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CUSTOM ANALYSIS AND CONCEPTUAL DESIGN OF CLUTCH PEDAL MECHANISM

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ABSTRACT

In this study, a conceptual design of clutch pedal system for low floor with manual transmission midibus vehicles is presented. This paper also describes the importance of the concurrent engineering technique in the total design activity. The parameters that focus on the conceptual design of the clutch pedal considered including height of clutch actuation point to cabin floor mat, lateral position acc. to steering column, size and angle of pedal pad, maximum pedal travel, working angle, pedal force and pedal ratio, packaging and modulation requirements considering all variants. Clutch pedal was analysed and the endurance of clutch pedal assy by taking into consideration of clutch pedal design criterias was verified by applying static and dynamic analysis onto the clutch pedal system. The aim of the study was conducted to seize an feasbile/effective clutch pedal for low floor applications by using weighted objective methods.

Keywords: Engineering Technique, Clutch pedal, Conceptual Design, Midibus Cluth Pedal System,

ÖZET

Bu çalışmada alçak tabanlı manuel şanzımanlı midibüs araçlar için tasarlanmış kavramsal debriyaj pedalı sistem tasarımı sunulmaktadır. Çalışmada, aynı zamanda tüm tasarım çalışması boyunca eş zamanlı mühendislik tekniğinin önemi de sunulmaktadır. Ortaya konulan debriyaj pedalı tasarımında, debriyaj tahrik noktası ile zemin arasındaki yükseklik, debriyaj pedalının direksiyon kolonuna göre yanal konumu, pedalın açısı ve boyutu, pedalın maksimum yer değiştirmesi, çalışma açısı, pedal yükü, pedal oranı, paketleme ve modülasyon gereksinimleri gibi kavramsal tasarım odaklı parametreler düşünülerek debriyaj pedal tasarımı ortaya konmuş ve tasarlanmıştır. Yapılan tasarım üzerine statik ve dinamik analizler uygulanarak debriyaj pedalı analiz edilmiş ve tasarım kriterleri göz önünde bulundurularak sistemin dayanıklılığı doğrulanmıştır. Çalışmanın amacı, alçak tabanlı araçlar için objektif ağırlıklı methodlar kullanarak uygulanabilir efektif bir debriyaj pedalı tasarımı ortaya sunmaktır.

Anahtar kelimeler: Mühendislik Tekniği, Debriyaj Pedalı, Konsept Tasarım, Midibüs Debriyaj Pedal Sistemi

1. INTRODUCTION

This study is about a conceptual design of clutch pedal system designed for low floor with manual transmission midibuses. This clutch pedal that was designed for midibus vehicles with manual transmission provides to reduce needed pedal force, to increase driving comfort and ergonomy of vehicle users and to prevent failures that may occur on hydraulic and pneumatic systems for clutch pedal usage requirement of drivers during shifting and first movement of the vehicle. Besides, this pedal clutch was designed for midibus vehicles can easily be mounted to the vehicle and doesn't require a periodic maintenance.

In this study, clutch pedal was designed and represented by considering conceptual design parameters like the height between activation point of cluth pedal and ground surface, lateral position of clutch pedal according to steering coloumn, working angle and maximum displacement of clutch pedal, pedal load and packaging & modulation requirement in terms of dimensions etc.

The clutch pedal was also analysed by applying static forces onto the system and the system endurance was verified with these analyses by considering design criterias.

2. THEORY OF DESIGN

In this paper, the clutch pedal was designed for low floor with manual transmission midibus vehicles. When new designed clutch pedal's compared to outdated technology, it provides to reduce required pedal force, increase driving comfort and ergonomy and prevent failures that may occur on hydraulic and pneumatic systems for clutch pedal usage requirement of drivers during shifting and first movement of the vehicle. Besides, this pedal clutch was designed for midibus vehicles can easily be mounted to the vehicle.

If we look at old type of clutch pedals designed for low floor with manual transmission vehicles.

Generally, A clutch pedal assembly consists of a mounting bracket and a pin which connects axially pedal arm and mounting bracket to each other. Mounting bracket contains bearing surfaces supporting pivot pin and pedal arm, too. Pivot pin is self-lubricated. Mounting bracket is an indivisible part with bearing surfaces. There is a pedal pad at the end of pedal arm. The system also includes a magnetic assembly which is installed at the end of pivot pin.

The driver depress the accelerator pedal when the vehicle is wanted to be shifted and cranked up, and hydraulic fluid is transmitted to clutch system from hydraulic rezervuar by pressing the clutch pedal.

However, high level forces need to be applied by the driver to move the clutch pedal due to push hydraulic cyclinder piston pin that is connected to the clutch pedal. Furthermore, air bubbles comprised in hydraulic rezervuar tank cause to reduce the clutch pedal system performance.

In this study, the clutch pedal which was designed for midibus vehicles with manual transmission according to nowadays technologies. In general, this clutch pedal system provides to reduce the needed pedal force to minimum levels, to increase driving comfort and ergonomy and to prevent failures that may occur on hydraulic and pneumatic systems for clutch pedal usage requirement of driver during shifting and first movement of the vehicle.

