CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)
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Project Number
J0312

Project Title
Constructing Science: Comparing the Strength of Wooden Joints Made with Nails, Screws, and/or Glue

Abstract

Objectives/Goals

I wanted to find out how the strength of wooden joints made with nails, screws, and/or glue compare. After researching the topic and choosing 15 joint types, I hypothesized the following:

Strongest joint: Red oak cross joint made with two screws and glue

Weakest joint: White pine butt joint made with two nails

I chose these joints because I believed that glue was going to be very strong and would be strengthened by screws and I believed nails alone would be the weakest. I also inferred that joints made with red oak would be stronger than joints made with white pine and cross joints would be stronger than butt joints.

Methods/Materials

I built a jig using a bathroom scale, a car scissor jack, and a wooden platform to apply moment (or a twisting motion) to my sample joints. I made test samples using 15 joint types and two wood types (red oak & white pine). I clamped each sample joint to my test jig and raised the scissor jack until the joint failed or the jack reached its limit. I used a video camera to record the maximum scale reading during each test. I repeated each measurement three times for a total of 90 measurements. I converted all results into moment in Nm and calculated average values along with error bars for analysis.

Results

After completing my experiments, I analyzed my results and found a few general patterns:

Adding Glue to Cross Joint = 500 -> 1000% Stronger

Adding Glue to Butt Joint (3 of 4) = 6 -> 11% Stronger

Adding Fastener to Cross Joint = -22 -> +4% Stronger

Adding Fastener to Butt Joint = 50 -> 300% Stronger

Red Oak vs. White Pine = 100 -> 600% Stronger

Conclusions/Discussion

In conclusion my hypothesis was reasonably correct. I hypothesized that the strongest joint would be a red oak cross joint made with two screws and glue. This was a reasonable prediction because this was the second strongest joint on average. The strongest joint was a red oak cross joint made with only glue. But, I cannot conclude that my hypothesis was incorrect because the error bars for the two joints overlap. I also hypothesized that the weakest joint would be a white pine butt joint made with two nails. This prediction was correct, but this joint got the exact same average results as the red oak cross joint made with two nails and the white pine cross joint made with two nails.

Summary Statement

I constructed an experimental setup and measured the strength of wooden joints made with nails, screws, and/or glue.

Help Received

My father supervised and assisted me with the use of power tools during the construction of my experimental setup and test samples.