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Artikel: Trials with a specimen frame in steel

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Trials with a Specimen Frame in Steel.

Versuche an einem Stahlrahmen-Modell.

Essais effectués sur un modèle de cadre métallique.

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Many researches have been published in recent years giving the stresses in various parts of a steel frame as deduced by extensometer readings taken at various parts of the beams or stanchions under loads within the design load for the building but the writer has not seen the results of tests carried out on an actual frame to the point of practical destruction.

In order to make such a test upon a frame small enough to be able to undertake the test in a laboratory the frame was designed in accordance with the Code of Practice for Structural Steelwork now adopted by the London County Council and the Rule as to minimum eccentricity (2 in. or 50.8 in.) to be assumed in stanchions recommended by the Institution of Structural Engineers. Each of the members of the frame is $4 \times 1\,^3/_4 \times 5$ lb. I section. The properties of this section are as follows:

	X-X Axis	Y-Y Axis
Moment of Inertia	3.66 in^4	.186 in^4
Section Modulus	1.83 in^3	.213 in^3
Area	1.47 in^2	

The beams were connected to the webs of the stanchions by top and bottom angle cleats $2'' \times 2'' \times ^1/_4$. The mild steel bolts $^5/_{16}''$ (794 mm) in diameter were employed. The design was made so that theoretically on the basis of the design beam and stanchions would reach their ultimate load simultaneously.

In the first test the frame was placed vertically on the floor of the laboratory and the load was applied through a lever loaded by weights. During this test the feet of one of the stanchions moved outwards at a load of approximately 2,5 tons and as the results were rather different from what the writer had expected another frame was made and tested. This frame, was identical with the previous one except that light ties were provided to prevent the feet from spreading and the frame was made slightly narrower to enable it to be accommodated in a horizontal hydraulic testing machine. The single beam which was tested under the same loading condition of the beams in the frame, was of the same cross-section and cut from the same length of beam.

Figure 1 shows the deflections for the single beam and for the beam as part of the frame for the two tests, the first test being shown by full lines and the second by dotted lines.

