CHAPTER III

EXPERIMENTS ON SIMPLY SUPPORTED BEAMS

Preparation of simply supported beams

Beams were taken from rolled black mild steel and rolled brass in the "as received" condition. For ease of calculation, the beams were chosen to be rectangular in cross section of $\frac{1}{8}$ in by $\frac{1}{2}$ in. They needed no surface finishing at all and required straightening by hand only before being subjected to bending.

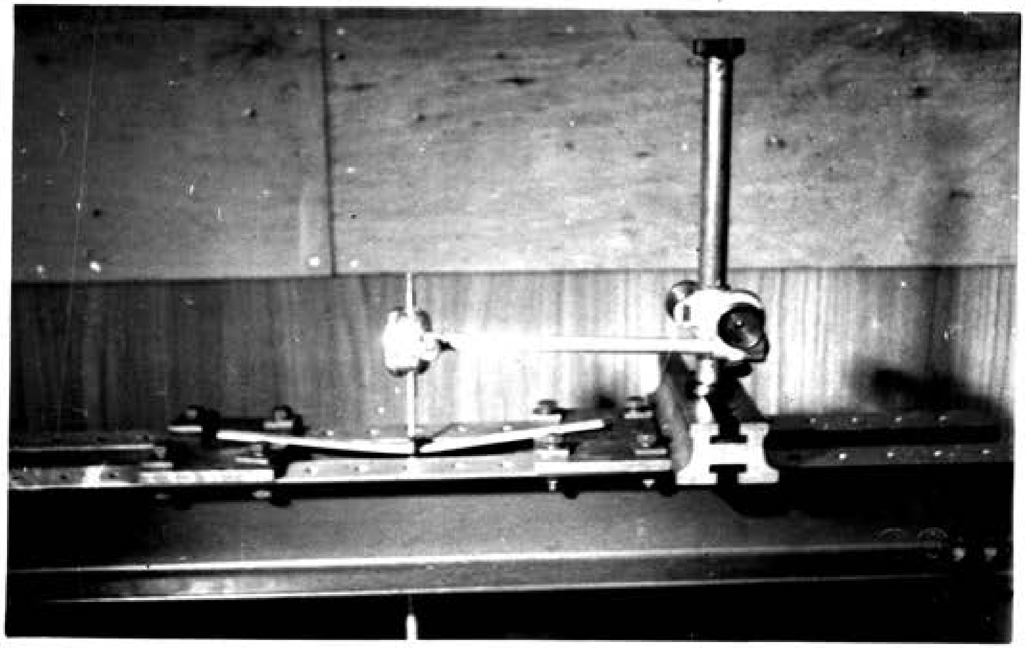


Fig. 3.1. - General arrangement of simply supported beam.

(The specimen shown is a brass beam).

Description of tests

Tests of the beams were on the test bench shown in Fig. 3.2. The test bench was designed to have a sufficiently high level so that dead loads could be used with great advantage and so that the effect of unloading could be avoided. The beams were placed between two $\frac{3}{8}$ in. plates of 8 in. clear span. Fig. 3.1 shows the general arrangement of a simply supported beam subjected to concentrated load at mid-span.

In the first stage of each test, load was added in increments of 5 lb. but increments were reduced later to 2 lb. The central deflexion was recorded by means of a dial gauge after the application of each load. After the plastic range had been reached as indicated by a certain amount of creep, the addition of each load increment was delayed until no dial gauge showed a rate of increase greater than 10^{-4} in per min. Loading was continued until a large increase of deflexion accompanied a small increase of load.

