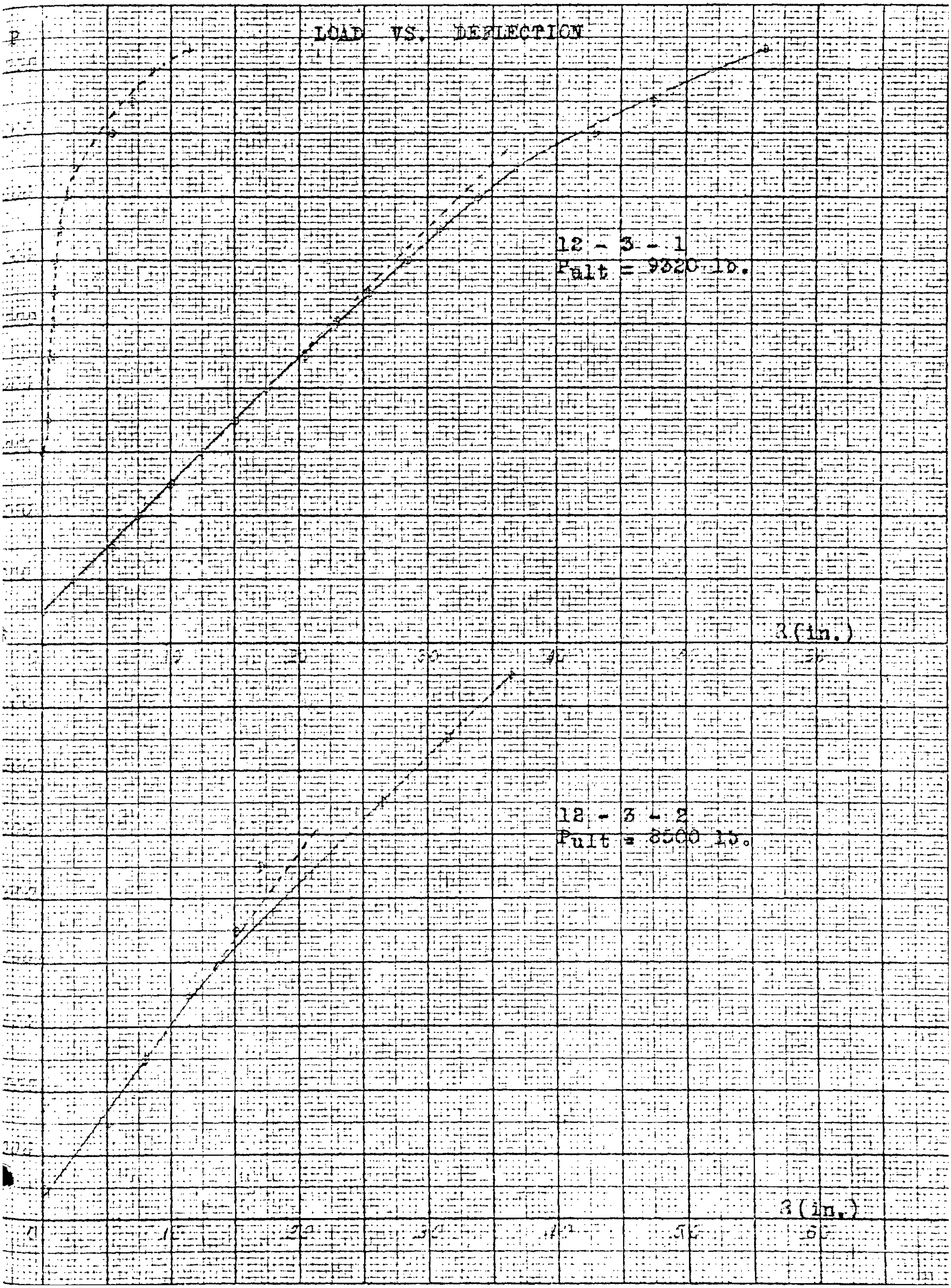
On beams 12-3 perceptible waves developed only at about 5000 lb., which is still far below the ultimate load, despite the greater thickness of the flange.

