THE EFFECT OF CHANGING THE VERTICAL RIGIDITY OF A VEHICLE SUSPENSION DURING BRAKING PROCESS*

T. KAPITANIAK

Technical University of Lodz
Received November 2, 1985.
Presented by Prof. Dr. L. Ilosvai

Summary

During a braking process the elements of a vehicle suspension have been elasticly deformated. These deformations make that a vertical rigidity of a vehicle suspension is changeable in function of a moment of friction of a braking mechanism.

Introduction — Hypothesis

During a braking process the effect diagrammatically shown in Fig. 1 takes place. The friction moment of a braking mechanism $M_T[+]$ works in the plane perpendicular to the axle steering knuckle. $M_T[-]$ moment goes together with it and makes a deformation of a pilot element of suspension; in Fig. 1 there are two suspension arms and a deformation of rubber—metal elements. The tortion angle of suspension in Fig. 1 angle — φ can be chosen as a measure of this deformation. For a given suspension a characteristic $\varphi(M_T)$ is available, for example in Fig. 2 there is this characteristic of a frontal suspension of a POLONEZ car. This is a static characteristic characterizing an effect for a quasistatic variation of a friction moment — M_T. As shown in Fig. 2 this characteristic is nonlinear and with a histeresis. For a moment $M_T = 1200$ [Nm] the tortion angle of a suspension is 0,113 [rad]. In addition to this information it is worth mentioning that a friction moment of a braking mechanism $M_e = 1200$ [Nm] corresponded with an example of braking with a full intensity on a pavement with adhesion coefficient $0{,}5 \div 0{,}7$. On a pavement with adhesion coefficient 0,9 the moment of friction of a braking mechanism can increase to 1800 [Nm]. For this value of M_T, we have the tortion angle of suspension $\varphi = 0{,}165$ [rad] by approximation.

This deformation gave an idea that during braking process an effect of changing the vertical rigidity of a suspension takes place. To demonstrate this hypothesis a test on the stand for examination of a characteristic of suspension was made.

* Work executed in the Institute of Vehicle Engineering, Technical University Budapest.

