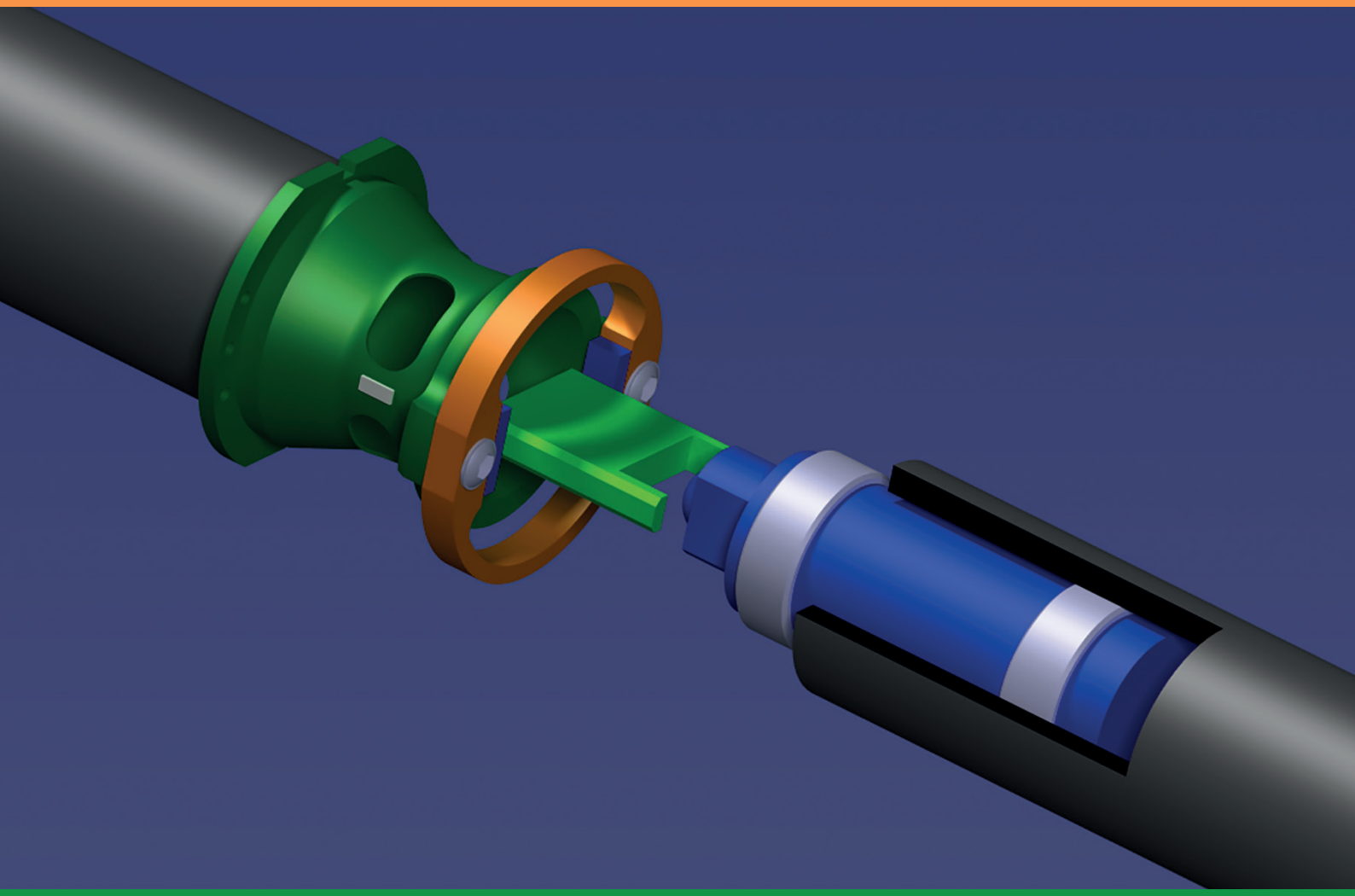
Abstract Book



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Exploding wire technology for control of structure subjected to low velocity impact

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Control of crash or impact process may be based on change of mechanical characteristics due to modification of inner structural connections. Presented work covers numerical and experimental analysis of sandwich fabric composite cantilever beam subjected to a low velocity impact. A set of metallic electrical conductors was placed between composite layers causing their controlled delamination when subjected to an electrical explosion. In result, separation of initially connected components in the vicinity of the exploded conductor is obtained, leading to the change of global mechanical characteristics, allowing for modification of beam behavior.

Exploding bridge wire (EBW) phenomenon is known from the end of the 18th century [1] and being in use today, mainly for ignition of high explosive materials [2] as well as in physics of high energy [3]. This effect is caused by a rapid heating of a conductor subjected to a pulse of high voltage electric current, what changes its state of matter from solid to vapor, expanding in surrounding continuum and forming a strong pressure wave. Afterwards, in result of current discharge through the formed plasma channel, additional heat is applied to the system increasing the effect. Depending on explosion parameters and properties of continuum elastic, elasto-plastic or shock waves can be observed. In case of action on the composite, exploding wire embedded between layers acts on adjacent surfaces causing their progressive separation in the vicinity of the explosion. Delamination decoupling adhesive is being extended by the pressure acting in the direction normal to the surface of the composite. Figure 1 depicts an example of experimental delamination process from a medium voltage EBW system.

A cantilever beam made of layered sandwich composite was modelled with shell finite elements. Problem was solved in a commercial FEM LS-DYNA package using explicit time integration with nonlinear material and geometric formulation. The delamination was simulated by a controlled separation of a connection between layers in the area surrounding the predefined location of the EBW wire. The initiation time of layers' separation was one of controllable parameters allowing for a wide search for solution dependencies. Numerical solution was compared with experimental results, showing good convergence and proving control feasibility. Also an analytical, rigid perfectly plastic model for explanation of first order effects was used for demonstration of governing principles [4].

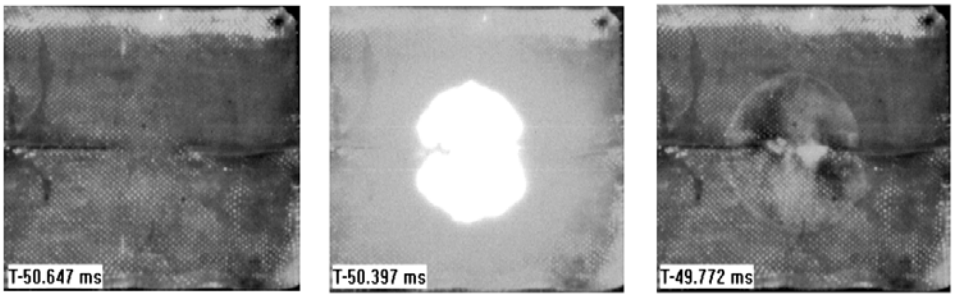

Fig. 1. Sequence of explosive delamination of a composite

Embedded electric conductor explosive delamination effect is a high speed phenomenon allowing for real-time modification of structural behaviour in impact dynamics events, as well as a robust and controllable laboratory technique for research in the field of structural dynamics. Presented results show high influence of the delamination time on beam behaviour when subjected to a transverse impact allowing for the change of localization of its deformation due to the impact. This effect may be used to preserve the structural integrity as well as, due to the change of the beam's stiffness characteristics, used for mitigation of loads acting on impacting objects.

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