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AN OVERVIEW OF COMPLEX ENVIRONMENTS

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Annotation: General concepts of complex environments, information studied by scientists are presented. In the next section, the definition and information about viscous plastic media, which is a special case of media with complex properties, is given**.**

Keywords: Complex, viscous, plastic, environments, body, stergen, viscous-plastic

Many media exhibit a combination of elastic, viscous, and plastic properties during deformation. Appropriate models are required to describe the behavior of such complex environments. In the following, we consider the construction of basic relationships between stress and strain states for a fairly broad class of rheologically complex continuous media. We base the deformation on the following three main concepts: elastic, plastic and viscous. The first mechanism (elastic) determines the process of reversible deformation, and the next two (plastic, viscous) are irreversible processes. We use dynamic models to describe the properties of rheologically complex environments (Figure 1). In such models, force corresponds to stresses, and displacement corresponds to deformations of the medium. Inertial properties of models are not taken into account[1].

The elastic deformation mechanism is represented by a spring E, the end of which is connected to a rigid wall (Fig. 1, a). The rigid wall can be interpreted as a dry friction process even with a large coefficient of friction. The plastic flow process is modeled by dry friction elements P (Fig. 1, b), i.e. a rigid body pressed against a non-smooth surface.

The viscous mechanism can be described in two forms (Fig. 1, c, d). In the first case (Fig. 1, c), the viscous mechanism is denoted by the index V^0, in the second case by the index V*. As shown, the difference between these models allows for the inclusion of various additives to the viscous process in complex models.[2]

Let us consider the simplest combinations of mechanisms: ER - elastic-plastic body model (Fig. 2, a), elastic-viscous body model EV^0 or EV* (Fig. 2, b, c). For these models, the total deformation results from elastic and plastic or elastic and viscous:

$$de=de^e+de^p, \quad de=de^e+de^v \qquad (1.1)$$

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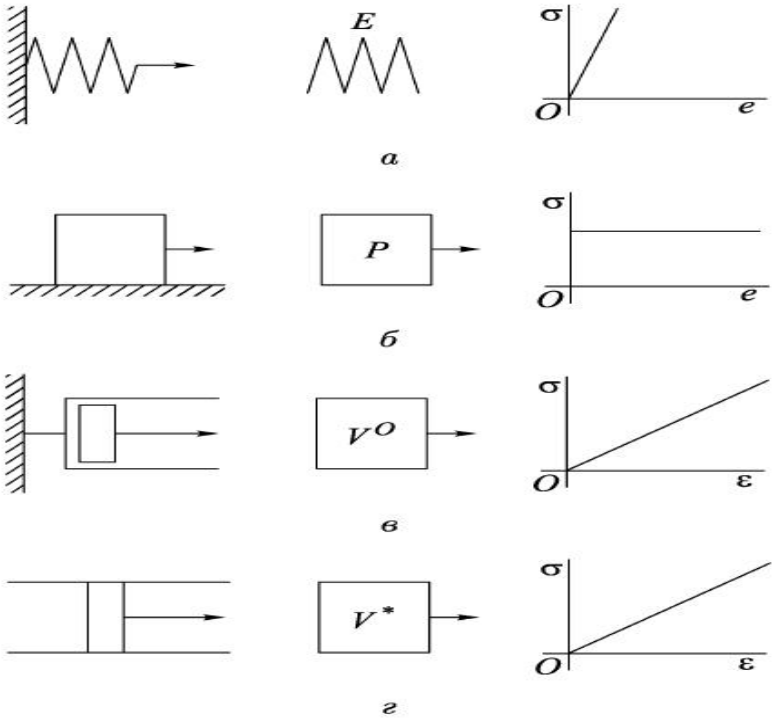


Figure 1

For elastic-viscous and elastic-plastic bodies, elastic deformations are related to the true stresses σij according to Hooke's law. There is no difference between the EV^0 and EV* models.

