

Allowable Stress Design

**Review of National
Design Specification
(NDS)
for Wood Construction**

Structural Design for Wood Construction

- **Allowable Stress Design (ASD) uses the National Design Specification (NDS) for Wood Construction**
 - **ANSI / AF&PA NDS-2001**
 - **Published by American Forest and Paper Association - American Wood Council**

NDS and Wood Design References

- **2001 Allowable Stress Design Manual for Engineered Wood Construction**
 - **ASD Manual**
 - **NDS**
 - **NDS Supplement: Design Values for Wood Construction**
 - **Additional Supplements**
 - **Guidelines**
 - **Special Design Provisions for Wind and Seismic**

NDS and Wood Design References

- **Supplements**
 - **Structural Lumber**
 - **Structural Glued-Laminated Timber**
 - **Timber Poles and Piles**
 - **Wood Structural Panels**
 - **Wood Structural Panel Shear Wall and Diaphragm**

NDS and Wood Design References

- **Guidelines**
 - **Wood I-Joists**
 - **Structural Composite Lumber**
 - **Metal Plate Connected Wood Trusses**
 - **Pre-Engineered Metal Connectors**

NDS and Wood Design Additional References

- **Wood Frame Construction Manual for One- and Two-Family Dwellings**
- **Commentary on the Wood Frame Construction Manual**

NDS and Wood Design

- **The NDS is one of two accepted standards of practice for structural wood design in the U.S.**
- **All model building codes have adopted the NDS**
- **Minimum design loads and load combinations for design are from building codes**

NDS and Wood Design

- **The NDS defines the methods to be followed for design of:**
 - **visually graded lumber**
 - **mechanically graded lumber**
 - **structural glued-laminated timber**
 - **timber piles**
 - **single and multiple fastener connections**
- **Design specifications for panel products are not included in the NDS - see APA's Plywood Design Specification**

ASD Manual

- **ASD Manual Contents**
 - **Intro and Case Studies**
 - **Member Design (checklists and examples)**
 - **Tension Members**
 - **Compression Members**
 - **Bending Members**
 - **Bending plus Axial Loads**

ASD Manual

- **ASD Manual Contents**
 - **Mechanical Connectors**
 - **Wood Structural Panels**
 - **Shear Walls and Diaphragms**
 - **Reference Information (beam tables, etc.)**

NDS Organization

- **NDS Contents**
 - **General requirements for design**
 - **Discussion of design values for structural members**
 - **Design provisions for structural members**
 - **Provisions for sawn lumber, glulam, round timber piles**

NDS Organization

- **NDS Contents, continued**
 - **General design provisions for:**
 - **Wood I-joists**
 - **Structural Composite Lumber**
 - **Wood Structural Panels**

NDS Organization

- **NDS Contents, continued**
 - **General mechanical connection design provisions**
 - **Provisions for Dowel-type fasteners:**
 - **bolts, lag screws, wood screws, nails and spikes, drift bolts and drift pins**
 - **Provisions for Split ring and Shear plate fasteners**
 - **Provisions for Timber Rivets**

NDS Organization

- **NDS Contents, continued**
 - **Provisions for shear walls and diaphragms**
 - **Special loading conditions (spaced columns, built-up columns, etc.)**
 - **Fire Design of wood members**
 - **Appendices**

NDS Supplements

- **Main NDS Supplement Contents**
 - **Sawn lumber species combinations and grading agencies**
 - **Section properties for sawn lumber and glued-laminated timbers**
 - **All design values for:**
 - **visually-graded dimension lumber**
 - **mechanically-graded dimension lumber**
 - **visually-graded timbers**
 - **visually-graded decking**
 - **structural glued-laminated timbers**

NDS Supplements

- **Other Specific Supplements**
 - **Structural Lumber** - contains simplified design procedures, adjustment factors, and selection tables
 - **Structural Glued-Laminated Timber** - contains adjustment factors, selection tables, and examples
 - **Timber Poles and Piles** - adjustment factors, design values, selection tables
 - **Wood Structural Panels** - design capacities, adjustment factors, section properties, selection tables, examples
 - **Wood Structural Panel Shear Wall and Diaphragm** – use of design tables and design considerations

ASD Guidelines

- **Guidelines provide additional information**
 - **Wood I-Joists**
 - **Structural Composite Lumber**
 - **Metal Plate Connected Wood Trusses**
 - **Pre-Engineered Metal Connectors**
 - **Design capacities**
 - **Adjustment factors**
 - **Design examples**
 - **Other design and installation considerations**

Special Provisions for Wind and Seismic

- Terminology
- Special provisions for designing members and connections
- Special provisions for shear walls and diaphragms

ASD Format

- Allowable stress design format:

$$f \leq F'$$

f = actual stress

F' = allowable design value

$$F' = FC_i$$

F = tabulated design value (from NDS Supplement)

C_i = adjustment factors for use conditions

ASD Format

- Example: Tensile stress $f_t \leq F_t'$

$$f_t = \frac{P}{A}$$

$$F_t' = F_t C_D C_M C_t C_F C_i$$

Alternate Format

- Example: Tensile capacity $T \leq T'$
 - T = actual tensile force
 - T' = allowable tensile capacity

$$T' = F_t' A \quad (\text{lbs})$$

$$F_t' = F_t C_D C_M C_t C_F C_i$$

ASD Format

- Example: Bending stress $f_b \leq F_b'$
 - f_b = actual bending stress
 - F_b' = allowable bending stress

$$f_b = \frac{M}{S}$$

$$F_b' = F_b C_D C_M C_t C_L C_F C_V C_{fu} C_i C_r C_c C_f$$

Alternate Format

- Example: Moment capacity $M \leq M'$
 - M = actual bending moment
 - M' = allowable bending moment

$$M' = F_b' S \quad (\text{in-lbs})$$

$$F_t' = F_t C_D C_M C_t C_F C_i$$

General Notation in NDS

A = cross section area

C = adjustment factors

D = diameter

E, E' = tabulated and allowable value of
modulus of elasticity

General Notation in NDS

F_b, F'_b = tabulated and allowable bending
design values

F_t, F'_t = tabulated and allowable tension
parallel-to-grain design values

F_v, F'_v = tabulated and allowable shear
parallel-to-grain design values

F_c, F'_c = tabulated and allowable compression
parallel-to-grain design values

General Notation in NDS

$F_{c\perp}, F'_{c\perp}$ = tabulated and allowable compression
perpendicular-to-grain design values

I = moment of inertia

K = various coefficients

M = bending moment

General Notation in NDS

P = concentrated load

S = section modulus

V = shear force

b = width of rectangular member

c = distance from neutral axis to
extreme outer fiber of beams

d = depth of beams

General Notation in NDS

- f_b = actual bending stress
- f_t = actual tension stress parallel-to-grain
- f_v = actual shear stress parallel-to-grain
- f_c = actual compression stress
parallel-to-grain
- $f_{c\perp}$ = actual compression stress
perpendicular-to-grain