THE ASSESSMENT OF REOLOGICAL BEHAVIOR OF A BEAM PROPPED ON THE ENVIRONMENT WITH VISCOELASTIC PROPERTIES

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INTRODUCTION

The Rheology is a science that study inter dependencies between mechanical stress, response of the solids and its proprieties. This since determines mathematical methods to describe the behavior of solids subjected to stress.

Deformation level of solids is changing over time until equilibrium is reached between internal and external forces in the solids.

On the assessment of rheological behavior of the solids are used mechanical methods for which are elaborated differential and integrated equations. Using these models to describe the properties of construction elements and the environment that they rest on, can be traced their behavior over time.

1. THE VISCOELASTIC BEAM PROPPED ON THE VISCOELASTIC MEDIUM

The following basic models: Maxwell (fig. 1, *a*); Kelvin-Voight (fig. 1, *b*); will be assess in rheology as integral parts of more complex mechanical models, reflecting closely, as much as possible, the rheological behavior of the solids.

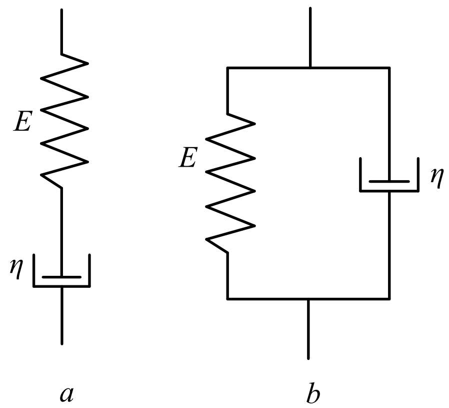

Figure 1.

Thus, for each material used in construction, standalone element or conjunction of items, can be adopted a rheological method to simplify and ordering a general problem of correlation between stress and deformations.

For a concrete beam, will be adopted Zener rheological model (fig. 2), and the beam is considered propped on viscoelastic base.

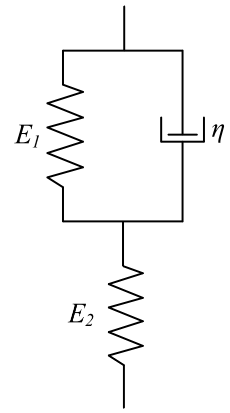

Figure 2.

The problem will be solved by applying numerical methods. Differential equations of viscoelastic beam propped on viscoelastic base (fig. 3) are following:

$$\begin{cases} nHI\dfrac{\partial^4 \dot{w}}{\partial x^4} + EI\dfrac{\partial^4 w}{\partial x^4} = q + n\dot{q} - p - np \\ n^* h\dot{w} + kw = p + n^*\dot{p} \end{cases}, \quad (1)$$

where: w – displacement; q – distributed load; $(\cdot)$ – time derivative;

I – moment of inertia of transversal section of the beam;

H, E, n – the constants of beam material, which are determined depending on modules of elasticity of springs E_1, E_2 and viscosity of dumper η with following relations:

$$H = E_2, \quad E = \frac{E_1 \cdot E_2}{E_1 + E_2}, \quad n = \frac{\eta}{E_1 + E_2}, \quad (2)$$

h, k, n^* – the constants of the supporting medium, which determined by relations (2) replacing modules of elasticity of springs and viscosity of dumper with those of the medium, ie E_1^*, E_2^* and η^*. So:

$$h = E_2^*, \quad k = \frac{E_1^* \cdot E_2^*}{E_1^* + E_2^*}, \qquad (3)$$

$$n^* = \frac{\eta^*}{E_1^* + E_2^*},$$

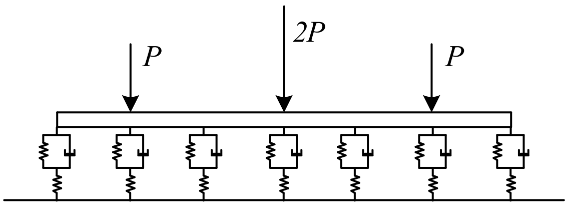

Figure 3.

2. THE SOLUTIONS OF THE CALCULUS

For a given concrete beam with sectional dimensions as $40 \times 60\, cm^2$ and the length of $L = 3{,}6\, m$ with following characteristics: $E_1 = 0{,}5775 \cdot 10^5\, MPa$, $E_2 = 0{,}33 \cdot 10^5\, MPa$, $\eta = 74 \cdot 10^{16}\, P$; $H = 0{,}33 \cdot 10^5\, MPa$, $E = 0{,}21 \cdot 10^5\, MPa$, $n = 81{,}543$; propped on the viscoelastic base (fig. 3) with $E_1^* = 350{,}4\, MPa$, $E_2^* = 20\, MPa$, $\eta^* = 10^{11}\, P$; $h = 20\, MPa$, $k = 18{,}92\, MPa$, $n^* = 0{,}0027$ calculations was made that permitted to determine displacements in time.

