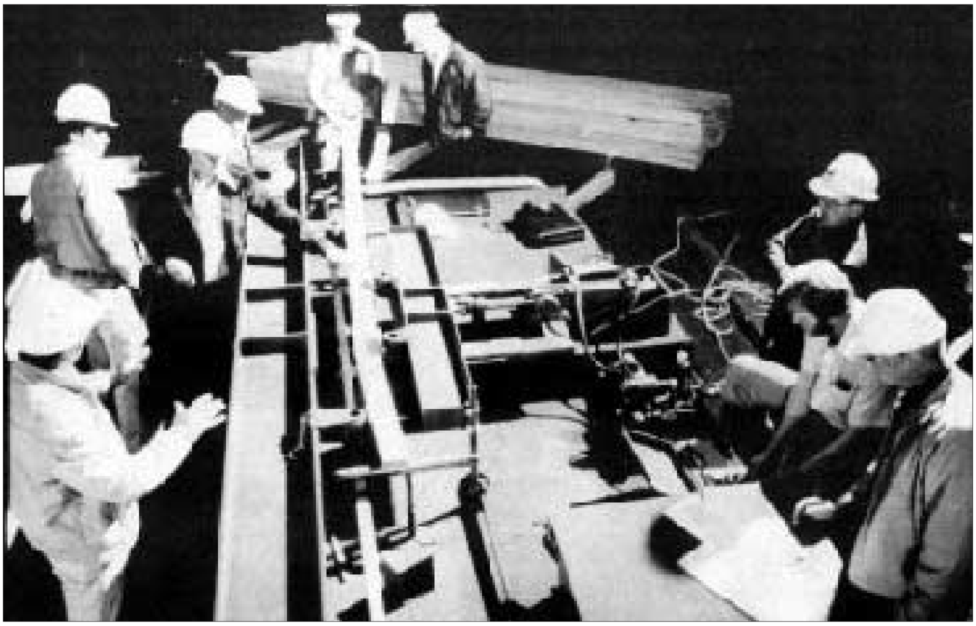
NEW NUMBERS FOR DIMENSIONAL LUMBER

Twelve years and 70,000 pieces of lumber later, the In-Grade testing program yields new lumber design values

by Paul Spring



A roomful of In-Grade engineers look on as a 2x4 is tested to destruction.

In an ambitious, 12-year testing program known as *In-Grade*, North American lumber producers have been gauging their strength. Or more accurately the strength of their products. The result will be new, tested design values for southern, western, and Canadian dimensional lumber.

These values determine the allowable structural limits of each species and size category, which in turn determine the numbers on span tables used by architects, engineers, designers, and builders.

The testing brought together the Canadian Wood Council, the Southern Pine Inspection Bureau, the West Coast Lumber Inspection Bureau, and the Western Wood Products Association (WWPA), along with the help of the U.S. Forest Products Laboratory. All told, the various groups tested to destruction over 70,000 pieces of dimensional lumber.

There were several reasons to review the current values. Though not a popular subject with timber producers and suppliers, lumber has changed over the last 20 years, as much smaller, second-growth trees with very different growth characteristics have replaced older timber.

But more important is that previous design values were determined in the laboratory by using short pieces of clear wood. Values for actual dimensions and lesser grades were then calculated, based on the small pieces. In-Grade testing, on the other hand, has made a point of using actual mill samples. These were randomly chosen in each grade and dimension, and used full length. To get the design values for a 12-foot-long Douglas fir 2x10, they tested a 12-foot-long Douglas fir 2x10.

This means that with the new design tables, each size of dimension lumber — 2x4, 2x6, etc. — will carry its own design value, whereas the current system divides dimension lumber into only two categories: 2x4s and all lumber 2x5 or wider.

Random Sampling

Within each producing region mills were chosen at random to contribute samples. At each mill, ten-piece lots were randomly pulled for each size, grade, and species. All ten pieces were taken sequentially from one bundle, just as a carpenter might do in breaking down a load to frame walls or floors. The samples were reinspected to confirm that they met grading rules, and then tested for compression, tension, and bending strength.

In this way, the samples were truly *in-grade* (a term coined by Canadian researcher Borg Madsen) — randomly selected, and representative of typical, commercially produced lumber from each size, species, and grade.

Calming Concerns

About 85% of dimensional lumber goes to the so-called *commodity* or framing market where it's used in conventional wall, floor, and roof systems. For this reason all of the developers of In-Grade are concerned about the construction industry's reaction to these new and often lower numbers. The first concern they want to allay is that homes and offices built with current design values are in danger of failing.

The WWPA put it this way: "Current light frame wood systems such as joist floors and roof rafters have always performed satisfactorily under the assigned values. One of the reasons for this is the conservative nature of the engineering of repetitive systems. Another reason may be that commonly used spans are often less than the maximum permitted."

In other words, although there will be some changes in the span tables, existing framing systems are probably not at any risk unless they've been pushed to the absolute limits. However, engineered systems like roof panels and trusses that push design limits much harder will come under close scrutiny. In these systems the new design values will have to be closely applied.