The clutch pedal was designed and represented by considering the following conceptual design parameters.

1. The height between activation point of cluth pedal and ground surface,
2. Lateral position of clutch pedal according to steering coloumn,
3. Clutch pedal working angle,
4. Maximum displacement of clutch pedal
5. Pedal load,
6. Pedal ratio,
7. Packaging and modulation requirement in terms of dimensions

This performed clutch pedal system design is illustrated in Figure 1 which is belong to clutch pedal system assembly.

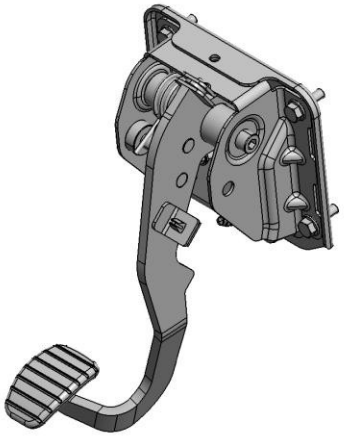

Figure 1. Clutch Pedal Assembly

All of the components related to designed clutch pedal assembly are identified as in the following.

1. Clutch Pedal
2. Clutch Pedal Switch Sensor
3. Clutch Pedal Switch Bracket
4. Clutch Pedal Bracket
5. Clutch Master Cyclinder
6. Master Cyclinder Piston
7. Master Cyclinder Piston Holder
8. Master Cyclinder Piston Holder Pim
9. Center Bearing Metal
10. Central Bushing
11. Clutch Pedal Recalling Spring
12. Recalling Spring Pim
13. Clutch Pedal Pad
14. Clutch Pedal Pad Cover
15. Central Bushing Plastic
16. Stopper
17. Clutch Hydraulic Hoses
18. Clutch Pneumatic Hoses
19. Clutch Hydraulic Reservoir
20. Clutch Master Cyclinder Boot

