DEVELOPMENT OF THE MODEL OF THE ACTIVE BRAKE PEDAL FORCE SIMULATOR BASED ON ELECTRIC DRIVE USING SOLIDWORKS

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Abstract: Brake pedal feedback is important for driver’s perception not only from customer satisfaction point of view, but also from the safety point of view. The thesis provides an investigation of car brake pedal “feel” and brake blending. Unlike conventional brake analysis using real electrohydraulic brake components, the thesis aims at the development and design of the active brake feedback simulator based on the electric drive [1]. The choice of electromechanical components for the test bench is based on experimental data. This paper is concerned with the design of the test bench by selecting proper components and structure materials which will be used in the simulator.

Keywords: brake pedal, solidworks, modeling, pedal feedback.

I. INTRODUCTION.

The design phase starts with the evaluation of the parameters that we will use in the development of our feedback simulator. As a reference, data from an automotive company have been used. The data were obtained from a real experiment. There were installed a pedal force sensor to measure the applied force, LVDT for the pedal position measurement. Besides, pressure and temperature sensors have been installed in order to measure the pressure in the hydraulic circuit and temperature of the calipers respectively. By plotting required graphs, it will be possible to understand the behavior of the car during the deceleration process (especially the instances when ABS is switched on) [2]. Speaking about the experiment, one should mention that it was conducted several times, with different braking regimes starting from a moderate braking to heavy braking. Combining plots from different braking regimes will allow to have an idea of how measured parameters change. The coherence of different parameters can be illustrated by taking one regime of experimental braking.

II. METHOD.

So that to design the test bench which will behave as a pedal feedback simulator, we have to know the range of forces and strokes that the system may be subjected to. Since the design covered in the thesis is based on the experimental data provided by FCA, all different braking operations have to be investigated in order to find the limits. To do so, the data from both the moderate and heavy braking regimes have been used to plot "force vs stroke" curves.

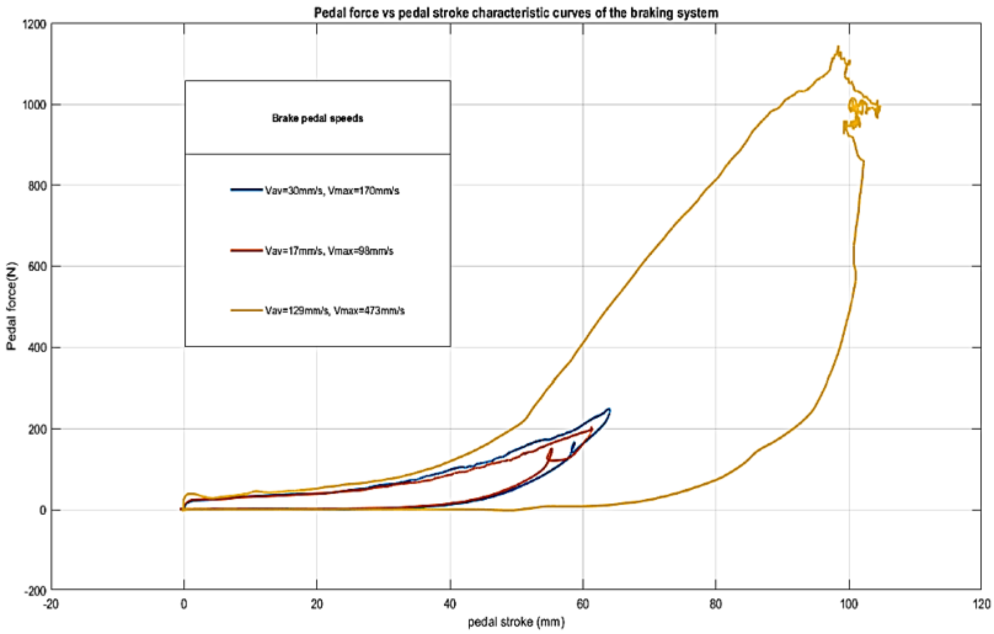

Figure 1 Comparison of three braking modes

Figure 1 provides information regarding the "pedal force-pedal stroke" relationship during different modes of braking. It can also be noted that for each of the modes the pedal velocity was estimated based on the pedal position during time interval under investigation. The design of the future simulator is based on the most "critical" values of applied force, pedal stroke and pedal velocity. And according to Figure 1, we can conclude that

$$F_{max} = 1100\,N;$$

$$s_{max} = 104mm;$$

$$v_{max} = 473\frac{mm}{s};$$

These three parameters will lay a foundation for the design phase of the feedback simulator. To be more precise, the electro-mechanical components and structure parts have to be chosen in such a way to satisfy the requirements of the braking system on the maximum values of force, stroke and speed of the brake pedal.

III. MODEL OF THE SIMULATOR.

Structure of the test bench in general, has to be made of proper components and materials. One of the key requirements is that the structure must be robust and reliable. In recent years, aluminum extrusion profiles have proven themselves quite reliable and easy to be installed, so the choice was stopped on applying them.

In any existing braking system, the brake pedal has a certain limited stroke, which approximately equal to 100-120 mm depending on the car and its braking system geometry. In this regard, the pedal simulator also has to restrict the stroke to approximately the same amount. To do so, a special limit stop has been designed which will guarantee a stroke of 100mm.

Besides, the electromechanical components such as the electric motor, its reductor and coupling must correspond the force and torque requirements [3]. The brake pedal used in the simulator must be able to withstand the maximum possible applied force.

Covering all the aspects mentioned above, the CAD model of the brake pedal force simulator was developed using Solidworks software (Figure 2).

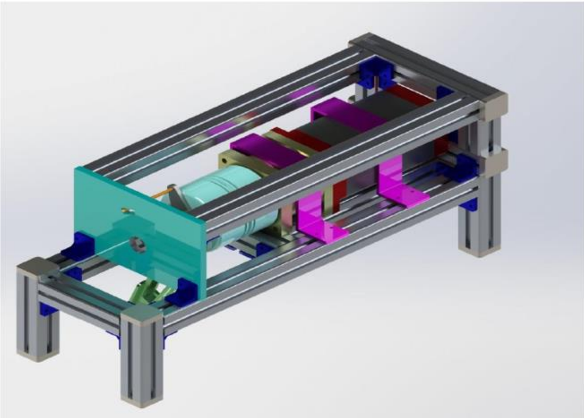

Figure 2 Model of the brake pedal force simulator.

When we speak about the analysis of brake pedal feeling, we should take into consideration that we need to approximate the test rig to the real braking procedure as much as possible. From this perspective, a car seat has to be included in the final assembly as well [3]. This will allow the braking procedure to be more realistic. However, the test bench illustrated above is not stabilized yet. To do so, a car seat and the test bench were bound by borders made of aluminum extrusion profiles.

Finally, the resultant assembly of brake pedal simulator has been obtained (Figure 3):

Figure 3. Final model of the simulator

IV. CONCLUSION.

The most important factor that has to be taken into account is the drive’s safety and comfort [3]. For this reason, it is very actual to study the brake pedal feeling. Instead of having very complex test benches with a huge number of components, or very costly experiments with cars it becomes much more proficient to use brake feedback simulators. To be more precise, they are much more compact, can be adjusted to test the braking system of most car models. In this regard the model proposed in this thesis can be of very high interest for researches working in the investigation of driver’s perception during braking.

V. BIBLIOGRPAHY

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