The aim of the conducted research is verification of applicability of the standardized delamination resistance stand tests for composite laminates applied in various branches of industry – aerospace, transport, naval or sports. The research will concentrate on a particular group of fiber-reinforced laminates, exhibiting the so-called mechanical couplings. Namely, in some cases of the composite layups it is possible to obtain twisting of an element subjected to bending or bending induced by extension etc. The reason for taking about this subject is the fact, that the set of possible couplings, as well as ply layups is equally vast (thousands of cases) and poorly explored. The obligatory standards for delamination resistance assessment apply in general to unidirectional laminates, with no couplings. Thus, there is a vital need for verification of the standardized computational procedures, having in target using them for the coupled laminates.

One of the basic research methods for achieving the project's goals is the computer finite element method (FEM). In the project the ABAQUS/CAE computational software will be used, which enables simulation of propagation of interlaminar cracks (delaminations). As the calculations are complicated and time-consuming, they must be conducted with a so-called computer work-station characterized by high efficiency: equipped with several processors, a set of hard disks configured in a RAID matrix, with extraordinary RAM capacity. So configured computer enables efficient parallel computing – delamination growth simulations in a composite laminate (Fig. 1a).

The FEM results will be verified experimentally with the standardized stand tests of the coupled laminate specimens' opening, shear or tearing. A small initial delamination will be present in any specimen from the beginning; during the test it will expand. Loading of a specimen with a universal testing machine (Fig. 1b) will enforce the delamination to propagate. Having the load – displacement data registered one can calculate the resistance of a composite to delamination.

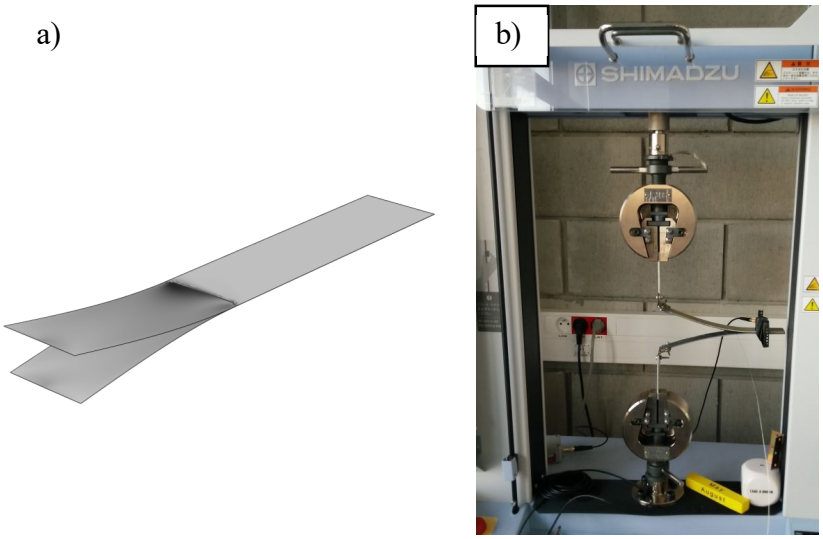

Fig. 1 FEM model of delaminating composite beam (a) and the opening stand test of the laminated specimen at the testing machine (AE sensor visible)

The strength tests will be assisted with the registration of the so-called acoustic emission (AE) signal, enabling catching the very moment of delamination growth onset. The wording „acoustic" is rather traditional, as actually the range of the registered frequencies is 100 ~ 1000 kHz. Note, that thanks to a thorough AE signal analysis one can distinguish between the composite matrix and fiber cracking etc., even though these phenomena take place inside the specimen and cannot be spotted with the naked eye.