Tech-Spring Report 9
COMPRESSION SPRINGS THAT WORK IN PUSH-PULL MODE

Introduction

Most compression springs are compressed throughout their working life (the push-push mode) either working between two fixed lengths as in an engine valve spring or with variable deflection as in a vehicle suspension spring. A few compression springs are bolted at each end and work either side of their zero deflection position (the push-pull mode). Vibratory screen springs are of this type, and at one location at London's land fill site they fail at an unexplained high rate, some within weeks of installation.

Investigation of the cause of failure.

Failed springs were examined and found to fail by torsional fatigue within an active coil. Failure was always initiated at the inside coil position, but at almost any position in its length. A few springs fail because of loosening or fatigue failure of their fixing bolts, but the majority have no identified abnormality in use. They are hot coiled in manufacture and no fault with the microstructure or shot peened finish is identified in most instances. The work environment (although malodorous) did not appear to have influenced the failures either.

High Speed Filming

At the London site, Lake Image set up a high-speed camera to film the motion of the springs in use. Three visits to the site were made recording better footage of the movement of the springs on each occasion - an example (slowed down) being attached herewith. From this filming it was clear that the springs were experiencing dynamic deflections significantly greater than had been previously known by the company that designed and built the screening equipment i.e. ~80mm c.f. 55mm previously advised.

Laboratory Fatigue Testing

IST are only able to test these large springs in the push-push mode. Previous tests had shown no failures when tested at 57mm stroke. Further tests were done at 75mm and then 85mm stroke in the light of the high-speed camera tests. Again no failures, so it was decided to design and make a scaled down version of these double pigtail springs so that IST would be able to test them in both push-push and push-pull mode.

Further Laboratory Tests

The springs, made by Mollificio Mevis, were tested at a 30mm stroke in both the push-push mode and in the push-pull mode. No springs broke under these conditions. A different test machine was required at IST to test at a larger stroke. Initial tests on this new machine either loosened the bolts or caused them to fail by fatigue, thus mimicking accurately what happens in service.

Using larger bolts it was found to be possible to cause the push-push mode springs to fail by a torsional fatigue mechanism at a 35mm stroke, but the same springs tested in the push-pull mode did not fail.

A 40mm stroke was found to be necessary in the push-pull mode with the zero deflection position being approximately central to cause them to fail by fatigue, as shown in the following table of results.

Mode	**Test Stroke**	**Results**
Push-Push	30mm	Unbroken at 10 million cycles
Push-Push	35mm	Failed at 279k, 504k and 668k, 1 Unbroken at 687k
Push-Pull	30mm	Unbroken at 10 million cycles
Push-Pull	35mm	4 unbroken at 1 million cycles
Push-Pull	40mm	Failed at 244k, 305k, 495k and 754k

Conclusion

A push-push 35mm stroke and push-pull 40mm stroke are approximately equivalent in terms of risk of fatigue failure. This result requires further explanation, but should be of practical help in finding an engineering solution to the current problems of unreliability.

Recommendation

Academic work to explain the above results should be worthwhile - the next project meeting should decide about this. Attempts to test compression springs in which both ends are moving should be made - all the above tests have one end still, whichever mode of testing was used.