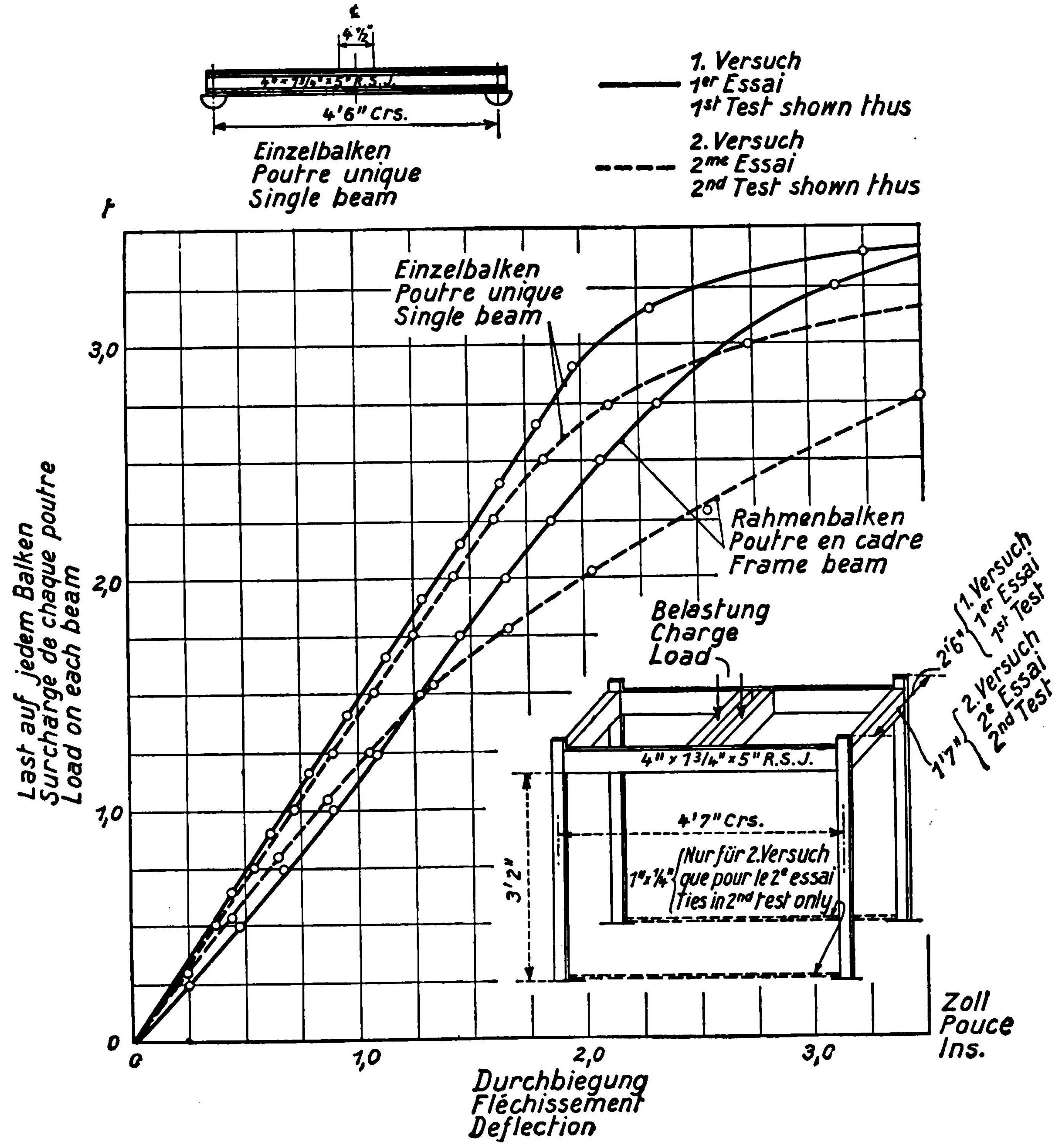

Fig. 1.

Figure 2 shows the same figures drawn to a smaller scale so that the ultimate loads may be seen. These tests were made for me by Mr. *R. H. Stanger*, Assoc. M. Inst. C. E., and the final load applied was that at which in his opinion the bending was continuous and would ultimately result in collapse of the structure.

Figure 3 shows the results of the single beam of test 1 tested again after it had been bent to a deflection of $1^1/_2''$ with the load applied on the opposite flange to that of the previous test so that the flange previously tested was then in compression. This test shows an earlier yield point but the ultimate strength is higher; the final load being 4.4 tons and the final deflection 3 inches.