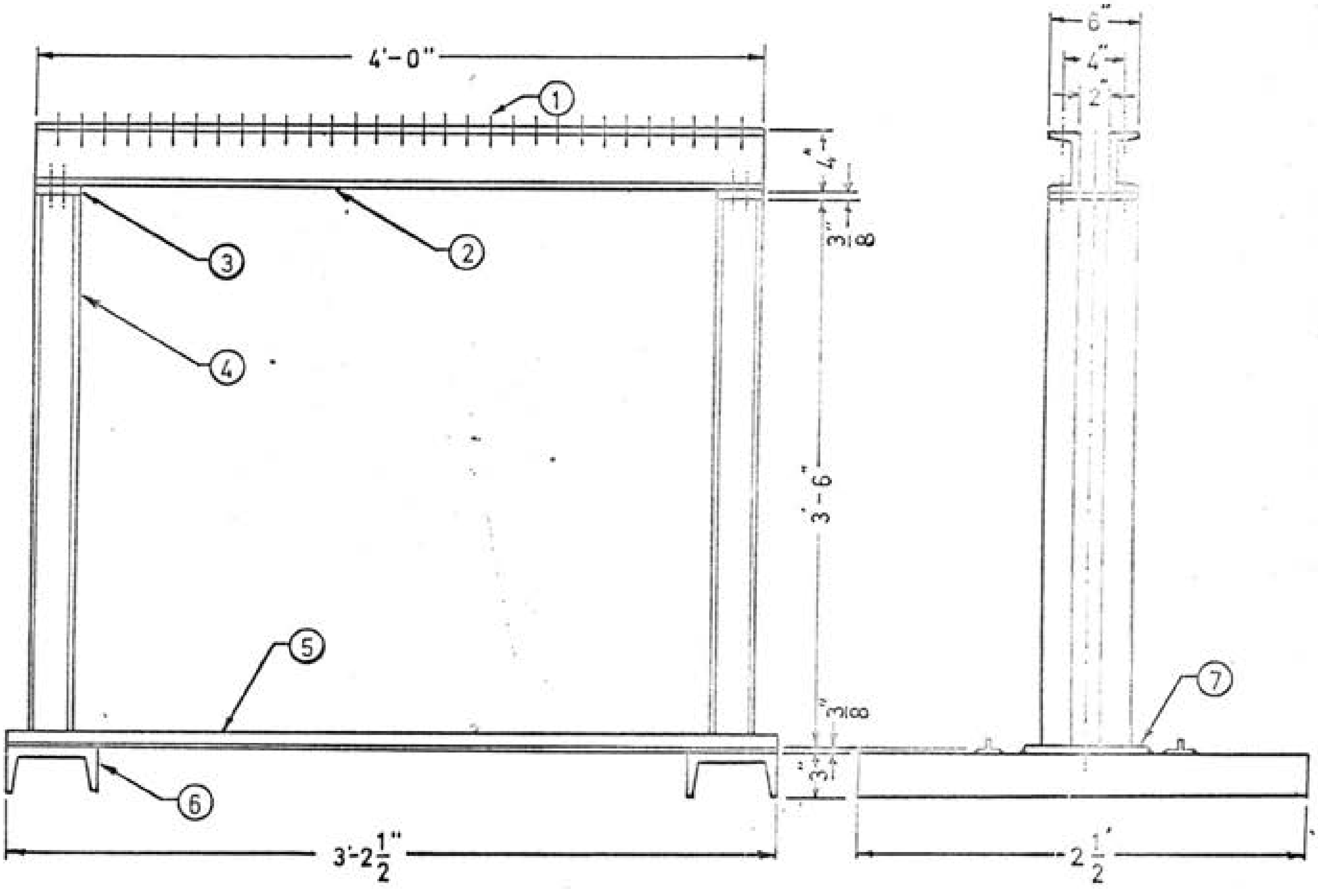
Discussion of results

Curves (a) and (b) in Fig. 3.4 illustrate the dimensionless relationship between moment and depth of elastic core of black mild steel and rolled brass respectively. The stress-strain curve of the former is represented in Fig. 2.3c in which the upper yield stress and strain hardening are not taken into consideration. Without these curves, the parameter used in calculating the central deflexion of simply-supported beams Eqns. (30) and (31) would not be available.

In the case of brass where the load and elongation are gradual, the stress-strain curve is approximately straight and is so represented by the two straight lines with $E = 13.9 \times 10^6$ psi., $\beta = 0.0121$ and $\sigma_0 = 45.2$ ksi. (see Fig. A1). These values were taken by tensile test from the Avery Testing Machine (Fig. A6). It is readily apparent from Fig. A1 that the represented yield stress σ_0, is very much higher than the 0.2 per cent proof stress. Therefore the calculated central-deflexion curve Eqn. (31) lies considerably above the experimental one.

For black mild steel, the actual stress-strain curves as obtained from the simple tensile test are shown in Figs. A2 to A5. All of them were recorded from specimens which had a nominal cross-sectional dimension of $\frac{1}{2}$ in. by $\frac{1}{8}$ in. and a gauge length of 8 in. The lower yield stresses vary from 41.63 to 50.10 ksi. With an 8 in. gauge length extensiometer and lever provided (magnification 20:1), the elastic modulus taken from the stress-strain curve in Fig. A2 is 25.2×10^6 psi. and the lower yield stress is 50.10 ksi. Since the elastic slope, due to insufficient strain magnification, is still very high. This causes the calculated central load-deflexion curve in the elastic range to deviate slightly from that obtained by the experiment. When the modulus of elasticity was corrected to satisfy the experimental value, the calculated curve in the range 42-47 lb. still lay below the experiment one. This may have been due to variation of yield stress which depends markedly on the strain rate and method of testing. Another factor may also have been neglect of the upper yield stress.

