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The electrical simulation of the rheological behavior of the asphalt mixes

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Summary

The paper presents the research work undertaken during author's doctoral studies on the electrical simulation on the rheological behavior of the asphalt mixes.

KEYWORDS: asphalt mixtures, electrical simulation, rheological behavior, analogical models

1. INTRODUCTION/GENERAL VIEW

1.1. The rheological behavior of the asphaltic mixtures is of visco-elastoplastic nature.

1.2. Material models (similar, analogical and structural ones) are used to simulate the rheological behavior. The analogical, the mechanical, and the electrical ones (the last one has the advantages of being very simple and very operative) are the most used.

1.3. The analogical models allow a better separation between the elastic deformation and the viscous and plastic ones than the rheological equations (relationships which connect the tension values both to the specific deformations and their derivatives which change over a period of time)

1.4. The different domains of the asphaltic mixtures behavior are represented according to the deformation amplitude (γ) and the number of cyclic loadings (N) at a certain rate.

2. RHEOLOGICAL MODELS

2.1. We mention below some of the mechanical models used for research regarding the behavior of asphaltic mixtures, models for which we further present the electrical simulation:

a. The Bűrgers Model;

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b. The Gretz Model;

c. The Bingham Model.

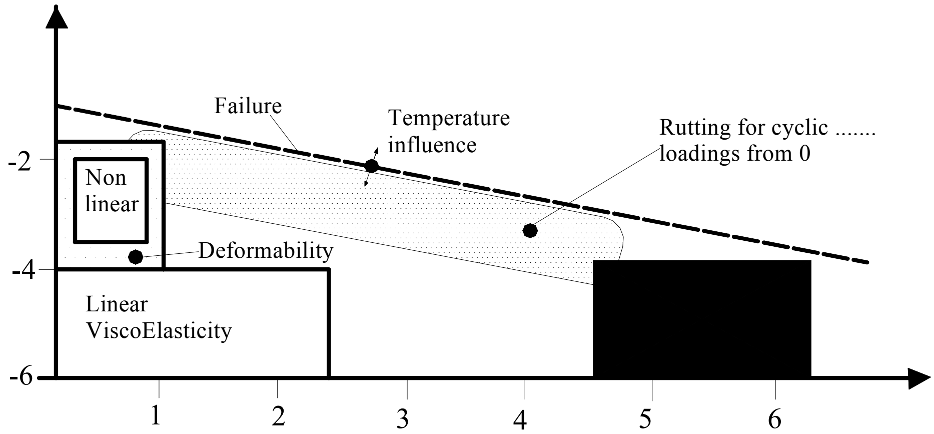

Figure 1.

2.2. The Bűrgers model consists of a Maxwell model and a Kelvin one, and models the instantaneous elasticity, the aftereffect elasticity and the viscous deformation properties.

The second figure presents the mechanical model (a) and the electric ones (c,d)

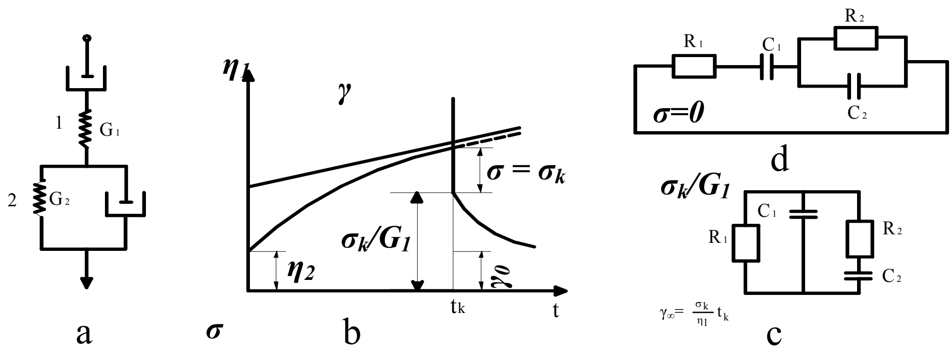

Figure 2.

G_1, G_2 – coefficients of elasticity;

η_1, η_2 – coefficients of viscuosity;

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c – the electrical model established through the analogy based on the condenser equation;

d – the electrical model established through the analogy based on the Ohm law;

c_1, c_2 –the capacities of the condensers;

R_1, R_2 –the electrical resistances.

2.3. The Bingham model (figure 3) shows the behavior of the asphalted mixture: elastic for small loadings and viscous after a certain value of the tension is overpassed.

