Annals of Warsaw University of Life Sciences – SGGW
Forestry and Wood Technology No 75, 2011: 113-116
(Ann. WULS-SGGW, Forestry and Wood Technology 75, 2011)

# Extrapolation of experimental creep curves of furniture joints' elements

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**Abstract:** *Extrapolation of experimental creep curves of furniture joints' elements.* Current research show that rheological properties of furniture joints shouldn`t be omitted in selection and evaluation of furniture construction features. The designing process of such constructions needs determination of rheological models of used connections. The research uses Rabotnov's method for extrapolation of creeping curves obtained during experiment. For mathematical description of experiment data a function of stress (load) and time was used, which was also used by Rabotnov. Appropriate constants were appointed on the example of creeping courses obtained from earlier examined samples that shape was pin driven in particle bard [8]. In the end summary of obtained dependences took place.

*Keywords:* furniture joints, Rabotnov's correlation parameter, creep, particle board

## INTRODUCTION

The connections used for fixing in modern furniture because of external and internal interactions are disposed to intensive rheological processes [4, 5, 6, 7, 8, 11]. Rheological properties of such connectors cannot be omitted in the aspect of technical furniture design. That is why, one should primarily determine extrapolation methods of experimental data to obtain possibly universal and simple rheological model.

Generality of such a model regards its application at least in the field of exploitation loads. There is a possibility of using such a model for numerical analysis. However the simple mathematical function apart from uncomplicated analytical calculations is supposed also to enable the selection of mechanical hypotheses of creeping. It can also enable generalizing of hypotheses on multiaxial states of stress (loads). This requirement in principle eliminates non-linear mechanical rheological models [3].

Current statistical methods of experimental data create among other very wide possibilities of analysis rheological models. It enables precise selection of dependences via analysis of selected courses [2]. Usage of models selected in such a way for wider range of load often requires variation of constants in formulas, which can lead to very complicated mathematical formulas.

## EXTRAPOLATION OF CREEP NEEDS PLACEMENT DATA

Function describing creeping can be more complicated than in the theory of elasticity or plasticity. Additionally it can contain time, deformation speed and moisture changes [1, 3]. Further divagations refer to earlier research which data were presented in the paper [8]. They were conducted at constant loading with extraction force in practically constant temperature and moisture content [8]. The dependence on creep displacement can be show as:

$$\Delta l^c = f_1(F) f_2(t) \tag{1}$$

where:

$\Delta l^c$ – creep displacement,
$F$ – loading force,
$t$ – time.

The extrapolation of experimental curves was made using method proposed by Rabotnov [9, 10]. On the basis of creep curves presented in the paper [8] isochronous curves were constructed (Fig. 1).

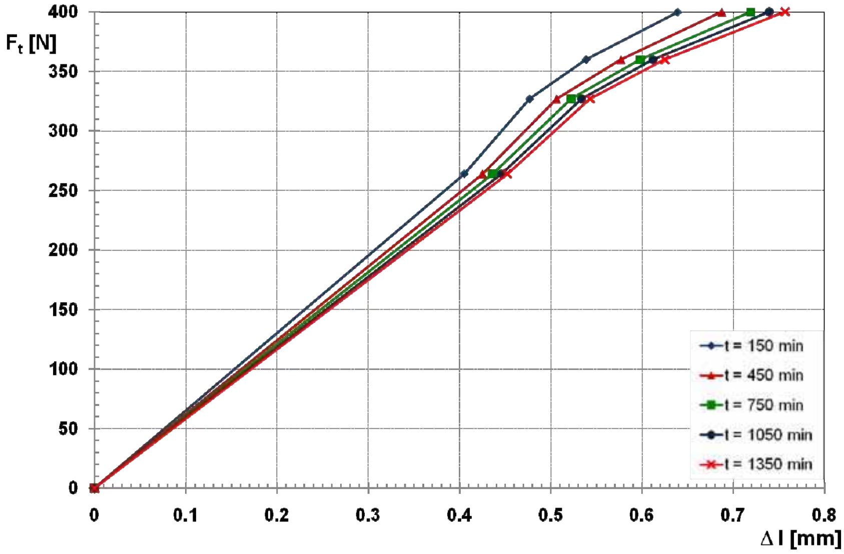


Fig.1. Isochronous creep curves

Because of similarity of the above curves, observed also by Rabotnov, one can make normalization into single master curve via transformation of loading axis [9, 10] (Fig.2). For this purpose Rabotnov's correlation parameter in general form was used:

