BONE PLATE DURABILITY TEST

RELEVANT JMP PLATFORMS AND STATISTICAL TECHNIQUES

Graph Builder : Mosaic Plot; Comparative dotplots

Distribution : Bar Charts; Summary Statistics; Inference for Population Proportion

Reliability: Life Distribution

PROBLEM STATEMENT

Surgeons will often use bone plates and screws to provide the necessary mechanical support to facilitate proper healing of a bone fracture (Figure 1).

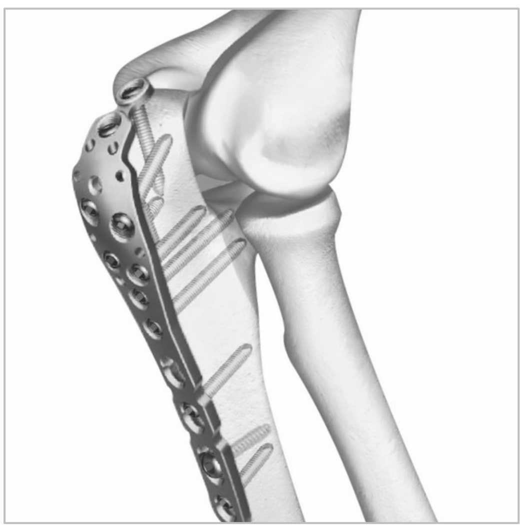

Figure 1.

Manufacturers of these plates and screws are required to subject their products to frequent testing in order to validate their durability. These tests are also part of R&D efforts as scientists and engineers work on structural changes and materials to improve upon the performance and durability of their products.

One such test procedure, known as flexture testing applies a repetative pulsating force onto the specimen and the number of cycles to produce an undesired amount of deformation of the specimen is observed. The force used for the testing is much greater than what would be experienced in real usage as a means to accelerate failure (Figure 2).

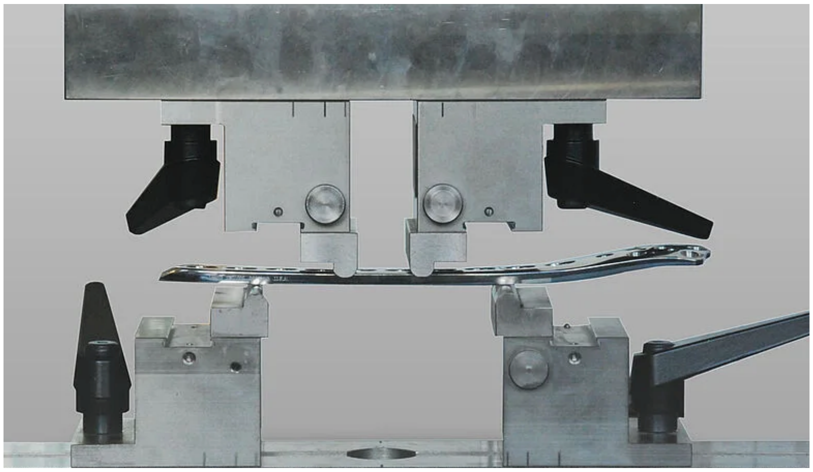

Figure 2.
Image of Flexure Testing Machine from ZwickRoell.
https://www.zwickroell.com

The engineering team is working on two new formulations designed to reinforce the base material. As the team is still early in the development stage, an initital sample of 20 specimens of both the XR and XT reinforcement material has been made in product development lab. These specimens along with a sample of 25 base specimens were tested. The tests were stopped after 5,000 cycles regardless if the undesired deformation had occurred.

DATA SET

Bone_Plate_Durability_Test.jmp

Material	Type of material used for the plate
Cycles to Fail	Number of cycles until failure (i.e., amount of deformation)
Fail	Identification of whether the specimen failed at or if the testing stopped after those number of cycles.

EXCERCISES

1. Analysis and Inference for failure rates.
   a. Create a Mosaic Plot showing the proportion of specimens of each Material Type that had failed and not failed by 5,000 cycles.
   b. For each Material Type, construct 95% Confidence Intervals for the proportion of bone plates that would fail by 5,000 cycles categorizing the data as a binary outcome (Fail, Not Fail). Provide an interpretation of the results. Does this provide any evidence indicating differences between the Material Types? If so, which Material Type does this graph suggest performs the best/worst?
   c. What information about these tests does this graph not provide that would also be important to examine in order to determine which Material Type performs best/worst?
2. Create a comparative dotplot of the cycles until failure for the three Material Types. Include those specimens that had not failed by 5,000 cyles. Note: choose a different color for the data points to make it clear in the graph which specimen had failed from those that had not. Interpret the graph comparing the performance of each Material Type. Is this the same conclusion you had reached in Exercise 1?
3. Perform life distribution analyses for each Material Type.
   a. Select a probability distribution that is a good model to describe Cycles-to-Failure for for each Material Type?
   b. For each Material Type, provide a 95% Confidence Interval estimate of the Average Cycles-to-Failure.
   c. For each Material Type, provide a 95% Confidence Interval estimate of the cycles that 90%, 95%, and 99% of the bone planes would survive.
   d. For each Material Type, provide a 95% Confidence Interval estimate of the proportion of bone plates that would survive 5,000 cycles.
   e. Compare results from Exercise 3d. to 1b. Which of these analyses do you think provide a more accurate estimate of proportion of bone plates that would fail by 5,000 cycles? Explain why.
4. Compare results of all your analyses in Excersie 3 across the Material Types. Summarize key findings, explicitly addressing if the reinforced formulations improve durability of the plates.