ISSN 1330-3651 (Print), ISSN 1848-6339 (Online)
UDC/UDK 629.33-592.13.015

CONTRIBUTION TO IDENTIFICATION OF MECHANICAL CHARACTERISTICS OF PASSENGER MOTOR VEHICLE'S DRUM BRAKES

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Original scientific paper

Based on the conducted analyses, it has been proven that there is no generally accepted method for evaluation of characteristics and output parameters of drum brake mechanisms. Experimental research of the drum brake subsystem with brake fluid pressure in the brake cylinder as input quantity and brake torque as output quantity is presented in the paper. The obtained results show that there is a time delay between the output and input due to the response of the drum brake mechanism. This points to the deficiency of determination of brake performance in time domain, because, in comparison, excitation and response of the system are not adequate. Hence, the dynamic mode is observed in the analysis of the drum brake subsystem. Dynamic analysis determines the behaviour of the system in transient period. With previously known transfer characteristics of a system, its response can be determined in relation to the specified inputs (excitations), which is a good basis for determination of correlation between the results obtained by different methods of identification and under different test conditions.

Keywords: *data processing, drum brakes, experimental research, mechanical characteristics*

Doprinos identifikaciji mehaničkih karakteristika bubanj kočnica putničkih motornih vozila

Izvorni znanstveni članak

Na temelju provedenih analiza, dokazano je da ne postoji opće prihvaćena metoda ocjene karakteristika i izlaznih parametara mehanizama bubanj kočnica. U radu su prikazana eksperimentalna istraživanja podsustava bubanj kočnica s ulaznom vrijednosti-tlakom kočione tekućine u cilindru kočnice i izlaznom vrijednosti-kočnim momentom. Dobiveni rezultati su pokazali da je između izlaza i ulaza postojalo vrijeme kašnjenja, zbog odgovora mehanizma bubanj kočnice. To ukazuje na nedostatak utvrđivanja performansi kočnica u vremenskoj domeni, jer u usporedbi nisu adekvatna uzbuda i odgovor sustava. Stoga se u analizi podsustava bubanj kočnice promatra dinamički mod. Dinamička analiza određuje ponašanje sustava u prijelaznom razdoblju. Uz već poznate prijenosne karakteristike sustava, njegov odgovor može biti određen u odnosu na navedene ulaze, uzbude, što je dobar temelj za određivanje korelacija između rezultata dobivenih različitim metodama identifikacije i pod različitim uvjetima ispitivanja.

Ključne riječi: *bubanj kočnice, eksperimentalna istraživanja, mehaničke karakteristike, obrada podataka*

1 Introduction

The main task of the brake mechanisms is to achieve the required brake torque acting on the wheels of the vehicle, causing their slowing down, and thus braking of the vehicle. Therefore, the brake torque is a fundamental characteristic of every brake, the measuring tool of its functional properties or performances. Operating characteristic of the brake, which is often called the brake factor C^*, links the activation force of hydraulic piston and brake torque as input and output values and includes all structural parameters of the brake and the available friction factor between the friction surfaces.

Vehicle design concept with disc brakes on the front wheels and drum brakes on the rear wheels enables manufacturers to continue providing most of the advantages of disc brakes, in addition to low production costs. Drum brakes are less expensive to produce than disc brakes, mostly because they can also operate as parking brakes, while disc brakes require a special parking brake mechanism [1].

The importance of the drum brakes comes from the fact that, in 2011, drum brakes were fitted to 45 per cent of new cars globally. This figure is set to remain above 40 per cent for the next five years, with statistics indicating that over 40 million new cars will be fitted with drum brakes at registration in 2016. Smaller cars that use drum brakes are becoming more popular, driven by both the economy and the need to reduce emissions. Since 2008, the average engine size of new cars at registration has been downsized across Europe. Sometimes viewed simply as an old technology, the drum brakes are still the most cost effective solution for rear brakes in the vast majority of cars. There is also a dangerous misconception that the rear brakes are not as important as the front brakes, as the front brakes provide up to 80 % of the braking force. Even though the rear brakes contribute with less braking force, they still have a large impact on the stability of a car [8].

Calculation methods and testing procedures for drum brake mechanisms, present in a large number of papers, have passed through several stages in their development. Classic analytical design methods are based on a number of simplifications that significantly reduce the accuracy of the results [2, 3]. The utmost assumptions are to ignore elasticity of the drum and friction lining and to idealize pressure distribution on the friction surface [4]. Calculation methods have experienced intense development thanks to the development of computer techniques. In this way, numerical methods have become the basic calculation methods, without which it cannot be possible to imagine the development of many products today, in technologically advanced countries. These methods allow rapid analysis of many different combinations and selection of the optimal solution (optimization). Numerical methods [5, 6, 7] are approximate and require reliable information on which the boundary conditions are derived. From this, their direct link with the testing of brake mechanisms comes, that provides information of high precision and quality, thanks to the advancement of measurement and processing techniques and analysis of measurement results. In this way, the period needed for the development of new brakes' elements is significantly