Analysis of multiple delamination in viscoelastic multilayered beams with rectangular section subjected to pure torsion

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The properties of continuously inhomogeneous materials depend on the location. This paper is focussed on the problem of multiple delamination in viscoelastic multilayered rectangular beams under loading that induces torsion. Beam layers are made by different materials that are continuously inhomogeneous along the length. The basic aim is to deduce the strain energy release rate (SERR). General approach is developed. The approach considers a beam made of adhesively bonded inhomogeneous layers with parallel delamination cracks. The approach uses the compliance of the beam. The external torques applied on the beam is smooth functions of time. The viscoelastic behaviour is taken into account by using a time-dependent shear modulus. The internal torques is determined by solving an internal statically undetermined beam structure. Analysis of the SERR in a cantilever beam structure with two parallel delaminations is presented. The SERR found by the general approach is checked by a method that is based on the energy balance in the beam. The findings are presented in graphical form.

Fig. 1. Multilayered viscoelastic beam structure with an arbitrary number of delamination cracks loaded in torsion.

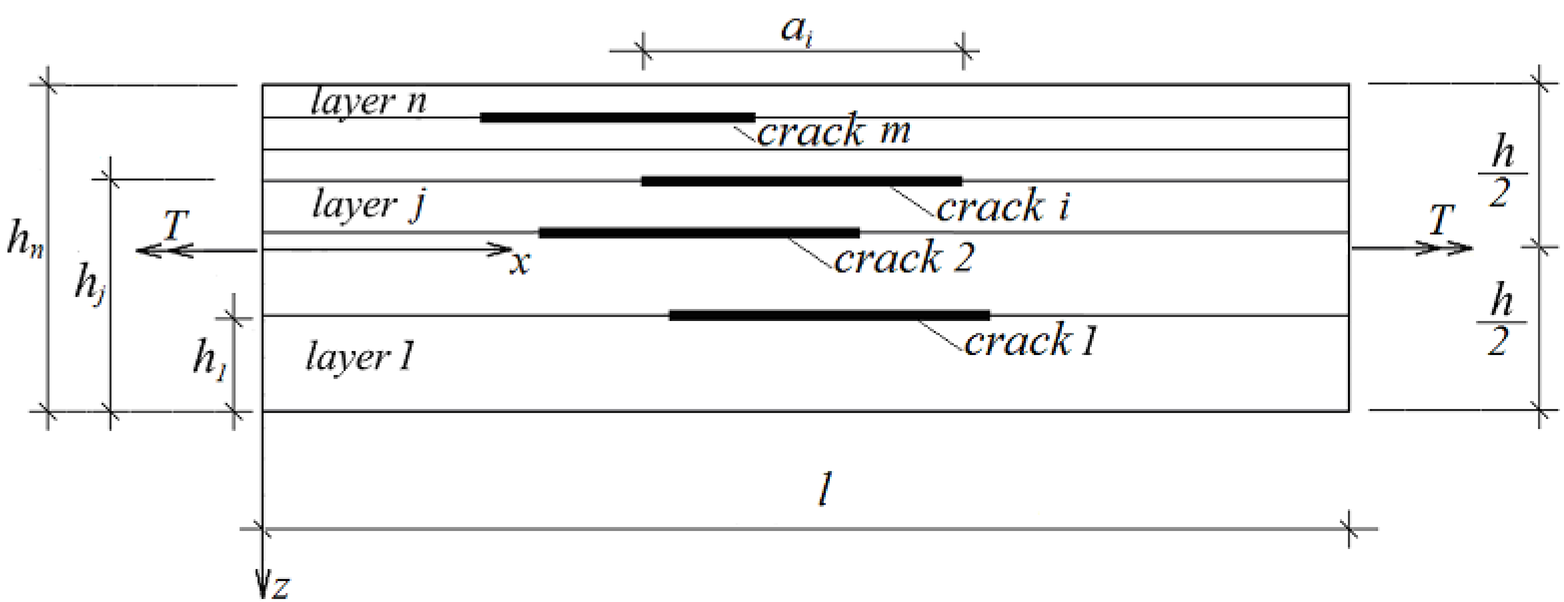

Fig. 2. Cantilever beam with two delaminations under torsion.

