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Fracture in notched elements made of plastics, under simple and complex loading conditions

Fracture is a dangerous phenomenon to which structural components are often exposed. The notches (holes or slots) concentrating stresses present in them are conducive to this type of damage. Usually, this process takes place at high speeds, especially in brittle and quasi-brittle materials such as plastics, which are increasingly replacing traditional construction materials. It is important to anticipate this phenomenon and thus prevent its negative effects. Predicting the fracture process is possible thanks to the application of fracture criteria. Existing criteria used to examine fracture in plastics are mostly brittle fracture criteria based on linear elasticity theory. Effective use of these tools is possible only for components operating at very low temperatures, under dynamic loading or weakened by sharp notches. Plastics have non-linearity that need to be taken into account when predicting fracture. There are no universal criteria that are not dedicated to a particular type of notch or loading condition.

The aim of this project is to develop a computational model to predict the fracture in plane plastic structural components, weakened by notches, under simple and complex loading conditions. The criterion will allow predicting fracture in plastics regardless of the notch type and loading conditions. The project provides for a three-stage test plan. The basis will be experimental tests, based on which numerical calculations will be carried out to determine the strain and stress fields under critical load conditions. The theoretical tests will be the last stage, the fracture criterion will be formulated and verified.

During the experimental stage, tensile, compression, torsional and torsional tension or compression tests will be performed on plane plastic specimens (PMMA, PC) weakened by V-notches with different root radius. For complex loads, proportional and non-proportional load components will be considered. The real hardening curve and critical load values will be implemented in a numerical model that will determine the strain and stress fields around the notch root. Geometrical and material nonlinearity will be taken into account.

Comprehensive fracture tests (experimental, numerical and theoretical) planned in the project will allow to supplement the existing knowledge on fracture of plastics notched elements. They will be a description of the physical basis of the damage development process. The results will be used both to develop new computational models and to verify existing ones. Effective prediction of the fracture process is the basis for determining the safe working conditions of a structural element and should be implemented already at the design stage.