

FAILURE TIMES OF BEARINGS

13. Final Comments

The purpose of the experiment described in the above paper was to compare the average times to fatigue failure (in units of millions of cycles) for ten high-speed turbine engine bearings made from five different materials. The materials are obtained by using five different processing methods.

The statistical analysis is supposed to determine which compounds tend to differ in their performance from the others and which material/processing method should be used to produce bearings having the highest fatigue failure resistance.

The fifty bearings made of the five types of material constitute the experimental units in the experiment. They were all subjected to the same (or approximately the same) amount of contact stress in a testing machine. It is well known that the stresses acting upon a material are usually random in nature. If we assume that the order in which the fifty bearings were tested was determined, there is no reason to believe that the bearings from any of the five material groups were subjected to higher stress levels. The response is time to failure in units of millions of stress cycles.

The F-test applied to the data found significant differences among the group means. The p-value of the test reported by SPSS was 0.002. The test has the underlying assumptions of normality and equal variances for the five groups. However, the graphical displays of the data in Section 3 indicate that the assumptions might be violated. Moreover, the data provided consist of a relatively small number of observations, ten in each group. Under these circumstances, it is necessary to interpret the results of the test with caution. The nonparametric alternative, the Kruskal-Wallis test leads to the same conclusion about significant differences among the group means.

The experiment is an example of an unplanned comparison because no comparisons had been suggested before the experiment was conducted. This setting calls for using multiple comparisons to detect actual group differences. We have examined the differences between all possible pairs of groups using Tukey's HSD procedure at the simultaneous confidence level of 0.95.

We have found that the material in the group 5 (Powder processed EX00007) is significantly superior to both the material in the group 2 (CEVM M-50) and the material in the group 3 (Powder processed AISI-T-15). On the other hand, the material in the group 5 cannot be claimed to be superior to any material from the other three groups.

For each of the five types of material ten specimens were prepared. Thus, they were not selected randomly from any well-defined population. Therefore, the observed pattern cannot be inferred to hold in some general population, for example the population of all bearings made of the same material unless we assume that the bearings are representative of their corresponding populations. This was probably the assumption made by the researchers in the experiment.