Guidance – Fatigue Life Calculations

Summary

There is significant scatter in test lives for rolling contact bearings and for idealised test geometry rolling contact fatigue tests. This is because rolling contact fatigue is essentially stochastic in nature.

Explanation

The fatigue lives of nominally identical rolling contacts, tested under identical conditions, can be widely different. The principal reason for this is that steels and other materials are not homogeneous. The production of a fatigue pit is dependent upon the action of cyclic stresses, produced by the motions of the rolling elements, on randomly sited stress raisers within the materials.

Scatter obtained in test lives is therefore not necessarily a result of poor experimental technique and cannot be avoided by refinements in testing machines or procedures. To accommodate the scatter the lives obtained from replicate tests are processed statistically to provide parameters which characterize the distribution of the results.

Statistical Presentation of Results

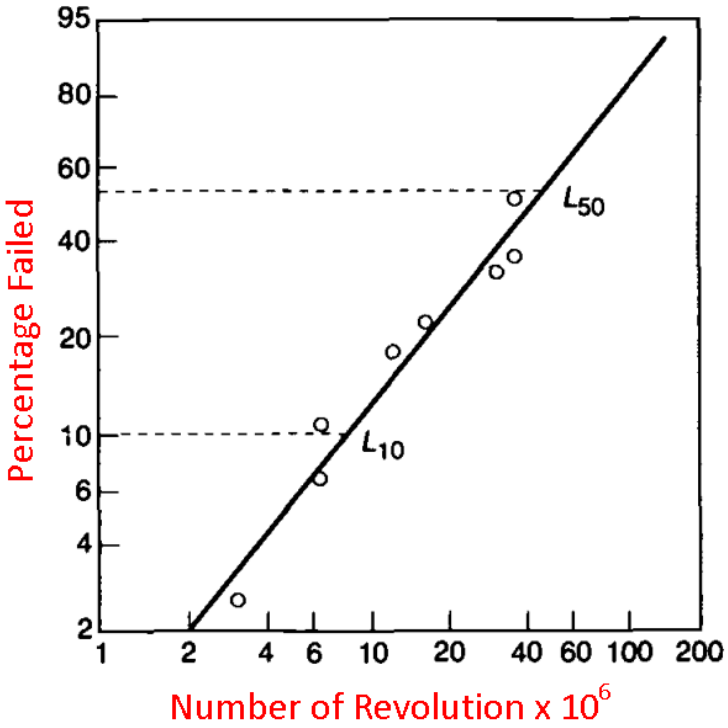
It is normal to run between 20 and 30 repeat tests in order to generate a statistically valid result, with the results plotted as a Weibull distribution.

To do this, start by re-ordering the lives to failure (in time, revolutions or number of fatigue cycles) in ascending order and then calculate the cumulative percentage failure. For example, if we had 20 samples in our test, we would plot:

Test Number	Revolutions to Failure	Percent Failed
6	10000000	5%
13	12500000	10%
5	13300000	15%
20	15700000	20%
etc	etc	etc

This would be for a test with twenty repeat runs, so one failure equals 5%, two failures, 10% etc.

Plot the cumulative percentage failure against the life (in time, revolutions or number of fatigue cycles) on Weibull coordinates. In this example, the cumulative percentage failed at 15700000 revolutions would be 20%.



The L10 and L50 lives of the samples are the lives at which, respectively, 10% and 50% of the samples will have failed, under the specified test conditions.

It will be apparent that there will be a maximum number of cycles at which all samples will have failed, in other words, unlike mechanical fatigue testing where, below a certain load, fatigue will not occur, with rolling contact fatigue, there will always be a limit to the number of cycles that the contact can run without failure, in other words, carry on long enough and all samples will eventually fail by rolling contact fatigue.