BULETINUL INSTITUTULUI POLITEHNIC DIN IAŞI
Publicat de
Universitatea Tehnică „Gheorghe Asachi” din Iaşi
Tomul LIX (LXIII), Fasc. 4, 2013
Secţia
CONSTRUCŢII DE MAŞINI

ANALYSIS OF THE INFLUENCE OF A HYDRAULIC RESISTANCE ON THE BEHAVIOR OF A HYDRAULIC WIM SYSTEM

BY

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Received: September 2, 2013
Accepted for publication: September 20, 2013

Abstract. A new type of the weigh in motion (WIM) system for heavy vehicles is a hydraulic one. This type is in the research and testing stage and may lead to the development of a prototype. In this paper is presented the proposed structure for the experimental model used in laboratory, as well as the results which allowed the analysis of the influence of some parameters on the system behavior. This paper presents the analysis of the influence of the hydraulic resistance on system behavior.

Key words: hydraulic system, weigh-in-motion, hydraulic resistance.

1. Introduction

The role of the weigh in motion (WIM) is to provide information about vehicles weight, as well as other information that are important for traffic safety (e.g. speed of movement, registration number etc.) (Monsere & Nicols, 2008), (Jacob, 2002) and for proper management of the roads (e.g. the status of roadway, number of vehicles in traffic, vehicle class etc.) (Nichols & Bullock,

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2004), (Vaziri & Haas, 2011). WIM systems began to be studied and used since the middle of last century. If at first were used the strain gauge systems (Bârsănescu, 2009) and the piezometric systems (Liu *et al.*, 2006) subsequently watched the growth performance of these systems through testing and other types of sensors for measuring, namely those with optic fibber, Bragg fibber beam and microwave.

A new type of WIM hydraulic sensor is presented in this paper. The novelty of this variant is that the whole process of weight measurement is done using fluid environment (Mardare *et al.*, 2007), unlike other types of weighing in motion sensors, considered hydraulic, but using fluid environment only for transmission of forces (pressure cell), information about the weight being obtained with strain gauges. This new type of sensor has a simpler construction, being composed of a hydraulic oil enclosure, which has a flexible wall to be mounted at the road level (Tiţa & Mardare, 2007). At this enclosure it is connected a pipe with two pressure sensors. Between the sensors it is a hydraulic adjustable resistance. The system also contains a pneumohydraulic accumulator, in order to compensate pressure variations caused by temperature variation. Starting from this operation scheme was designed an experimental model with which they one can test in laboratory conditions a hydraulic WIM system. In this paper it is presented the analysis of the influence of adjustable hydraulic resistance on measured pressure signals.

2. Experimental Model

To simulate in laboratory conditions the effect of load forces of the vehicles tyres was designed an experimental model (Fig. 1).

Fig. 1 − Experimental Model.
1- manual pump, *2*- frequency converter, *3*- electric motor, *4*- cam,
5- single acting hydraulic cylinder, *6*- purge valve, *7*-pressure chamber, *8*- accumulator,
9 - hydraulic resistance, *10*- bypass circuit.

The variation similar with that of the volume of the enclosure is obtained using a single acting cylinder, whose rod is the follower for a cam mounted on the shaft of an electric motor. In order to determine the recommended value for the hydraulic resistance the system includes an adjustable hydraulic resistance. Using this experimental model was registered pressure signals inside enclosure filled with oil, for different values of cross section of the hydraulic resistance.

3. Experimental Results

Pressure signals acquisition took place for four different stroke values for the component of hydraulic resistance that changes cross section. The comparative analysis of these signals reveals how the cross section of hydraulic resistance influence the amplitude of the measured signals.

In Figure 2 are superposed pressure signals registered upstream hydraulic resistance, corresponding to two strokes of its component: $C = 4\cdot10^{-3}$ m and $C = 8\cdot10^{-3}$ m, for a rotation frequency of the electric motor $f = 2$ Hz and a precharging pressure of the pneumohidraulic accumulator $p_0 = 15\cdot10^5$ Pa.

It is found that, as the cross section increase, it is registered a slight increase in pressure signal amplitude.

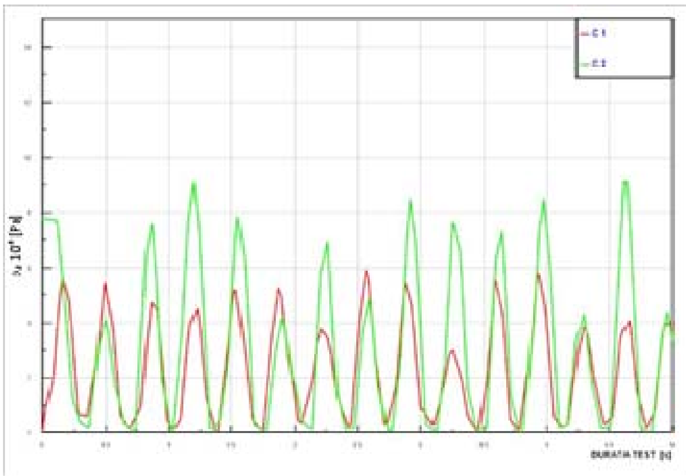

Fig. 2 − Pressure signals for two different values of the hydraulic resistance (stroke of moving part $C_1=4\cdot10^{-3}$m, $C_2=8\cdot10^{-3}$m), $f= 2$ Hz, $p_0= 15\cdot10^5$ Pa.

If one diminishes the cross section of passage growth of phase difference of signal results (Fig. 3). The phenomenon is more visible at low frequencies (Fig. 4).