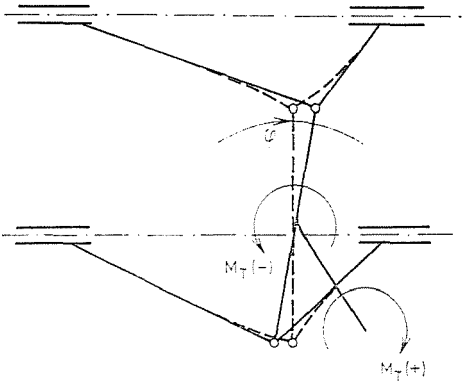

Fig. 1

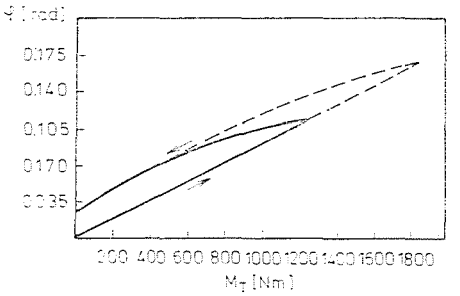

Fig. 2

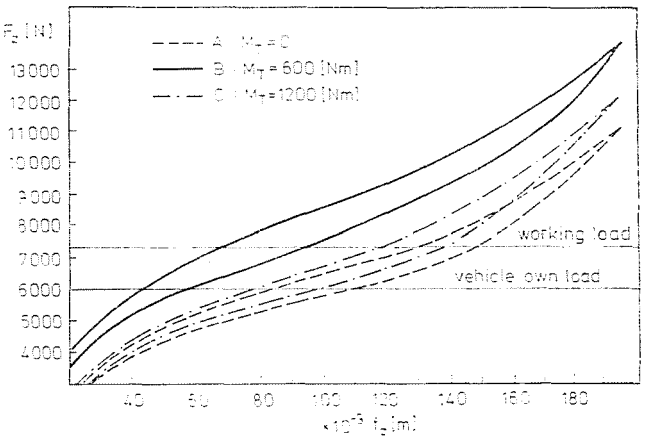

Fig. 3

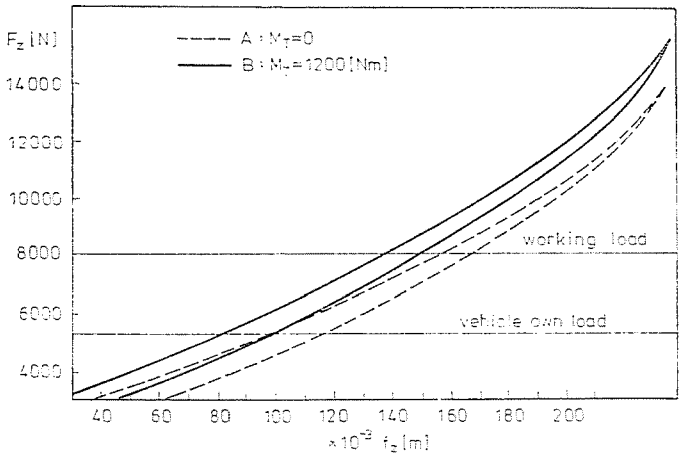

Fig. 4

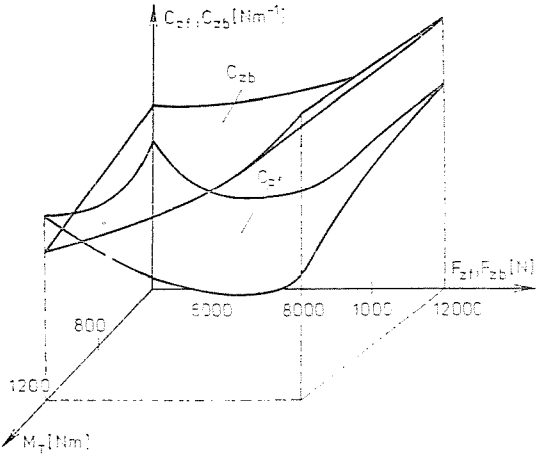

Fig. 5

Tests and their results

On the stand a vertical displacement of a car body in relation to the axle of a driving wheel — f_z was measured for various values of vertical load — F_z and friction moment — M_T.

In Figure 3 and 4 suspension characteristics $F_z(f_z)$ of a frontal and back suspension of a POLONEZ car were shown. In both figures the influences of a friction moment of a braking mechanism on the characteristic of suspension are seen very well.

Based on these characteristics for various values of moment M_T a relation of a vertical rigidity of suspension c_{zf} and c_{zb} in function of vertical load — F_z and moment of friction — M_T was obtained. These relations for a frontal and back suspension are shown in Fig. 5.

Vertical rigidity of a frontal suspension — c_{zf} has a value of 27000—77000 [Nm^{-1}], for a values of vertical load — F_z from interval 3000 $\div$ 14000 [N] and a friction moment $M_T = 0$. If a moment $M_T = 1200$ Nm for the same interval of vertical load, a value of rigidity is 36000 $\div$ 96000 [Nm^{-1}].

For the back suspension these values are as follows: $M_T = 0$, $F_z = 4000 \div 14000$ [N], $c_{zb} = 48000 \div 100000$ [Nm^{-1}] and $M_T = 1200$ [Nm], $F_z = 4000 \div 14000$ [N], $c_{zb} = 40000 \div 100000$ [Nm^{-1}]

Vertical rigidity of a vehicle suspension depends on the tortion deformation of the elements of suspension, under the influence of the friction moment of a braking mechanism.

The test was made on a car with a frontal suspension consisting of two suspension arms and a back suspension consisting of a leaf spring. It shows the necessity of conducting similar tests on a car with another kind of suspension.

The effect of changing the vertical rigidity of a vehicle suspension during braking process should be taken into consideration in model research as well as in a designing process.

Tomeas KAPITANIAK, Technical University of Lodz, 90—924 Lodz Stefanowskiego 1/15, POLAND