IDENTIFICATION OF DAMPING CHARACTERISTIC EXAMPLE SUSPENSION OF CAR THE HYDROPNEUMATIC CONSTRUCTION

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Summary

Determine dynamic properties is the main question of diagnostics of susceptible element, represented by characteristic. The changes of technical condition, as the results for example the exploational wear, can be find in their reflection. The paper presented method of identification of dynamic parameters susceptible elements build in suspension of car based on the analyses of changes of dynamic behavior. Received foundations of the methods of identification were verified in time of simulating investigations. The execution the investigations of hydropneumatic suspension of passenger car was the next stage. The gotten results confirmed the legitimacy of foundations the proposed method of identification dynamic parameters susceptible element build in suspension.

Keywords: identification, characteristic of damping, car suspension, hydropneumatic strut.

IDENTYFIKACJA CHARAKTERYSTYKI TŁUMIENIA ZAWIESZENIA SAMOCHODU NA PRZYKŁADZIE KONSTRUKCJI HYDROPNEUMATYCZNEJ

Streszczenie

Istotnym zagadnieniem diagnozowania elementu podatnego jest wyznaczenie jego własności dynamicznych, reprezentowanych przez charakterystykę. Zmiany stanu technicznego, wywołane np. zużyciem eksploatacyjnym, znajdują w niej swoje odzwierciedlenie. W pracy zaprezentowano metodę identyfikacji parametrów dynamicznych elementów podatnych zabudowanych w zawieszeniu samochodu na podstawie analizy zmian stanów dynamicznych. Przyjęte założenia dotyczące metody identyfikacji zostały zweryfikowane w czasie badań symulacyjnych. Kolejnym etapem było przeprowadzenie badań hydropneumatycznego zawieszenia samochodu osobowego. Uzyskane wyniki potwierdziły słuszność założeń proponowanej metody identyfikacji parametrów dynamicznych elementu podatnego zabudowanego w zawieszeniu.

Słowa kluczowe: identyfikacja, charakterystyka tłumienia, zawieszenie samochodu, kolumna hydropneumatyczna.

1. INTRODUCTION

The operation of vehicle diagnostic functions can be carried out by an external diagnostic device, or on-board diagnostic systems, with the primacy person assessment [1, 6]. In the case of the first group of diagnostic methods in practice, it is possible to determine the technical condition of all components, but often raise questions are used graduating systems that do not meet all of the technical diagnostics. Therefore, the methods used are subject of constant alteration, which should lead to an improvement in the quality of diagnostic derived estimators condition.

In the OBD (On-Board Diagnostics) the most often ignored is diagnostic system for the suspension (some exceptions are vehicles with controlled flexible elements, failure of which leads to a significant reduction in the level of security).

The aim of presented study was to propose a method for determining the technical condition of suspension elements. This method can be used to improved standing diagnostic methods or the extension of the on-board diagnostic procedures.

2. THE FORMULATING PROBLEM

Now one hydraulic shock absorbers are the main element responsible for the minimization of vibrations acting on the users of car vehicles [5]. During the operation changes the intended design features of the wear and tear caused by impact on the damping characteristics.

Appointment of the characteristics of an element isolated from a particular system does not at present large problem. An example is the method of research shock-absorbers in the indicatory stand. Drawback of such methods is the need for disassembling.

Commonly used methods for the diagnosis of complete suspension set up to assess the use of simple symptom-condition status [1, 3 and 6]. Such an approach does not take into account the complex relationship between the current technical condition of a dynamic non-linear element characteristics susceptible.

The paper assumes that the method of identification of dynamic parameters flexible parts buid-in car suspension will be based on an analysis of the dynamic state variables. In this regard, the impact of the temporary transfer of damping forces to the temporary suppression of vibration signals sprung and unsprung masses.

3. SIMULATION RESEARCHES

Simulation test was conducted using a dynamic mathematical 2DOF model of the car [2, 4], which allows to obtain easily interpreted results (Fig. 1).

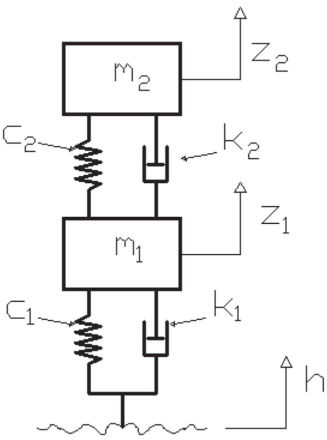

Fig. 1. The quarter model of car suspension. m_2 – sprung mass, m_1 – unsprung mass, c_1 – stiffness of wheel, c_2 – stiffness of suspension, k_2 – damping of suspension, k_1 – damping of wheel, h – excitation, z_2 – vertical displacement of sprung mass, z_1 – vertical displacement of wheel

The quarter model of car suspension can be considered as well the dynamics of the maps provided that included the following assumptions:

- the vehicle has a symmetrical construction,
- the sprung and unsprung masses are rigid solids whose entire mass is concentrated at the point of their center of gravity,
- it will be taken to translate the mechanical construction of the resulting system of connecting the suspension. So the stiffness and damping characteristics of the corresponding elements are multiplied by these factors.