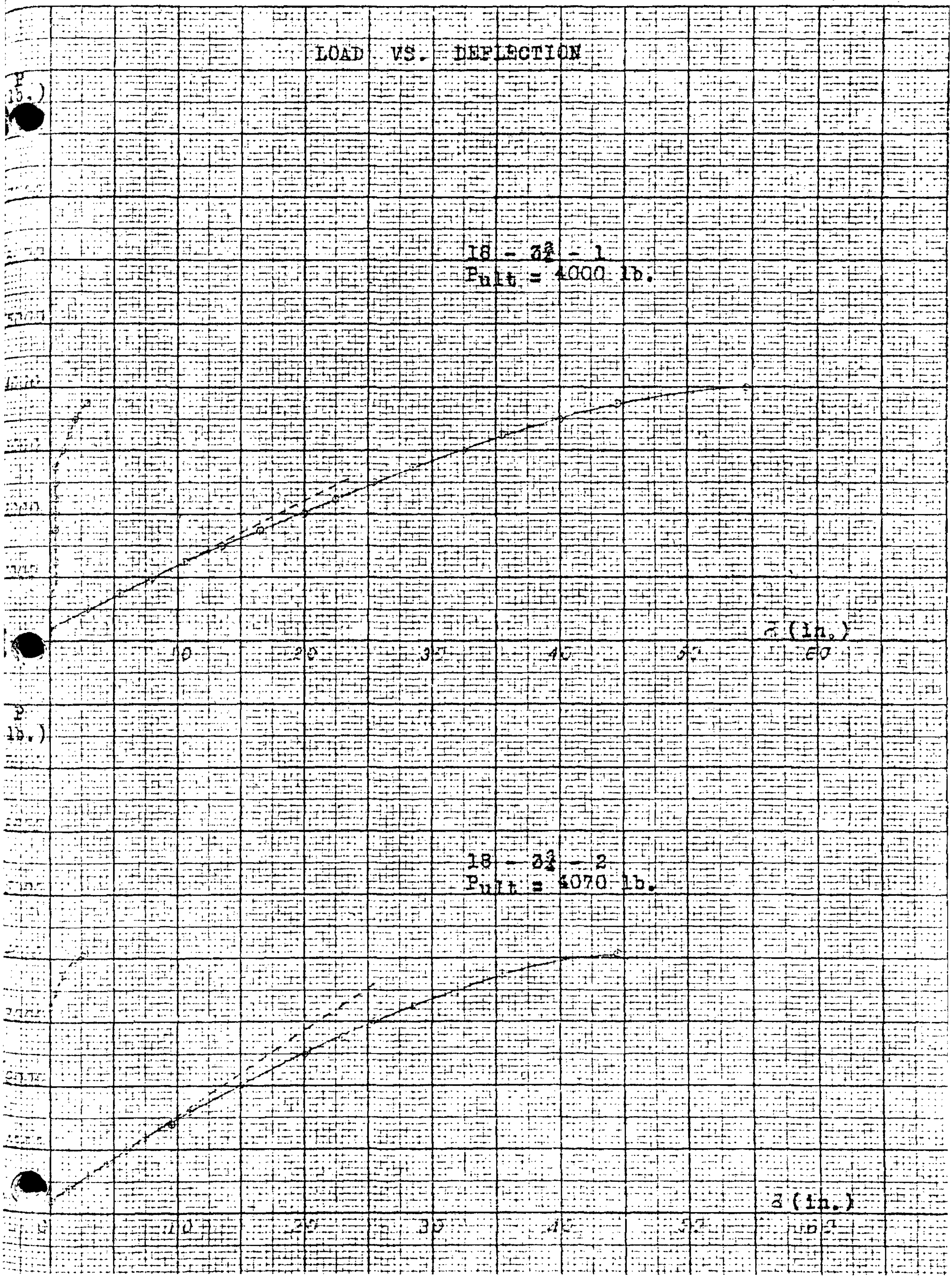
Without detailed evaluation it is seen from the load strain curves that the stresses near the web are much greater than those near the edge. This is evident from the fact that the average of the strain readings of H_1 and H_2, for any given load is larger than for H_3 and H_4. This difference is seen to be greater for 18-3 3/4 than for the thicker and narrower flange of 12-3. This is in qualitative agreement with the interpretation of previous tests.

Huggenberger gages were also mounted on 20-3 3/4. However, the intensity of the waves developed on this extremely thin flange was so great as to make the Huggenberger readings entirely erratic. The degree to which the waves affect the regularity of the strain readings is seen from a comparison of the rather regular graphs for the thick flange of 12-3 as compared with the very irregular character of the curves for the thin flange of 18-3 3/4. For this reason the use of strain gages in these tests is hardly of much value except to give a qualitative confirmation of the fact that the stresses decrease from the web toward the edges of flanges and that this decrease is greater for smaller ratios of t/w.

