Engineering Failure Analysis 18 (2011) 1308–1321

Contents lists available at ScienceDirect

Engineering Failure Analysis

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

Failure analysis and effects of redesign of a polypropylene yarn twisting machine

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ARTICLE INFO

Article history:
Received 17 November 2010
Received in revised form 21 March 2011
Accepted 28 March 2011
Available online 1 April 2011

Keywords:
Failure analysis
Vibration
Fracture
Design
FEM analysis

ABSTRACT

Presented in this paper are the results pertaining to technical condition diagnostics, redesign, and analysis of its effects for a complex mechanical system of a polypropylene yarn twisting machine. Twelve twisting machines were installed on a polypropylene yarn production line. Due to design flaws and manufacturing errors, the winches were soon prone to failures and an unacceptable level of vibrations. Owing to insufficient structure rigidness, errors in design, manufacturing errors, and a high level of vibrations, the majority of twisting machines developed cracks in their foundation framework. FEM analysis was used with experimentally measured displacements in the crack zone to define stress distribution. Also shown in this paper is the method for measurement and analysis of the vibration signal during the winch run-up, with the aim to determine resonance zones and a condition analysis of the twisting machine framework. In order to make the winches fully operational, a redesign of the mechanical structure was performed. The level of vibration was measured again at the characteristic framework parts, and FEM analysis of the foundation framework was used to analyse the effects of the redesign. The vibration measurements and the results of FEM analysis proved that the redesign was successful, showing that the measures undertaken made this system fully operational again.

1. Introduction

The determination of complex technical systems and the causes of the breakdown of their components is a multifaceted problem which requires an interdisciplinary approach [1]. Engineering analyses (FEM analysis, modal analysis, thermal analysis, and other methods) sometimes fail to provide sufficient information for a valid conclusion as to the cause of a breakdown. For this reason, the analysis of complex, real-life designs sometimes requires a combination of numerical and experimental methods. Some typical examples of such combination of methods in analysis of complex mechanical structures are given by Ref. [2–5]. This paper reviews the results of investigation on diagnostics of real-life mechanical structures and their proposed redesign. Trebuna et al. [2] analysed a press frame failure with the aim to propose an optimal variant of its strengthening. Witek et al. [3] described the fracture problem of the turbine casing of a helicopter engine. Goksenli and Eryurek [4] analysed a failure analysis of an elevator drive shaft. Poursaeidi and Mohammadi Arhani [5] presented the results of a failure investigation of an auxiliary steam turbine in a power plant. One common feature of these investigations is that their stress analysis of the mechanical structure is based on the known load values, which is not the case in this study.

Many rotating machines may be considered as consisting of three major parts: the rotor, the bearings and the foundations [6]. With the majority of rotating machines the influence of foundations on machine dynamics is very important. With a

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doi:10.1016/j.engfailanal.2011.03.020