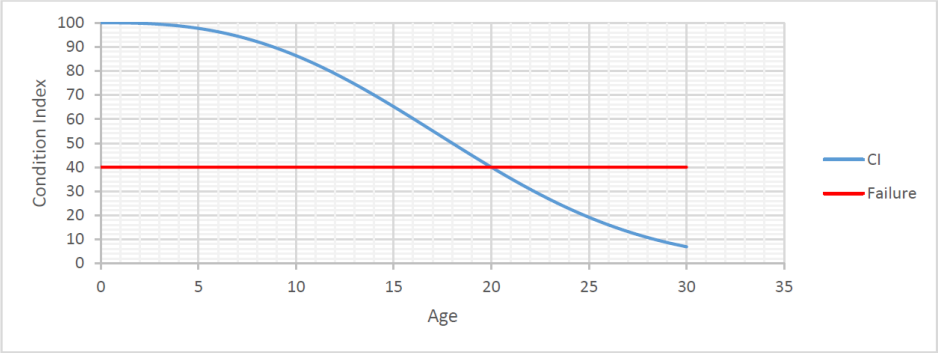
BUILDER Beta-Shift Parameter

Marcuccilli, Daniel H ERDC-RDE-CERL-IL CIV - 2020-11-19 - Comments (0) - BUILDER

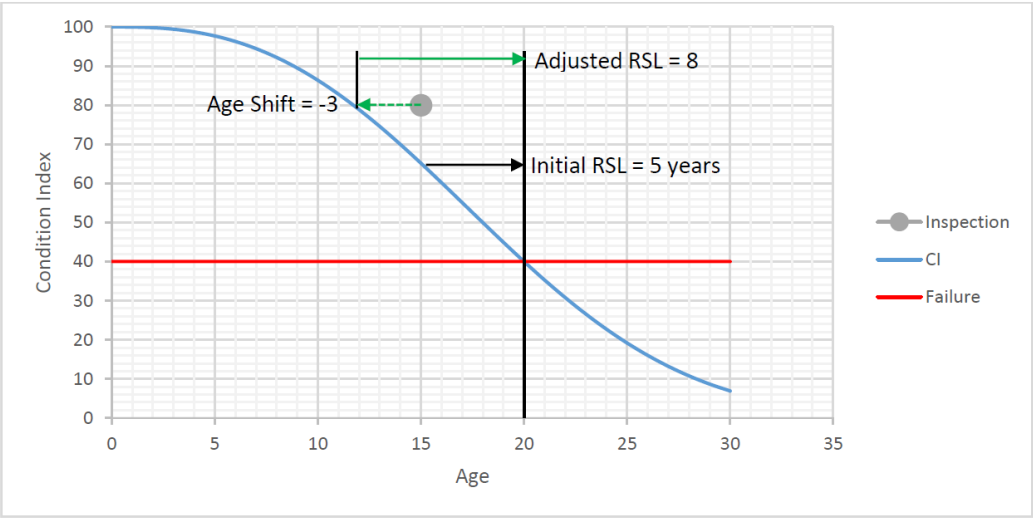
BUILDER Beta-Shift Parameter

Let’s say I have a component with a 20-year expected service life and a characteristic deterioration curve that looks like this:



The x-axis is the age of the component, and the y-axis is the expected condition index of the component at that age. Having this, if I know the age, I can forecast what the average expected condition index should be at that age.

Now say an inspector performs an inspection on this component when it is 15 years old and nearing the end of expected life and they rate the condition as A+ (CI = 80). If we plot this point on the curve above, we see that the inspection doesn’t fall right on the curve. In fact, the condition is better than we would initially expect and we see that the observed age appears to be about 3 years less than its actual age at the time of the inspection. So while the actual age is 15 years, the effective age from the inspection observation is 12 years.

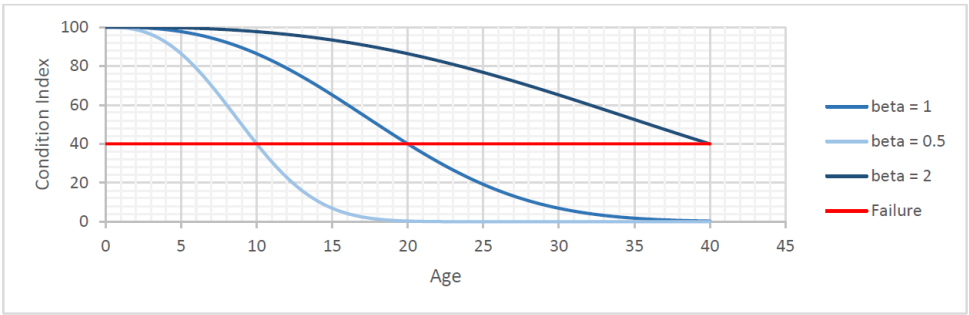


So the question is, projecting the condition forward from this point, do I trust the forecasts based on its actual age, or the forecast based on its observed age from the condition assessment. The degree of trust I put in each of these scenarios can be controlled with the beta-shift parameter.

