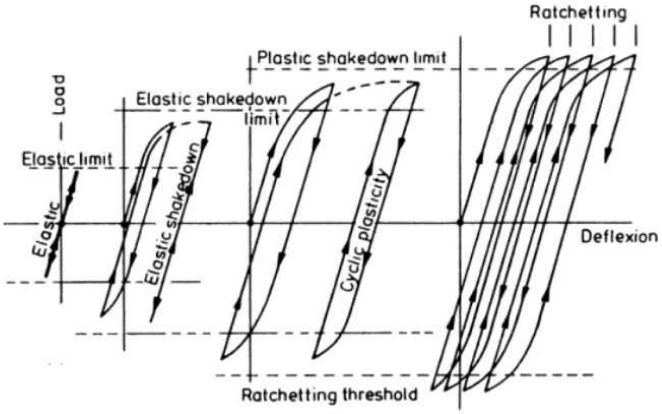
Guidance – Running-in of Rolling Contacts

Extract from:

https://www.phoenix-tribology.com/wp-content/uploads/products/guidance/Tutorial-Rolling-Contact-Fatigue-Testing.pdf

Importance of Running-in



The influence of repeated loading, residual stresses and shakedown on the behaviour of tribological contacts

J. Williams - Tribology International 38 (9) (2005) 786-797

PLINT Tribology Products from Phoenix Tribology Ltd

In rolling contacts and rolling element bearings, "shakedown" refers to the initial running-in stage where, providing the contact pressure is not too high, microplastic deformation and work hardening occur. This leads to a buildup of residual stress and a subsequent increase in the contact's ability to withstand cyclic loads. After this shakedown stage, the bearing material can behave elastically, under loads above those associated with the initial, pre-shakedown, elastic limit. The material has become harder and stronger.

Residual stresses are stresses that remain in the material even when the external load is removed. After “shakedown”, the load experienced by the material is subjected to both contact stresses and the residual stresses introduced during the “shakedown” process. At this point, further plastic deformation ceases to be possible, and the material achieves a steady state running condition, which is a necessary pre-condition for any subsequent rolling contact fatigue test. This running-in process is referred to as “elastic shakedown”.

The "elastic shakedown limit" represents the highest stress that can be applied to the contact without inducing macroscopic plastic deformation. The steady state running condition can only be reached if the stress induced from loading is below the "elastic shakedown limit".

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If the load during initial running-in exceeds the "elastic shakedown limit", each load cycle will result in a combination of elastic and plastic deformation in a process termed "plastic shakedown". If the load remains below the "plastic shakedown limit", in due course, the material response becomes one of steady state cyclic plasticity. Increasing the load during running-in still further results in progressive plastic ratchetting of the surface leading to premature failure; steady state conditions can never be achieved.

In a bearing, "elastic shakedown" typically takes between 10^4 and 10^5 cycles and the "elastic shakedown limit" is typically considered to be around 2 GPa.

The elastic behaviour of materials under rolling contact is crucial for predicting the fatigue life of components. It follows that, **after satisfactory running-in, subsequent rolling contact fatigue testing should be carried out under primarily elastic contact conditions**.