the top of the beam and the neutral axis from the top of the beam, thus causing an error in the strain indications for the extreme fibres. Correct results could be obtained by supporting the extensometers on the top and attaching them on the sides of the beam in the plane of the steel. Another set of extensometers might be attached to the sides with the lower screws in the plane of the steel and the others midway between the theoretical position of the neutral axis and the top of the beam.

[It will be noticed that in the above article Mr. Scott gives Professor Talbot credit for being the first to state that curve representing the stress-strain relation follows closely the parabola.—Ed.]

FOREST SURVEY METHODS.*

By A. H. D. Ross, M.A., M.F., Faculty of Forestry, University of Toronto.

A complete Forest Survey includes (1)A more or less accurate plane and topographic survey of the tract under examination; (2) A careful estimate of the amount of timber upon it; (3) A determination of the rate at which the timber is growing, and (4) A study of the conditions of light, moisture, soil and other factors which influence both the present and the future condition of the forest crop.

Degree of Accuracy Required.

The accuracy of the methods employed to bring together information of this sort will, of necessity, be determined by (1) The use that is to be made of it, and (2) The time and money allowed for the collection of the necessary data. For example, if a woodsman is given a month to look over a township and is required to bring in a report on the amount of standing timber, and the cost of logging it without regard to the conditions most favorable for the securing of another crop from the cut-over area, his report will deal almost entirely with the amount of lumber that is likely to be obtained and the cost of logging it per thousand feet, board measure. It will say very little, if anything, about the leaving of seed trees to fill with their progeny the openings made in the forest by the loggers; the age, density and condition of the seedlings which have already established themselves; the precautions necessary to protect the seedlings from destruction by fire and browsing animals; the effect of opening up the forest upon the trees that remain, as regards liability to windfall and increased rate of growth; the effect of leaving undesirable species in possession of the soil; and other matters that must be considered when it is proposed to prevent the destruction of our rapidly diminishing forested areas.

If, however, it is proposed to diminish the possible revenue that may be obtained by the present destructive methods of lumbering, and to so manage the woodlands that they will always regulate the flow of water in the streams and yield a perpetual supply of timber, it will be necessary to establish permanent roads for the removal of forest products and the protection of the growing stock from fire. It will also be necessary to know exactly the amount of growing stock, and the rate at which it is increasing, so that it may not be removed at a faster rate than it is being replaced. To lay out roads to the best advantage, whether for destructive lumbering or for the purpose of deriving a sustained yield, it is necessary to have exact information regarding the topography of the tract, and before it is possible to put it under proper management it is necessary to know its sylvicultural condition. Thus it appears that the forest engineer who would make a complete survey of a tract of timber must be familiar with the methods of plane and topographic surveying, so that he may properly mark the boundaries of his timberland and prepare an accurate map showing the size and location of the various ridges, gullies, swamps, lakes, streams and other topographical features that will determine the location and character of the necessary roads, dams, bridges, etc. He must also be able to estimate the amount of standing timber and know how to make accurate studies of its rate of growth. Without this information he would not know how much timber it would be safe to remove at each cutting, without diminishing the value of the property.

From this it will be seen that the essential difference between a forester and an old-time lumberman is that one makes provision for the production of future crops, the other does not. Heretofore, it has not been considered necessary to make such provision, but the truth is rapidly being forced home upon us that if we are wise in our day and generation we must speedily correct the error of our ways and make a determined effort to get our forest areas managed in a less suicidal manner than in times past.

Topographic Methods.

In a rough way every logger is his own topographer, and has acquired his knowledge by cruising, but unfortunately it is apt to be inaccurate, is easily forgotten, and cannot be transferred to his successor, who has to acquire his knowledge of the locality all over again. Thus, to the man who directs the conduct of a large business from a central point, an accurate map showing the topography of the tract is simply invaluable, because its topography very largely determines the course of all woods work. The essential features of such a map are that it clearly indicates

Recording Measurements for a Growth Study of Aspens.

the positions of ridges and streams, the shape and steepness of slopes, the areas of valleys and lakes, and the grade of roads that it may be necessary to build.

Methods of Collecting Data.

The method of securing the necessary data for such a map is somewhat as follows:—

From points of known elevation, along railways, etc., a line of levels is run to the ponds and other suitable places well distributed throughout the township to be surveyed. From the places whose heights above sea level are thus determined, it is customary to work out with aneroid barometers, which give the approximate elevations with sufficient accuracy for all kinds of woods work. In determining the grades of roads which it may be desirable to build, it is found that any Abney clinometer is much lighter, quicker and almost as serviceable as a land level. Usually the land is blocked out into mile squares, and easily found marks are made every quarter of a mile. These marks serve as starting points for the examination of the interior of any given "forty" (see Estimation of Timber on Forty Acre Squares), and enable the cruisers to locate themselves quite accurately on a line by pacing. With practice, measurements by pacing can be made much more accurately than would be supposed. Steps taken to get round obstacles are

* Part of an address delivered at Montreal.