INVERSE MODEL OF DISPLACEMENT FOR THREE-POINT BENDING TEST

I. Kožar[1], N. Bede[1], S. Mrakovčić[1], Ž. Božić[2]
[1]*University of Rijeka, Faculty of Civil Engineering, R. Matejčić 3, 51000 Rijeka, Croatia*
[2]*University of Zagreb, Faculty of Mech. Eng. And Nav. Arch., I. Lučića 5, 10000 Zagreb, Croatia*

Three-point bending is an important test for various parameters in material science. In [1] we have developed simple layered model for correlation between the loading (force) and the vertical displacement. In [2] we have presented stochastic properties of the load - displacement curves resulting from bending tests. In order to validate our layered fracture model we need a relationship between the loading force and the displacement.
Standard displacement model is obtained from the solution of beam differential equation but it is valid only in the elastic regime, i.e., up to the peak load. Therefore, an additional term has been added to the standard solution, as presented in Equation (1)

$$Y_0(P,\kappa) = P\left({}^{2\,L^3}/_{EI_0}\cdot\left(1-\frac{\kappa}{L}\right)+{}^{3\,L^2}/_{EI_0}\right)\Big/_{48}+{}^{1-\kappa}/_{\kappa} \tag{1}$$

This equation is named the 'forward' model and has two parameters, force 'P' and fracture parameter 'κ'. Only for the correct values of fracture parameter 'κ' we obtain the inverse model that is capable of reproducing the data measured in the experiment. The correct values result from solving the following nonlinear equation:

$$Y_0(P_m,\kappa_{inv}) = \delta_m \tag{2}$$

Values of the correct fracture parameter 'κ' are depicted in Figure 1a as 'inverse' values.

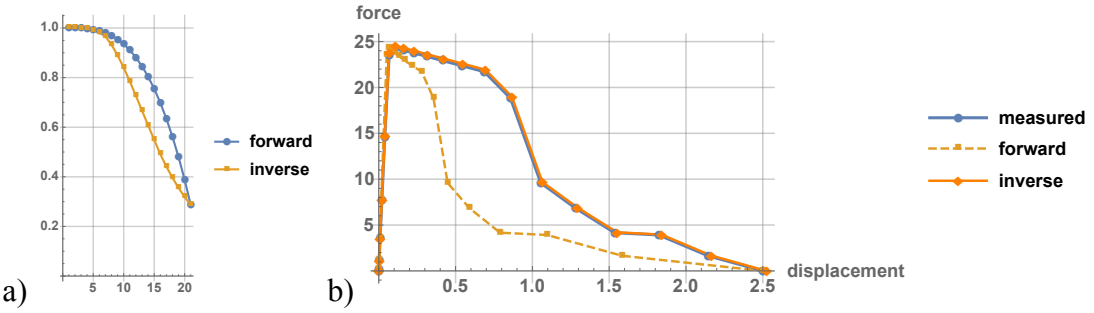

Fig. 1. Forward and inverse models: a) fracture parameters; b) load - displacement diagrams.

Figure 1b presents experimental results (line 'measured'), results of the forward model with some guessed values for the parameter 'κ' (line 'forward') and results of the inverse model (line 'inverse', the one with the correct fracture parameter 'κ' calculated from the Equation (2)). The inverse model demonstrates an excellent agreement with the experimental results.

References

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[2] Kožar, I., Torić Malić, N., Simonetti, D., Božić, Ž. Stochastic properties of bond-slip parameters at fibre pull-out. Eng Fail Anal. 2020; 111: 104478.

[1] Corresponding author
E-mail address: ivica.kozar@gradri.uniri.hr (I. Kožar)