$$\psi(t) = \frac{F_t}{\phi(\Delta l)} \tag{2}$$

where: $F_{t=0} = \phi(\Delta l)$ curve of instantaneous load-displacement curve.

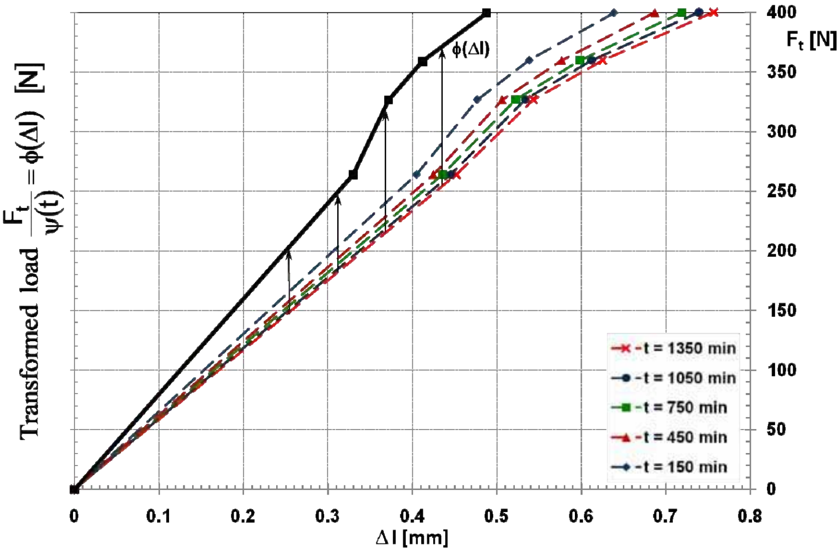


Fig. 2. Load – displacement of master curve derived from board (Fig. 1)

As the parameter of correlation a function suggested by Rabotnov was accepted in the following form:

$$\phi(\Delta l) = F_t\left(1 + At^b\right) \tag{3}$$

where:

*A*, *b* – constants.

On the basis of experimental creep curves for loading up to 360 N constant *A* and *b* were appointed and dependence was obtained:

$$\phi(\Delta l) = F_t\left(1 + 0.034t^{0.23}\right) \tag{4}$$

From the above function using dependence between immediate displacements and load [8] analytical curves were obtained for individual loads. In the below illustrations (Fig.3, Fig. 4) graphic courses of curves analytically calculated and those obtained in the experiment [8] and creep surface were presented respectively.

