Introduction

Lumber products represent about one-half of the quantity of timber removed annually from the forests, and of this about three-fifths is used for building and construction. Because of the enormous amount of material involved and the variety of use requirements, research in building and construction offers not only one of the most extensive fields, but also an almost unlimited opportunity for effecting economy and improved practices. There is the further assurance that even small savings and economies when projected percentage-wise in such a large use area result in enormous aggregate dividends.

In reviewing broadly some of the important research needs, we can start with the assurance that while wood was among the first structural materials in the primitive world, it still maintains an indispensable place in the modern age. It should be kept in mind also that during the unprecedented abundance of the timber mining period, lumber was used lavishly and in better grades than necessary. Often high-class specialty species found their way to commonplace uses. Lumber economy was neither practiced nor deemed necessary. As we face the timber crop era, more of the lumber must come from smaller trees and greater proportions of lower grades will be produced. These factors must be reconciled further with increased production and material costs, which brings wood into a sharper competitive focus with other materials than has heretofore been experienced. The obvious conclusion is that wood utilization in the future must depend more and more on the true value of the product as established by exact information and modernized practices, and that wood must be used with entirely new concepts of economy. These problems suggest an increasing dependence on research with like increasing emphasis on basic research. This trend toward a new economy in structural utilization is fundamental to profitable use and profitable use is essential to a profitable forest crop.

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Four factors inherent with wood greatly complicate and diversify the needed research as compared with other materials. These are the great number of species, the variability within species, the moisture effect, and the orthotropic structure. They contribute to an almost endless variety of research problems that may challenge the entire effort of all available research agencies for an indefinite period.

Research Needs and Opportunities

Research on wood and plywood as structural materials may be discussed under three broad classes, as follows:

(1) Composition and Properties

Basic research on the properties and variation in properties of all species is fundamental to their intelligent use. Factors affecting strength provide another comprehensive research area, including some major problems, such as strength-temperature relations on which but little data are available. Included also are studies of the effect on properties of moisture, defects, rate of loading, duration of stress, preservative treatment, fire-retarding treatment, synthetic resin treatment, acetylation, kiln-drying methods, stress concentrations, and length of service.

The plywood problem and the basic sandwich problem provide extensive fields for fundamental research.

Still another area with unlimited opportunity for fundamental research of importance in the structural field is that relating to the plastic behavior of wood. This involves the theoretical concept of plastic flow and yield, and has practical applications in the analysis of sag in beams and camber in truss design.

The fundamental properties, which include the three moduli of rigidity and the six Poisson’s ratios, have been but little studied. Data are needed not only on the actual average properties on different species, but also on the influence of density and moisture content.

Perhaps newest of the fundamental research fields is that relating to the application and use of sonic methods, both in the evaluation of properties, and in the inspection of glued material and sandwich constructions.

(2) New and Improved Products and Designs

Joints and fastenings have always been the weakest link in timber structures, and have been a factor in limiting wood applications. Although much has been accomplished in the study of joints and fastenings, the problem is so important and has so many variables, that much further attention is essential. Detail studies involve the relative efficiency of different kinds of nails with various species, under various and varying moisture conditions of the
wood; also the influence of the nail surface, the form of shank and type of point. Roofing nails are another special problem, with the need of particular consideration to the cause of loosening and working out under exposure conditions.

Laminated construction, which proved invaluable for wartime building construction, and which has already received considerable study, still has many details requiring further research. A major problem relates to the use, number, and placement of butt joints in relation to the thickness of lamination and size of member. Needed also are methods of determining the effectiveness of gluing, as an inspection procedure.

The design and strength of structural elements, including built-up joints, girders, and trusses presents another important research field. Combinations of wood, plywood, and sandwich constructions, employing nails, bolts, connectors, or glued fastenings offer numerous variations for consideration.

Turning to buildings, there is another group of challenging technical research problems, some bordering on the intangible, but nevertheless crying for solution. Of these, none are more important from the standpoint of economy of labor and material than the group which may be classified as "minimum requirements" for small buildings. How stiff must a floor be in a home? How far can one economize in material for conventional house framing with respect to size and spacing of members? What floor, wind, and snow loads are reasonable for design of houses? To what extent can low grades be employed? New construction systems and improvements in construction details offer other opportunities.

(3) Application to Processes and Uses

Among the major problems worthy of mature consideration because of the opportunities for improvement in marketing practice is the possibility of converting dimension grades of lumber to structural grades. It is common knowledge that large portions of the present dimension grades are used for structural purposes, yet when allowable stresses are based on grade descriptions the stresses are extremely low. There appears to be a possibility of basing dimension grades on structural features, thereby greatly increasing the allowable working stresses, and the value of the lumber, without limiting its utility. The following example is a case in point:

One association has found that in its present No. 1 grade, the allowable bending stress for 2 by 4 is 570 pounds per square inch, and for 2 by 10 is 870 pounds per square inch. In the No. 2 grade, the allowable bending stress for all sizes was 660 pounds per square inch. By regrading, according to the principles of the Forest Products Laboratory supplement to USDA Miscel. Pub. No. 185, it was found that 50 percent of the No. 1 and No. 2 Common would be acceptable for a stress of 1,000 pounds per square inch, greatly increasing the utility and value of the material for purposes where strength is required. Of even greater significance is the fact that dimension graded on these principles can be used with assurance structurally, and still serve for other general utility purposes.

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Building codes frequently are restrictive and call for certain sizes and constructions. There is a great opportunity for the development of factual data to establish performance requirements as a criterion for the acceptability of a construction, thus permitting opportunity for new developments. Recently established by the ASTM is a new committee to develop methods of testing building constructions.

Another group of problems relates to the development of methods of selecting structural material of a species, with the thought of giving full recognition to the inherent properties, rather than penalizing the better than average material by employing it at the level of the lower density stock which controls the grade or limits the use.

Structural material used in exposed locations subject to decay generally requires inspection at intervals to determine its condition, and to establish the necessity of replacement. Present practice in deciding on the necessity of replacement is largely based on experience and judgment. Scientific study should be made to determine the feasibility of developing inspection aids which would be of material assistance in establishing more accurately the replacement need, and in this way contribute to increased safety and possible economy.

These problems represent but a few of the many on which research could be profitably directed in the field of structural applications. They should hence be regarded as only illustrative of an extensive research area, rather than as a comprehensive compilation or catalog of research projects.