In-Class Demonstration – Single Shear versus Double Shear

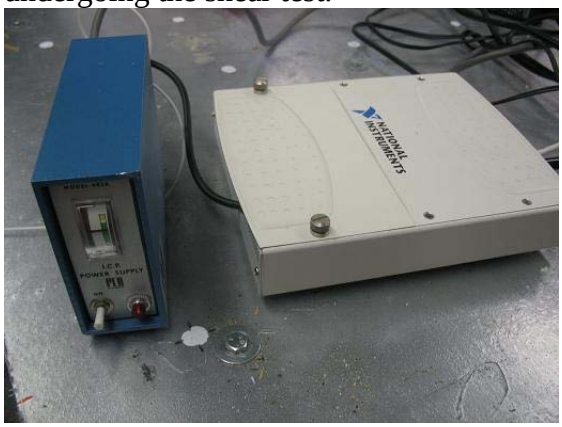
Objective

To demonstrate the concepts of single shear and double shear. Students should learn that the shear force required to shear the pin in double shear is twice the shear force required in single shear since there are two shear planes (the total shear area is doubled). However, while the shear force is doubled, the shear stress at failure is the same in both cases.

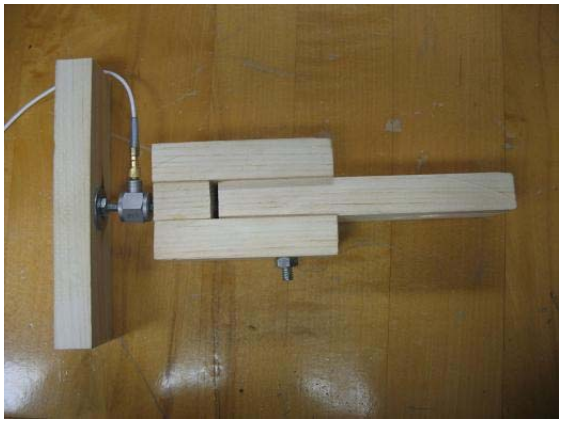
Demonstration Tools

The in-class demonstration consists of a wooden bracket specially outfitted with a load cell to measure the pulling force applied at the end handle. This load cell is powered by a portable signal conditioner and the output signal is fed into a data acquisition unit, which is read by a computer. The computer reads the instantaneous force and tracks the maximum force throughout the test to capture the applied force at failure.

Two coupling brackets are also used to provide either a single-shear or double-shear connection. Both brackets have parallel bars, but while the single-shear block is routed out so that there is only one shear plane, the double-shear block has a hole through each bar. A large pretzel rod is used as a pin to secure the special load-measuring bracket to either the single-shear or double-shear bracket. This pretzel rod is the pin that is undergoing the shear test.



