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Investigating Vibration Behavior of Cover Clutch of Passenger Automobiles

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ABSTRACT

In the present article, main purpose is to determine natural frequencies and shape modes of cover clutch of different passenger cars (Tiba and Peugeot) by using finite element method (FEM). The simulations are carried out for two types of cars with free-free conditions in ANSYS WORKBENCH software. Results are presented as Tables and Diagrams stating natural frequencies of different automobiles and compared shape modes. The results indicate that natural frequencies Peugeot are upper than Tiba for materials st-14 and critical area on the both model is seat bolt.
Keywords: Natural Frequencies, Cover Clutch, Passenger Car, Tiba, Peugeot

I. INTRODUCTION

Automobile friction clutch is an essential component in the process of power transmission and its proper performance got a direct effect on vehicle performance in driveline section at automotive industry. Therefore all designers want to obtain the best possible performance with comfortable condition (reduce the noise and vibration as much as possible) for the friction clutches.
The vibration and noise generated during the engagement is one of the biggest obstacles faced designers; this is because there are many variables that affected on this phenomenon such as pressure distribution, coefficient of friction, materials properties, and sliding velocity …etc. For that reason, it's very important to estimate the natural frequencies of clutch disc, cover clutch and the corresponding modal shapes within acceptable degree of accuracy at the design stage.
Gaillard et al. performed dynamical analysis of clutch damper of car and the dependence of dynamical parameters to frequency and excitation amplitude that a 4 DOF model has been suggested for clutch, gearbox and flywheel [1]. Tsujiuchi et al. investigated the effect of the clutch dampers on driveline's rattle in idle state [2].

Li et al. discussed velocity-dependent amplification in ground car's drivelines during start-up process. A modern nonlinear model of a multi-staged clutch damper is developed and is successfully validated by a transient experiment, then a SDOF is extended by incorporating a multi-staged clutch damper model, and it is used to examine the velocity-dependent amplification process during the engine begin [3].

Abdullah et al. studied vibration analysis of the friction clutch disk using FEM. In this work, performed modal analysis to calculate natural frequencies and derivation its mode shapes for clutch disk [4]. Esfahani et al. investigated longitudinal vibrations analysis of vehicular clutch [5].

Shendkar et al. accomplished natural frequency and mode shape analysis of diaphragm spring of clutch in automobiles and compared FEM results with experimental data [6]. Anstatt et al. investigated clutch pedal vibration and counter measures [7].

II. METHODS AND MATERIAL

A. Modeling

At the first step, has been provided clutch of the two certain vehicles completely and decomposed to different parts such as cover clutch, clutch's disc, strap plates, springs and etc. in the next step, extracted all points of outside surfaces of different cover clutches by using CMM 3D scanner and imported to the CATIA as a optic files, so modelled 3D geometry of covers in the software like Figure.1 and Figure.2.