In presented model, characteristics of the susceptible have been putted in the form of mathematical functions. During the simulation research have been applying different damping characteristics, examples of which are shown in Figure 2. No other dynamic parameters of the model were selected on the basis of previous authors research and are not subject to testing during the simulation changes.

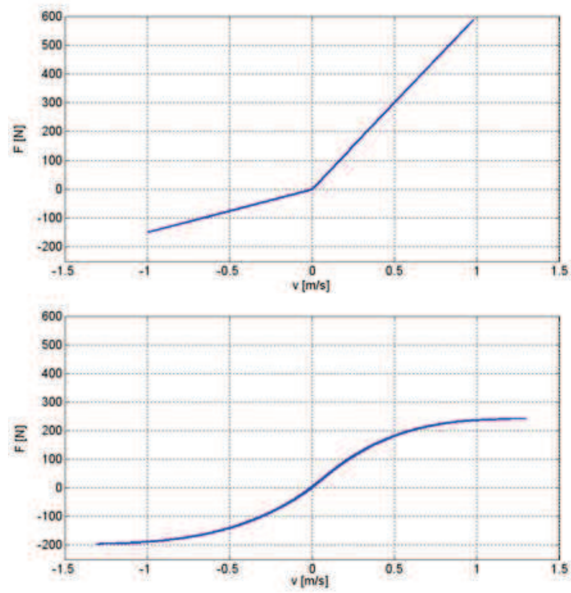

Fig. 2. The sample characteristics of damping used in simulation researches

During the studies different types of kinematic extortion was used. It should marked that the extortion should result in a variable frequency response of model. This is associated with the adopted assumption of the temporary transfer time between the entry and exit damper, that is sprung and unsprung masses.

The equation of sprung mass shows that when the elastic element of the suspension deflection is equal to the distortion of the static equilibrium, instantaneous value of the dynamic forces acting on the mass is balanced by the instantaneous value of the damping forces. The model assumptions for constant sprung mass enables them to establish direct proportionality between the values: a dynamic force acting on the mass and its acceleration. The base for the determination of the temporary damping forces are the relative displacement of the model masses. On this base the set of absolute values of instantaneous acceleration as a function of sprung mass momentary relative speed of both masses model, as described in Figure 3.

Identified by this way characteristics are representation of the intended damping characteristics. Admission to describe the shape characteristics of the temporary acceleration is expedient, as in the case of measurements on an real object to measure the actual forces always associated with the interference in its structure. Another important result of simulation research was the appointment minimum sampling frequency, which should exceed the Nyquist criterion of at least ten times.

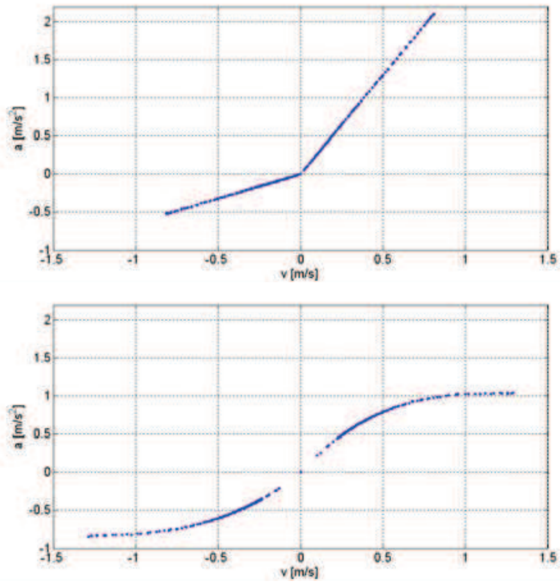

Fig. 3. Determine images of damping characteristics

4. VERIFICATION OF THE METHOD IN REAL OBJECTS RESEARCH

Experimental confirmation of the validation of the proposed method, were research hydropneumatic suspension of car, which an essential element is hydropneumatic strut. This subsystem of suspension combines the functions of spring and damping. The design vibration damper of hydropneumatic strut are similar to those used in the telescopic shock-absorbers, however, damping force is inextricably linked to the gas springs work inside the sphere [3].

Damping characteristics of the hydropneumatic strut was set at the testing on the indycatory stand, which charts the work was obtained, F (x [mm]) for different sinusoidal forcing frequencies. Based on the points of intersection of the graphs with the abscissa, where the maximum damping force at the highest speed of relative velocity of the piston set points that describe the characteristics of damping, which was presented in Figure 4. The characteristics were approximation of polynomials the 3-step degree separately for compression and decompression.

