

Dissertation title:

The analysis of the perforation process of composite conveyor and drive belts in terms of the design process of punching tools

**Abstract**

The topic of the dissertation is connected with the analysis of the influence of the constructional features of the piercing punch and technological parameters of the perforation process of multilayer polymer composite conveyor and drive belts on the peak value of the cutting force and its characteristics during perforation, the quality of the holes and the tool life. Performed research is conducted in a form of theoretical analyses, analytical and numerical model derivations with the application of Finite Element Method (FEM), experimental tests and designing of the innovative constructions. The research is focused on improving the efficiency of the machines for a precise mechanical belt perforation. In order to solve the research problem the material model of the belt along with the perforation force estimation model were developed and the spherical bowl piercing punch was proved as an effective shape of the perforation tool for a conveyor and drive belts with polyamide core. Subsequently, the influence of the geometrical features of the spherical bowl piercing punch (bowl depth  $H$ , bowl radius  $R$ , punch nominal diameter  $D$  and punch-die clearance  $L$ ) on the peak perforation force value, the holes quality and the tool life was determined, the optimization model was developed and based on it the effective piercing punches with diameter  $D = 5, 6, 8$  and  $10$  mm were designed. Additionally, the analysis of the influence of the technological and constructional parameters on the exploitation features of the designed tool was performed. The methodology of evaluation the belt punching process efficiency based on the resistance force of the compressed material was also developed. To verify the applicability of the dissertation results the automatic device for belt perforation was designed and built, as well as the algorithm of the belt perforation process modelling in terms of designing such constructions was developed.