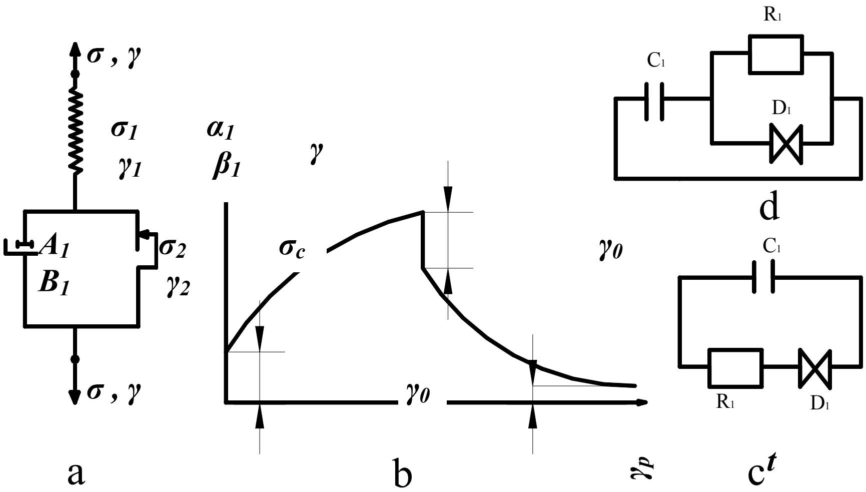

Figure 3.

2.4. The Gretz model is a non-linear model which presents both the reversible and the irreversible deformations.

Within the second element, the damper takes action only if the tension σ allows the overpassing of the friction force within the friction element''p''("p" has the same role as the diode from the electrical model).

The model we present is a non-linear one (from this point of view being similar to the Bingman one); therefore, the characteristic curve shows either the residual or the permanent deformation.

Figure 4 displays the mechanical model (a) and the electrical ones(c, d).

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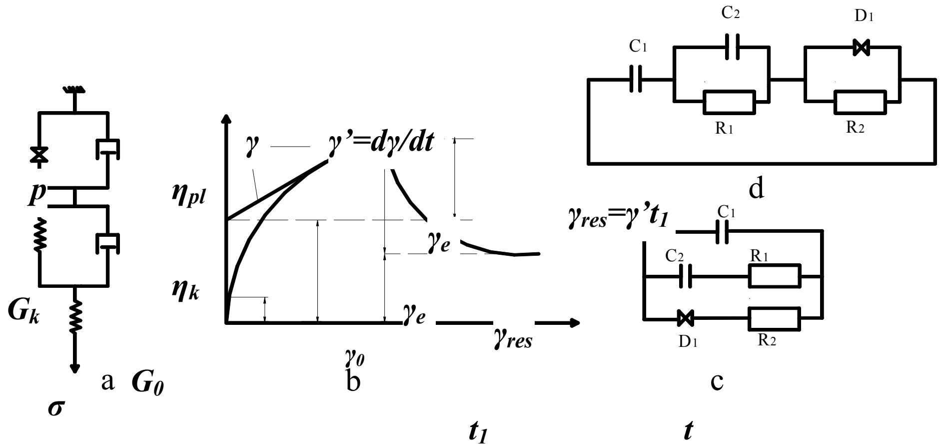

Figure 4.

The friction element ”p” is emphasized within the general rheological model displayed by figure 5.

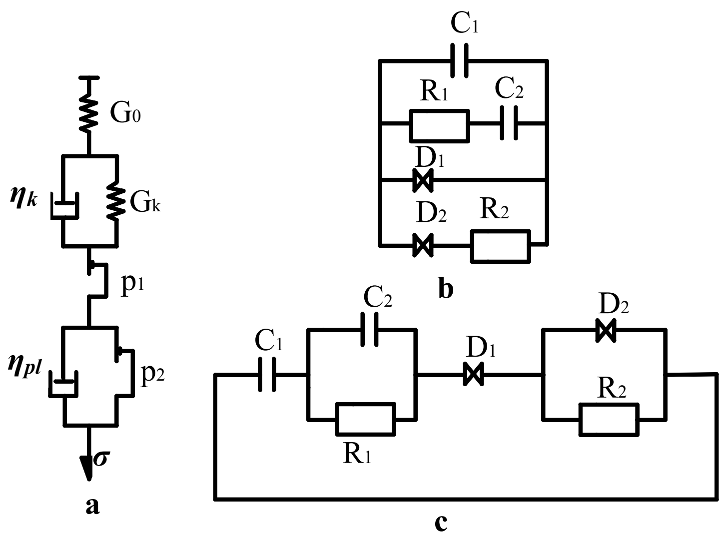

Figure 5.

The OrCad programme can be used to study the electrical models and it can simulate analogically, digitally or mixt (analogical-digital).

With the help of the running programme, the form of the signals is connected to time (being defined in time).

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The characteristic curve obtained through the electrical simulation and the characteristic curve obtained inside laboratory is being compared on specific sections (section connected to the elastic or the viscous behavior).

The trust level of the simulation has the form of statistic parameters represented by the correlation coefficient, the standard error and the maximum values of the positive/negative residuum.

3. CONCLUSIONS

The electrical simulation of the asphalted mixtures rheological behavior will be chosen over the mechanical modeling because of their simplicity and operativeness.

If we consider the electrical model, then the friction element model can be assimilated to a diode.

The simulation trust level will have the form of statistic parameter obtained from comparing the characteristic curves (the laboratory/modeled one) from specific section.

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