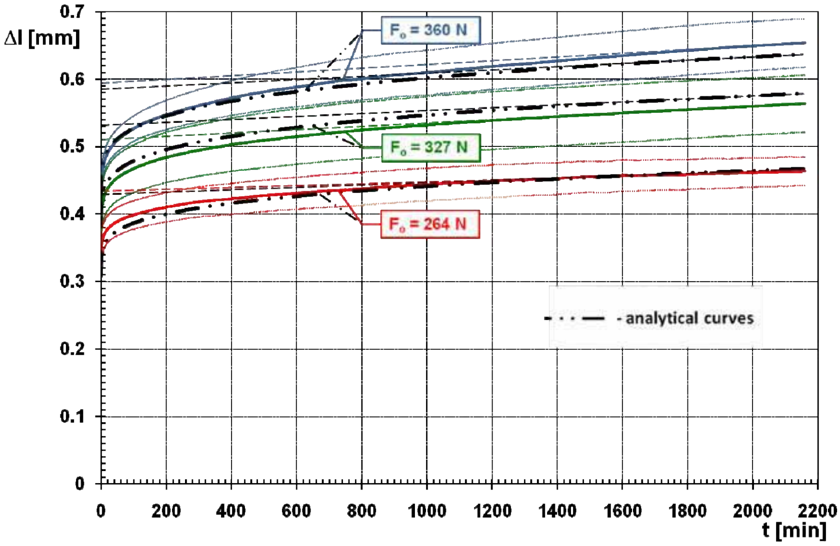


Fig 3. Analytical and experimental creep curves [8]

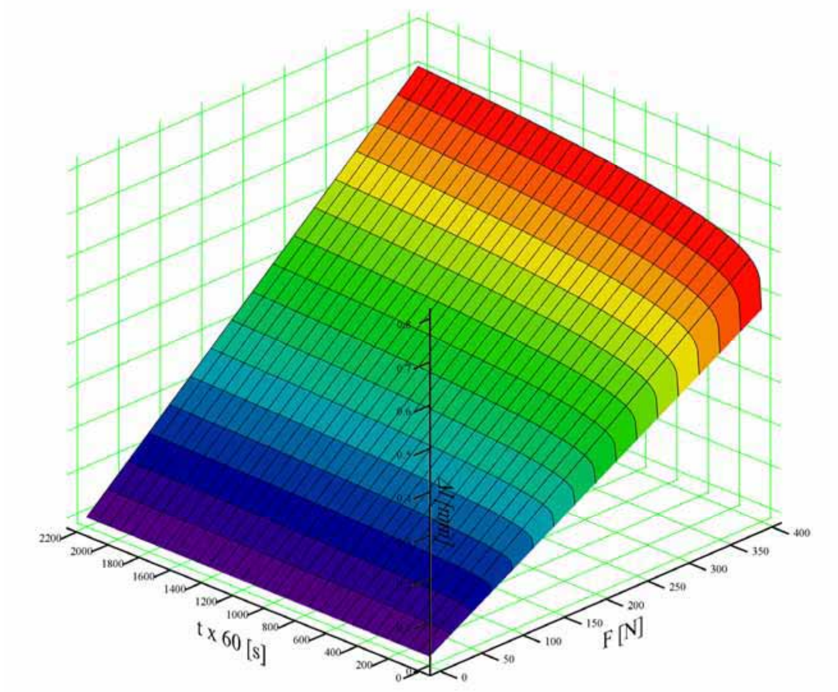


Fig 4. Creep surface

CONCLUSIVE REMARKS

The Rabotnov's method used in this experiment in order to appoint the empirical equation turned out to be very effective. Divergences between analytical and experimental curves result from linearization of courses of described curves shown in Figs. 2. Approximation with other empirical functions requires only placing them in the place of correlation parameter. The above described method creates wide possibilities of further both theoretical and numerical analyses.

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**Streszczenie:** *Ekstrapolacja eksperymentalnych krzywych pełzania elementów połączeń meblowych.* Dotychczasowe badania eksperymentalne wykazały, że właściwości reologiczne połączeń meblowych nie mogą być pomijane w doborze i ocenie cech konstrukcyjnych mebli. Proces projektowania tego rodzaju konstrukcji wymaga określenia modeli reologicznych stosowanych w nich połączeń. W pracy wykorzystano metodę Rabotnova celem ekstrapolacji uzyskanych z eksperymentu krzywych pełzania. Do matematycznego opisu danych eksperymentalnych posłużono się funkcją naprężenia (obciążenia) i czasu zaproponowaną również przez Rabotnova. Wyznaczono odpowiednie stałe na przykładzie przebiegów pełzania uzyskanych z wcześniejszych badań próbek w postaci trzpienia wkręconego w płytę wiórową. Dokonano podsumowania uzyskanych zależności.

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