Analysis of the Influence of Clutch Pedal to Vehicle Comfort

Jiangchuan Li, Feng Deng, Shaojin Liu and Hao Hu

Abstract Driving comfort is one of the most important factors affecting automobile comfort, it also reflect the quality of automobile design. Clutch pedal force and pedal motion stroke mainly affect the driving comfort. Too light pedal force makes drivers feel the juncture not obviously, too heavy pedal force makes drivers fatigue; Separation would lead to clutch would release excessive if the separation distance was too short, there would be flameout problem if the combined distance is too long and this may also make drivers feel pedal engagement point is much more higher. This paper mainly analyzes the influence of clutch comfort to vehicle comfort according to theoretical calculation, objective test and subjective evaluation of the clutch system. The impact of clutch pedal to drive comfort can be analyzed mainly from pedal travel and pedal load. A multi-body vibration model with four degrees of freedom, including toe-in, camber angle, vertical jumping and self-vibration of tread in the lateral orientation, is set up. Parameters sensitivity, which would affect the vehicle bifurcation speed, are calculated by means of numerical simulation method in Matlab, and several control strategies which would suppress the tire self-excited vibration are proposed. This study mainly focuses on clutch pedal comfort analysis of economic car, the model in this research is the company's developing car, but the research method is applicable to any vehicles. A multi-body self-vibration model is established to predict the polygonal wear of tire and several suggestions are made to avoid the polygonal wear of tire. Conclusions: The result showed that separation distance of 100–125 mm and engagement point pedal force of 85–100 N can satisfy the requirements of vehicle driving comfort better.

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L. Jiangchuan (✉) · D. Feng · L. Shaojin · H. Hao
Changan Auto Global R&D Centre of Changan Automobile Co LTD, Chongqing, China
e-mail: sunqiemail@163.com

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1 Introduction

Nowadays people have much more requirements in vehicle performance including power, economy and safety, especially the vehicle comfort. Ride comfort and driving comfort are the two aspects in research of automobile comfort [1]. The analysis of car operating comfort mainly focuses on the pedal, driving environment and the seat [2]. Among them, quality of clutch pedal is directly related to the safety performance of the vehicle, as it is a car security part which separate or combine clutch and engine by trampling clutch pedal. In order to provide a more comfortable and easier operating clutch, the first job is to analyse the main factors influencing the clutch.

2 Analysis Factors Influencing the Comfort of Clutch Pedal

Pedal force and pedal motion stroke are the main factors influencing clutch manipulation. Main factors effecting pedal force and pedal stroke are diameter of both clutch main cylinder and sub-cylinder, leverage ratio of clutch pedal and clutch parameters.

Pedal force is definitely the force acting on the pedal by feet; joint pedal force is the main characteristics evaluating pedal comfort. Pedal motion stroke contains separating stroke and combining stroke showed in Fig. 1. Separating stroke is the travel form top limiting position to clutch separating point, while combining stroke is the pedal travel form bottom limiting position to combing point.

2.1 Motion Stroke of Clutch Pedal

A certain clutch separating bearing demands the moving distance during separating should between 7.5–8.5 mm, but there is abnormal sound when the pedal is trampling to the bottom according to road trial feedback which influences the driving comfort seriously (Fig. 2).

Separating characteristics of this certain clutch show that total separating trip is 7.5 mm, separating point trip is about 2.4 mm, while combing point trip is not sure. Theoretical calculation is showed below in Table 1 case of separating point has the same position as combining point.

