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FINITE ELEMENT ANALYSIS OF AUTOMOTIVE RIVETED CLUTCH DISC

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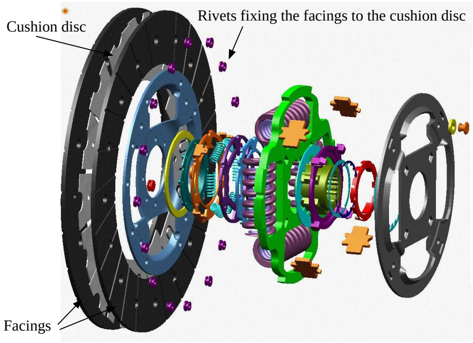
ABSTRACT

Car manufacturers requirements for greater power transmission, lightweight, low cost design, smaller design space, high comfort and high effectiveness lead to develop optimized clutches components. In this work we are interested in an automotive clutch system that permits the coupling and decoupling of motor and transmission during the gear change. One of the most important components used in this process is the friction disc (Fig. 1) that allows a soft gradual re-engagement of torque transmission. This progressive re-engagement obtained by the friction disc characteristics in the axial direction preserves the driver's comfort and avoid mechanical shocks. The axial elastic stiffness of this component is obtained by a cushion disc which is a thin wavy shell, located between the two facings and fixed by rivets (Fig. 2). It acts like a spring allowing a soft gradual re-engagement. This axial nonlinear stiffness is obtained by cutting the cushion disc into paddles and forming them to get a wavy shape. The axial nonlinear elastic stiffness of the cushion disc is described by the cushion curve (Fig. 3) [1]. This load-deflection curve gives the axial load versus axial displacement obtained by crushing a cushion disc between two flat pressure plates. This experimental test validates a cushion disc.

The objective of the present work is to model the cushion curve of the riveted assembly (cushion disc, rivets and riveted facings) in order to predict the behavior of a mounted friction disc, decreasing the number of prototypes, experimental tests and reducing development costs. The difficulty to realize a FE Model (Fig. 4) is due to the complex wavy shape of the disc that generates variable contact areas during the compression phase. The elastic springback which occurs after the forming process of the disc and the facings affects the geometry accuracy and alters the FE analysis results. The riveting process induces a complex response of the system, affected by clamping force, clearance, geometry defaults and other phenomena [2], [3], [4]. In this article, we will first detail the friction disc Finite Element Model. We will then present a sensitivity study on the different modeling parameters (contact stiffness and penetration, friction coefficient, material properties, riveting clearance and clamping force influence). We will also



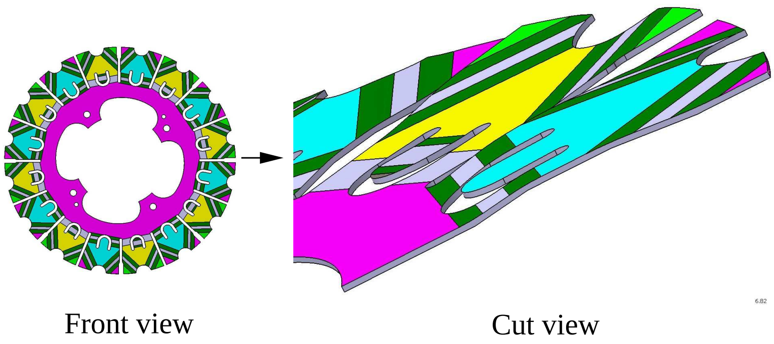
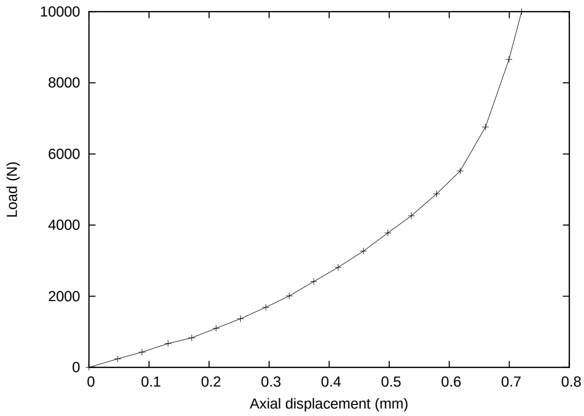


Figure 1: Detailed design of the friction disc.

Figure 2: Cushion disc.



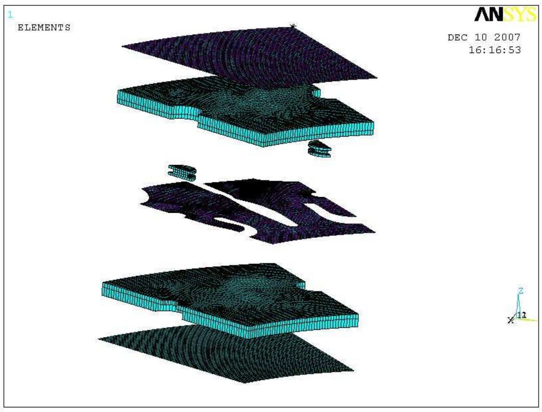


Figure 3: Cushion curve of the disc.

Figure 4: Riveted disc FE model.

study the geometric variation influence of facings, rivets and their combination, demonstrating that mastering the geometric variations due to the process is of prime importance for correlating the cushion curve with experience. On another side, the high level of contact pressure applied by the cushion disc on each facing, causes it to penetrate into the facing degrading the cushion curve stability. In order to minimize this phenomenon, we will propose a methodology for predicting contact pressures and confront it to experimental measures. This work would allow us to establish design rules for riveted friction discs in term of stability.

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