In figures 4, 5, 6 are represented variation in time (*a* – seconds, *b* – minutes, *c* – hours, *d* – days, *e* – years) of displacements, reactive pressure and bending moment respectively on the middle of the beam.

CONCLUZIONS

1. According to the results obtained, the bending moment in the central section of the beam is not varying.
2. Displacements occurs mostly in the first day of observations and by the fifth day will reach 38% out from total value. After first year the value of displacement will stabilize.
3. The reactive pressure, also, will increase first five days reaching 38% out from total value, and also at the end of first year this pressure will stabilize.

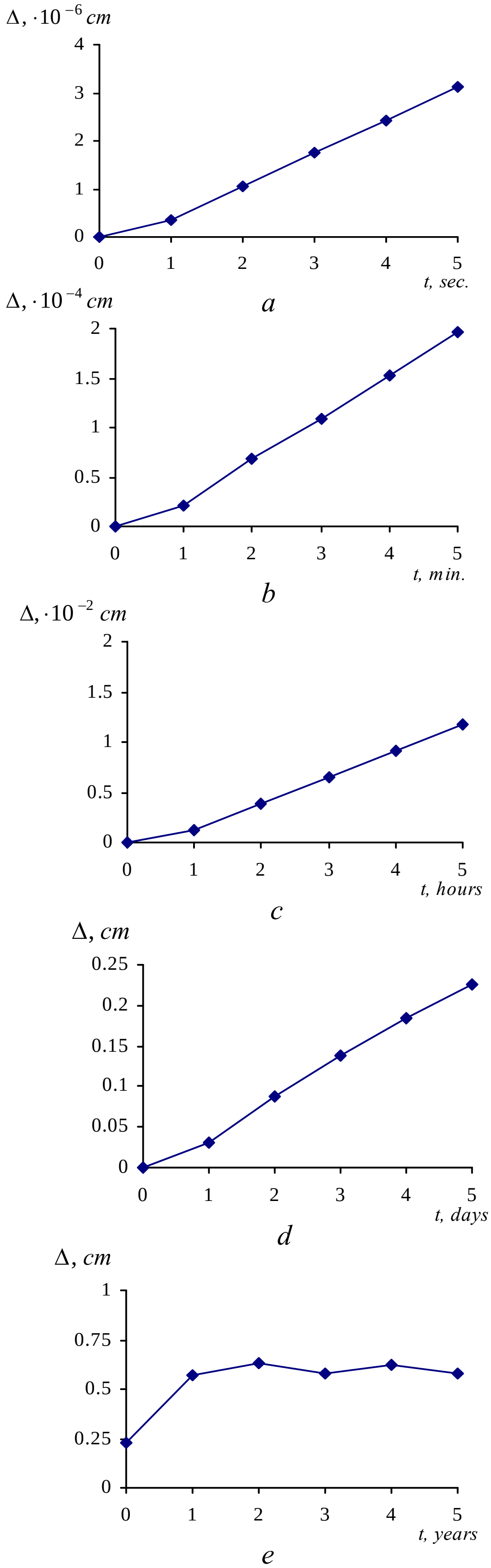

Figure 4. Variations of displacements:
a – seconds, b – minutes, c – hours, d – days, e – years.