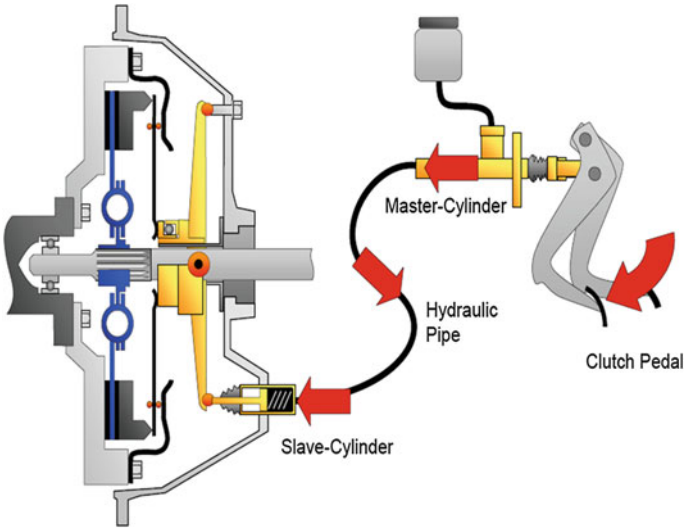
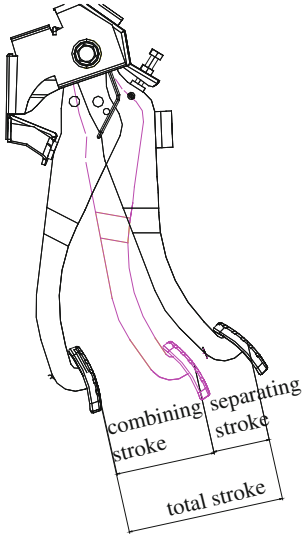


Fig. 1 Schematic diagram of clutch separating system

Fig. 2 Schematic diagram of clutch pedal motion stroke



Testing data of these above three schemes are showed in Figs. 3, 4, and 5.

Scheme 1 show that 134 mm total travel is much better, but the combining position is a little bit higher; scheme 2 present a worse driving comfort evaluation with no combining point and 138 total travel; while scheme give a too long total trip and higher combining position, shifting motion can go smoothly even though the pedal is not trampled during the last 20 mm trip.

