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Reliability modeling of Transport Systems: Influence of the Running-in Period of Life

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Abstract

Improving reliability in the context of transportation is of great importance. The running-in period allows material to increase its life duration and therefore its availability. This means the modelling of early failures, considering the specific distributions of failure time. Unlike the exponential distribution which is used for random failures, these distributions must have at least two parameters. Despite the fact that the log normal and normal distributions are frequently used to model the effects of aging, the Weibull distribution is probably the most universally used. With it, we can model the early and random failures as well as the effects of aging. The Weibull distribution (3 parameters) describes the situations in which some time t_0 must pass before a failure happens. It is equal to a two-parameter distribution with a right to a translation. This work consists of modelling the influence of running-in time over the duration of additional life.

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1. Introduction

The reliable assessments of mechanical systems are based on many parameters where the failure rates are the first considered. By default, databases are commonly used for reliability. For the most part, are collections of data [1] [2] and [3] and many others from the feedback experience for various sectors. Potential users of these are based on the fact that their materials are substantially similar and that the reliability of these databases can be transferred to their concerns. One can observe that the data of studied

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systems reliability are not homogeneous, as is sometimes suggested significant variations of the failure rates between bases. The causes are many: Materials have their own characteristics. Same type of system comes in a range of equipments whose reliability is different; operating conditions and operating environment vary between systems. Reliability of mechanical equipment is sensitive to loading, operating modes, stresses, failure modes considered, maintenance politicizes… These differences are highlighted between the sectors; to synthesize the data collected for each type of system often requires regrouping irrespective equipments to various intrinsic and extrinsic properties, regardless of characteristics. The use of these databases as input data of reliability assessments will therefore result in large uncertainties about the relevance of the results. The second point to be noted is that all the databases described above only provide constant failure rates. However, the mechanisms of degradation of mechanical components such as fatigue, vibration, la corrosion and other stresses creating wear phenomena, therefore the system ages. To this a running-in phase that usually causes failures in young systems can be added. In what follows, the running-in phase is to be modeled in order to highlight its importance in the total lifetime of the mechanism. The example cited in this study is the case of bearings that are virtually present in the majority of mechanical systems. Although their lifetime is relatively short compared to the entire mechanism in which are mounted, but their running-in phase provides a significant mechanical stability [4].

2. Failure rate base λ(0)

It has been seen earlier that the mechanical equipments rarely respond to a constant failure rate, synonymous with exponential probability distribution. Here, a model by the Weibull distribution with two parameters has been proposed. The failure rate is expressed as follows:

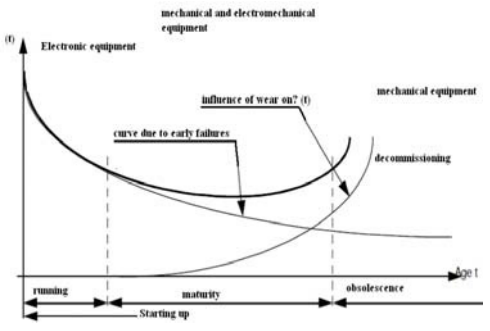

Fig. 1.a: failure rate λ0 (t) [5]

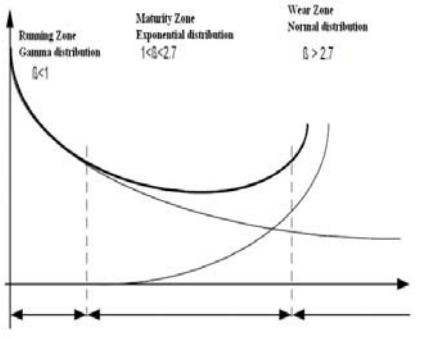

Fig. 1.b: distribution law [5]

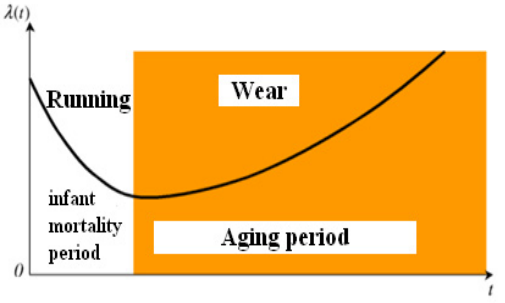

Fig. 1.c: failure rate of a mechanical system [6]