Engineering Failure Analysis 18 (2011) 1477–1486

Contents lists available at ScienceDirect

Engineering Failure Analysis

journal homepage: www.elsevier.com/locate/engfailanal

Analysis of the stress state of multilayer pressed joints

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ARTICLE INFO

Article history:
Received 1 February 2011
Received in revised form 26 April 2011
Accepted 10 May 2011
Available online 18 May 2011

Keywords:
Pressed joint
Stress
Strain
Pressure
Strain gage

ABSTRACT

This paper presents the results of analytical, numerical and experimental research of the stress–strain states of multilayer pressed joints in the field of elastic deformations. Suitable numerical (FEM) and analytical models were developed, in accordance with the small elastic deformations hypothesis, for analysis of the stress–strain state of multilayer pressed joints. Numerical and analytical research results were verified experimentally, using tensiometric measurements (strain gages) in laboratory conditions on real models. The purpose of such investigations was to clarify the cause of a fan shaft failure in the fossil fuel power plant.

1. Introduction

In the process of designing a mechanical system, the quality of joints between its components has a significant impact on its technical and economic characteristics. Use of joints can substantially simplify the complicated technical solutions through constructing a number of simple components and joining these into a functional unit. Joints enable easier assembling and disassembling of complex structures on their way from the production plant to the installation site, as well as during their periodic overhauls. This results in an increased economic efficiency of mechanical systems. To ensure a maximum utilization of such positive effects, joints must not be a weak point in a mechanical system. For that reason their structural solutions and appropriate mathematical models have been thoroughly studied and permanently improved.

The comprehensive range of different types of joints includes the multilayer pressed joints as well. A complex stress state, along with the numerous influential factors of stochastic nature (including the friction coefficient, roughness of contact surfaces, tolerances for linear measures, shapes and position of coupled components) require complex mathematical models for the analysis of their operating capacity. The investigations of pressed joints conducted so far have mainly focused on determining the most reliable data on the friction coefficients (both static and kinematic), as well as on studying the impact of the contact surfaces roughness on the load-bearing capacity of the pressed joints [1–3]. Stressed state and operating capacity of large pressed joints are presented in Ref. [4]. Parameters which are responsible for failure of bushings of large press joints were determined on the basis of theoretical and experimental investigations.

The multilayer pressed joints subjected to variable elastic deformations are sensitive to the occurrence of fretting [5,6]. The autofrettage of thick-walled cylinders with variable thickness is considered on the basis of a variational formulation of

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doi:10.1016/j.engfailanal.2011.05.002