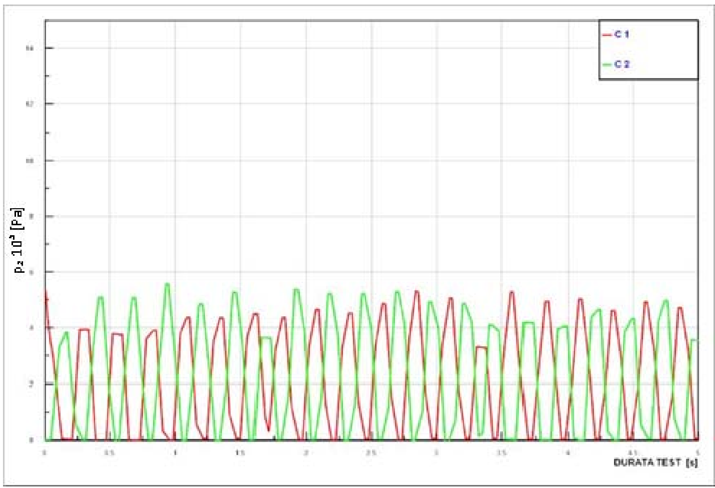

Fig. 3 − Pressure signals for two different strokes of the mobile component of hydraulic resistance ($C_1=2\cdot10^{-3}$m, $C_2=6\cdot10^{-3}$m).

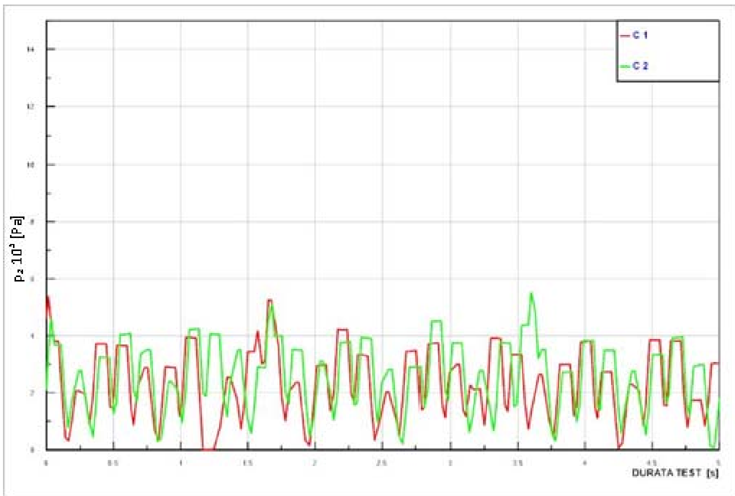

Fig. 4 − Pressure signals for two different strokes of the mobile component of hydraulic resistance ($C_1=2\cdot10^{-3}$m, $C_2=6\cdot10^{-3}$m).

In Figure 5 the signals obtained for three different strokes of the mobile component of hydraulic resistance: $C_1= 4\cdot10^{-3}$m, $C_2= 6\cdot10^{-3}$m and $C_3= 8\cdot10^{-3}$m, are analized at a precharging pressure of accumulator $p_0=15\cdot10^5$Pa and a rotational frequency f = 3 Hz. A decrease in amplitude for pressure signals when cross section of the resistance decrease occurs.

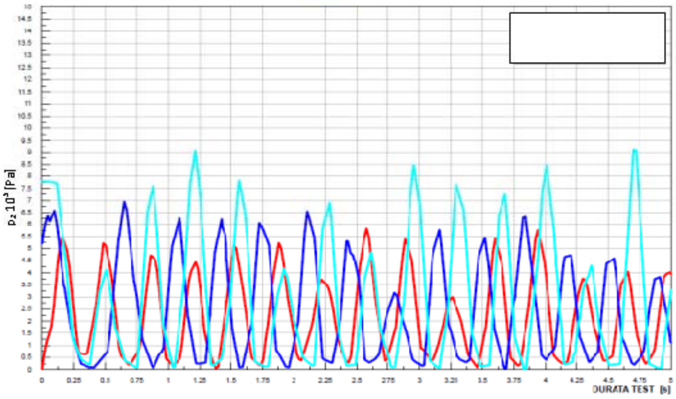

Fig. 5 − Pressure signals for two different strokes of the mobile component of hydraulic resistance ($C_2=4\cdot10^{-3}$m, $C_3=6\cdot10^{-3}$m, $C_4=8\cdot10^{-3}$m, f= 3 Hz, $p_0= 15\cdot10^5$ Pa).

4. Conclusions

1. It is noticed that the growth of the hydraulic resistance increases the amplitude of the pressure signals.

2. For high frequencies of load variation it is recommended to use greater cross section in order to obtain greater amplitude of recorded pressure signals.

3. It was also noticed that if one decreases the cross section of the resistance, phase difference grows (Fig. 3). The phenomenon is more visible at low frequencies.

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ANALIZA INFLUENŢEI REZISTENŢEI HIDRAULICE ASUPRA COMPORTĂRII UNUI SISTEM WIM HIDRAULIC

(Rezumat)

Lucrarea de faţă prezintă un sistem de cântărire în mişcare hidraulic şi varianta propusă pentru testarea sistemului în laborator. Este descris modelul experimental şi modul în care acesta funcţionează. Este prezentată, de asemenea, o analiză a influenţei variaţiei secţiunii de trecere a rezistenţei hidraulice reglabile din componenţa sistemului, asupra semnalelor de presiune înregistrate cu acest model experimental.