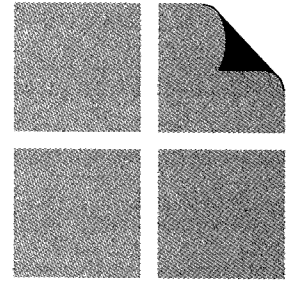


**1997 Edition**



**C O M M E N T A R Y**

**N D S<sup>®</sup>**

**NATIONAL DESIGN SPECIFICATION<sup>®</sup>**

**F O R W O O D C O N S T R U C T I O N**

This Commentary and its Addendum were prepared for the American Forest & Paper Association by Edward G. King, Jr., Wood Construction Technologies, Inc., McLean, Virginia. He was Director and Assistant Vice President of Technical Programs for the Association from 1970 to 1987. Technical information for Part V of the Commentary was contributed by Thomas E. Brassell, P.E., technical advisor and consultant to the glued laminated timber industry since 1960. Design examples were prepared by Clifford G. King, Wood Construction Technologies, Inc.

# COMMENTARY ON THE NATIONAL DESIGN SPECIFICATION FOR Wood Construction

## FOREWORD

The National Design Specification<sup>®</sup> for Wood Construction (NDS<sup>®</sup>) was first issued in 1944 as the National Design Specification for Stress-Grade Lumber and Its Fastenings. In 1977 the title of the Specification was changed to its present form. The 1991 edition is the eleventh edition and sixteenth revision of the publication. The history of the development of this national standard of practice is given in a subsequent section.

For many years, a commentary on the Specification has been requested by architects, engineers, product manufacturers, researchers and other users. As the demand for more efficient and more reliable wood structures has grown, calls for background information and interpretative discussion of the provisions of the Specification have increased commensurately. The Commentary presented herein is intended to respond to these user needs.

The Commentary follows the same subject matter organization as the Specification itself. Discussion of a particular provision in the Specification is identified in the Commentary by the same section or subsection number assigned to that provision in the Specification. The Commentary on each provision addressed consists of one or more of the following: background, interpretation and example. Information presented under background is intended to give the reader an understanding of the data and/or experience on which the provision is based. References containing more detailed information on the subject are included. Interpretative discussion of how a provision should be applied is given where users have suggested the intent of a requirement is ambiguous. One or more examples of the application of a specific provision may be given to illustrate the scope of conditions covered by the requirement. The examples are not meant to be inclusive of all design considerations for a given application, but are intended to illustrate the provisions being discussed in that particular section of the Commentary.

Only those provisions of the Specification whose application by the user would benefit from elaboration of background and interpretation are addressed in the Commentary. Provisions of a self-explanatory nature are omitted.

Inquiries, comments and suggestions from the readers of this document are invited.

American Forest & Paper Association



## **FOREWORD to the Addendum**

The Addendum provides commentary on changes that have been made in the 1997 Edition of the *National Design Specification for Wood Construction* since the last edition was published in 1991.

In addition to providing background and interpretative information on new or revised provisions, the Addendum includes discussion of other requirements in the Specification that user inquiries have identified as needing further clarification.

The comprehensive 1991 *NDS Commentary* is applicable to the 1997 Edition of the Specification except where superseded by this Addendum.

American Forest & Paper Association



# COMMENTARY ON THE NATIONAL DESIGN SPECIFICATION FOR WOOD CONSTRUCTION

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## **HISTORY OF THE DEVELOPMENT OF A NATIONAL STANDARD OF PRACTICE FOR WOOD DESIGN**

### **Non-Uniform Local Practices**

In the early part of the century, structural design with wood was based on general engineering principles using working stresses or design values published in engineering handbooks and in local building codes. These design values were often not in agreement, even for the same species of wood. Further, in most cases, the assigned values were not related to lumber grade or quality level (193).

### **First Uniform Working Stresses**

To meet the growing need for a national standard of practice, the Forest Products Laboratory, an agency of the Forest Service, U.S. Department of Agriculture, in cooperation with the National Lumber Manufacturers Association (now the American Forest & Paper Association), prepared a guide for grading and determining working stresses for structural grades of timber (60). This guide was issued in 1933 and subsequently published as U.S. Department of Agriculture Miscellaneous Publication 185, "Guide to the grading of structural timbers and the determination of working stresses" (207). It provided basic working stresses for clear, straight-grained material of the important commercial species and presented strength ratios for adjusting basic strength values for the effect of any size and location of knots or other natural characteristics permitted in a structural grade. The basic stresses and the strength ratios established in Miscellaneous Publication 185 were based on extensive test data for small, clear specimens and structural timbers obtained from over twenty years of testing and evaluation at the Forest Products Laboratory. The procedures of Miscellaneous Publication 185 were employed by the lumber industry to establish working stresses for the commercially important species and grades of lumber manufactured in accordance with American Lumber Standards for Softwood Lumber, Simplified Practice Recommendation R16-29 and R16-39, promulgated by the U.S. Department of Commerce (60,188,193).

### **Wood Structural Design Data**

In 1934, the National Lumber Manufacturers Association (now the American Forest & Paper Association) assembled the information given in Miscellaneous Publication 185 and working stresses derived therefrom together with engineering design equations and other technical information on wood in the publication "Wood Structural Design Data" (WSDD) (127). Included as supplements to the publication was design information for timber fastenings. The information contained in this publication was based largely on information developed over the years at the Forest Products Laboratory and subsequently published under one cover as the first edition of the "Wood Handbook" in 1935 (57). A major component of the WSDD was extensive span and load tables for various sizes of timber beams and columns. A second edition of the WSDD was issued in 1939 with a revised second edition being issued in 1941 (127).

