equal time intervals apart. Evidently, as the time increases, the stresses in the fibres tend to give away, causing the curve to bend over during the latter part of the sweep up to the ultimate. Motion is extremely rapid, the time between two successive points being only 0.00167 second. The values of stress at the ultimate, the so-called modulus of rupture, computed according to the flexure formula, the modulus of elasticity, the energy consumed up to the ultimate, and the deflection to the ultimate are all tabulated in the summary of results below.

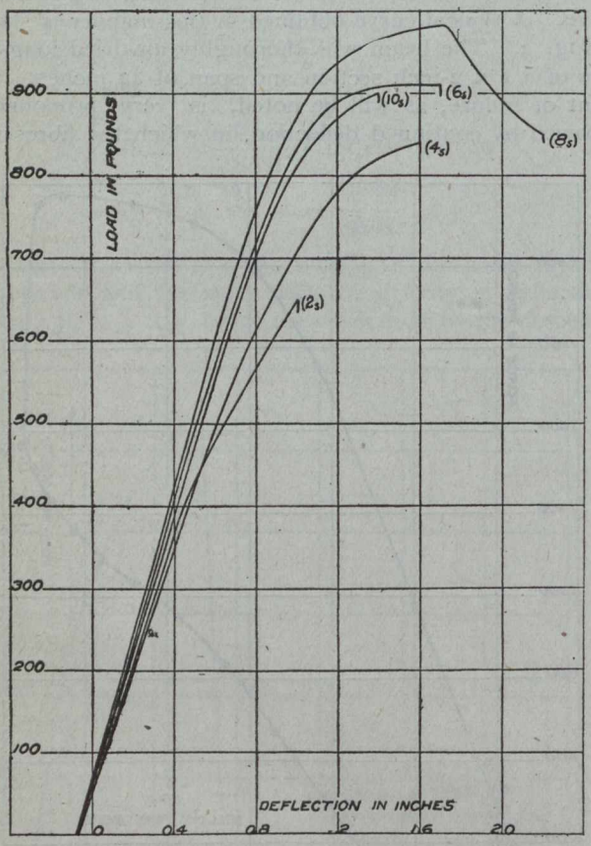


**Fig. 5.—Load-Deflection Curves for Douglas Fir Beams in Static Cross-bending**

The stresses found range from 10,000 lb./in.$^2$ to 22,000 lb./in.$^2$, values considerably in excess of those of ordinary cross-bending tests. The difference in moduli of elasticity is not quite so pronounced. The large values for stress may be due in part to selected material, but more probably to the nature of the loading itself.

### Summary

1. Fibre deformations in impact set up forces which overcome the kinetic energy of the tup and the kinetic energy acquired by the beam during the short impulse period immediately after initial contact.

2. By setting up a general energy-work equation for impact, differentiating, and dividing by the velocity, an expression for the effective force was obtained:

$$F = W_t + \left( W_t + \frac{17}{35} W_b \right) \frac{1}{g} \frac{d^2s}{dt^2}$$

3. Double differentiation of the time-deflection curve obtained autographically yielded the acceleration-time curve.

4. By substituting values of the acceleration from the acceleration-time curve in the equation for $F$ and plotting against the corresponding deflections from the deflection-time curve, force-deflection curves for impact were obtained.

5. From a series of force-deflection curves for six beams of Douglas fir broken under a single blow and five beams broken in static cross-bending, all beams being cut from the same piece of timber, the following conclusions were drawn:

(*a*) The impact fibre stresses are almost double the slow bending stresses, at rupture.

(*b*) The energy of rupture in impact up to the ultimate load is twice that of static bending.

(*c*) The deflection at the ultimate load and the modulus of elasticity are about one-fourth higher for impact than the corresponding properties under static loading.

6. The mechanical properties of long-leaf yellow pine and spruce are higher in impact than the average values for the same properties in static bending.

7. The energy available is practically entirely consumed by the beam, supporting the contention that very little energy is lost in vibrations of the machine frame.

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## METROPOLITAN DISTRICTS FOR PLANNING AND ADMINISTRATION*

*(Continued from page 156.)*

Canada has not been backward in this respect. Two important districts have been formed in the Dominion, one for the purpose of a metropolitan water-supply and the other for the purpose of constructing district sewerage works. The Winnipeg Water District was formed in 1913, to bring a supply of water from Shoal Lake for Winnipeg and the surrounding territory, with an area of 92 square miles and a population of 238,000. The Greater Vancouver Sewerage District was organized in 1913 for the construction and maintenance of the necessary intercepting sewers and sewage disposal plants needed in the urban territory around Vancouver and the city itself, including 5 municipalities, covering an area of 90 square miles, with a population of over 150,000 in 1911.

Many variations have been worked out in the methods of dividing costs of such systems, but most of them may be classed either under general taxation, special assessment, or rates based upon quantity of service. It is desirable that the methods shall not be specified too definitely in the preliminary legislation, as much more satisfactory results can be worked out after the details of the project have been largely determined. The change of the methods of apportionment of the charges for the various services in the Boston Metropolitan District is an illustration of the growth of public opinion as to desirable means of payment. It is always possible in any case, however, to work out a method which will be equitable and which will give service to each community involved, at a cost far below that which could be attained by independent action.

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The South African Government Railway Administration has ordered twenty superheater mountain type locomotives from the American Locomotive Company.

It is reported from France that the Société des Mines de la Loire has recently started its first of two electric furnaces for the production of iron, utilizing current from its own generating station.