The central load-deflexion of the steel beam shown in Fig. 3.6, showed a marked collapse load and it will be seen that the strain hardening, as deduced from the tensile tests, does not start until the deflexion becomes very large.



ITEM	NAME	MAT.	SPEC.	QUANT.
1	Holes		$\frac{3}{8}$" dia. at $1\frac{1}{2}$ C.R.S	
2	Beams	Black mild steel	4" × 2" channel sections	2
3	Plates welded to stanchions	Black mild steel	$\frac{3}{8}$" thick × 3" wide × 6" long	2
4	Stanchions	Black mild steel	3" × $1\frac{1}{2}$" channel sections	4
5	Base fittings welded to bases	Black mild steel	1" × 1" I-sections	2
6	Bases	Black mild steel	6" × 3" channel sections	2
7	Plates welded to bases	Black mild steel	$\frac{3}{8}$" thick × 5" wide × 8" long	2

Fig. 3.2—Details of mild steel test bench.

Fig. 3.3.- The test bench and loads.

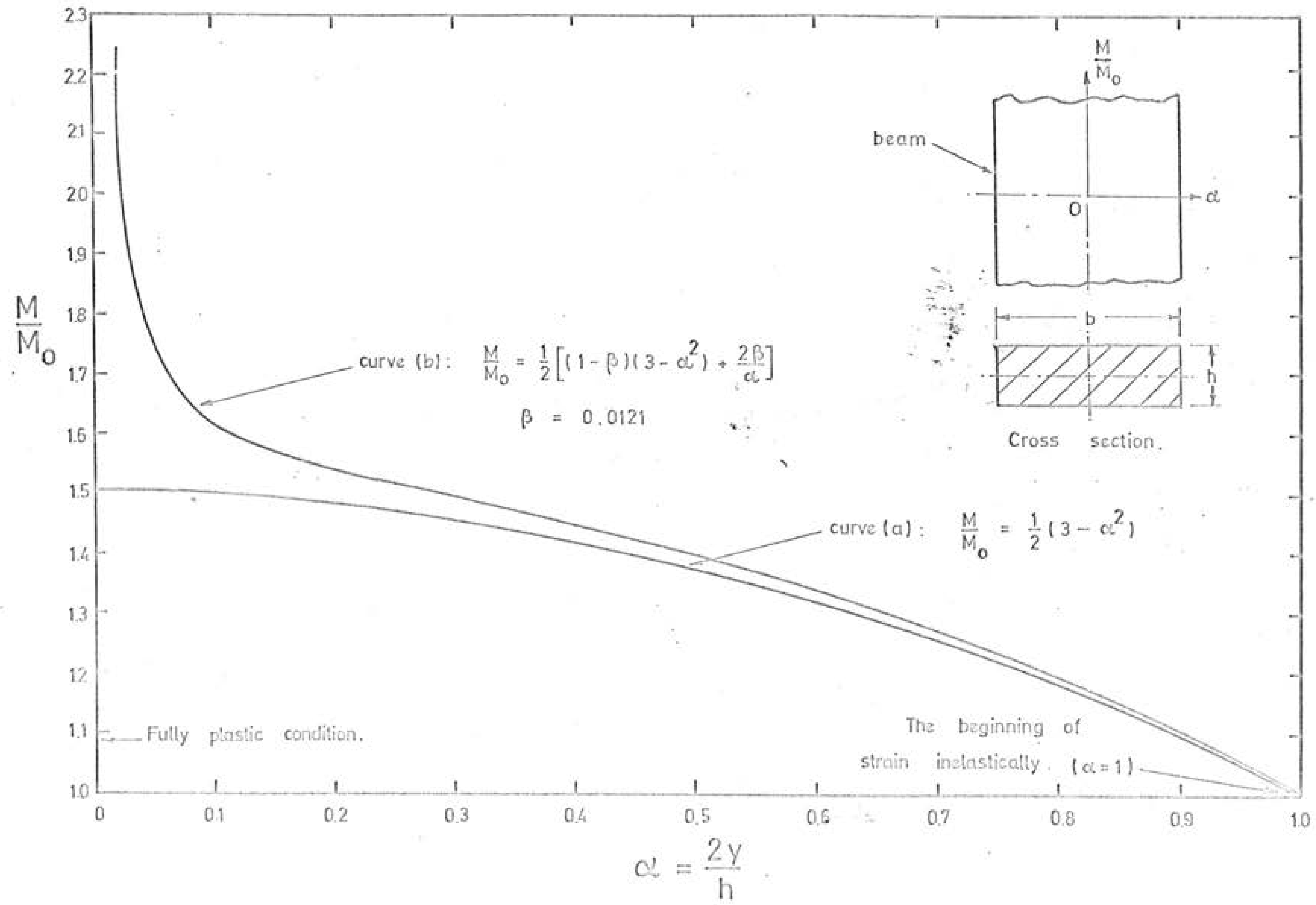


Fig. 3.4.— Dimensionless Moment – Depth of Elastic Core.

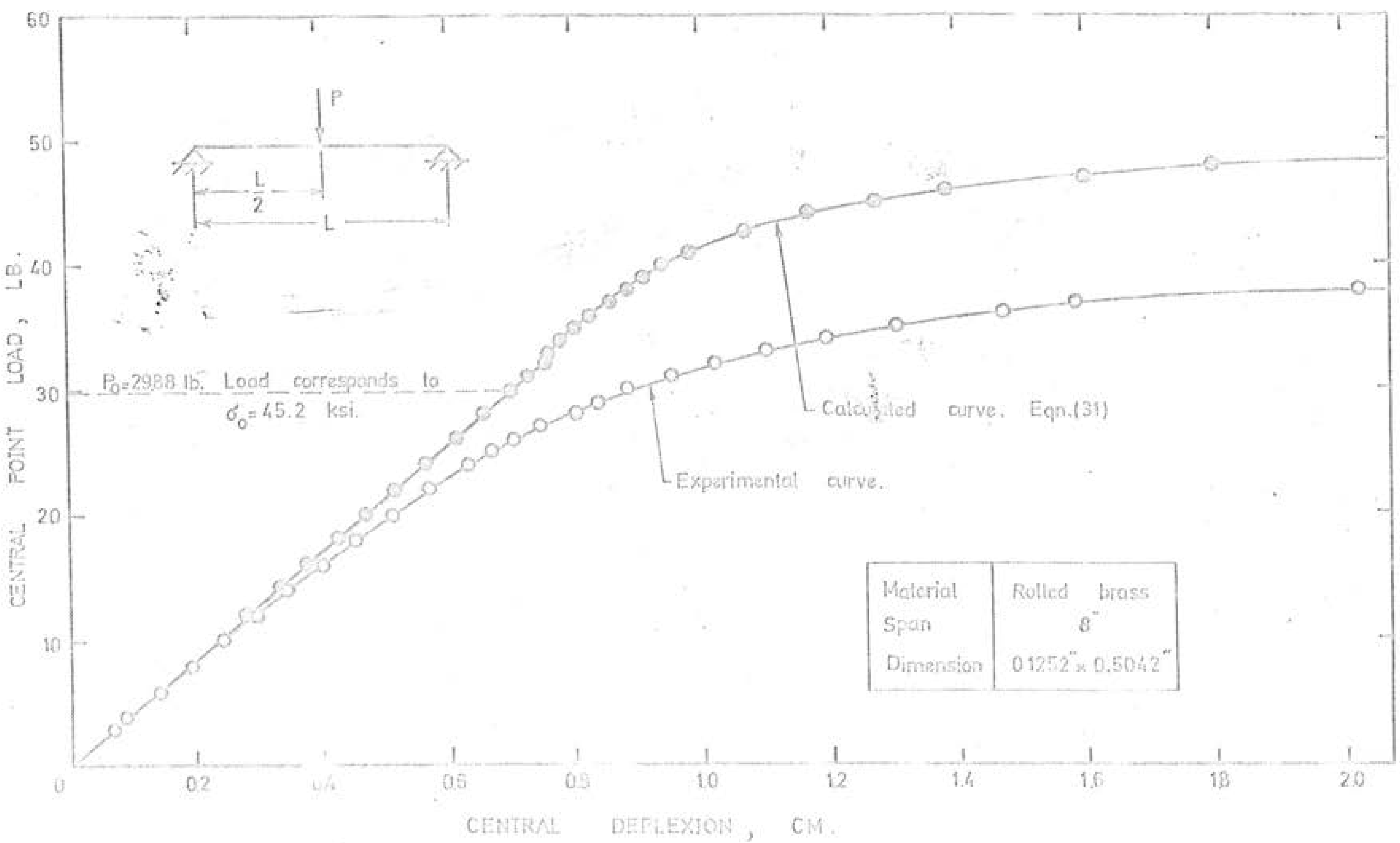


Fig. 3.5 — Central Load – Deflexion Curves of Brass Beam.

