FACTORS TO BE CONSIDERED IN TESTING STRUCTURAL TIMBERS

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Too much emphasis cannot be placed on the importance of standard procedure in making strength tests on structural timbers. This article enumerates the more important factors that should be considered in any series of tests on structural timbers whether new or old with the hope that future tests will be conducted according to standard procedure, so as to obtain results that can be compared with those of other investigators without danger of arriving at totally unjustifiable conclusions. The need for standard procedure is fully demonstrated by the lack of uniformity in early as well as more recent tests made on structural timbers by various investigators in the United States. In recent years several series of tests have been made on structural timbers that have been removed from old buildings and bridges in the process of rebuilding. The diversified methods used in testing and the lack of appreciation of the effect of a number of factors of importance has resulted in data of questionable value.

The standard procedure[2] now followed and advocated by the Forest Products Laboratory, U. S. Department of Agriculture, Forest Service, in testing large structural timbers has been essentially the same for the past 25 years. This method calls for third-point loading, which consists in loading the beam at two points one-third the span length from each support. The beams are usually tested over a 15-foot span.

The center loading method, which has been used by some investigators, results in giving less influence to injurious defects, such as knots and cross grain, and does not bring horizontal shear into play, as does the third-point loading method, which approximates more nearly practical loading conditions. For this reason, strength tests made by the center loading method give considerably higher results than by the third-point method.

The effect of defects, such as knots and cross grain, on strength has been fairly well established and recognized in the basic

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[2] Standard Methods of Conducting Static Tests of Timbers in Structural Sizes, American Society for Testing Materials, Standards for 1927, Part II, p. 664.

grading rules and working stresses advocated by the Forest Products Laboratory, the American Railway Engineering Association, and the American Society for Testing Materials. Fully as important as the actual presence of the defects themselves is their size, number, and location in the piece. Obviously, defects will have their greatest effect when at points of maximum stress. In a beam tested under center loading, the maximum stress in bending occurs at the center. Defects would have their maximum effect at the center of the length on the bottom face and also on the lower edges of the vertical faces of the beam. If the defects were located toward the neutral axis and toward the ends, their effect would diminish. Under third-point load, defects would have the maximum effect in the lower surface and edges anywhere between the loads. It is evident that with center loading the full influence of defects within the middle third of a beam is not obtained.

Careful attention must also be given to such factors as speed of test and kind of bearings at supports and load points. Tests have shown that multiplying or dividing the rate of application of the load by 10 raises or lowers the strength by approximately 10 percent. The bearings at the load points require special attention in order to prevent premature compression failure both along and across the grain. This is taken care of in the standard procedure by distributing the load through special bearing plates and curved blocks. In the case of center loading, the standard bearings result in a calculated bending moment that is higher than the moment actually developed.

With third-point loading the calculated moment is developed in the central portion of the beam in spite of the distributing effect of the load blocks.

Size is another important consideration in tests of structural timbers. The smaller the timber the higher the stresses developed and the less the influence of seasoning checks. Consequently, it is evident that in order to obtain a true measure of the effect of seasoning checks and of the magnitude of stresses developed in structural timbers in service, it is necessary to adhere largely to a single size of timber for comparison.

It is, of course, well known that the moisture content of wood has a tremendous effect on the strength of small clear pieces. In structural sizes, however, the development of defects tends to offset any increase in fiber strength that may take place as a result of a reduction in moisture content. Furthermore, structural timbers, even after air seasoning for 1 to 2 years, are only partially dry. The outer shell may be somewhat near an air-dry condition, but the moisture content increases from this point to a practically green condition at the center. This unequal distribution of moisture content in most species used for structural timbers causes a progressive failure and appears to be one of the large factors that prevent so-called air-dry timbers from showing any higher strength than green timbers. After many years of seasoning, structural timbers will assume a more nearly uniform moisture content throughout, and, with the exception of additional weakening due to defects, whose effect may be largely missed in testing with center loading, would be expected to increase in strength much as do small clear pieces.

The impression should not be gained that standard procedure alone is a panacea for all ills in timber testing. As a general rule, any series of tests to determine the influence of such factors as age, preservative treatments, and seasoning require similar tests of control specimens, either full sized or small clear, as a basis for comparison. Furthermore, since all grading rules take into account certain practical conditions which do not give careful consideration to such factors as density, exact size of timber, and exact size and location of defects, to merely grade the timbers proves relatively ineffective from the standpoint of careful analysis of the data.

In other words, it is highly essential that none of the details, such as average moisture content, moisture distribution, and size, number, and location of defects, referred to in the American Society for Testing Materials Standards be overlooked or slighted in any way if results of any significant value are to be obtained. Careful analysis should also be made of the data to see that none of the factors that affect the strength of structural timbers have been overlooked or misinterpreted.