

INVESTIGATIONS OF MECHANICAL PROPERTIES OF HOP CONES

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INTRODUCTION

During hop harvest hops are plucked manually or by a ripper. The cones undergo loading, which, taking into account time parameter, can be divided into static and percussive ones. When loading is static, the force increases continuously in time and the velocity of stress increase is sufficiently small in comparison the critical velocity of the stress waves in the given material. This kind of load takes place during manual hop harvest. On the other hand, when cones are plucked mechanically, the strength phenomena are very complicated, because apart from the simple stress condition there are loadings of changing value and direction. We assume that shock load dominates.

THE PURPOSE OF STUDIES

The objective of the studies was experimental determination of some physico-mechanical properties of the hop cone for different load methods. Changes of strength properties of hop cones were measured taking into account the following factors:

- different hop varieties,
- different years,
- different phases of technologic ripeness of hop.

Static experiments were made to determine the necessary force to pluck the cones. The purpose of percussive experiments was to measure the work necessary to pluck the cones. Moreover the objective was comparison of the strength properties of cones for static and dynamic load.

Dynamic plucking and breaking tests were performed in order to check the relationship between linear velocity of the plucking machine elements and the number of broken cones.

METHOD AND PROGRAMME OF INVESTIGATIONS

STATIC TESTS OF HOP CONE PLUCKING

The static hop cones plucking was conducted with a specially constructed dynamometer. During investigations the dynamometer was hung, cones were introduced into a seating and then plucking started by pulling the stem. The force was increasing, slowly reaching its maximum value. These test were similar to those of construction material tension. The results were statistically analyzed assuming the proper accuracy of estimation as well as adequate standard deviation.

PERCUSSIVE TESTS OF HOP CONES PLUCKING

The percussive tests of hop cone plucking were conducted with Charpy's pendulum hammer.

DYNAMIC TESTS OF CONES BREAKING AND PLUCKING

For dynamic tests a special system imitating cone plucking in harvesting machines was built. In the tool holder of the driller a rotary ripping element with two teeth was fixed. A tooth however was fixed to the stand, to control the intertooth slit. A stroboscopic lamp was directed perpendicularly to the driller axis to measure angular velocity. The autotransformer served to regulate the supply voltage which caused the change of the number of rotations. Cones were given from the stem one by one. Every measurement was made 20 times.

RESULTS

STATIC TESTS OF HOP PLUCKING

Mean weighted of the means for 39 varieties and clones is equal:

$$\bar{y} = \frac{\sum_{i=1}^c n_i \bar{y}_i}{\sum_{i=1}^c n_i} = 3.12 \text{ N.}$$

The significance for the difference of two means, i.e. 8 hop varieties and 39 varieties and cones were determined by the known methods of mathematical statistics. It appeared that the difference in resistance of cones to plucking was not significant. They average force needed for cone plucking was measured by a completely random block method for seven hop varieties. The means from statistical tests in 1970 and 1971 were taken as blocks. Calculations performed on the basis of the significant

tests proved that there were no significant differences in the plucking force for the seven hop varieties. Significant differences existed for different years.

PERCUSSIVE PLUCKING OF HOP CONES

Percussive hop cone plucking made the determination of the resistance to percussive tension possible. This value was obtained on the basis of following variables:

- work read on the hammer scale,
- cross section area,
- average elongation of sample.

The mean resistance to percussive tension equals:

$$\delta_{ru} = \frac{1000 L_n}{\Delta l A_0} = 35.63 \frac{\text{N}}{\text{mm}^2}.$$

Statistic estimation of the experiments was performed by the method of extreme term distribution, and extreme values of static and dynamic force were found according to Smirnov. A straight line for the maximum in statical measurements was found from the equation:

$$x_1 = 2.27 + 0.257y.$$

The equation for the straight line of the maximum in dynamical investigations has the form:

$$x_2 = 22.52 + 7.65y,$$

where:

- x — force in N,
- y — normalized deviation being the argument of the function:

$$\varphi(y) = e \exp(-e^{-y}).$$

Maximal forces corresponding to the confidence level $P = 0.999$ are:

$$N_{\text{stat}} = 4,06, \quad N_{\text{dyn}} = 76,07\text{N}.$$

It follows from the above, that there is a significant increase of strength characteristic of cones with percussive loading, which is also valid for other construction materials.

DYNAMIC HOP CONE PLUCKING AND BREAKING

Dynamic hop cone plucking and breaking enabled us to estimate the linear velocity range for mechanical hop harvesting. Optimal velocities should be kept in the range from 1.8 to 5 m/s, because this gives the lowest losses in the form of broken cones.

R. Panas

BADANIE WŁASNOŚCI MECHANICZNYCH SZYSZEK CHMIELU

Streszczenie

W pracy przedstawiono metody pomiaru i wyniki badań niektórych własności mechanicznych szyszek chmielu. Na podstawie tych metod przeprowadzono badania różnych odmian chmielu w latach 1970—1971. Szyszki poddano podstawowym próbom wytrzymałościowym. Ocenie wytrzymałości podlegał ogonek szyszki, jak i sama szyszka. Na podstawie uzyskanych wyników określono zakres występujących wartości sił statycznego i dynamicznego zrywania szyszek. Określono też wytrzymałość na udarowe zrywanie szyszek. Na podstawie prób statycznych i udarowych wyznaczono ekstremalne wartości występujących sił.

W zakresie prób dynamicznych uzyskano wyniki dotyczące optymalnej prędkości liniowej elementów zrywających maszyn.

Р. Панас

ИССЛЕДОВАНИЯ МЕХАНИЧЕСКИХ СВОЙСТВ ШИШЕК ХМЕЛЯ

Резюме

В настоящей работе представлены методы измерений и результаты исследований некоторых механических свойств шишек хмеля. С использованием этих методов были проведены исследования различных сортов хмеля в 1970-1971 г.г. Шишки подверглись основным прочностным исследованиям. Оценивалась прочность ножки шишки как и самой шишки. На основании полученных результатов был определен диапазон значений сил статического и динамического срывания шишек. Была определена также прочность шишек на ударное срывание. На основании статических и ударных испытаний были установлены экстремальные значения выступающих сил. По части динамических испытаний были получены результаты, касающиеся оптимальной линейной скорости срывающих элементов машин.

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