The underlying equation that drives the curve above is based on a Weibull cumulative probability distribution function that takes the form:

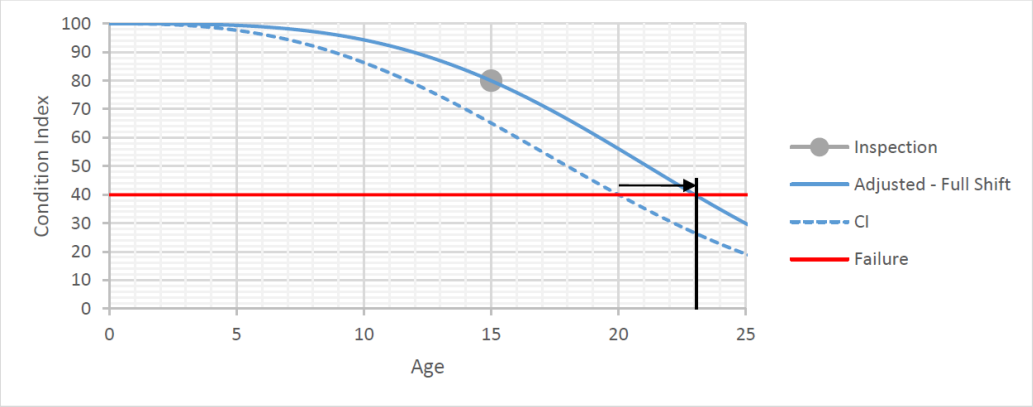
$$CI = A \times (100/CI_t) \wedge - ((t / beta) \wedge alpha)$$

The beta parameter in this equation is the service life adjustment factor. If beta is 1, then there is no adjustment from the initial expected service life. A beta value of 2 results in 2x the initial service life, and a beta value of 0.5 results in half the initial expected service life. See below:



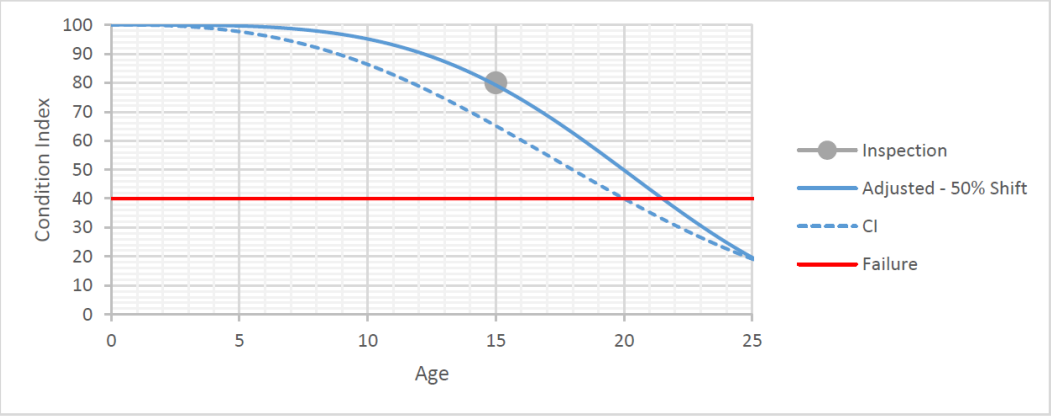
In the situation above the component is 15 years old, but has an

effective age of 12 years and an effective remaining service life based on the last inspection of 8 years. As a result, the adjusted expected service life is now 23 years versus 20, resulting in a beta value of 23/20 = 1.15.



This would be the beta value going forward for CI forecasting IF you completely trusted the effective age resulting from the inspection, and put no trust in the actual age based on its installation date. If on the other hand, you completely trusted the actual age regardless of what any inspections say, then beta would always stay 1 and there would be no adjustment.

However, if you wanted to weigh each of the assumptions equally (put some trust in the actual age and some trust in the observed condition), then you can apply a beta-shift parameter to control how much the beta value is allow to shift due to new inspection information. Let's say we set the beta shift parameter at 50%. So, while a full shift due to inspection would result in a 3 year service life extension,
the 50% parameter only allows half of this shift (1.5 years) to occur, resulting in a beta of 1.075. This is a less extreme shift that is dampened by the component's actual age.



Tags

Beta-Shift

CI

CI Value

Attachments

- BUILDER-Beta-Shift-1.pdf (367.33 KB)