Pressure measurement in disintegrated medium

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Abstract: *Application of a piezoelectric sensor for pressure measurement in disintegrated medium is presented. It was evidenced that the sensor must be equipped with a liquid adaptor to enable non-directional pressure measurement in disintegrated medium. Results of dynamic examination of the developed sensor are presented. It was found that the developed liquid adaptor is an inertialess element. Results of pressure measurements in dynamic densened moulding sand using the developed sensor are also presented.*

Keywords: disintegrated medium, unit pressure, piezoelectric sensor, liquid adaptor, measurement

1. Introduction

Piezoelectric sensors make possible the measurements of dynamic pressures, i.e. very rapid pressure changes reaching ca. 100 - 200 kHz with high amplitudes of several hundreds MPa. These sensors are characterised by very good linearity in the entire range of transforming a mechanical signal into electrical signal. The shortcomings of these sensors, however, include their susceptibility to electrical interferences and side piezo-efects like temperature or vibration effects.

Typical sensors manufactured by Kistler company, e.g. type 601H, are designed for pressure measurements in continuous media, i.e. in liquids and gases. For that reason, such sensors can not be directly used for pressure measurements in disintegrated media like soils or moulding sands.

Measurement of non-directional pressure inside disintegrated medium using the piezoelectric sensor is only possible with an intermediate piece that transfers the measured quantity (pressure in disintegrated medium) to the sensor. Such an intermediate piece should be an inertialess element, which can be achieved by a liquid adaptor only.

In the following text, a piezoelectric sensor with liquid adaptor, developed in the Laboratory of Basic Automation of the Institute of Production Engineering and Automation, Wroclaw University of Technology [1], is presented, as well as its application for pressure measurement in disintegrated medium, that is for non-directional pressure measurement inside moulding sand.

2. Pressure sensor and measuring system

For pressure measurements, the piezoelectric sensor with liquid adaptor, shown in Fig. 1, was used. The measurements were taken on the measuring stand shown in Fig. 2. Measurements in the moulding sand contained in a moulding box were carried out in the following way. After the impulse head GI was filled with air up to the preset initial pressure value p_0, the valve ZI was opened and, at the same time, the measuring line was released. The signal from the charge amplifier was recorded on a magnetic disk. The signals were stored in a computer at 10 kHz.

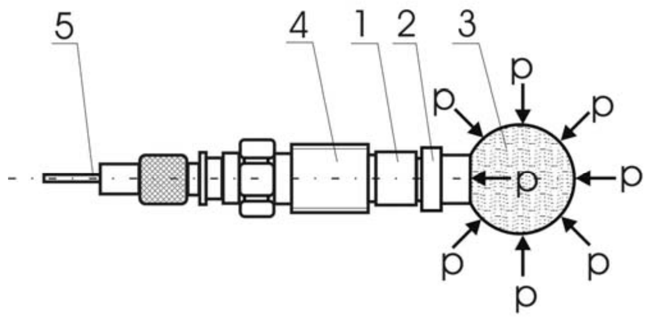

Fig. 1. Layout of the sensor for pressure measurement in disintegrated medium: piezoelectric sensor 601H (1), sealing clamp (2), liquid adaptor (3), holder (4), cable (5)

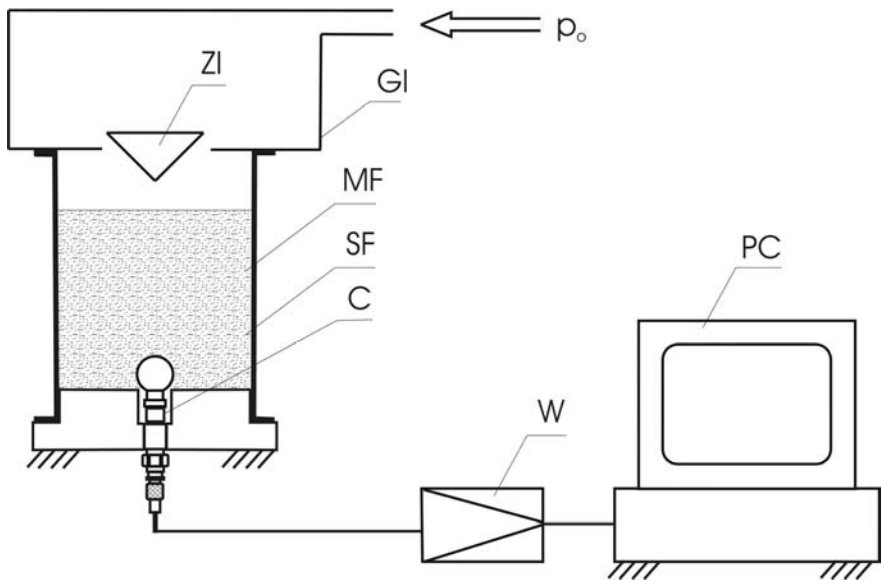

Fig. 2. Layout of the measuring stand: GI - impulse head, SF - Moulding box, ZI - impulse valve, MF - moulding sand, W - charge amplifier type 5001, PC - computer with measurement card TAD 05