## **First Edition of National Design Specification**

With the initiation of World War II, the need for a comprehensive national design standard for timber structures, including wood connections, became more urgent. The Technical Advisory Committee of the National Lumber Manufacturers Association undertook a more than three year effort to develop the necessary specification in close consultation with the Forest Products Laboratory (128). The first result of this initiative was the issuance of "National Emergency Specification for the Design, Fabrication and Erection of Stress Grade Lumber and Its Fastenings in Buildings", Directive 29, by the Conservation Division, War Production Board in August 1943 (194). The Directive was prescribed for all federal departments and agencies involved in war construction. In 1944, the copyrighted first edition of the "National Design Specification for Stress-Grade Lumber and Its Fastenings" was published by the National Lumber Manufacturers Association (128). The Specification, which had the same content as Directive 29, included allowable unit stresses for stress graded lumber, design formulas, and design loads and provisions for timber connector, bolted, lag screw, nail and wood screw joints. Also included were guidelines for the design of glued laminated structural members.

Revisions of the 1944 edition of the Specification were issued in 1948, 1950, 1951, 1952 and 1953. New editions were published in 1957, 1960, 1962, 1968, 1971, 1973, 1977, 1982, 1986 and 1991. The 1968 edition was the first published under the Association's new name, the National Forest Products Association (NFPA). In 1993, NFPA merged with the American Paper Institute to form the American Forest & Paper Association (AFPA).

The scope of the Specification has remained essentially unchanged since the first edition was issued in 1944. Information on machine stress rated lumber and timber piles was introduced into the 1971 edition and expanded in the 1973 edition. The name of the Specification was changed to the "National Design Specification for Wood Construction" in the 1977 edition (123).

## **Use of ASTM Standards**

As indicated by the early history of structural design with wood, wood strength properties or design values are an essential component of a national standard of practice. The material design values incorporated in the National Design Specification are those developed by the rules writing agencies or wood product interest involved. Whereas the authoritative source of the procedures used by these organizations to establish design values prior to World War II was the U.S. Department of Agriculture's Forest Products Laboratory, in the years following the war the standards of the American Society for Testing and Materials (ASTM) began to be utilized to an increasing extent by the manufacturers and consumers of structural lumber to achieve uniformity in and acceptance of the technical aspects of establishing structural grades of lumber and related design values. Procedures and data developed by the Forest Products Laboratory for this purpose were incorporated into ASTM standard methods. In 1960, the Forest Products Laboratory determined that it would no longer continue to recommend and publish basic stresses for wood, but rather would provide test data and related information to ASTM Committee D-7 on Wood to enable that body to make the final determination as to the appropriate stresses to assign to the commercially important species and species groups (63). Since that time, ASTM technical standards have served as the authoritative basis for the establishment of design values for lumber, glued laminated timber and timber piles by the various lumber grading rule agencies and product manufacturers.

## **Size and Grade Standards**

National standardization of the sizes, grades and inspection of lumber began in 1924 with the issuance by the U.S. Department of Commerce of Simplified Practice Recommendation R16 for Softwood Lumber (188). Design values incorporated in 1970 and earlier editions of the National Design Specification were based on the application of Forest Products Laboratory procedures, and subsequently ASTM standards, to the grades defined in Simplified Practice Recommendation R16. R16 was superseded in 1970 by the U.S. Department of Commerce Voluntary Product Standard PS 20-70, American Softwood Lumber Standard. Product Standard PS 20, which was approved by a general concurrence of producers, distributors, users and manufacturing consumers of softwood lumber, provides for the uniform application of ASTM standards in the development of design values published in lumber grading rules (190). The design values for lumber contained in American Lumber Standards Committee approved grading rules are the lumber design values tabulated in the 1971 and subsequent editions of the National Design Specification.

## **Review and Improvement Process**

Since the first edition was published in 1944, the design formulas and other provisions contained in the body of the National Design Specification, including those related to the design of mechanical connections, have been subject to continued review and evaluation by the National Forest Products Association's Technical Advisory Committee. Appropriate revisions have been made in the Specification to reflect new information from laboratory tests, new developments in design, and experience with wood construction in service. Research and engineering data developed over more than eight decades by the Forest Products Laboratory continue to be the principal basis for the provisions in the Specification. However, to an increasing degree in recent years, the results of research conducted at universities and other private and public laboratories, in Canada and other countries as well as the U.S., have been utilized to improve the Specification as a national standard of practice for wood construction.

The 1982, 1986 and 1991 editions of the Specification contain numerous revisions recommended by a Special Advisory Committee composed of consulting design engineers; representatives of user groups, research laboratories and educational institutions; and wood and engineering specialists representing manufacturers of various wood products. The reviews conducted and the changes proposed by this balanced Committee have helped to assure the technical soundness and broad applicability of the Specification.

In 1992 NFPA was accredited as a canvass sponsor by the American National Standards Institute (ANSI). The Specification subsequently gained approval as an American National Standard designated ANSINFoPA NDS-1991 with an approval date of October 16, 1992.