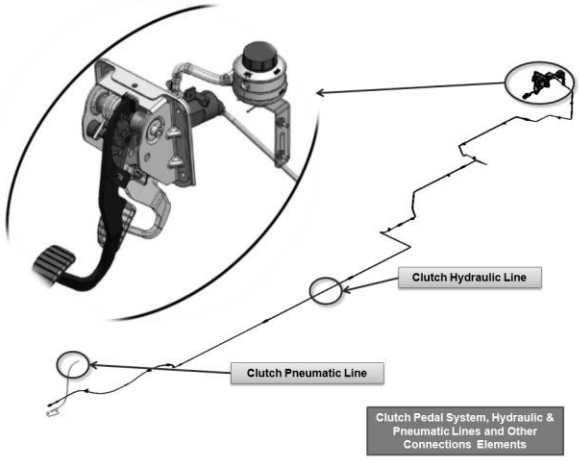

Figure 2. Cluthc Pedal System

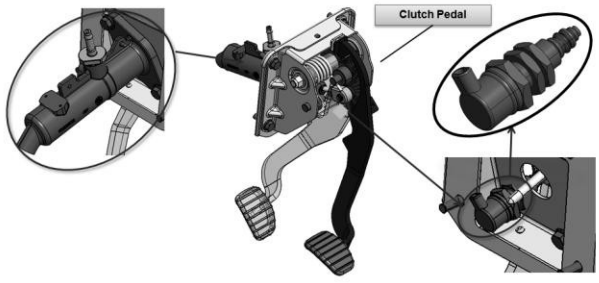

Figure 3. Cluthc Pedal, Clutch Master Cyclinder, Clutch Pedal Switch Sensor

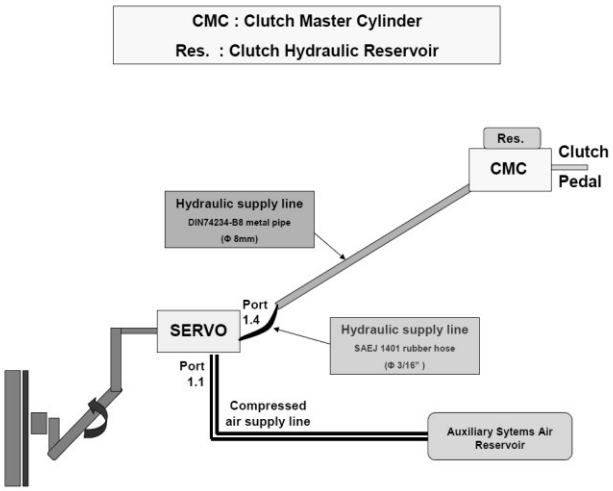

Figure 4. Pneumatic Assisted Hydraulic Clutch Pedal System

Table 1: Clutch Pedal System Requirements and Specifications

AIR SUPPLY		
Supply pressure	bar	Max. 10
Minimum pressure	bar	6
Maximum pressure	bar	10
Backup pressure	bar	8
PEDAL		
Pedal Force	N	132
Pedal travel	mm	135
Working angle	°	32
Pedal length	mm	250
Pedal ratio		5
Pedal efficiency	%	90
Return spring force	N	25
CLUTCH		
Bearing load for new disc	N	5000
Bearing load for worn disc	N	5400
Fork ratio		2,05
Clutch minimal stroke	mm	10
Clutch maximal stroke	mm	12
Clutch disc wear stroke	mm	13
Clutch Fork deformation information		1,5
MASTER CYCLINDER		
Piston diameter	mm	8
Return spring load at zero pedal travel	N	5
Return spring coefficient		0.8
Piston lost stroke	mm	2
Piston max. Stroke	mm	42
Piston Working Stroke	mm	33
Piston working temperature	mm	-40 °C +80 °C
Piston operating temperature	mm	max. 30 bar

Materials:
Debriyaj Pedalı – ERD 4936
Switch bracket pedal – ERD 4936
Pedal pad – ERD 4936

Bushing metal – ST 37
Bushing plastic – POM
Pedal brackets – ERD 4936
Pedal Pad Cover – Rubber
Center Bearing Metal – ST 37
Master cyclinder piston pim – ST 37
Pedal recalling spring – Yay çeliği
Spring pims – ST 37
Clutch pedal swtich bracket – ERD 4936
Stoppers – Rubber

In the most basic form, clutch pedal assembly is consist of three brackets which provides to be mounted to the body, a clutch pedal, a clutch pedal pad, a recalling spring which firstly resist to pedal movement and then supports the movement after the motion according to pedal movement, a central bushing pin which is mounted to recalling spring and bracket and can be rotated about the axis that's mounted to bracket, a hydraulic rezervuar which is mounted on piece, a clutch master cyclinder which transfers the motion to fluid in the tank, clutch pedal switch sensor, piston pin and pedal joint.

In the design of clutch pedal system, it's aimed at the driver while pressing the clutch pedal with least effort. In this state, optimal clutch pedal was designed and freezed by considering received targets like pedal load, pedal length pedal ratio, pedal travel, pedal working angle, pedal efficiency, return spring force, clutch parameters & loads, and the loads/pressures of clutch servo mechanism system values etc.

In addition to design study, clutch pedal was verified by utilizing virtual analysis prosedures via ansys and hypermesh prgrammes. Clutch pedal system were analysed staticly by considering target design criterias and the system endurance was verified and presented as an feasible product.

3. RESULTS

This clutch pedal which was designed for low floor with manual transmission midibuses was analysed staticly in compliance with Hexagon Verification and Design Standarts under the force of 500N.

The finite element method of clutch pedal assembly designed for midibuses is illustrated in Figure 5. The force of 500 N was applied straightly onto the clutch pedal pad. Clutch pedal bracket was mounted from body mounting points at all directions. Boundary conditions and type of force execution clutch pedal asembly are illustrated in Figure 5. Clutch Pedal and pedal central bushing are free to rotate around Y-axis. Clutch pedal and its' stopper bracket were determined as a contact part of the assembly in the analysis.

The used material parameters are;

For Steel (ST 52): E: 2,1 e + 05 / NU: 0,3 / RHO : 7,8 e -09 ; Steel (ST 52) Yield Stress: 355 MPa

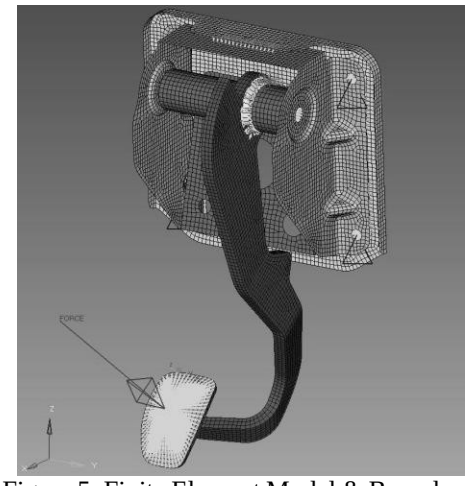

Figure 5. Finite Element Model & Boundary Conditions on Clutch Pedal Assembly and Type of Force Execution.

When the static analysis results are investigated, Maximum stress was determined as 146 MPa on clutch pedal stopper bracket. The determined maximum stress value is under the yielding point of material. Therefore the clutch pedal assembly is on safe side. The values of maximum stresses were determined are illustrated in Figure 5.

4. CONCLUSION

In this new design of clutch system, a clutch pedal was represented to increase driving comfort and ergonomy, to prevent the failures that may occur on hydraulic and pneumatic systems for clutch pedal usage requirement of drivers, can easily be mounted & dismounted to the vehicle and to have periodic maintenance free by trying to reduce required pedal force to be applied for pedal movement and considering conceptual design parameters as well as effective objective methods in this study.

As a result of this design which was made around these basic concepts, multiple clutch pedal system applications is possible to be improved and it's an open topic for improvement which is not possible to be limited with examples can be explained here.

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