

Team #21 Wood Density NDT Device

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Background

- Redwood and Douglas fir in DOW Chemical's cooling towers are subject to brown rot and decay as shown in Figure 1.
- Current test method utilizes a hammer and the pitch of sound resulting from an impact with the wood to determine integrity.
- Method is both qualitative and subjective.
- Stress wave timing allows for quantification of decayed area of wood samples.

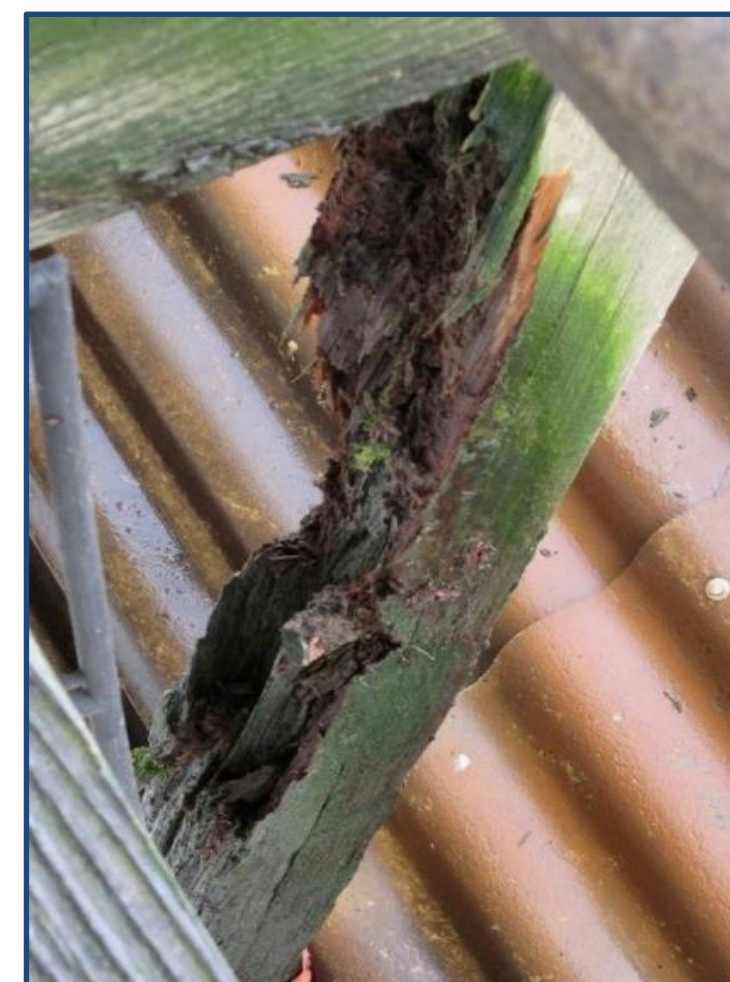


Figure 1: Rotten 4X4 Redwood Sample

Objective

Build a non-destructive, field-use device that outputs the load-bearing area percentage of a 4x4 or 4x6 Douglas Fir or Redwood sample

Engineering Specifications

- Device weight less than 10 pounds
- 8 Hour Battery Life
- Waterproof all vulnerable components
- Estimate remaining load bearing area to within 10% of actual value

Operational Procedure

- Set Pelican Case
- Establish settings
- Set impact mechanism and sensor on either side of test section
- After gun is fired, read output displayed on control panel

Safety Considerations

- Follow Boom Lift safety guidelines
- Follow OSHA and Dow regulations
- Blaze orange to avoid confusion with real firearm
- Read and understand device user manual