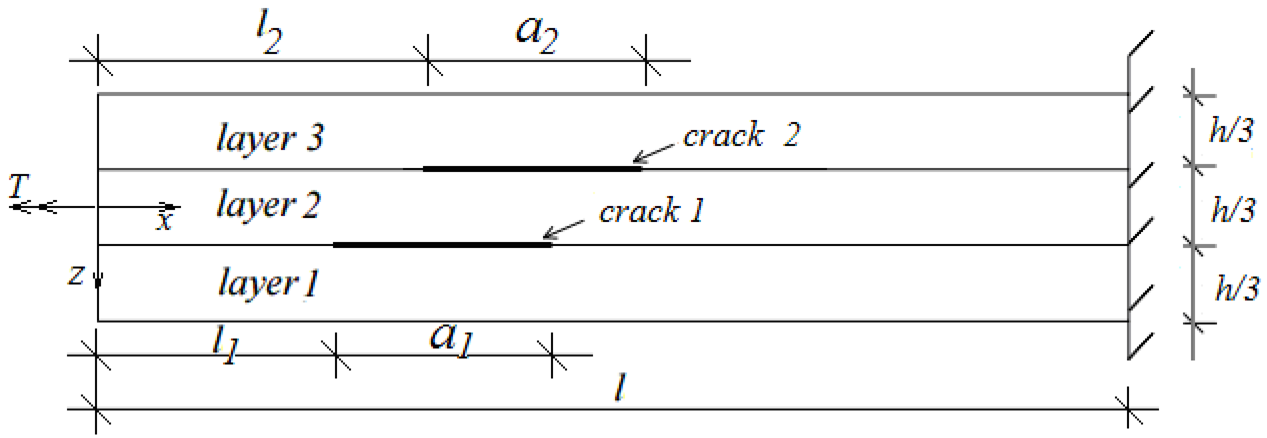

Fig. 3. Viscoelastic mechanical model.

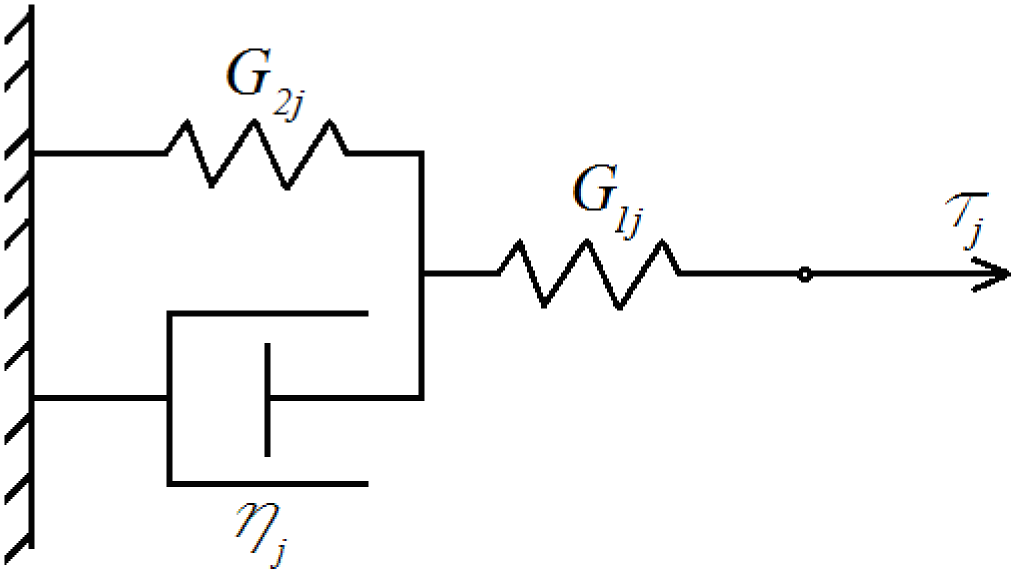

Fig. 4. The strain energy release rate presented as a function of time (curve 1 – for crack 1 and curve 2 – for crack 2).

