This research project is related to study of optical strain sensor application for symmetric and antisymmetric elastic guided wave mode sensing in damage detection and localisation problems.

Guided wave propagation phenomenon is utilised in structural health monitoring systems. Damage is structure is source of changes in elastic wave propagation. Based on registered changes in wave propagation and its processing it is possible to conduct structural health monitoring. Elastic waves are excited and sensed using piezoelectric transducers. Some disadvantage of using piezoelectric transducers (limited operational temperature, the use of electric signals, sensitivity to electromagnetic interference, problems with lightning discharges) cause that researcher study other wave excitation and sensing methods. In the case of elastic wave sensing optical strain sensors based on Bragg gratings (FBG) are utilised since some period of time. Such sensors do not use electric signals (important in explosive hazard zone), lack of problems with electromagnetic interferences and lightning discharges. One fibre optic line could include many FBG sensors and optical signal could be sent for very long distances. Due to fact that FBG sensors are created on the fibre optic line they are light, have small dimeter and could be embedded in material (epoxy based laminates, 3D printed polymers). FBG sensors could be utilised in high temperatures.

The aim of this research project is study of FBG sensors sensitivity to symmetric and antisymmetric elastic wave modes and possibility of sensing the effects (of interaction of these modes with damage in the structure (reflections, mode conversions). Research will be related to separation of symmetric and antisymmetric modes due to different placement of FBG sensors (top and bottom surface). Results related to wave sensing obtained by FBG sensors will be compared with results obtained by piezoelectric sensors taking in consideration possibility of damage detection. Detailed studies of influence of sensor length, its orientation in respect to wave front, work in resonance and ratio of sensor length to elastic wave length on sensitivity to particular wave mode.

Research will be also related to connection of elastic wave sensing techniques based on piezoelectric and FBG optical sensors in such a way to use the advantages of FBG sensors (directivity, lack of sensitivity to electromagnetic interferences) in order to improve the effectivity of damage detection. Piezoelectric elastic wave sensors are influenced by electromagnetic interferences induced during the elastic wave excitation by piezoelectric transducers. This caused problems with damage detection and localisation. Moreover, piezoelectric transducers due to larger size, mass and stiffens thang FBG sensors are source of additional wave reflections and mode conversions what also causes problem with damage detection. So, the aim of the project will be development and validation of hybrid PT-FBG elastic wave sensing method.

Research will be relate to beam and panel-like structures made out of metallic and composite materials. In the case of metallic materials, physical properties do not depend on direction (isotropy) and wave propagate with the same velocity in all directions. In composite materials properties depends on the directions therefore the velocity of wave propagation depends on direction of propagation. In such materials damage localisation is more problematic.