

一种新的“并行升降法”及其在疲劳实验研究的应用

姜青青, 谢季佳², 孙成奇, 洪友士*

(中国科学院力学研究所 非线性力学国家重点实验室, 北京 100190)

摘要: 升降法是用于敏感性实验的重要方法。在疲劳研究领域, 升降法通过敏感性实验和参数估计, 给出指定寿命下疲劳强度的分布, 或是指定应力下疲劳寿命的分布。1948年 W.J. Dixon 和 A.M. Mood 提出该方法的一种估计方法, 被广泛引入各国的疲劳实验数据统计分析的国家标准。然而, 由于在传统升降法中, 后一个试样的加载应力需要根据前一个试样的实验结果而定, 所以实验要依次进行。当应用于超高周疲劳范畴, 其耗时将特别长。本文将传统的升降法进行改进, 提出了一种新的并行升降法, 并给出了估值方法。该方法在不降低估计精度的前提下, 显著减少了实验所需时间(以 30 件样品为例, 可将实验周期减少至原周期的 1/3), 并用 Monte Carlo 方法进行了分析和验证。应用这种新的升降法对一种合金钢的疲劳强度进行了测试, 在较短的时间内就得到了结果。

关键词: 升降法, 超高周疲劳, Monte Carlo 方法

A NEW PARALLEL STAIRCASE METHOD AND ITS APPLICATION IN FATIGUE EXPERIMENTAL RESEARCH

Jiang Qingqing, Xie Jijia, Sun Chengqi, Hong Youshi

(State Key Laboratory of Nonlinear Mechanics, Institute of Mechanics, Chinese Academy of Sciences, Beijing 100190, China)

Abstract: The staircase method is an important method used for sensitivity experiment. In fatigue study, fatigue limit under a certain life or fatigue life under a certain stress level can be obtained by this method with parameter estimation. W.J. Dixon and A.M. Mood proposed an valuation method to deal with the experimental data based on staircase method, which is used in the national standards of many countries. However, for traditional staircase method, the following loading force relies on the previous one, so samples must be tested one by one. When used in very-high-cycle-fatigue, the total time will be very long. Here, a new parallel staircase method is proposed, which is a modification from traditional one-by-one staircase method to parallel style staircase method and the valuation method is given. This new method will shorten experimental period markedly with valuation accuracy unchanged (2/3 period is saved for a group of 30 samples). Monte Carlo method is used to analyze and verification the accuracy. Fatigue limit of an alloy steel is tested with this new parallel staircase method, experimental result is obtained in a short period of time.

Keywords: staircase method; very-high-cycle fatigue; Monte Carlo method

本文通讯联系人: 洪友士, 北京 100190, 中国科学院力学研究所