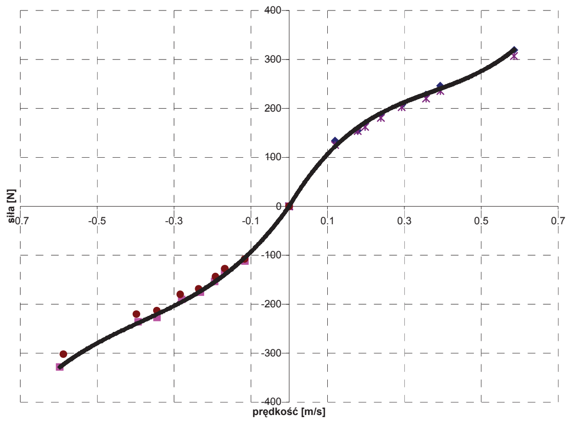

Fig. 4. Characteristics of shock absorber for the sphere of the pressures of P0 = 5.5 MPa

The strut with identified of technical condition mounted in the suspension, which then exiting the vibrations using high-powered shaker similar to those used in the stands of the test suspension at the control vehicle services. Amplitude of vibration displacement shaker plate was fixed at around 6 [mm], its application in the control of frequency adjustment of the length of time allowed forcing cycles. In researches using thirty seconds cycles: running start and running stop the drive stand and is not subject to regulation section of the work force at a constant frequency. During the researches have been recorded signals: acceleration of vibration at the point of the upper body strut fixing the suspension and relative displacement wheels and the body. Examples of the results are presented on figure 5 and 6.

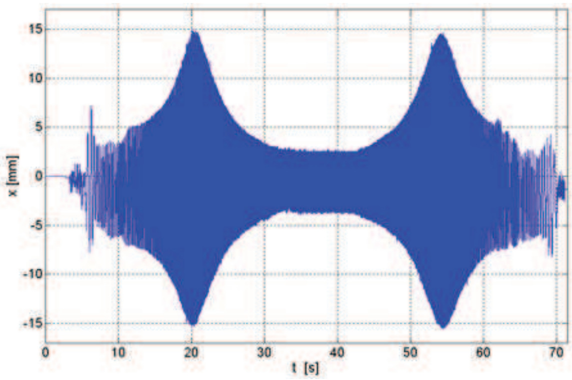

Fig. 5. Relative vibration of displacements of the wheels and body

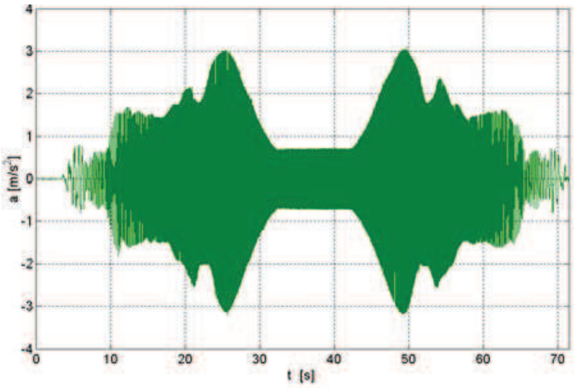

Fig. 6. Absolute acceleration of the body vibrations

Relative displacement signal was differentiation, which allows to determine of the relative velocity of the wheels and body of car. Applying similar to the one described in the case study method of simulation is scheduled pass time value of absolute acceleration of body and relative velocity sprung and unsprung masses that have non-zero-values for the moments in which the value of relative displacement was equal to the deflection of the suspension in a static equilibrium position. Obtained by this way realizations were put together on a common plane normal to the axis of time (Figure 7).

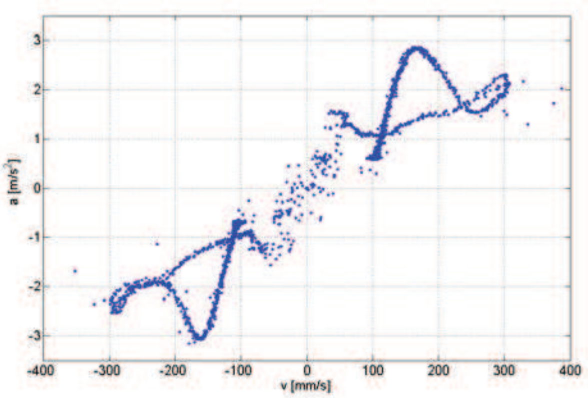

Fig. 7. Determine image of the damping characteristics

Empirically determined image of damping shows some similarity to the real hydropneumatic strut characteristics. It can be assumed that apparent differences arise from the variable values of body weight per wheel excitation to vibration.

5. CONCLUSION

The presented results confirmed the validity of the proposed methods of identifying the parameters of dynamic element susceptible built in suspension. The aim of further work is to develop methods for estimating the temporary value of the sprung mass per wheel for different amplitude and frequency of vibration.

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