Case Studies in Engineering Failure Analysis 4 (2015) 100–103

Contents lists available at ScienceDirect

Case Studies in Engineering Failure Analysis

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

Case study

Failure analysis of a motor-car coil spring☆

Ladislav Kosec [a], Aleš Nagode [a,*], Gorazd Kosec [b], Dušan Kovačević [c], Blaž Karpe [a], Borut Zorc [a], Borut Kosec [a]

[a] University of Ljubljana, Faculty of Natural Sciences and Engineering, Aškerčeva 12, 1000 Ljubljana, Slovenia
[b] Acroni, d.o.o., Cesta Borisa Kidriča 44, 4270 Jesenice, Slovenia
[c] University of Novi Sad, Faculty of Technical Sciences, Trg Dositeja Obradovića 6, 21000 Novi Sad, Serbia

ARTICLE INFO

Article history:
Received 22 May 2013
Accepted 5 December 2013
Available online 28 December 2013

Keywords:
Motor-car coil spring
Corrosion
Fatigue
Rupture

1. Introduction

A motor car coil spring of a rear shock absorber has been ruptured during car operation. The surface of a spring was protected against corrosion with a thick layer of paint on polymer basis. Around the fracture surface, a protective layer was damaged and removed over a length of several centimeters. In this area, spring has long been exposed to corrosion attack and thus surface heavily corroded and winkled (Fig. 1).

The fracture surface of a spring is discontinuous and in major part of it covered with fresh rust. On a minor portion of a fracture surface, a compact, dark brown rust (like on the circumference of the spring) is visible, which was formed substantially (months) before the final rupture of the spring (Fig. 2). From this part of the fracture surface, crack gradually propagated (the "arrest lines" are clearly visible), due to the combination of corrosion attack and cyclic loading during the car operation (Fig. 3), until the length of the crack reached its critical value, and the spring broke instantly (Fig. 4).

Part of the fracture surface, covered with thick, compact and dark rust is the primary crack, which was exposed to corrosion attack for months. Part of the fracture surface (Fig. 5), where a layer of compact surface rust and indentations of rust into the material are clearly visible represents a propagating stage of a fatigue and part of a surface (Fig. 6), which is covered with thin fresh rust (formed in a few days after final rupture) the terminating stage of the fatigue.

* Corresponding author. Tel.: +386 1 2000 433; fax: +386 1 4704 560.
E-mail address: ales.nagode@omm.ntf.uni-lj.si (A. Nagode).

2213-2902/$ – see front matter
http://dx.doi.org/10.1016/j.csefa.2013.12.004

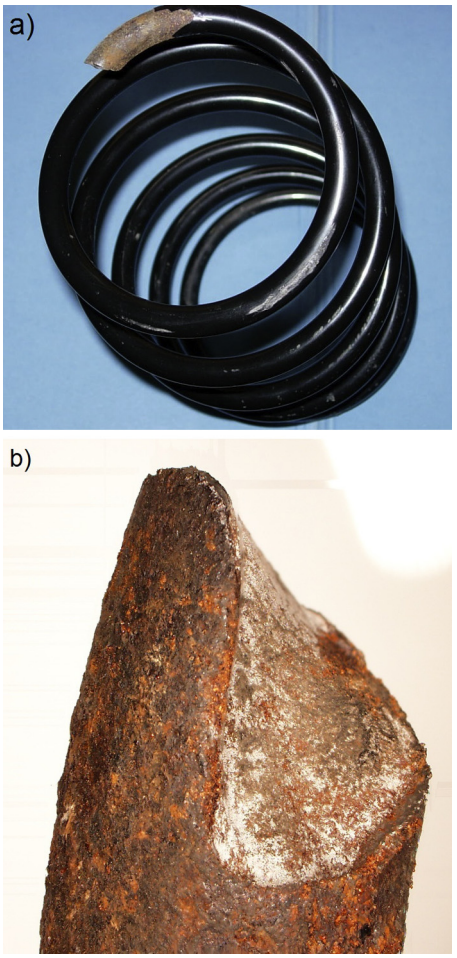

Fig. 1. Damaged motor-car coil surface (a) and corroded fracture surface (b).

2. Failure origin

Rupture of the coil spring is considered as a failure due to corrosion induced fatigue. Corrosion fatigue caused simultaneous action of corrosion, due to damaged protective layer, and cyclic loading [1,2]. From one of the corrosion induced indentations, crack propagated through the material and led to the final rupture of the spring [3].

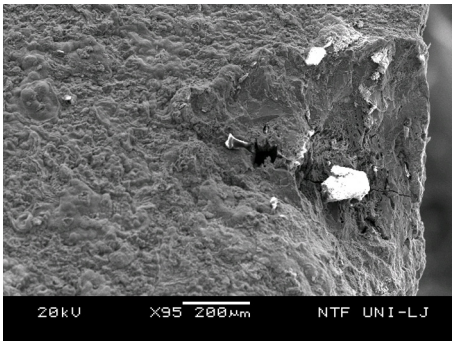

Fig. 2. The fracture initiation surface of a coil spring, covered with corrosion products and secondary cracks.