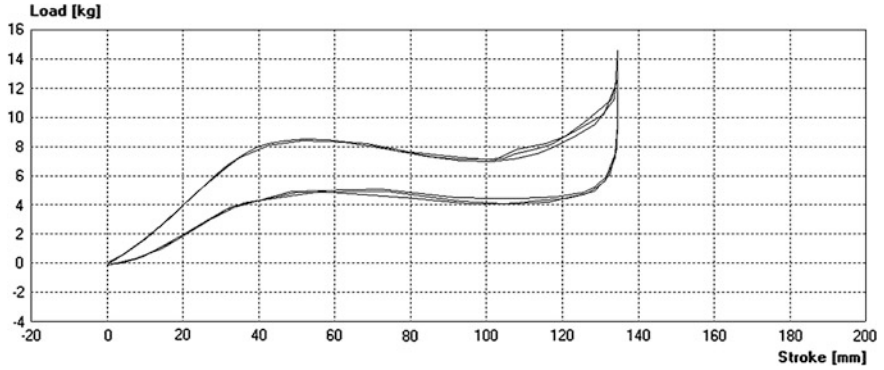


Fig. 3 Testing data of scheme 1

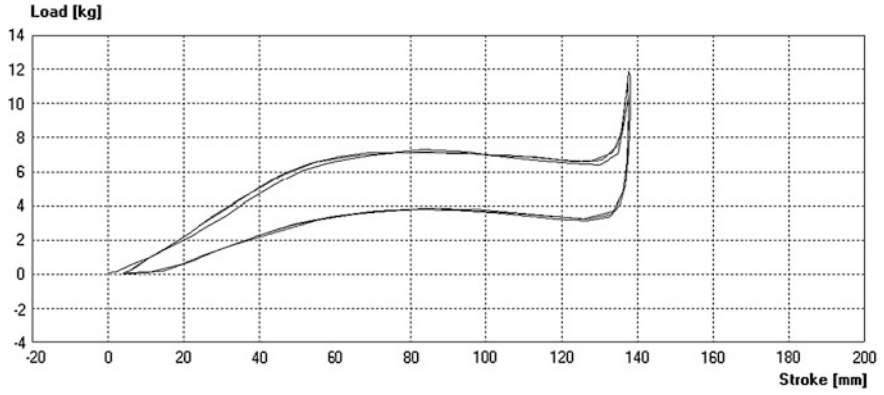


Fig. 4 Testing data of scheme 2

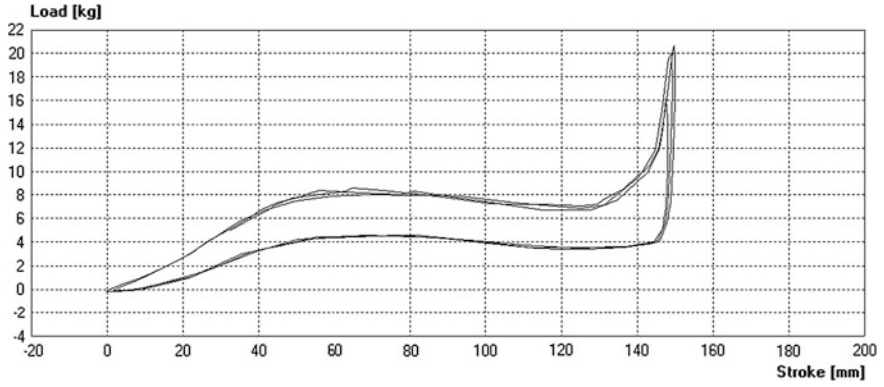


Fig. 5 Testing data of scheme 3

Table 1 System calculating

	Scheme1			Scheme2			Scheme3		
Clutch separating force N	1050	750	850	1050	750	850	1050	750	850
Sectional area of sub-cylinder mm^2	590	590	590	590	590	590	590	590	590
Clutch separating stroke mm	2.4	5.75	7.5	2.4	5.75	7.5	2.4	5.75	7.5
Separating pressure needed Mpa	1.78	1.27	1.44	1.78	1.27	1.44	1.78	1.27	1.44
Diameter of main cylinder mm	19.05	19.05	19.05	15.87	15.87	15.87	17.46	17.46	17.46
Sectional area of main cylinder mm^2	285.02	285.02	285.02	197.81	197.81	197.81	239.43	239.43	239.43
Total stroke of main cylinder mm	27.00	27.00	27.00	34.00	34.00	34.00	27.00	27.00	27.00
Thrust force of main cylinder needed N	507.24	362.32	410.63	352.03	251.45	284.98	426.10	304.36	344.94
Stroke loss	0.90	0.90	0.80	0.90	0.90	0.80	0.90	0.90	0.80
Main cylinder stroke needed mm	5.52	13.23	19.41	7.95	19.06	27.96	6.57	15.74	23.10
Pedal force lever ratio	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50	6.50
Pedal force N(theoretic) N	78.04	55.74	63.17	54.16	38.68	43.84	65.55	46.82	53.07
Pedal force N + 25 N	103.04	80.74	88.17	79.16	63.68	68.84	90.55	71.82	78.07
Pedal stroke (theoretic) mm	48.88	98.96	126.14	64.70	136.86	181.76	55.71	115.33	150.16

2.2 Pedal Force

Combining point pedal force comfort need experienced drivers to evaluate subjectively as whether the pedal force is appropriate or not is related to drivers' subjective sensation based on operating all sorts of devices through acting force during driving process.

84.9 N combining pedal force is accepted in scheme 1, scheme 2 gives 72.9 N pedal force, scheme 3 shows that 82.6 N pedal force is more proper through the above testing results and experienced drivers' evaluation.

3 Conclusion

Above the theoretical calculation and practical test show that 100–125 mm separation trip is more appropriate. Clutch will separate excessively with a too short separating stroke which can lead friction between clutch diaphragm spring and clutch friction plate rivet. The proposal is presenting less than 50 mm combining stroke, too long combining stroke lead vehicles flameout easily because drivers feel the pedal combining position is too higher.

We can also conclude from the above analysis that 85–100 N combining pedal force is more suitable. The pedal can not provide enough support to feet if the pedal force is too light, while too heavy pedal force makes drivers tired easily.

Proper pedal feeling ensure driving safety, it is also the important factor influencing driving comfort that makes drivers keep steady mood and quick response to ensure driving safety and vehicle service life as well.

References

1. Jing Hu (2010) Measurement and Evaluation System of Vehicle Control Comfort Based on Correlation Analysis. J Hefei Uni Technol 33(12):1775–1778
2. Meng Aihua (2011) Study on Test Method of Clutch Comfort. J Mech Electr Eng 28(5):553–555

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