Technical Q & A

Duration of Loads

by Ryan J. Dexter, P.E.

Details about applying load duration factors.

It is very important for those who supply wood building components to understand wood's unique ability to carry different durations of load. This includes taking into account the type of load or the combination of loads that is being applied to lumber, knowing how to apply that load when there are two or more types of applied loads, and doing both in a way that ensures safe and economical design.

Wood has demonstrated design properties that allow it to carry greater loads when the load is applied for shorter durations rather than for longer durations. Tabulated lumber design values are listed for "normal" load duration. According to the *National Design Specification® for Wood Construction (NDS®),* "normal load duration represents a load that fully stresses a member to its allowable design value by the application of the full design load for a cumulative duration of approximately ten years." However, when the cumulative duration of the full maximum load is less than ten years, most tabulated lumber design values can be multiplied by the appropriate load duration factor (LDF).

LOAD DURATION	LDF	TYPICAL DESIGN LOAD
Permanent	0.90	Dead Load
Ten Years	1.00	Occupancy Live Load
Two Months	1.15	Snow Load
Seven Days	1.25	Construction Load
Ten Minutes	1.60	Wind/Earthquake Load*
Impact	2.00	Impact Load

Table 1 presents the LDFs that can be used to adjust the tabulated lumber design values per the *NDS®*. [*1.33 (one day) in some jurisdictions and NDS® prior to 1987.]

LDFs are only used when designing wood products using Allowable Stress Design (ASD) methods. It should be noted that if designing wood products by the Load and Resistance Factor Design (LRFD) method, time effect factors (λ) are used instead of LDFs.

It's also important to understand that the application of load duration increase factors is a *separate* evaluation from the load combining reduction factors. Specifically, the *NDS®* states the following in Appendix B:

> Reductions in total design load for certain combinations of loads account for the reduced probability of simultaneous occurrence of the various design loads. LDFs account for the relationship between wood strength and time under load. LDFs are independent of load combination reduction factors, and both may be used in design calculations.

at a glance

- Lumber design values, not loads, are adjusted by the load duration factor (LDF).
- The application of LDFs is separate from load combining reduction factors, although both may be used in truss design calculations.
- In areas where snow load controls the design, code allows an LDF of 1.15, not 1.00.

The 2006 International Building Code (IBC) Sections 1605.3 provides the load combinations using ASD and states that "structures shall resist the most critical effects resulting for the following combinations of loads..." The equation below (taken from the IBC) is an example of the load combination with applicable load combination reduction factors:

$$D + H + F + 0.75\,(W \text{ or } 0.7E) + 0.75L + 0.75\,(Lr \text{ or } S \text{ or } R)$$

Additionally, IBC Section 1605.3.1.1 states specifically that the LDF may be used in addition to any applicable load combination reduction factors: "a duration of load increase shall be permitted in accordance with Chapter 23" (wood).

The following information about load combination and load duration was taken from *The Load Guide (TLG): Guide to Good Practice for Specifying & Applying Loads to Structural Building Components* which is available as a free download at www.sbcindustry.com/loads.php.

The load duration for the shortest duration of load in a combination of loads is applied to the lumber design values for that combination (see Table 2).

LOAD COMBINATION	SHORTEST LOAD DURATION	LDF
[Dead + Roof Live]	Roof Live = construction load	1.25
[Dead + Snow]	Snow load	1.15
[Dead + Live + Roof Live]	Roof Live = construction load	1.25
[Dead + Wind]	Wind load	1.60
[Dead + Live]	Live load	1.00

Table 2.

Lumber design values, not loads, are adjusted by the load duration factor. The *NDS®* permits the following lumber design values to be adjusted by the LDF:

- F_b = Bending
- F_t = Tension Parallel to Grain
- F_v = Shear Parallel to Grain
- F_c = Compression Parallel to Grain

For example, Table 3 provides the adjusted lumber design values for a snow load duration based upon snow loading (1.15) and the given tabular design values.

TABULAR DESIGN VALUE	LDF	ADJUSTED DESIGN VALUE
F_b = 875	1.15	1006
F_t = 425	1.15	489
F_v = 170	1.15	196
F_c = 600	1.15	690

Table 3.

Question

I am a building official in Colorado, and we have a couple different component manufacturers supplying trusses to our city. One manufacturer states that snow loads should be designed with a duration factor of 1.00 while the other manufacturer is supplying trusses to a local builder who argues a duration factor of 1.15 is sufficient. Most of the other builders are fine with the 1.00 factor because we get a lot of snow. Which LDF should be used?

Answer

When truss design is performed where snow load controls the design, the code allows the use of a lumber design value load duration factor of 1.15, not 1.00, unless an area-specific LDF is provided by the authority having jurisdiction (AHJ). As a building official, you are the AHJ, and because you are asking the question, we assume you are not specifying a local LDF.

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We are aware of jurisdictions in the Western states that do require snow loads to be run at a duration factor of 1.00, versus the code-allowed 1.15, due to the high snow loads in certain areas. We believe that rather than making an adjustment to the LDF to allow for the truss design to resist a higher quantity of snow, it is probably more appropriate and beneficial to adjust the design snow load regionally. This will allow normal design methods to be used in a traditional manner and create less confusion in the market.

Question

Should attic trusses be run with a load duration factor of 1.00 instead of 1.15?

Answer

Using the same concepts from the answer above, there is no need to run the attic frames with a more conservative LDF. The snow load cases should be run at 1.15 and the wind load cases at 1.60. This is supported by *ANSI/TPI 1-07, Section 6.4.1.4:*

> **6.4.1.4 Load Combinations.** For combinations of loads with different durations, the load duration factor, CD, for the shortest duration load that is part of that load combination shall apply for that entire load combination. SBC

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