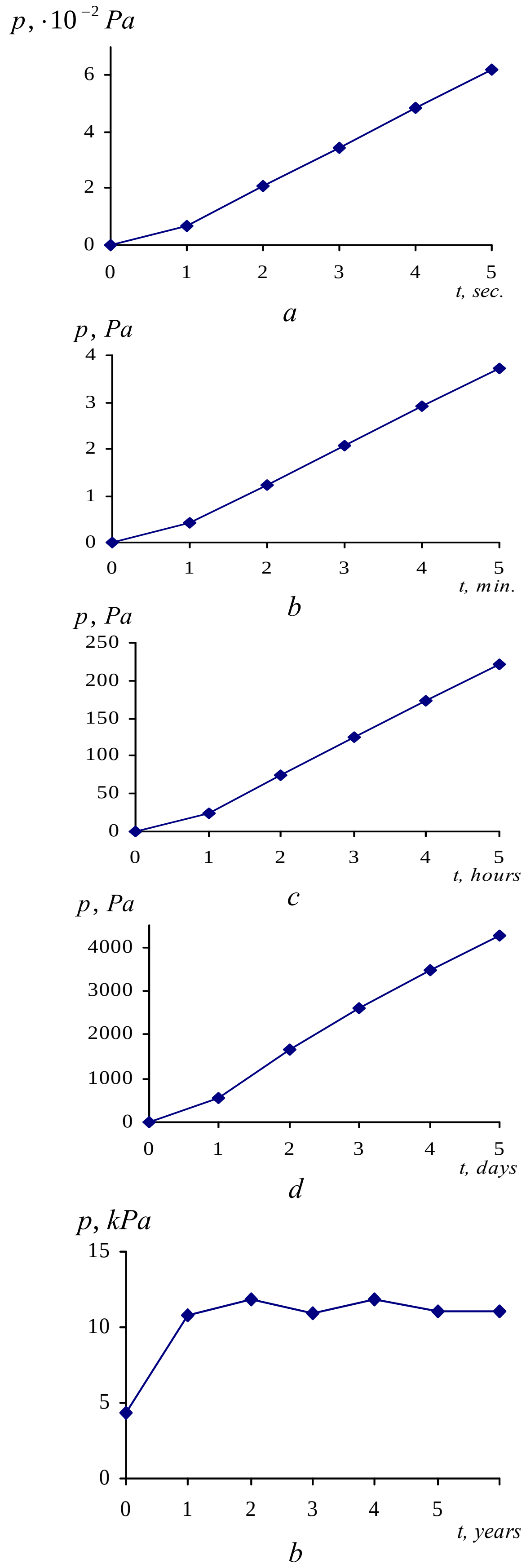

Figure 5. Variations of reactive pressure:
a – seconds, b – minutes, c – hours, d – days, e – years.

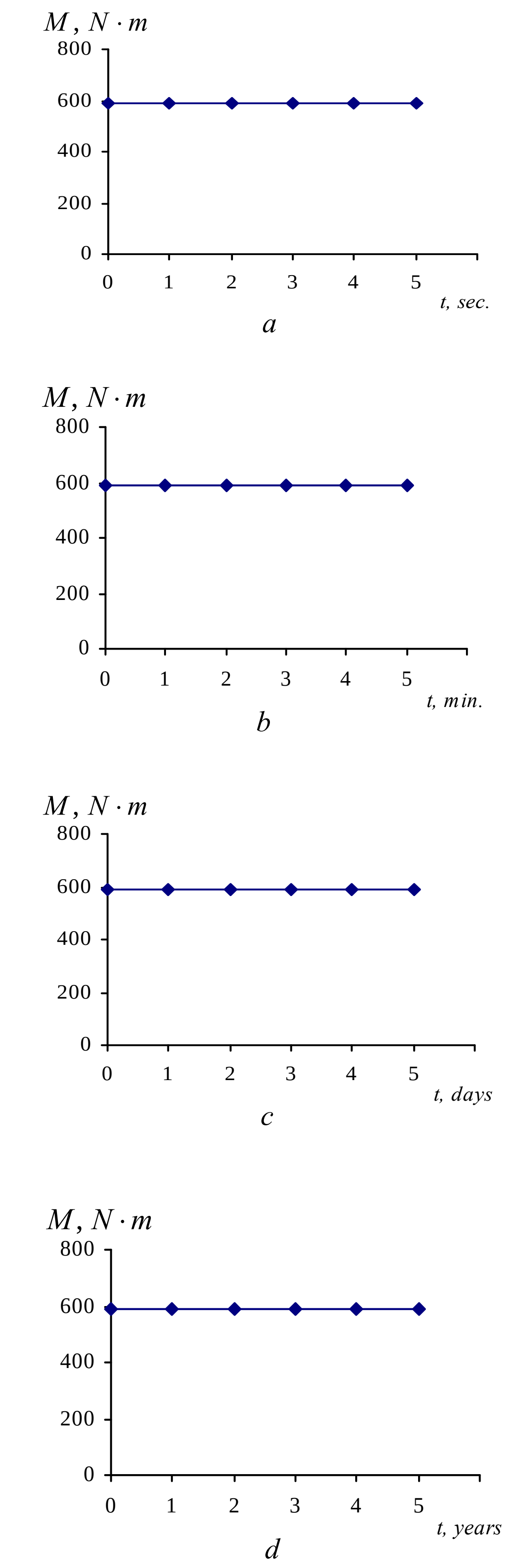

Figure 6. Variations of bending moment:
a – seconds, b – minutes, c – days, d – years.

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Recommended for publication: 22.09.2016