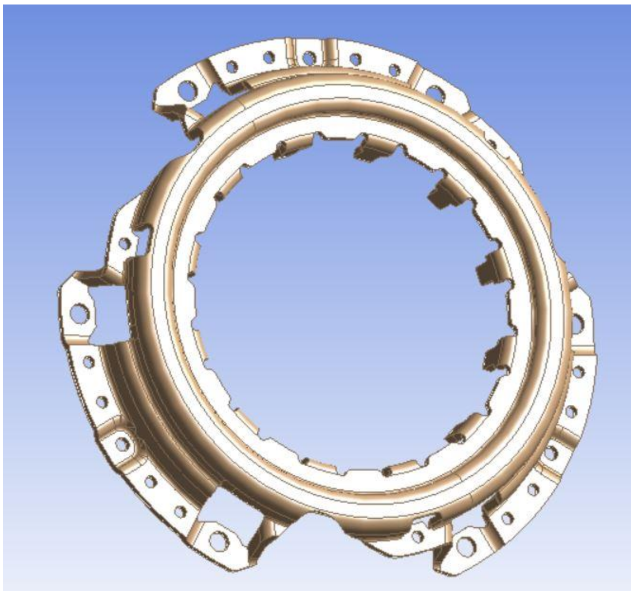

Figure 1 : Geometrical model of cover clutch of Tiba

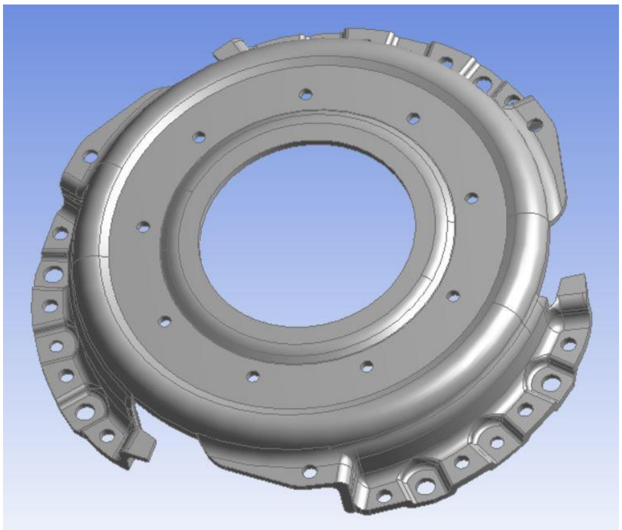

Figure 2 : Geometrical Model Of Cover Clutch Of Peugeot 405

B. Material

In the present work, used st14 [8] with mechanical properties according to Table.1 and stress-strain diagram shown as Fig.3

TABLE.1

MECHANICAL PROPERTIES OF ST-14

MATERIAL	**ST-14**
YIELD STRESS (MPA)	220
TENSILE STRESS (MPA)	270-350
ELONGATION (%)	36.0
HARDNESS	<=50 HRB
ELASTIC MODULUS (GPA)	200
DENSITY (KG/M3)	7850
POISSON'S RATIO	0.31
MELTING TEMP**ERA**TURE (C)	1500
SPECIFIC HEAT	490
THERMAL CONDUCTIVITY	46
THERMAL EXPANSION	12

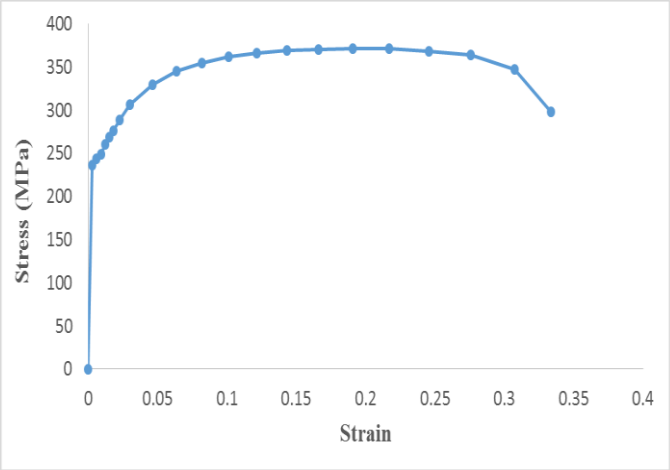

Figure 3 : Stress-Strain curve of St14

III. RESULTS AND DISCUSSION

Using modal analysis to obtain natural frequency and its shape mode. So if the structure is not completely constrain, on the other hand, there are insufficient conditions (Free-Free condition in the present work) appear rigid mode and the value of frequency are equal zero. The natural frequency of a structural is always increasing.

The First 12 natural frequencies of both geometries are calculated and reported as Table 2

TABLE.2

NATURAL FREQUENCIES OF CLUTCH COVER IN DIFFERENT AUTOMOTIVE WITH MATERIAL ST-14

NUMBER OF NATURAL FREQUENCIES	TIBA	PEGUET-405
1	0	0
2	0	0
3	0	0
4	0.0023	0
5	0.01	0.0027
6	0.025	0.004
7	459.932	414.765
8	459.964	415.313
9	762.559	793.867
10	1195.87	971.286
11	1221.31	1266.79
12	1221.33	1282.68

Can compare obtained results in Fig. 4

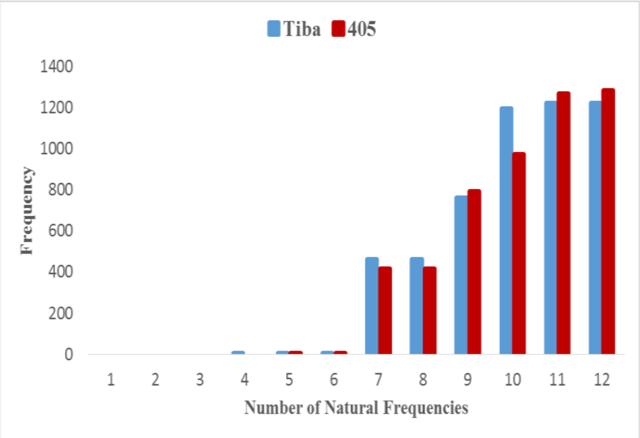

Figure 4 : compared natural frequencies of different passenger car with material St14