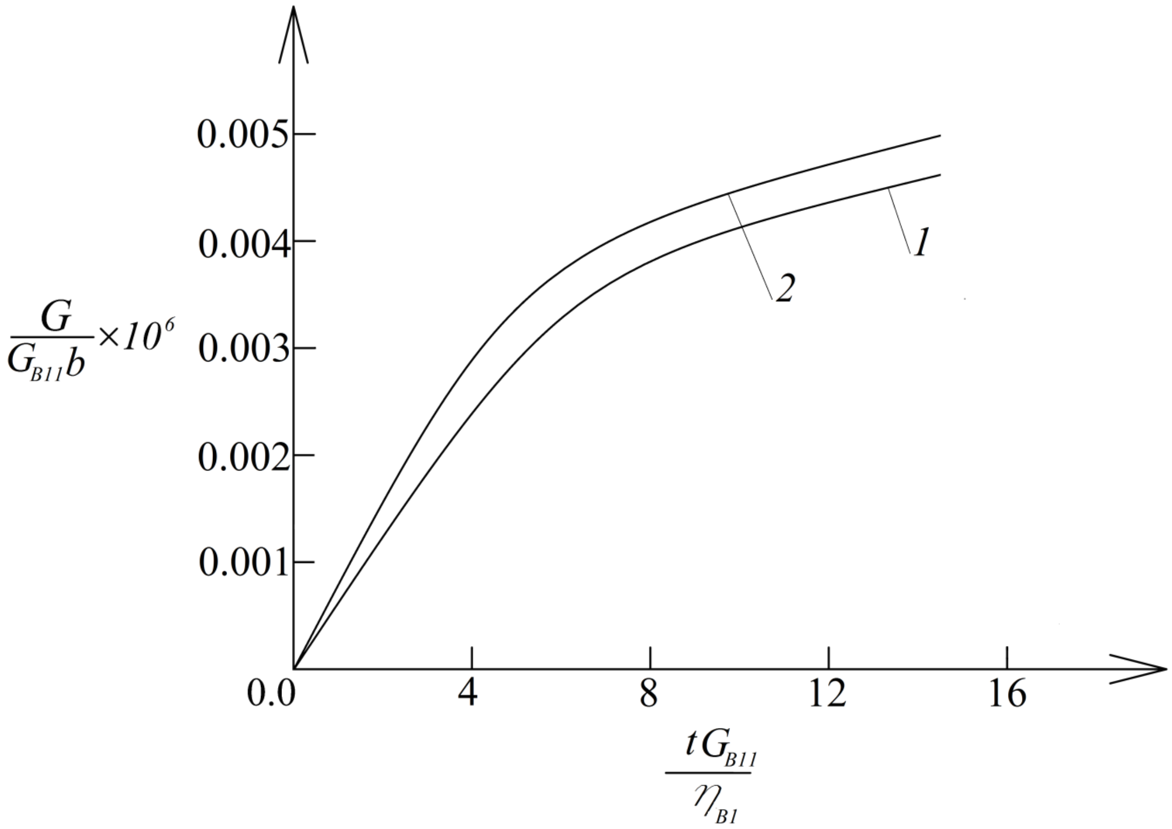

Fig. 5. The strain energy release rate presented as a function of ratio GD11/GB11 (curve 1 – at nd1/nb1=0.5, curve 2 – at nd1/nb1=1.0 and curve 3 – at nd1/nb1=2.0).