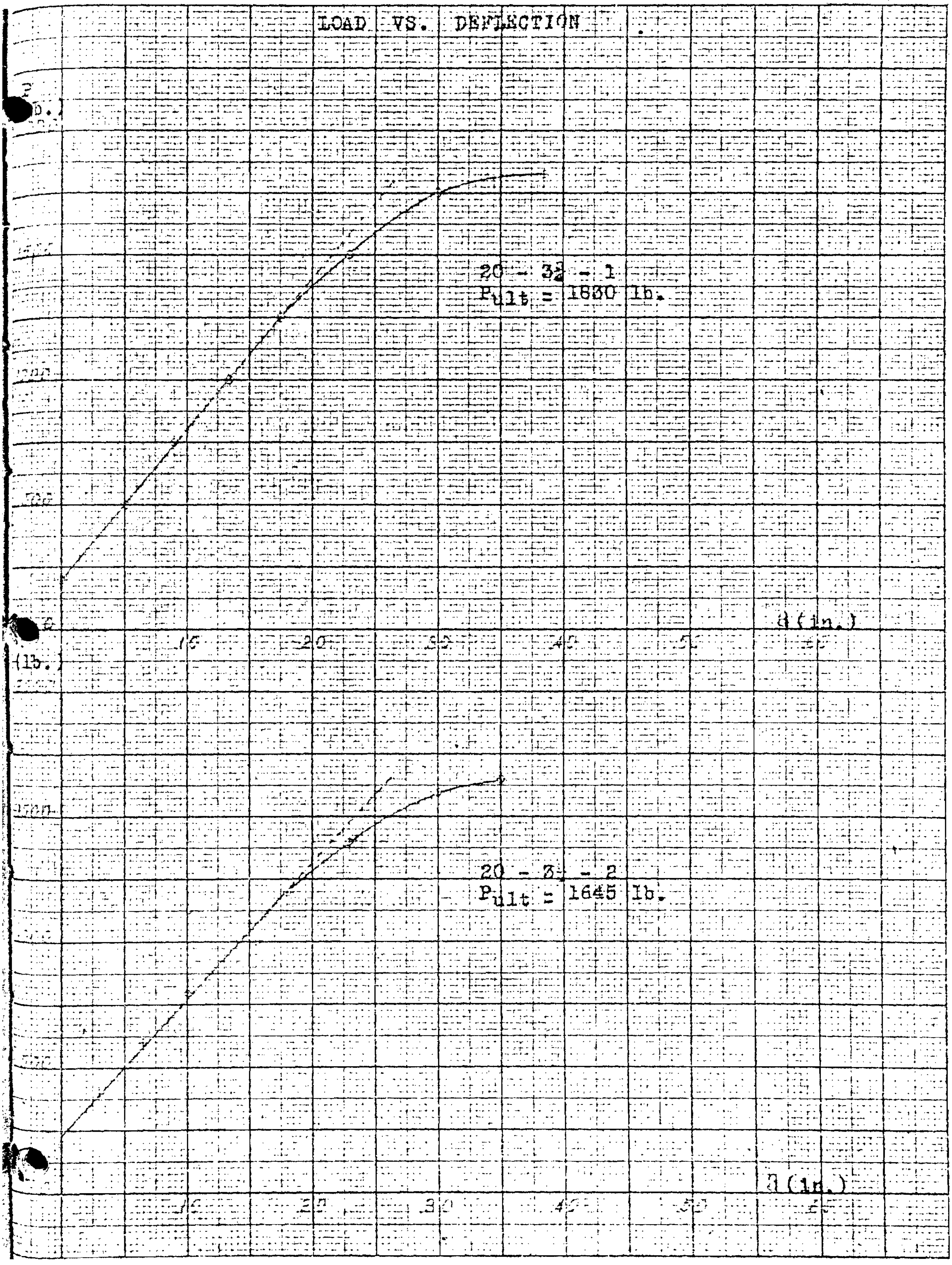
V. IMPROVEMENT OF PROCEDURE

Since Huggenberger readings proved of little value in obtaining direct evidence on the effective area of the top flange, an attempt will be made in the coming tests to establish this effective area in the following way: 8 in. Berry Strain Gages will be mounted, one on the top flange directly over the web and the other on the bottom flange directly under the web. Provided that these readings are not too much disturbed by wave formation, it should be possible to determine the position of the neutral axis experimentally from these readings. Since the dimensions of the beams are such that the bottom flange at points sufficiently removed from the loads is fully effective, an attempt will be made to compute the effective area of the top flange from the measured position of the neutral axis.

