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ORIGINAL ARTICLE

Failure analysis of vise jaw holders for hacksaw machine

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Abstract Failure analysis in mechanical components has been investigated in many studies in the last few years. Failure analysis and prevention are important functions in all engineering disciplines. Materials engineers are often the lead role in the analysis of failures, where a component or product fails in service or if a failure occurs during manufacturing or production processing. In any case, one must determine the cause of the failure to prevent future occurrences and/or to improve the performance of the device, component or structure. For example, the vise jaw holders of hacksaws can break due to accidental heavy loads or machine misuse. The parts that break are the stationary and movable vise jaw holders and the connector power screw between the holders. To investigate the failure of these components, a three-dimensional finite element model for stress analysis was performed. First, the analysis identified the broken components of the hacksaw machine. In addition, the type of materials of the broken parts was identified, a CAD model was built, and the hacksaw mechanism was analyzed to determine the accurate applied loads on the broken parts. After analyzing the model using Abaqus CAE software, the results showed that the location of the high stresses was identical with the high-stress locations in the original, broken parts. Furthermore, the power screw was subjected to a high load, which deformed the power screw. Also, the stationary vise jaw holder was broken by impact because it was not touched by the power screw until the movable vise jaw holder broke. A conclusion is drawn from the failure analysis and a way to improve the design of the broken parts is suggested. © 2016 The Authors. Production and hosting by Elsevier B.V. on behalf of King Saud University. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

1. Introduction

For striving for excellency the finite element usage is not limited to the engineering field but also extends to medical and geospatial applications. Rapid advancement in finite element is due to powerful computer processors and continuous software development. In recent years the use of finite element in engineering was enormously increased. Key factors in finite element analysis (FEA) are numerical computations that calculate all parameters and boundaries given.

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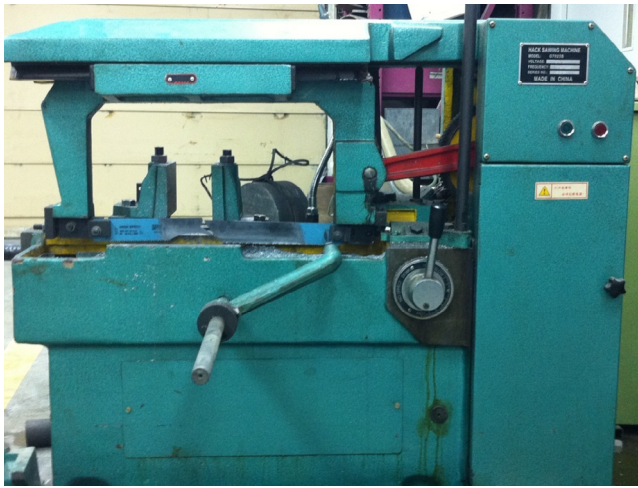


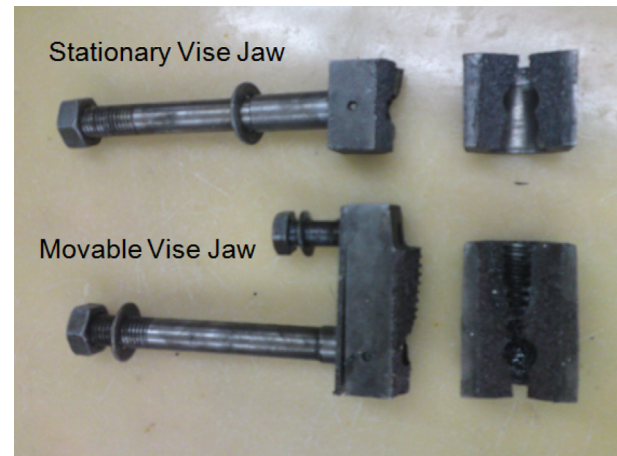
Figure 1 A reciprocated hacksaw machine.

A comprehensive broad understanding of many different failure modes that exist for any given system will be the key for analyzing any failure of mechanical components. Spanning a wide range of applications, such as steam turbine engines, gas turbine engines, plastic structures, machine tools and fixtures, compressors, office equipment, pumps, turbine blades, rotating shafts heating tans, exhaust hoods rotors, turbines, impellers, and support structures would solve the failure analysis for industrial equipment components (ABAQUS, 2012). Fatigue is the gradual deterioration of a material when subjected to repeated loads, normally separated into three stages: crack initiation, crack propagation (power law growth) and unstable, rapid growth. The average of the maximum and minimum is the mean stress key factor and the variation (difference between the maximum and minimum) in components. For alternating fatigue situations most data have been developed for fully reversing an application; however, there are techniques for applying these data.

The designers of machines or structures must achieve acceptable levels of performance and at the same time, assure the part is safe and durable. Therefore, it is necessary to avoid excess deformation, such as bending, twisting, or stretching, of the machine's components. In addition, cracking in components must be avoided entirely to prevent the crack from progressing to the point of complete fracture (Leonel et al., 2011).

To avoid structural failure, the stress in a component must not exceed the strength of the material, where the strength is simply the stress that causes a deformation or fracture failure. Failures in mechanical structures occur due to various reasons. Boyer et al. (1975) showed that failures could occur due to mechanisms and environmental factors. He also suggested that failure analysis of a metal structure requires identifying the type of failure mode. The failure mode is classified as either a deformation or fracture. Layer et al. (2002), Irisarri and Silveria (2010) concluded that the process of identifying a failure mode is complicated because different techniques can be used to determine the actual cause of failure.

Linder and Armero (2009), they are concerned with the numerical modeling of crack branching in brittle materials using finite elements with embedded strong discontinuities, that is, discontinuities in the displacement field defining the solution of the underlying boundary-value problem. In



(a) Broken stationary and movable vise jaw holders



(b) Deformed power screw

Figure 2 Broken parts of the hacksaw machine.

particular, new finite elements are developed in this framework accommodating the different branches of the bifurcating discontinuity in the element interior. The key aspect of these developments is the correct representation of the kinematics of these configurations. This is accomplished through the identification of the proper separation modes characterizing these solutions and their incorporation in the discrete strain field of the finite element. The resulting enhanced modes are activated based on a branching criterion depending on the velocity of the crack tip. The performance of the new elements is illustrated with several numerical simulations involving other approaches for the treatment of branching and comparisons with available experimental results.

Travaš et al. (2009), investigated the influence of loading rate on the failure mode of the beam parametric. The numerical results are evaluated, discussed and compared with test results known from the literature. It is shown that the beam resistance and failure mode strongly depend on loading rate. For lower loading rates beam fails in bending (mode-I fracture). However, with increasing loading rate there is a transition of the failure mechanism from bending to shear. Results are in good agreement with theoretical and experimental results known from the literature.

The reason of the crankshaft fracture of the air compressor has been analyzed through the chemical composition, mechanical properties, macroscopic feature, microscopic structure and theoretical calculation methods. The analysis results show that

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