Basic requirements that mechanisms and mechanical or building structures need to fulfil are reliability, durability and safe operation. Design recommendations and operational regimes do not account for the fact that structural elements may contain crack defects. A material fault can result from the technological process, or it can develop when the element is in service. Currently applied quality control systems allow the detection and elimination of a majority of defects before an element is put into operation. However, the defects that are revealed when the elements are already in service pose a serious problem as it is difficult to assess the strength of such elements. Mechanisms and structures in service which contain defects pose a technogenic hazard because they can produce large-scale disasters. Sometimes, it is not possible to instantly put those constructions out of operation or make repairs. In most cases to the only available solution is to reduce the construction working load in order to gain time for the commencement of the repair works, or making a replacement. To assess the strength of elements containing crack-like defects, and establish safe operational regimes for them, it is necessary to rely on fracture mechanics and methods. Advancements seen over recent decades in fracture mechanics methods, and in the methods used to evaluate crack-containing elements make it possible, in many cases, to precisely establish safe operational conditions. However, some problems, in particular the analysis of tear delamination cracking in steel elements have not been investigated thoroughly.

In view of the above, the project objectives have been formulated. ***The project goal is to determine the level of the critical stress which, under load conditions, leads to the occurrence of internal delamination cracking producing tearing separation in the walls of steel elements. Another objective is the assessment of the effect of delamination crack occurrence on fracture toughness and strength of the element***.

To carry out the proposed project, a hybrid research method has been proposed. The method will involve both experimental investigations and numerical analyses. For the quantitative analysis of the stress state using FEM numerical calculations, it is necessary to have materials data and the data on the specimen loading. In addition, critical parameters need to be identified experimentally.

Experimental investigations will be conducted on standard specimens used for strength tests, and on single edge notch bending specimens (SENB) or compact specimens (CT), for the complete temperature range of brittle-to-ductile transition, according to the procedures recommended by ASTM. In specimen loading, Zwick, Instron and MTS testing machines, equipped with thermal chambers and automatic control and data acquisition systems, will be used. The recording of acoustic emission signals with the use of the MISTRAS system will make it possible to find the instants of the load history at which delamination cracks occur.

Qualitative analysis of metallographic sections and specimen fractures will be carried out using scanning and optical microscopy. That will allow the identification of fracture mechanisms and delamination crack sizes and locations.

Quantitative analysis will be performed based on FEM numerical calculations that will simulate experimental conditions. Adina and Abaqus FEM software will be used. In model analysed will be take into account 3*D* geometry and large finite strains. The degree of congruence between numerical computations and experimental results will be verified the accuracy of numerical modelling and correctness of adopted assumptions.