3. Measurement results

Figure 3 shows change of air pressure recorded in the empty working space (without moulding sand) using the sensor, both without and with the liquid adaptor. Change of air pressure in the working space resulted from opening the impulse head valve ZI.

It can be found on the grounds of the presented results that the recorded courses (1) and (2) are almost identical. So, it can be said that the developed liquid adaptor is an inertialess element.

The piezoelectric sensors can be used for pressure measurements in dynamically densened moulding sand, but they must be equipped with inertialess liquid adaptors to enable measurement of non-directional pressure in the moulding sand.

Figure 4 shows measurement results of pressure changes: squeezing pressure p_p and total pressure p_c, in impulse squeezed moulding sand [2]. The Figure also shows pressure p_v representing pressures in the moulding sand after the squeezing process has been completed. That pressure is approximately equal to the strength of the moulding sand.

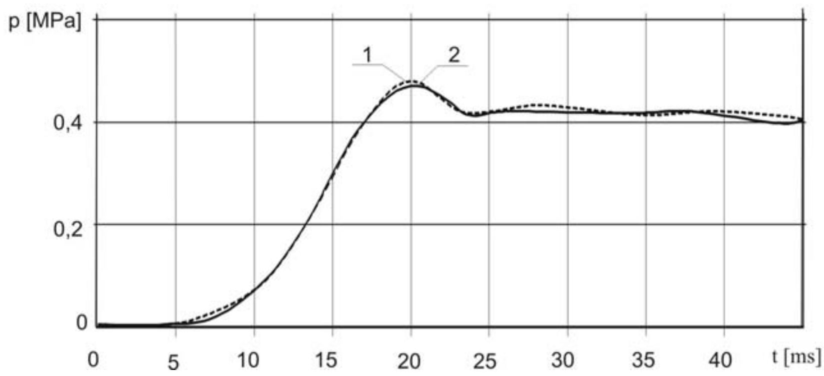

Fig. 3. Air pressure change in closed working space recorded using the sensor without adaptor (1) and with liquid adaptor (2)

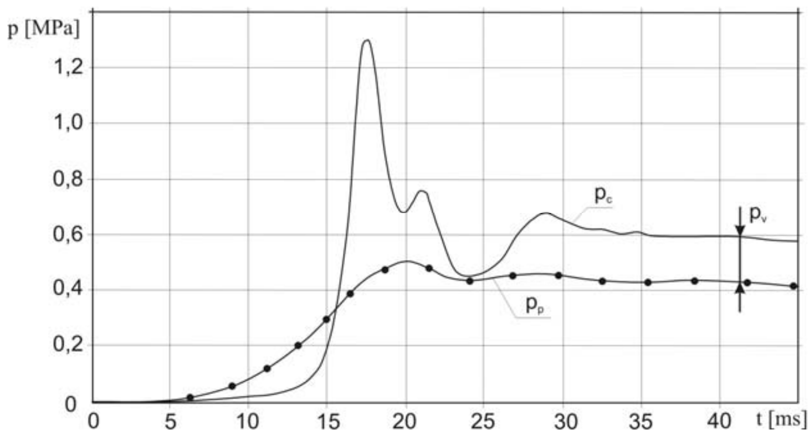

Fig. 4. Course of squeezing pressure p_p and total pressure p_c in moulding sand during its impulse densening; p_v = pressure resulting from densening of the moulding sand

4. Summary

A sensor for pressure measurement in disintegrated media is presented. The included results prove that the piezoelectric sensors equipped with liquid adaptors can be used for pressure measurements in dynamically densened moulding sands.

The liquid adaptor for the 601H type sensor, developed by the author, enables inertialess measurement of non-directional pressure in moulding sand.

Analysis of the presented relationships between pressure changes in moulding sand and squeezing pressure, determined in the experiments, can be used e.g. for evaluation of the impulse densening process of moulding sands. Pressure measurements in densened moulding sands can make a ground for verification of the impulse densening mechanism of moulding sands.

References

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