The deformation corresponding to the sequential action of the mechanisms P and E (Fig. 2, d) is exclusively plastic (the model corresponds to a hardening rigid-plastic body), therefore this mechanism is denoted by Re. Here and in the following, it is assumed that the internal deformations of the elastic elements are not capable of overcoming the resistance forces of the plastic elements by themselves.

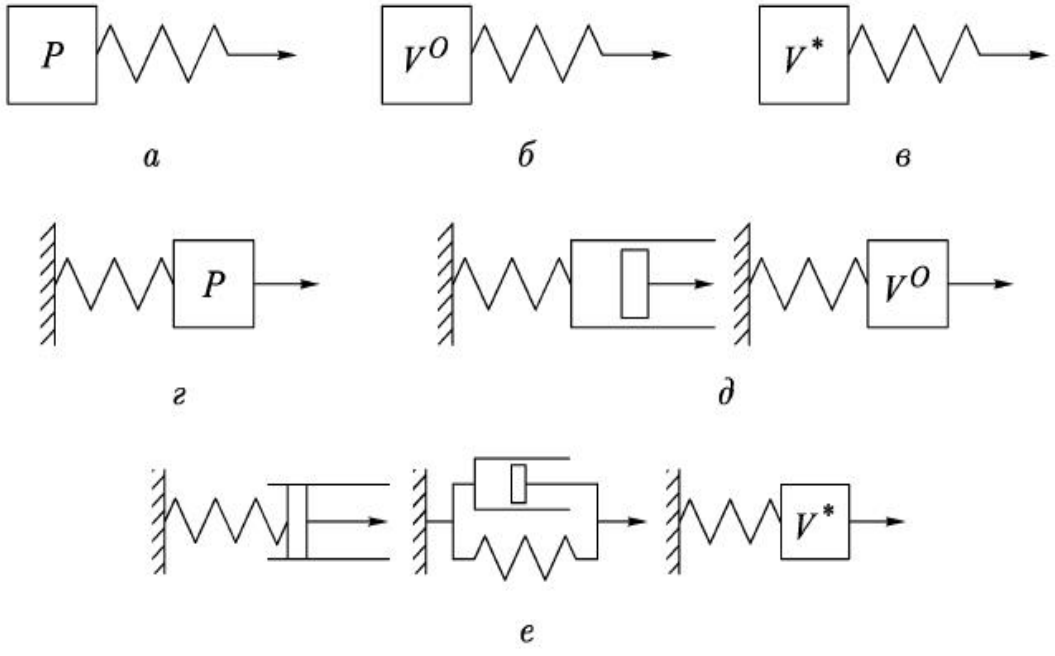


Figure 2

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We consider the sequential connection of the mechanisms V^0, E and V*, E (Fig. 2, d, f). It can be seen that the sequential connection of the mechanisms V^0, E leads to a force connection of the elements: the forces in the viscous and elastic elements are equal (Maxwell body), and the sequential inclusion of the elements V* and E leads to a kinematic connection: the displacements of the viscous and elastic elements are the same (Feucht body). It can be seen that the model V0E corresponds to the parallel inclusion of the elements of elasticity E and viscosity V^0.

Note that the order of introduction of elastic and viscous elements is not important when they are connected by force: the V^0E model is equivalent to the EV^0 model. However, in the case of kinematic connection of V* and E elements, the elastic element is present internally (Fig. 2, e), the deformation becomes viscous, and the model corresponds to V*E.[3]

Thus, with the adopted indexing, capital letters indicate the mechanism that determines the nature of the deformation; internal mechanisms that do not change the nature of the deformation are correspondingly designated by lowercase letters.

Note that in the case under consideration, the deformation can be elastic, viscous, plastic, elastic-viscous, elastic-plastic. The model formed by the mechanisms Pv* should be denoted by V* and Pv*, since in this case the deformation is plastic and the viscous element V* is internal. To be sure of this, it is enough to reduce the load: the total deformation will be residual. It is seen that the Pv° model is absolutely equivalent to the Pv* model, the difference between the elements V, V* affects only the presence of subsequent elastic or plastic elements.

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