Statistical Analysis of Failure Data for Wooden I-Joists

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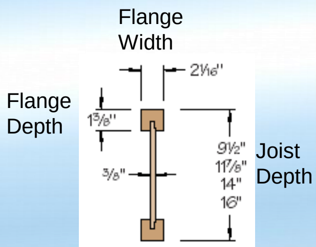
Abstract

Wooden I-joists are manufactured by adhering oriented strand board (OSB) webbing into the groove of a laminated flange. I-joists are tested for strength by a destructive test. The measure is called ultimate load at failure and is the force (lbs) required to break the I-joist. I-joist products have different mixes of web depths and flange widths. Each joist depth and flange width combination has an associated "resistive shear load". The ultimate load divided by the resistive shear load yields the *specific strength ratio*.

I-joist Diagram

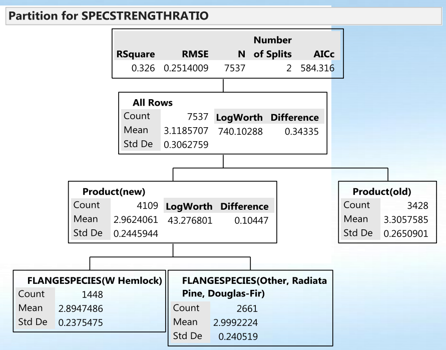


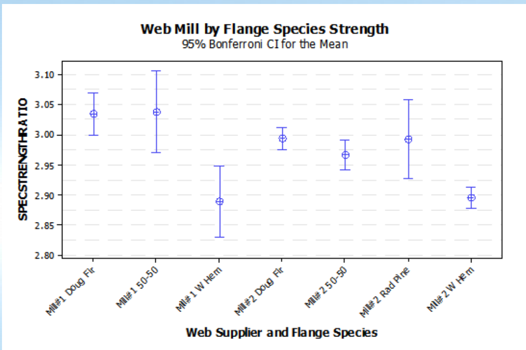
Introduction

The I-joist plant experienced more *strength ratio* failures during the one year than previous years. Production lots that did not meet shear load specification were scrapped. The data set contained 7537 observations of the stress test results, product types, web mill ID, and other manufacturing information. It was believed that web mill #2 had a higher failure rate compared to web mill #1.

Data mining with regression trees (JMP®) were used to explore the nominal data and its relationship to the shear load result. Reliability probability plotting (Minitab®) were used to understand the groupings discovered by the regression trees.

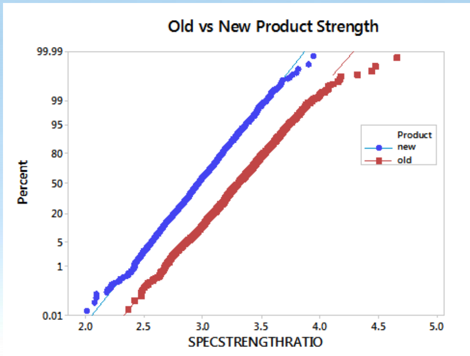
Methods: Regression Tree Results



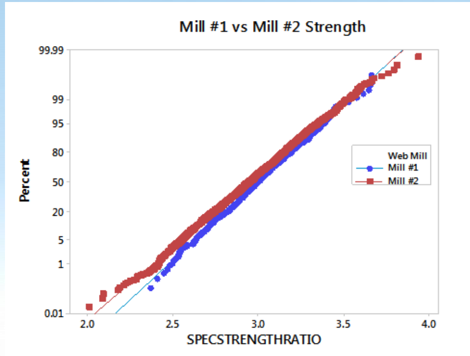


The first partition was on the *specific strength ratio* was for old vs. new product. The second partition was within the new product for the flange material wood species. The plot of the mean *specific strength ratio* show that the Western Hemlock was lower than the other wood species.

Methods: Reliability Probability Plots



(a)



(b)

The results of the regression tree analysis showed that *specific strength ratio* was different for old vs. new product. The probability plots are used in reliability analysis to examine the data distribution and location of one group relative to the other. The *specific strength ratio* follows the Normal distribution. Plot (a) shows that the old product is stronger than the new product. Plot (b) shows that there is little difference between the strength results when comparing the web mills.

Other probability plots of the *strength ratio* showed that that the new product had lower strength compared to the old for both web mills. Also, the Western Hemlock had the lowest strength compared to the other wood species.

Conclusions

- The new product fails at a higher rate than the old, especially with Western Hemlock flanges.
- The failure rates for web mill #1 and web mill #2 are not much different.
- Web mill #1 and mill #2 failed at a higher rate for the new product vs. old.
- Reducing flange depth from 1.5" to 1.375" and using Hemlock flanges increased the likelihood of *strength ratio* tests below the failure threshold.

Results

- The new product will no longer be manufactured with the Western Hemlock wood species for the flange material.

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