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CREEP PROCESS OF BEET ROOTS SUBJECTED TO AXIAL COMPRESSION

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INTRODUCTION

Sugar beet roots, as in any other agricultural product, are subjected to mechanical treatments during harvesting, handling and processing. To have a minimum degree of product damage and the highest efficiency of mechanical process, the mechanical behaviour of the product when subjected to stress and strain must be known.

To determine viscoelastic constans of sugar beet roots the uniaxial compression test is applied.

EXPERIMENTAL INVESTIGATION

Sugar beet roots of Polish variety AJ_3 harvested in Wilanów in 1975 were used in the experiments. Cylinder — shaped samples having the diameter of 12 mm and the height of 10 mm were placed under the plunger of the Hoeppler consistometer and subjected to constant stress of $17.5 \times 10^5 \, N \cdot m^{-2}$. The sample strain was measured throughout the period of each experiment and recorded. The Hoeppler consistometer was altered to enable the recording of strain versus time.

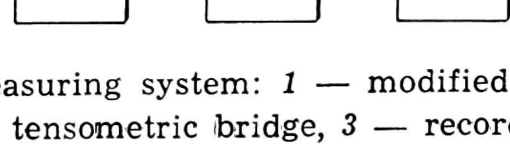

Fig. 1: Diagram of the measuring system: *1* — modified Hoeppler's consistometer, *2* — tensometric bridge, *3* — recorder

Figure 1 shows the outlook of the outfit. The outfit is composed of the following elements: a Hoeppler consistometer equipped with the strain gauge appliance, a bridge with an amplifier and a recorder.

The sample strain is transfered to an elastic beam equipped with a strain gauge (strictly speaking with two strain gauges on the opposite sides of the beam). The beam deformation causes a change in the resistance of the strain gauges. The change of resistance can be read on the bridge — amplifier scale and transfered to the recorder. Figure 2 pre-

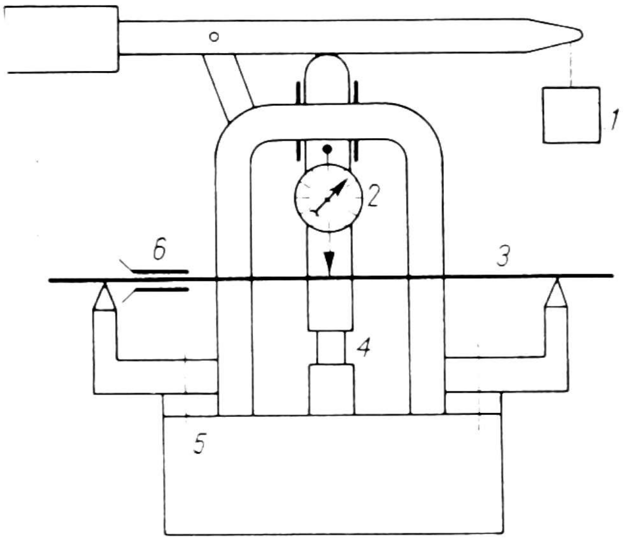

Fig. 2. Diagram of the modified Hoeppler's consistometer: *1* — weight, *2* — clock probe, *3* — elastic beam, *4* — sample, *5* — supports of the beam, *6* — strain gauges

sents the outlook of the modified instrument. The elastic beam is placed on two supports fastened to the base of the consistometer so that the tappet of the flexometer presses against the central part of the beam. The beam deflexion obtained in this way is equal to the deformation of the sample. The beam deformation causes the changes of the strain gauge resistance. The use of two strain gauges instead of one makes it possible to obtain more accurate measurements, because while one of the strain gauges reacts to the extension of the upper part of the beam, the other one reacts to the abridgement of the lower part. The beam rigidity and deformations should be small, otherwise the elastic effect of the beam would effect the sample loading. That is to say that the beam reaction should not be compared with the sample load. So the deflection of the beam should also be small. The use of the standard flexometer makes the calibration of the system very casy, as the same quantity can be read on the scales of the bridge, the recorder and the flexometer itself, so it is possible to calibrate the bridge, based on the flexometer readings.

THEORETICAL CONSIDERATIONS

The creep curve obtained is shown in Fig. 4 (mean result of 30 measurements).