Western Lumber

Like the other regional producers, western species had both good and bad news. For most wide lumber (2x10 and 2x12), the new bending and stiffness values were lower than existing values.

Particularly in the lower grades, this will produce some changes in the span tables. "For instance, No. 3 Wide Width has a considerable market in the South, and this will be impacted because of lower numbers," commented Dr. Kevin C.K. Cheung, R&D Manager for WWPA.

One gain came in species like spruce-pine-fir and hem-fir. These generally received numbers closer to other species with the advent of testing that is grade specific and based on actual milled lumber.

Southern Lumber

The major changes for southern pine involve two grading classifications. The first has to do with moisture. Currently KD15 (kiln-dried to 15% moisture content) has a lower design value than MC19 (moisture content of 19% or less); in the future they will share the same design values.

The other change involves densities. Look for three categories rather than two: *No. 1 DNS* (Dense), *No. 1 N* (Non-dense), and *No. 1* (Unclassified). As for design values, the Southern Forest Products Association is claiming that the testing validates "most" of the current southern pine numbers, and that most uses of pressure-treated southern pine will not be affected.

Canadian Lumber

The Canadian Wood Council has sponsored two testing programs over the last 15 years. They joined the In-Grade program in 1980.

Like those of western U.S. lumber, the preliminary Canadian numbers show major gains in spruce-pine-fir in bending, tension and compression, according to spokesman Eric Jones. "One of the major things we're seeing is that differences between species are much less pronounced than with the former test methods. When you introduce knots and other natural characteristics, the differences are lessened; lesser grades of different species tend to act the same."

Another significant lesson learned from testing: There was little difference between No. 1 and No. 2 grade, despite visual differences. As a result, these are being assigned the same values. Admitted Jones, "This could have some effect on span tables. I think we may see more interest in the select-structural grade than we have in the past since it represents the next 'plateau' of strength."

Code Acceptance

Most of these adjustments, however, will affect the builder or remodeler in the trenches very little. A greater concern comes with the amount of time it will take for these new numbers to be absorbed by various official bodies. Thomas explains it this way:

"We see the adoption of these values by the national code bodies as a transition period that could extend up to three years. Our concern is putting the builder's mind at ease. His engineer may calculate loads based on the new In-Grade values, which are then rejected by a local jurisdiction that has not yet adopted these values. We're available to provide support and explain to local officials what procedures were followed to arrive at these numbers, but ultimately, the local code officials make the call."

By and large, though, the various trade associations that participated in In-Grade are confident that their new numbers have unquestioned validity because of the thoroughness of their program. As Thomas of the WWPA puts it, "Given the amount of testing we have done over the last twelve years, we sometimes wonder if we couldn't legitimately claim an 8-foot Doug fir 2x4 as engineered lumber." ■

Paul Spring, former executive editor of JLC, is the Manager of Marketing Communications for Wedge Innovations. He lives in Oakland, Calif.

What's It All Mean? Musings on In-Grade

We sent some preliminary design values given to us by the WWPA to Harris Hyman, an engineer in Bar Harbor, Maine, and asked him to explain the significance of the new numbers. Here's his answer.

A naive interpretation of the In-Grade research is that a lot of buildings are going to fall. (The concept of a White Paper from the WWPA or the SFPA or even the CIA causing a building to fall staggers the imagination.) But in fact, the research should simply bear out the impressions of most engineers who make post-construction site visits and see that the floors and walls are both a lot stronger and also a lot bouncier than the calculations show.

Let's look at the rupture stress values given in the U.S. Forest Products Laboratory *Wood Engineering Handbook*. Clear pieces of white spruce break at stresses of 5,100 psi to 9,100 psi. However, as designers, we use 1,100 psi as a *safe* working stress level, and this is institutionalized by code. The fraction of the strength to be used in real designs — 20% or so — is known as the *aggregate strength ratio* and is institutionalized by the National Bureau of Standards. *We have a whole lot of built-in safety*.

So how will the new numbers from the In-Grade research affect our designs? In three ways. First, those who push the code limits on strength will have to shorten the spans by approximately half the reduction in allowable design stress. For example, the bending stress value of #1 hem-fir 2x10s should be reduced from the present 1,200 to 1,045 psi. This is a 13% reduction, so spans should be reduced by about half that, or 6 1/2%. Personally, I *always* overdesign joists as a relatively inexpensive way to give a building a nice solid feel, and since studs are lightly stressed anyway and rafters usually overdesigned to accommodate insulation, I am generally unaffected.

Next, more posts will be needed for girders. My eye and experience tell me that most builders use excessive spans in their girders. With the new In-Grade values, the spans should be cut about in half, some of this for generally weak "intuition" and some for the reduced design values.

Third, those who use Douglas fir for its extra strength will find that, compared with engineered lumber, it's not as cost-effective as it used to be; you can get a lot more strength per dollar with engineered lumber. Douglas fir is beautiful though, and should be used in big sticks where it shows. For exposed timbers, a little oversizing to meet the In-Grade values will look good, too.

So, what's it all mean? Not a lot, really. Keep using the old span tables until the new ones come out and you'll be just fine — nothing's going to fall down. It never did before.

— Harris Hyman