To determine critical area on the model, derivation shape modes in relation to each frequencies. Shape modes of cover clutch of passenger car Peugeot 405 and Tiba shown as Fig. 5 and Fig.7

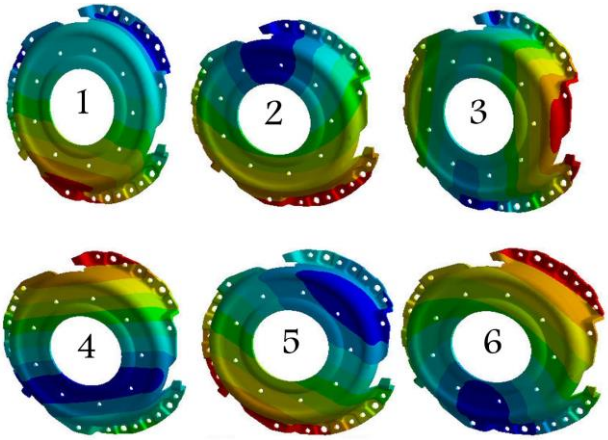

Figure 5: The First 6 Natural Frequencies of Cover Clutch of Passenger Car of Peugeot

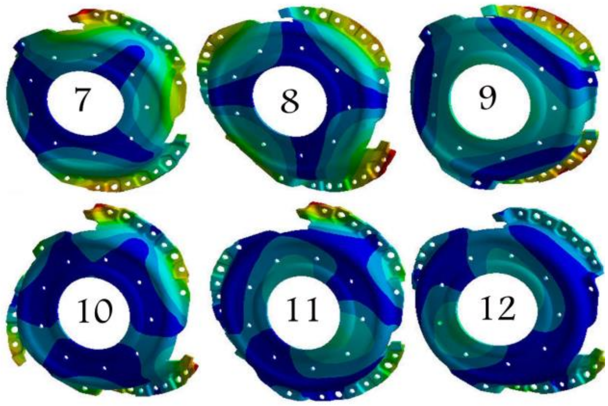

Figure 6: The Second 6 Natural Frequencies of Cover Clutch of Passenger Car of Peugeot

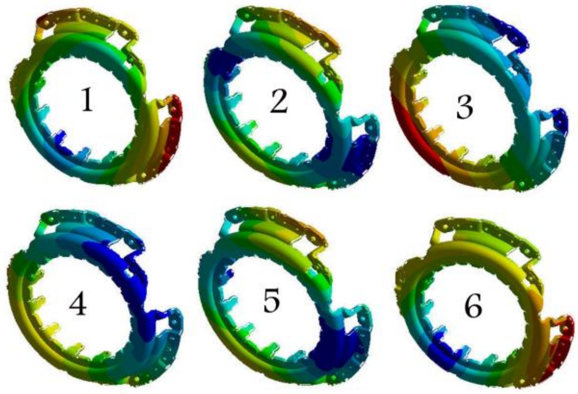

Figure 7 : The Second 6 Natural Frequencies of Cover Clutch of Passenger Car of Tiba

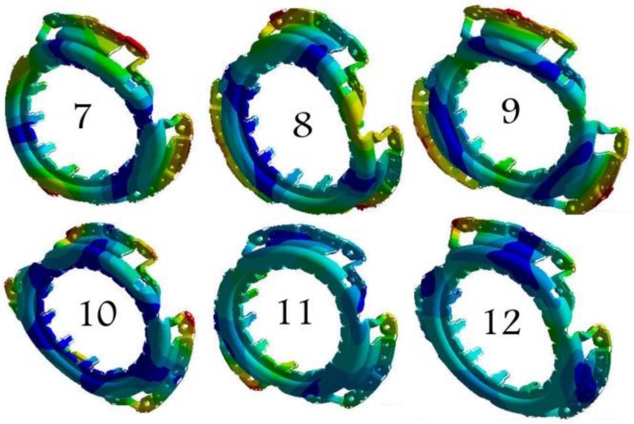

Figure 8 : The Second 6 Natural Frequencies of Cover Clutch of Passenger Car of Tiba

IV. CONCLUSION

Cover clutch of different passenger cars (Tiba and Peugeot 405) are simulated on ANSYS WORKBENCH and performed modal analysis to determine natural frequencies. And compared shape modes in relation to each frequencies on both model.

The results indicate that natural frequencies Peugeot are upper than Tiba for materials st-14 and Changes in Peugeot's values are much higher than changes in Tiba car. Critical area on the both model is seat bolt. So, should be more attention to this area in the future analysing.

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