Data Acquisition Hardware



Bar w/ load cell to measure shear force

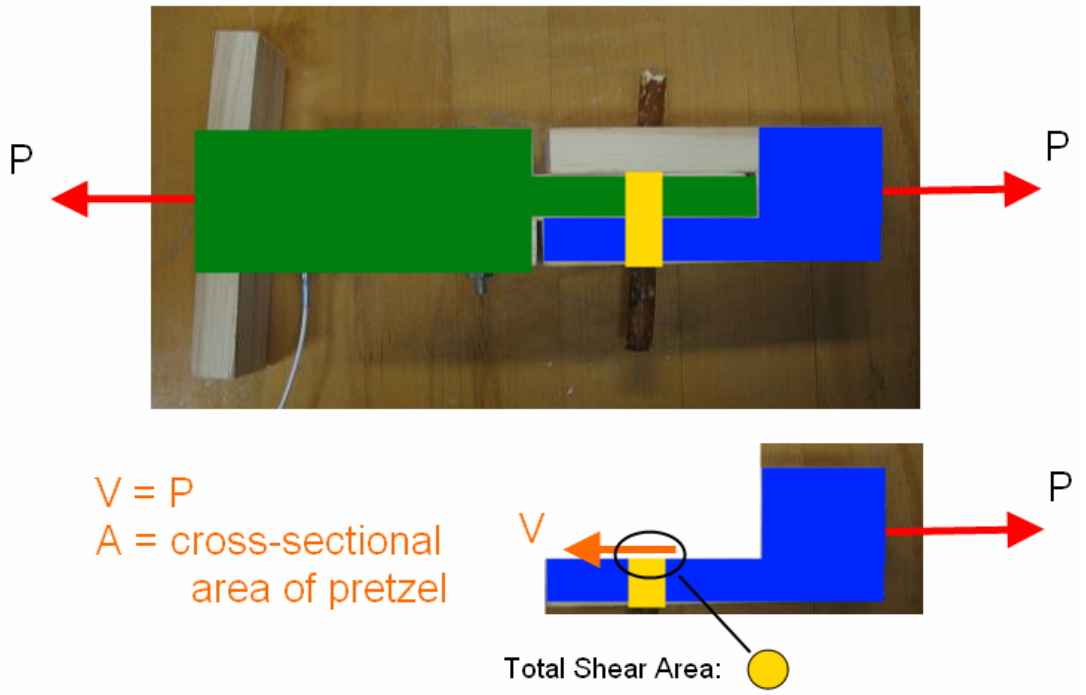
Single-Shear Bracket

Double-Shear Bracket

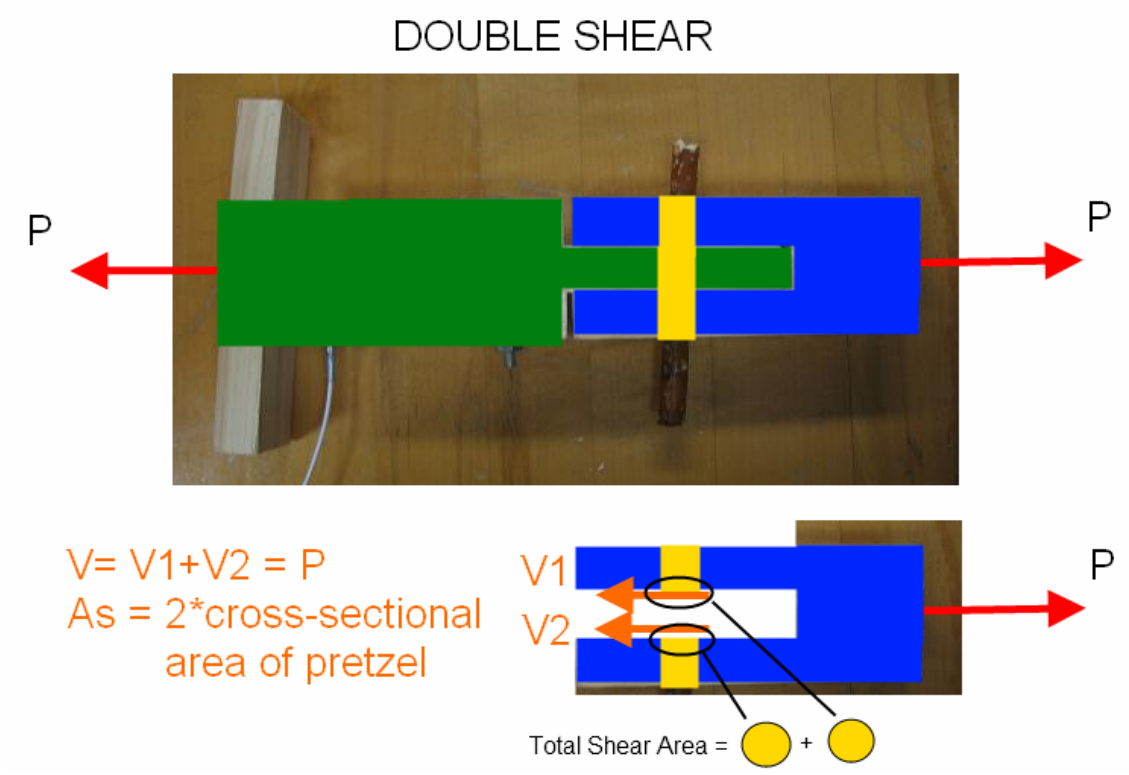
Experiment

The pretzel rod is placed through the pin holes and the two brackets are pulled apart until the pretzel rod shears. The maximum applied load is displayed on the computer screen.

SINGLE-SHEAR



DOUBLE SHEAR



When we perform the experiment, we find that:

$$\mathbf{P_{double\text{-}shear} = 2{*}P_{single\text{-}shear}}$$

So at <u>failure</u> we have:

Single-Shear:
$$\tau_{avg,Failure} = \frac{P}{A_{pretzel,cross-section}}$$

Double-Shear:
$$\tau_{avg,Failure} = \frac{2P}{2A_{pretzel,cross-section}} = \frac{P}{A_{pretzel,cross-section}}$$

Which means that although the case of double-shear allowed us to apply 2x as much load to the bracket than the case of single-shear, the shear strength of the pretzel was the same in both cases. This is true because, like normal strength $\sigma_{ultimate}$, the shear strength $\tau_{ultimate}$ is a <u>material property</u>.