Based on the experimental results it can be assumed that the mechanical behaviour of sugar beet samples can be described by using a three — parameter viscoelastic model shonw in Fig. 3.

According to the model the strain — stress — time equation is:

$$\varepsilon = \frac{\delta}{E_1} + \frac{\delta}{E_2}\left(1 - e^{-\frac{t}{\lambda}}\right),$$

where

$$\lambda = \frac{\eta}{E_2}.$$

The constants were evaluated by means of solving three equations (three constants as unknown quantities).

Experimental results were taken each time as ε and t values.

The constants obtained are:

$$E_1 = 87.5 \times 10^5 \ \mathrm{N \cdot m^{-2}},$$
$$E_2 = 219.0 \times 10^5 \ \mathrm{N \cdot m^{-2}},$$
$$\lambda = 0.46 \ \mathrm{min},$$
$$\eta = 604.2 \times 10^5 \ \mathrm{N \cdot s \cdot m^{-2}}.$$

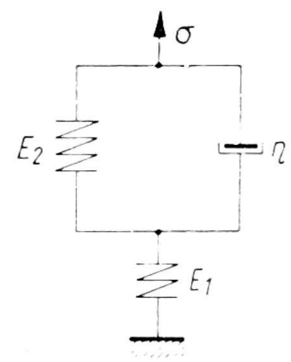

Fig. 3. Viscoelastic model of sugar beet during a creep experiment

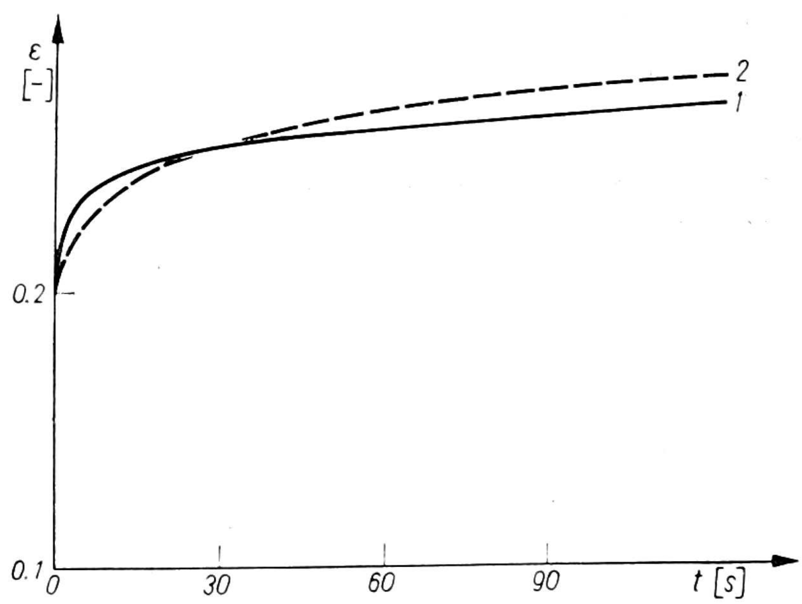

Fig. 4. Comparison of the curves of creeping for root of sugar beet. *1* — experimental curve, *2* — model curve (theoretical)

It can be seen in Fig. 4 that the deviation between the model behaviour and the observed data is small and the accuracy obtained is good enough for technical applications.

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PROCES PEŁZANIA KORZENIA BURAKA CUKROWEGO PRZY ŚCISKANIU

Streszczenie

W pracy zbadano zachowanie się korzeni buraka cukrowego poddanych osiowemu ściskaniu. Zaproponowano teoretyczny model lepko-sprężysty i wyznaczono odpowiednie stałe lepko-sprężyste.

Do doświadczeń użyto zmodyfikowanego konsystometru Hoepplera. Rozważania teoretyczne porównano z danymi doświadczalnymi, uzyskując dobrą zgodność wyników.

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ПОЛЗУЧЕСТЬ КОРНЕЙ САХАРНОЙ СВЕКЛЫ ПРИ СЖАТИИ

Резюме

В работе исследовали поведение корней сахарной свеклы, подвергнутых осевому сжатию. Авторы предложили теоретическую вязко-упругую модель и определили вязко-упругие константы.

Для исследований использовали модифицированный констистометр Гепплера. Теоретические рассуждения сравнили с опытными данными, получив крупное совпадение результатов.

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