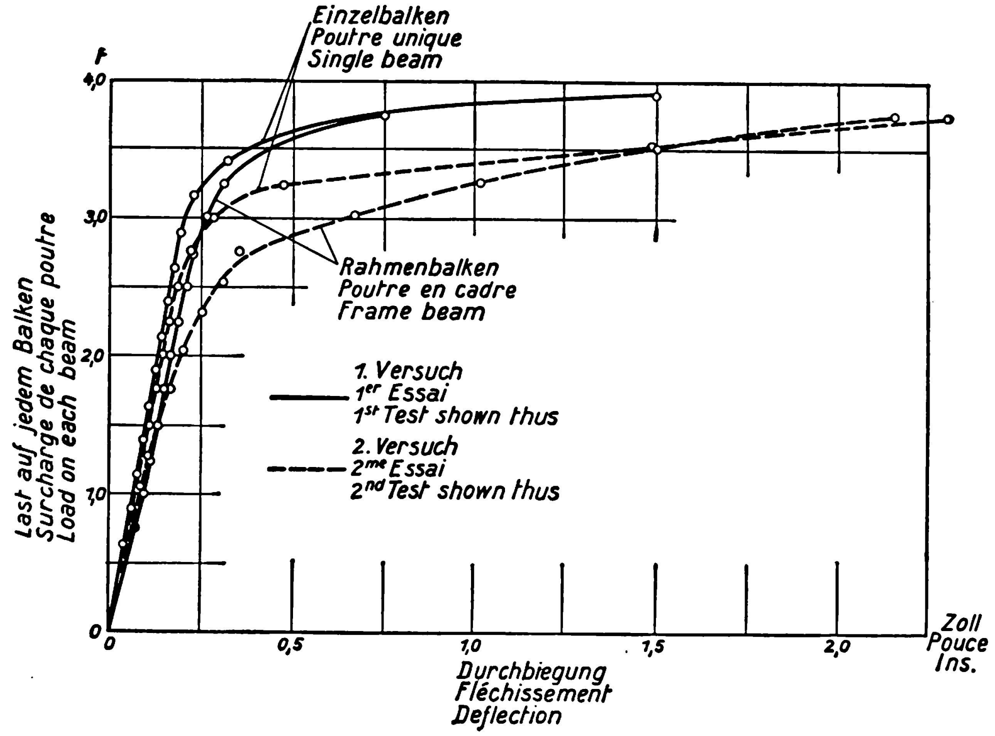
Einzelbalken
Poutre unique
Single beam
Rahmenbalken
Poutre en cadre
Frame beam
1. Versuch
1er Essai
1st Test shown thus
2. Versuch
2me Essai
2nd Test shown thus
Last auf jedem Balken
Surcharge de chaque poutre
Load on each beam
4,0
3,0
2,0
1,0
0
0
0,5
1,0
1,5
2,0
Zoll
Pouce
Ins.
Durchbiegung
Fléchissement
Deflection

Fig. 2.

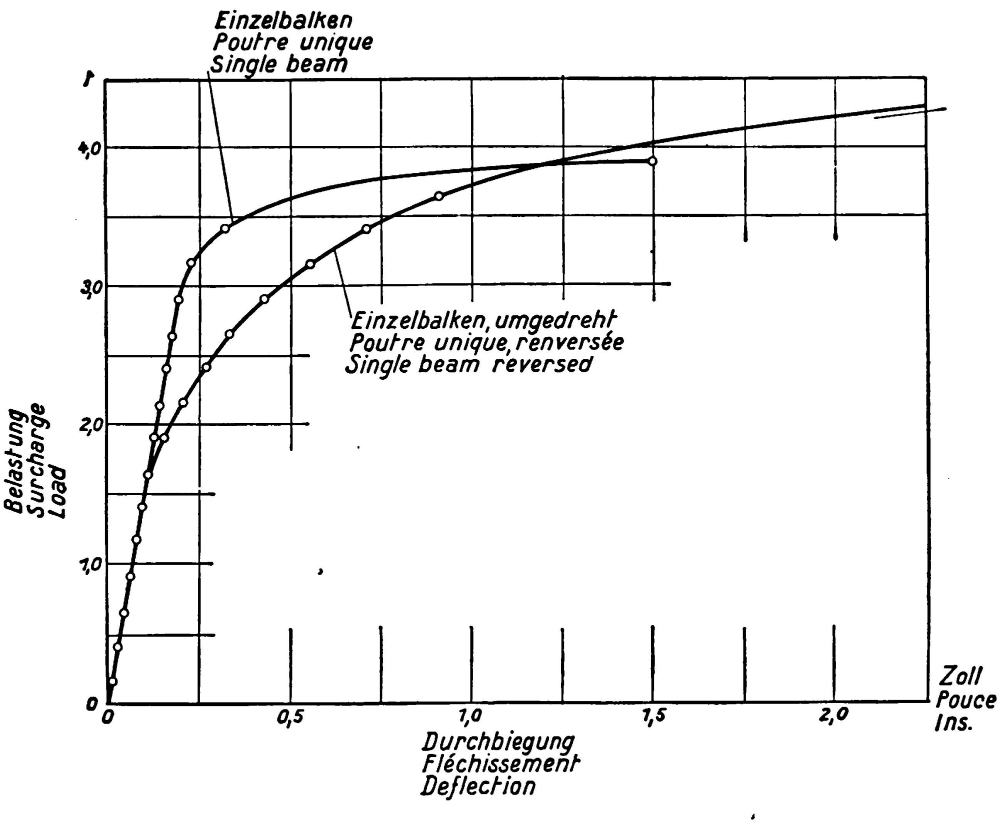
Einzelbalken
Poutre unique
Single beam
Einzelbalken, umgedreht
Poutre unique, renversée
Single beam reversed
Belastung
Surcharge
Load
4,0
3,0
2,0
1,0
0
0
0,5
1,0
1,5
2,0
Zoll
Pouce
Ins.
Durchbiegung
Fléchissement
Deflection