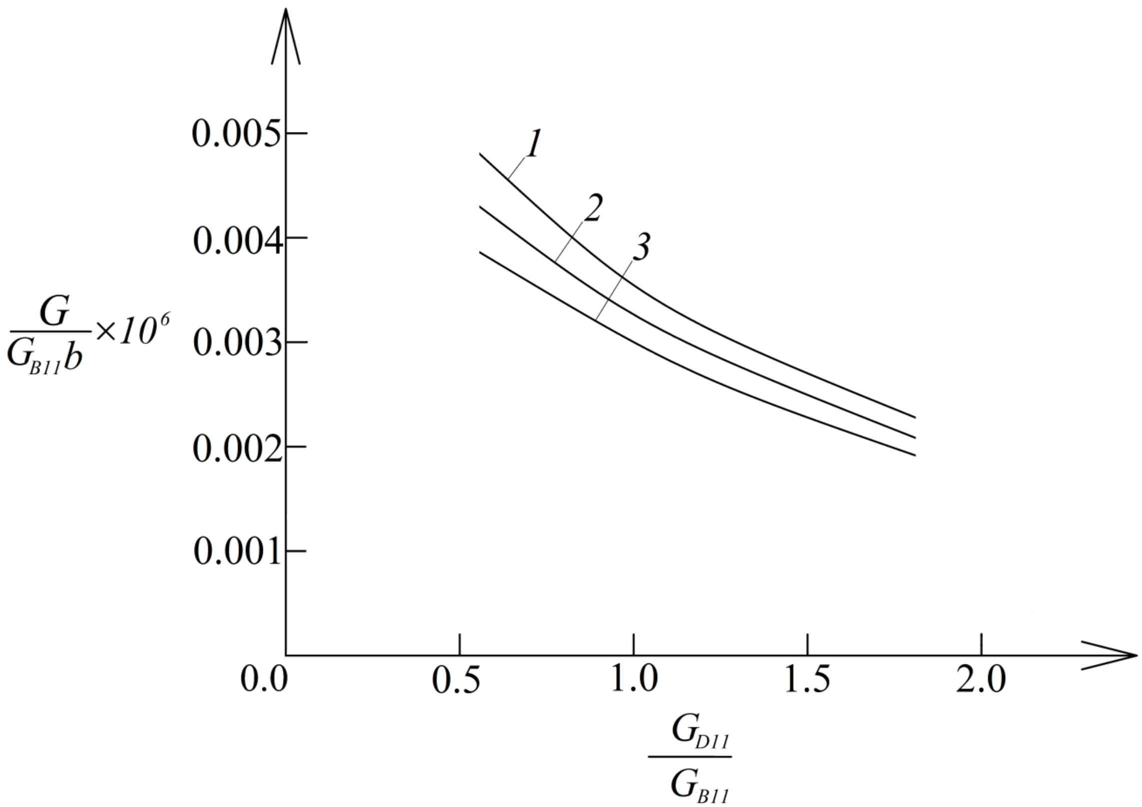

Fig. 6. The strain energy release rate presented as a function of ratio GB12/GB11 (curve 1 - at GB22/GB21=0.5, curve 2 - at GB22/GB21=1.0 and curve 3 - at GB22/GB21=2.0).

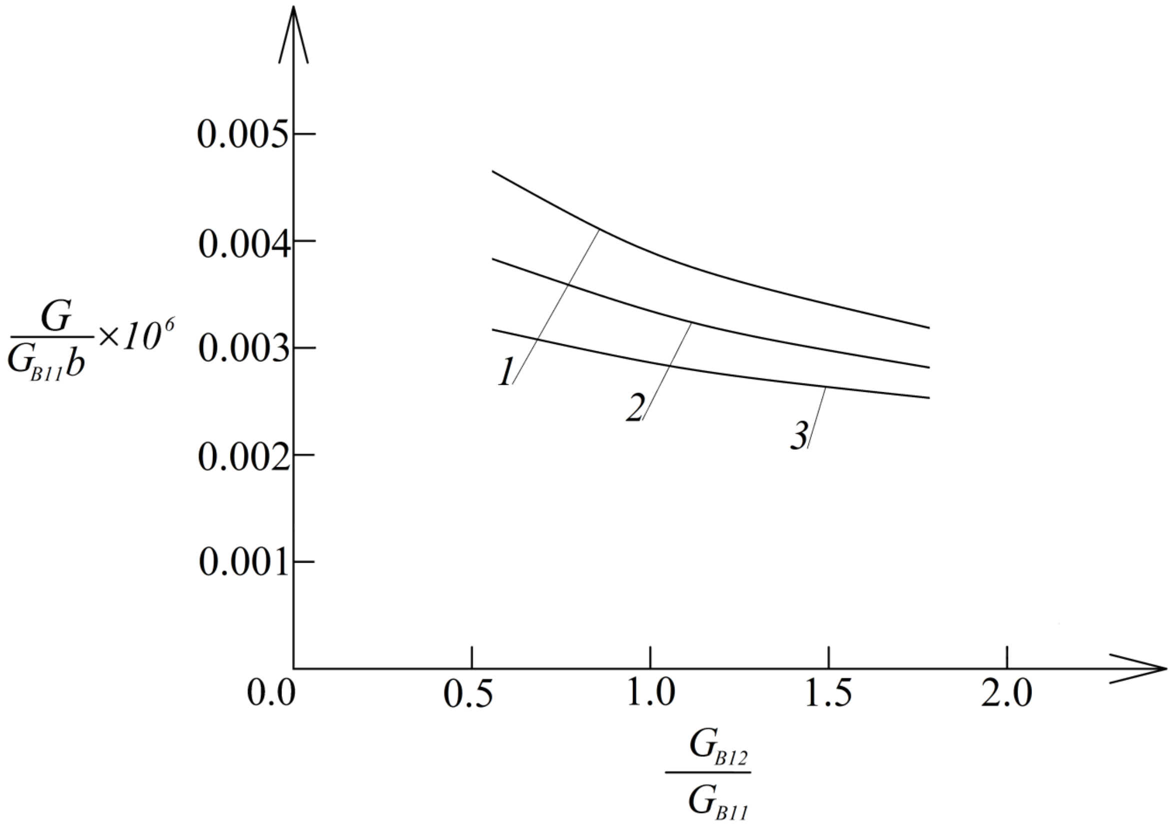

Fig. 7. The strain energy release rate presented as a function of vT (curve 1 – at nb1/nb2=0.5, curve 2 – at nb1/nb2=1.0 and curve 3 – at nb1/nb2=2.0).