CAUTIONARY TALES

Part IV Predicting Relaxation Performance

By Mark Hayes

Nearly all springs lose load or relax during their design life. When the loss of load is 2 or 3%, the spring often continues to operate almost as well as it did when it was new, but when relaxation is greater, then the loss of load can impair function. The more astute of the customers (and the number of these is increasing!) of the spring industry will specify that relaxation should not exceed x % over the y years that is the design life of the spring. Confronted with such a requirement what would you do if you have not got access to a databank of relaxation performances, such as the one at *IST*?

The purpose of this cautionary tale is to advise that you can do much better than make an educated guess. Testing relaxation performance is relatively easy – often a springmaker can do the testing themselves – without incurring great costs or wasting too much time.

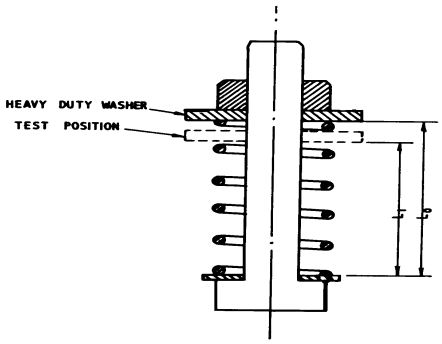
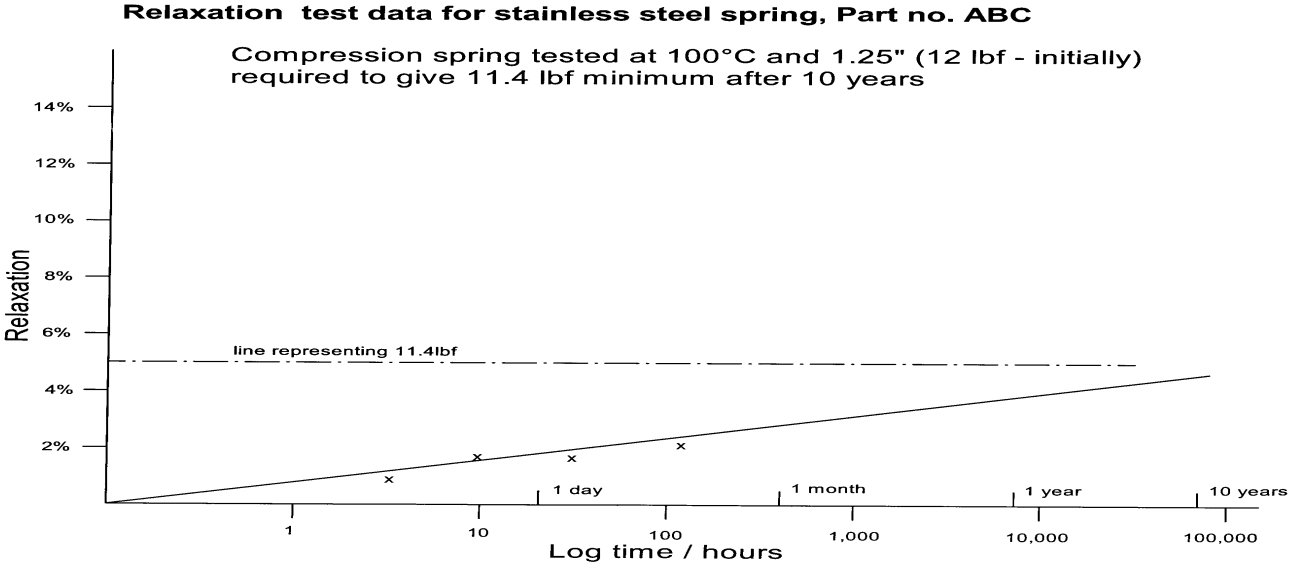


FIG. I. STRESS – RELAXATION APPARATUS.

For instance, testing a compression spring requires only a strong nut and bolt, a spring load tester and an oven if the spring is to be exposed to elevated temperatures. Relaxation testing involves load testing at the maximum service deflection, bolting up the spring and holding at that deflection and at the maximum service temperature for cumulative time periods of 3, 10, 30 and 100 hours. A load test at each of these time periods will show how the load is reducing, and if the data is plotted as % relaxation vs log time, the data will look like that on the graph below. Predicting relaxation for the design life involves simple (and safe) extrapolation. The example shown is for a stainless steel spring that will see service temperatures of 100°C maximum.



As can be seen the design requires 5% relaxation maximum over 10 years, assuming one tenth of the life of the springs is spent at 100°C – the relaxation at lower temperatures can be disregarded since it will be very small in comparison with that at 100°C. Armed with such a graph you would rightly be very confident in assuring your customer of the fitness for purpose of your product.

What if your test shows that your springs will not meet the customer's relaxation requirement? For compression springs, increasing stress relief temperature to near the maximum allowed for that material, and/or prestressing cold (or better still hot) is beneficial. Shot peening is detrimental. Use of stainless steel will give much better relaxation performance than any carbon or low alloy steel.

The last cautionary tale in this series pointed out how difficult it is to predict the fatigue life of torsion springs, so to make it clear that these tales are not all bad news, this one shows how easy it is to predict relaxation. For more information on this subject, the author will be giving a paper on relaxation at the Close the Loop II in Chicago in June, where he will be willing to answer your detailed questions on this or any of the Cautionary Tales. He will also demonstrate the first efforts to incorporate relaxation prediction into CAD spring design programs.

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