Nondestructive diagnostics based on elastic wave propagation has received significant attention in recent years. The idea of the use of waves in damage detection is based on excitation their propagation in investigated object, registering the signals by special sensors attached at selected locations and then correct data interpretation. Due to waves' ability to monitor large areas during single measurement and significant sensitivity to various defects, they are particular attractive solution for various structural elements, which are characterized by a large size and additionally their condition assessment is difficult due to the limited accessibility. Therefore, recently the research on damage detection in elements made of steel, which is commonly used for structural applications has been intensified. Because steel elements are often exposed to corrosion degradation, the numerous studies have been devoted to nondestructive methods of assessment the level of corrosion degradation. They indicate the great potential of elastic waves in detection of point damages (corrosion pits) and surface damage resulting in uniform thickness reduction. However, several unsolved research gaps do not allow for practical application of nondestructive methods in practice.

Many studies proved that it is possible to monitor the damage development by comparing the signals collected for structure at various stages of degradation. However, this approach requires using the continuous monitoring system often based on significant number of sensors and measurements. The second group are methods that do not require reference data. In such cases it is possible to use i.e. wave propagation velocity or the ratios between particular peaks registered in signals. The formulation of reference-free methods and their further use in diagnostic process usually requires the detailed knowledge about the wave propagation phenomenon in the investigated specimen. Meanwhile, the wave propagation in corroded steel elements strongly depends on several factors which so far were not analyzed. In general, in some cases the corrosion products which cover the elements cannot be removed because the additional layer protects the undamaged metal elements against further degradation. The additional layer of corrosion products significantly differs in parameters and thickness from undamaged part. The investigated specimen cannot be considered as homogeneous and isotropic which significantly effect on theoretical predictions concerning wave propagation phenomenon. Secondly, in the most so far analyzed cases the corrosion damage was forced by applying the direct current to the analyzed element. This approach is very fast and effective but the corrosion caused by DC flow is completely different from actual corrosion damage. The DC-induced corrosion cause uniform changes in thickness of damaged element, while in real cases the thickness reduction is strongly non-uniform. Non-uniform thickness reduction lead to development of localized cracks and damaged, which as mentioned above remain invisible because there are covered by a layer corrosion products. All these aspects need to be considered in detail to improve the diagnostic process of steel elements exposed to corrosive environment.

The main aim of the project is detailed recognition, description and utilization of global vibration-based methods as well as local method based elastic waves propagation in diagnostics of corroded specimens with taking into account their complex layered structure. It is assumed that global vibration-based methods will allow for assessment of the total stiffness reduction and in consequence the average thickness reduction caused by corrosion. The local wave-based methods will be used to analyze in detail the corroded structure, detect the damages or corrosion pits. The formulation of the novel combined diagnostic algorithms will be proceeded by complex numerical simulations and experimental tests including generation of corroded surfaces using random field modelling and microscopic measurements of the exact roughness of corroded surfaces. The experimental tests will be conducted on specimens corroded in specially prepared set-up providing oxygen, temperature, salinity and water circulation velocity control. Such conditions provide accelerated corrosion process, but also will allow for reflection the real corrosion environment.