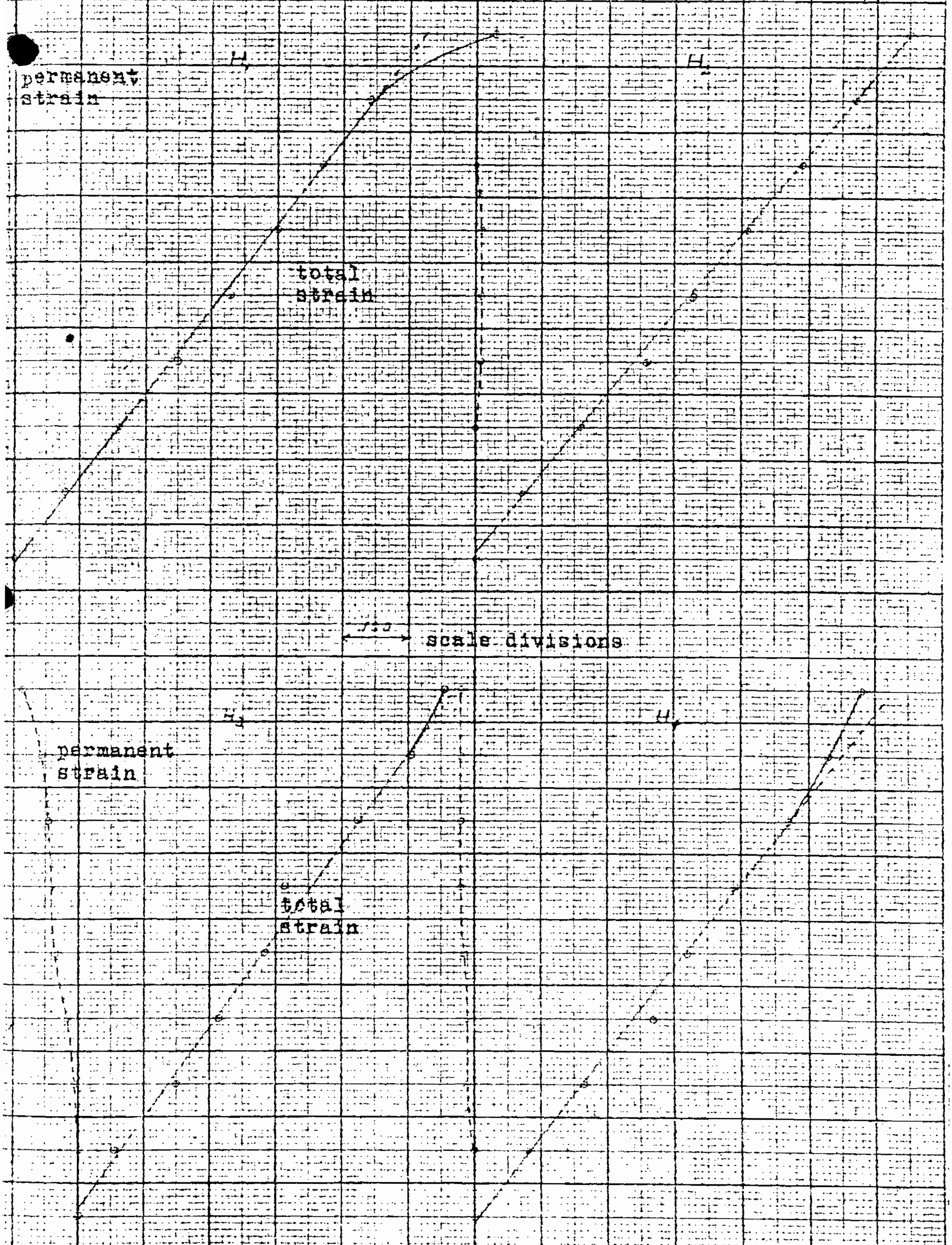

LOAD VS. DEFLECTION
P
12 - 3 - 1
Pult = 9320 lb.
δ (in.)
12 - 3 - 2
Pult = 8500 lb.
δ (in.)



LOAD VS. DEFLECTION
P (lb.)
18 - 3¾ - 1
P_{ult} = 4000 lb.
δ (in.)
10
20
30
40
50
60
P (lb.)
18 - 3¾ - 2
P_{ult} = 4070 lb.
δ (in.)


LOAD VS. DEFLECTION
20 - 32 - 1
P ult = 1630 lb.
20 - 3 - 2
P ult = 1645 lb.
(lb.)
δ (in.)
.10
.20
.30
.40
.50
δ (in.)

LOAD VS. STRAIN



18 - $3\frac{3}{4}$ - 2

LOAD VS. STRAIN