Fig. 3.

Figure 4 shows a photograph of the frame in elevation after removal from the testing machine in the second test, and Figure 5 shows a corresponding plan view.

The general form of the frame after test in the first test was very similar to this; but the total deformation was not quite so great because it was not possible to put any further load on the lever, nor would it have been safe to have allowed further movement to take place.

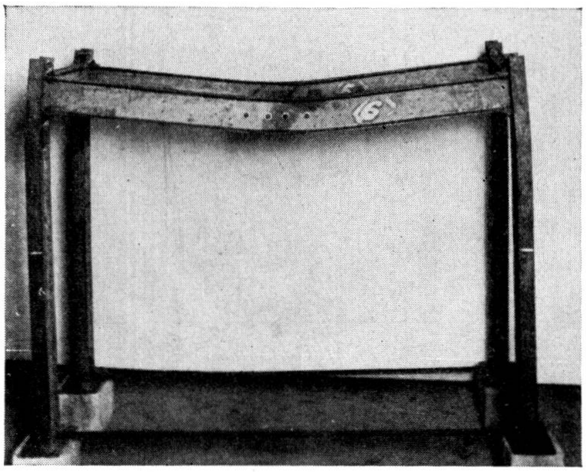

Fig. 4. Experimental steel frame after test.

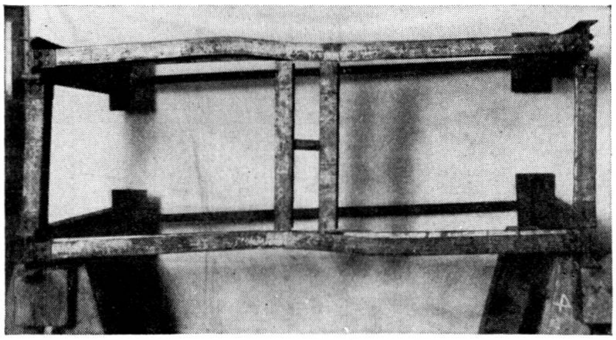

Fig. 5.

Examination of the frames after test showed that the angle cleats had apparently not been deformed and that the beam had been much more seriously over-stressed than the stanchion.

On the ordinarily accepted theory for the stresses in a portal frame, assuming rigid joints, the stress in the beams should have been considerably in excess of the stanchion; but on the approximate method of design employed in practice, both beams and stanchions should have been equally over-stressed. The maximum loads carried were as follows: —

	Test 1	Test 2
	Tons	Tons
Frame Beam	3.75	3.95
Single Beam	3.9	3.75

Taking as the load factor, the proportion between the load at failure and the design load, we obtain the following: —

	Test 1	Test 2
Load Factor of Frame	3.21	3.59
,, ,, ,, Beam	3.38	3.19

The similar figure for the load factor of the frame in Test 1 is probably accounted for by the fact already mentioned that the limit of loading of the machine had been reached and although the frame was clearly permanently deformed it might have taken a slightly higher load before actual failure.

Summary.

The Author studies the behaviour of two steel frame models if subjected to loads leading to destruction. The purpose of his investigations is to obtain a check on the usual methods of calculation. It is found that the actual behaviour does not tally with prevailing rules of calculation.

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