Figure 4: Caution sticker advising against improper use

Systems and Assemblies



Trigger

- 316 Stainless Steel
- Stainless steel torsion and compression springs

Plunger Assembly

- 316 Stainless Steel
- Pull handle
- 2 1/8 inch stainless steel spring

Impact Mechanism

- Magpul grip
- FAKOPP piezoelectric sensor

Testing

- Moisture
 - Results show the stress wave velocity has little difference throughout extended sample submersion
- Reliability
 - Repeated sampling at one location shows standard deviation for time readout of 3 microseconds over multiple test specimens
- Engineered Defect
 - A defect of a set area yields a stress wave velocity change such that:

$$\text{Velocity Decay} = \text{Area Decay to Area Decay} + 10\%$$

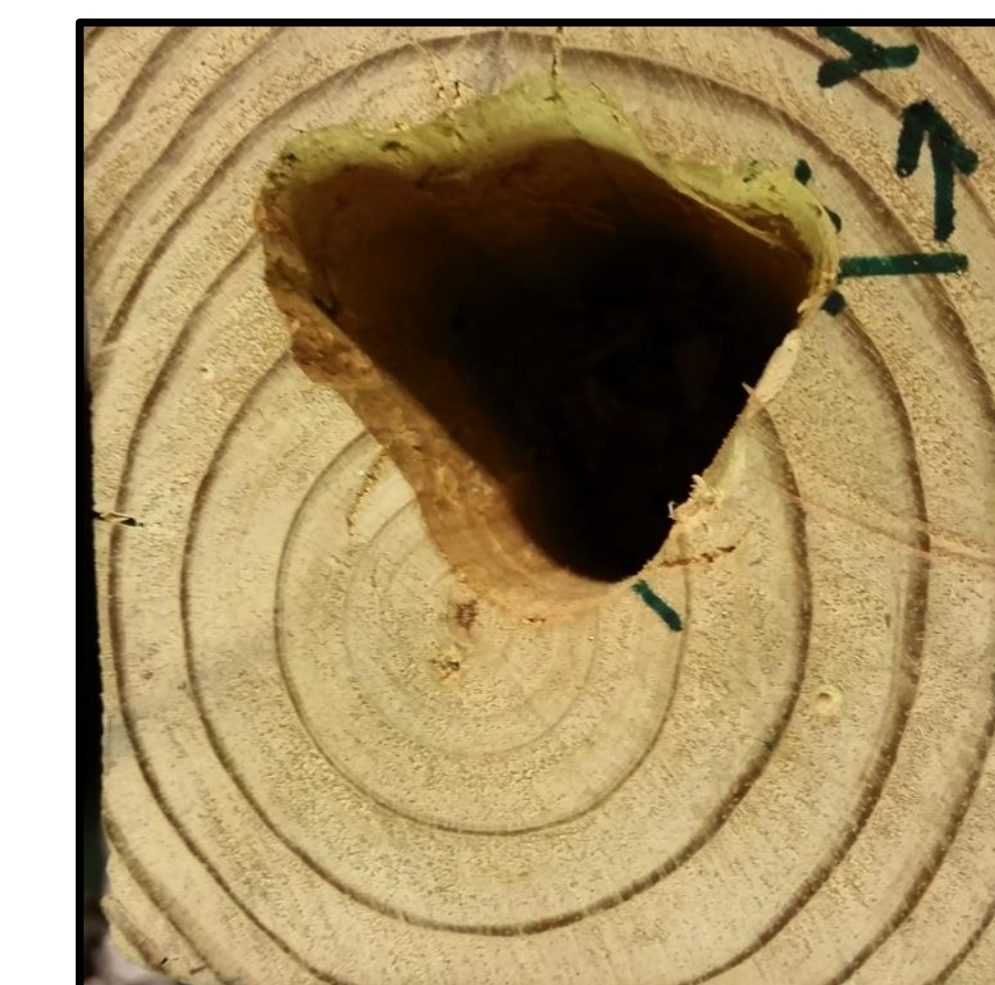
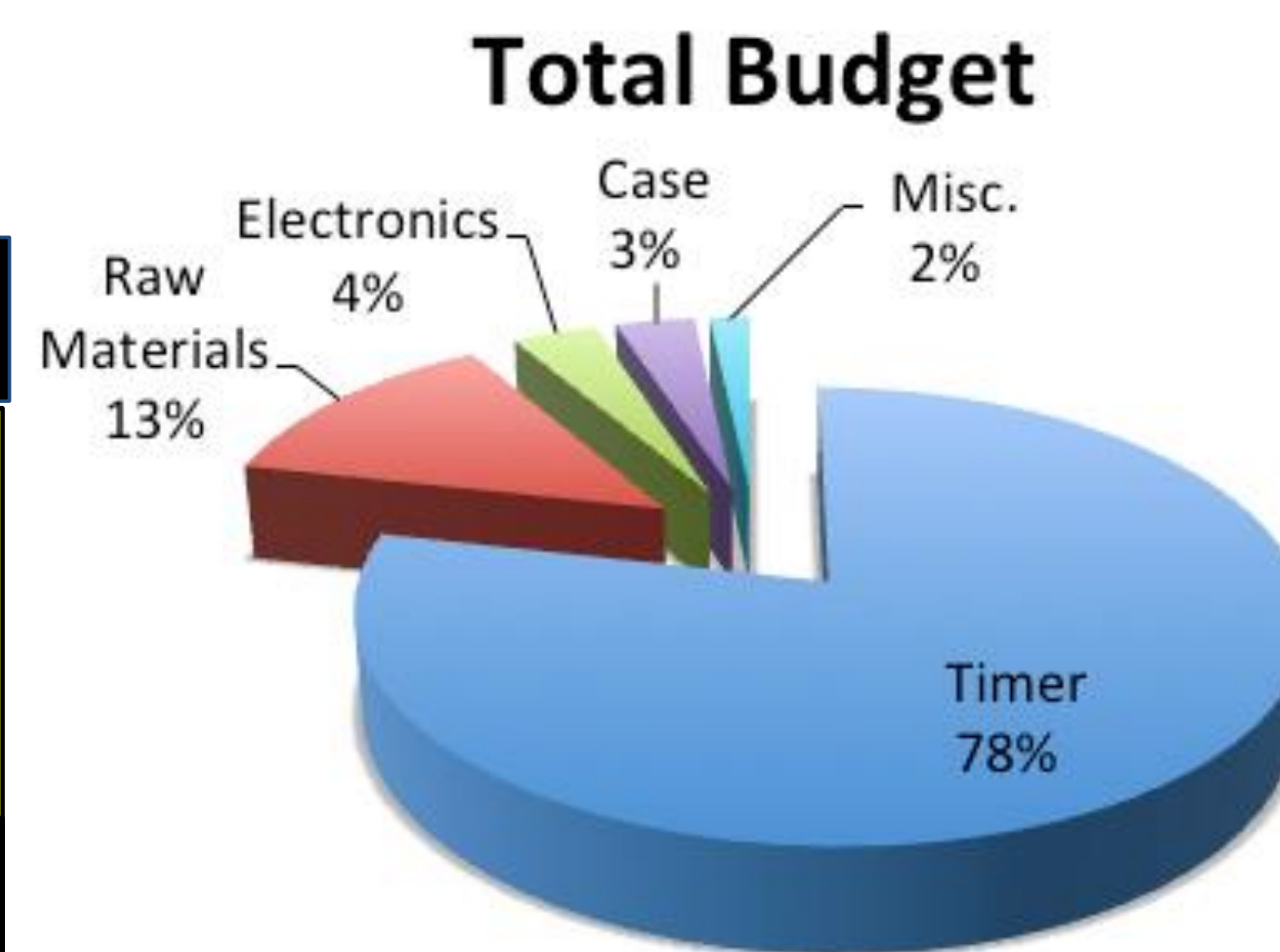


Figure 2: Irregular Defect Test Sample



Figure 3: Swiss Cheese Defect Test Sample

Budget



Components	Spent (Dollars)
Timer	3040.03
Raw Materials	503.68
Electronics	136.37
Casing	127.70
Miscellaneous	64.69
Total	3872.47

Conclusions

- Final, complete assembly weighs 11.0 pounds
- Battery life well exceeds 8 hour work day requirement
- Tests confirmed stress wave timing can be used to estimate the remaining load bearing area in a wooden member for a given signal path to within 10%
- At least two tests must be run on a given cross section, one on each minor axis, to maximize chances of hitting rot area while maintaining efficiency