Materials Science Forum
ISSN: 1662-9752, Vol. 1141, pp 35-40
doi:10.4028/p-rYw4RJ

Submitted: 2024-05-28
Accepted: 2024-10-20
Online: 2024-12-20

Analysis of Experimental Studies of Titanium Alloy

Medved Ivan[1,a], Rashkevich Nina[2,b*], Otrosh Yurii[2,c] and Tomenko Vitalii[3,d]

[1]Vladimir Dahl East Ukrainian National University, Central Avenue, 59-a, Severodonetsk, Ukraine, 93400

[2]National University of Civil Defence of Ukraine, 94, Chernishevska str., Kharkov, Ukraine, 61023

[3]Cherkassy Institute of Fire Safety of National University of Civil Defence of Ukraine, 8, Onoprienko str., Cherkassy, Ukraine, 18034

[a]lw.medwed@gmail.com, [b]rninav@nuczu.edu.ua, [c]otrosh@nuczu.edu.ua, [d]firech1996@gmail.com

Keywords: mathematical model, mathematical planning methods, low-cycle fatigue, titanium alloy.

Abstract. When predicting the service life of a material, it is important to take into account its mechanical characteristics. The authors have developed a mathematical model that describes the dependence of titanium alloy durability on cyclic loads. The research tool was the "Solution Search" add-in of the Microsoft Excel spreadsheet program. Regularities and dependencies have been established, which help to improve the understanding of damage mechanisms of titanium alloys. It is proved that the temperature of preliminary plastic deformation does not influence the durability of titanium alloy PT-3V. The developed model can be used to optimize loading regimes and improve the performance characteristics of titanium alloy building structures.

Introduction

The durability of building structures depends on the operating conditions [1, 2]. Taking into account factors such as cyclic loads and temperatures is critical to ensure sustainability [3, 4]. Cyclically varying loads account for the bulk of damage. The residual service life is calculated using mathematical models and numerical modelling methods, taking into account the results of diagnostics and analysis of operating conditions, as well as the characteristics of the materials from which the structures are made [5]. Based on the data obtained, the residual service life of structures is predicted, which allows us to plan repair work and determine the optimal operating modes to extend their service life [6, 7].

Thus, the assessment of the influence of the load history on the cyclic strength of structural material is an urgent scientific and technical task, the solution of which requires additional comprehensive experimental and theoretical studies [8].

Analysis of Publications

The search for optimal solutions is based on mathematical programming methods [9, 10]. Mathematical programming involves the use of various models [11, 12]. The model is an analytical dependence of the objective function on the dependent (controlled) variables, the numerical values and range of which are set based on the actual operating conditions of the material [13, 14].

One of the mathematical programming methods is implemented in the Solution Finder add-in for Microsoft Excel [15, 16]. It can be used to find the values of controlled variables at which the objective function takes the optimal (maximum or minimum) numerical value. Optimisation parameters depend on specific conditions [17, 18].

In [19], the value of the bending moment in an arbitrary section was used as an optimisation criterion. The results showed the optimal combinations of external loads that can be used at the stage of selecting the parameters of the design scheme of a structure. The Solution Finder add-on allows you to perform complex calculations and solve optimisation problems directly in spreadsheets. The results of solving problems are the basis for developing management decisions to extend the service life of structures and reduce the risk of accidents [20, 21]. This ensures safe operation and efficient