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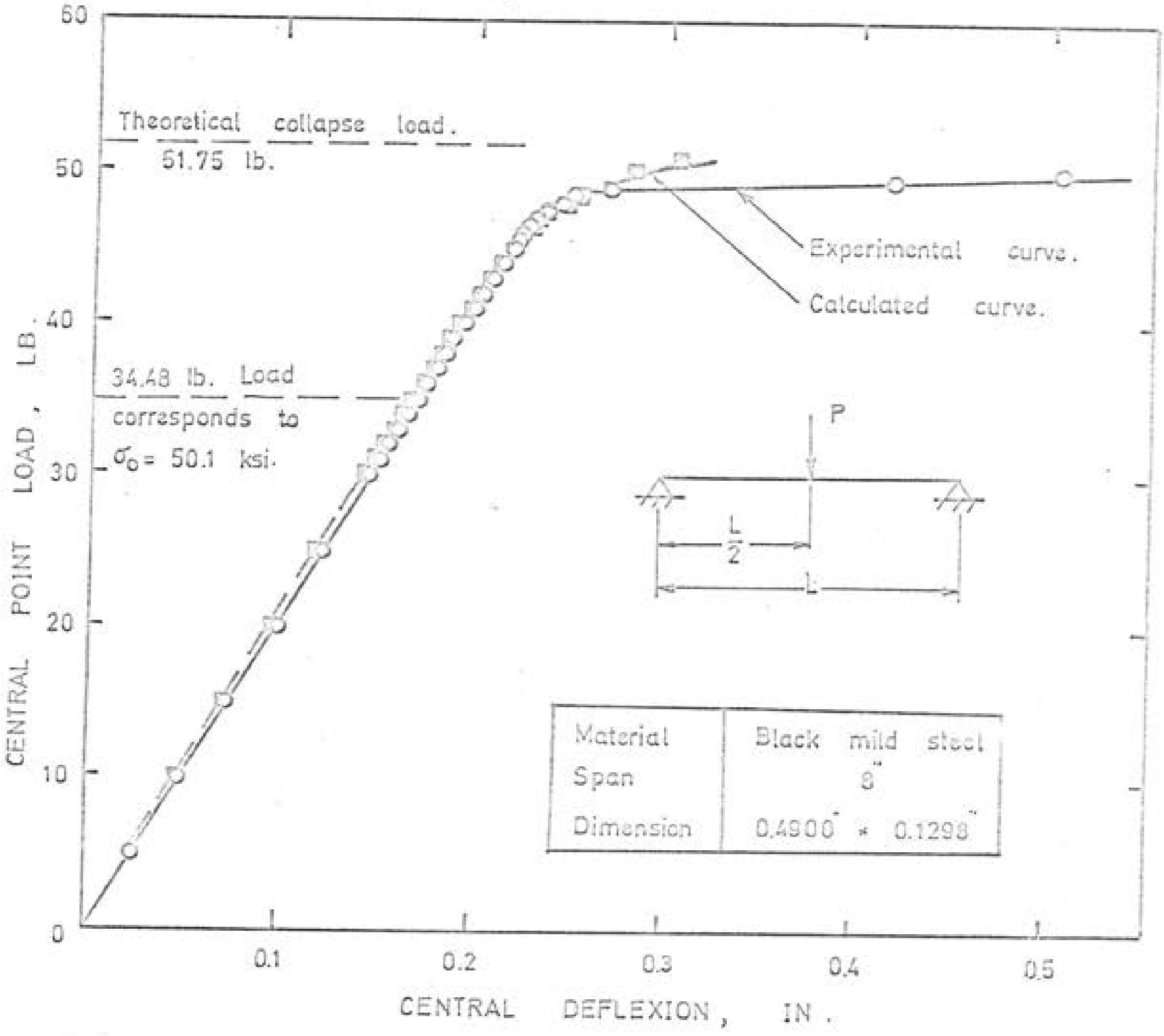

Fig. 3.6.— Central Load-Deflexion Curve of Black Mild Steel Beam.