ABSTRACT

The assessment of the protection level of constructions generally and particularly of reinforced concrete and/or masonry structures has become a constant preoccupation of all the specialists involved in design, execution and monitoring of construction.

The habilitation thesis presents research and case studies connected to the structural rehabilitation aspects as follows:

- **Introduction** to: durability problems; behaviour at seismic actions; repair and strengthening of existing structures.
- **Rehabilitation of existing concrete structures:** experimental research; case studies.
- **Rehabilitation of existing masonry structures:** experimental research; case studies.

The vulnerability of existing structures under seismic motions may be due to structural system weaknesses and specific detailing. Structural weaknesses are characterised by various irregularities and discontinuities or by general structural vulnerabilities. Specific detailing of existing structures is function of building materials: reinforced concrete; steel; masonry; wood. Reinforced concrete (RC) structures are characterised by common non-ductile detailing:

Regarding the rehabilitation solutions, for vertical irregularities the main solutions consist of: strengthening of existing structural elements and / or the structural system by increasing the strength, stiffness and ductility of the weak structural elements; stalling additional structural members. In the case of horizontal structural irregularities, the aim of rehabilitation is to decrease torsion effects and displacements as well as an increase of the strength with the respect to lateral actions. For irregularities of the geometric plan, the rehabilitation solution consists of the use of new walls and / or seismic joints. The rehabilitation solutions adopted in the case of deterioration of building component parts depend on the structural material.

EXISTING REINFORCED CONCRETE STRUCTURES are to be repaired and/or strengthened in cases when the general damage is limited, and demolished when the structural safety is greatly affected and the rehabilitation cost is very high.

Repairs are used for surface deterioration, cracks, damage resulting from casting defects and reinforcement corrosion. The methods used for repairs are: jacketing of damaged surfaces; infilling of cracks with usual mortar, epoxy resin or other polymers; replacement or strengthening of damaged reinforcement.

Strengthening of reinforced concrete structures takes into account the increase of strength, stiffness and ductility. In case of reinforced concrete framed structures, the increase in stiffness and ductility is to be achieved by jacketing of beams, columns and joints. The jacketing is performed by reinforced concrete, steel profiles, carbon fibres CFRP, etc. CFRP may be used for increasing ductility and slightly increased stiffness.

Sometimes it is necessary to transform the existing structure completely, especially for framed structures. In this case, special techniques are to be used: steel bracing of reinforced concrete structures; infilling of frame openings with reinforced masonry or reinforced concrete.

Experimental studies were performed on the RC jacketing strengthening method characterized by some important advantages: leads to a uniformly distributed increase in strength and stiffness of element (column); the durability of the original structural member is also improved; this strengthening procedure does not require specialized workers. Different techniques for increasing the bond between the old (existing) and new (jacketing) concrete layers were studied and presented in the thesis.

Experimental studies were also performed for strengthening of reinforced concrete framed structures in seismic zones by using Carbon Fiber Reinforced Polymers (CFRP). The system's advantages as rehabilitation application at seismic resistant structures are: increase of load-carrying capacity; structural elements designed only for gravity loads will be able to withstand seismic loads; elements' mass remains, practically, the same; the technology is simple and rapid.

The reinforced concrete structures' rehabilitation case studies presented are: the Western University of Timisoara; tanks supporting structure; office building; the Palace Building; apartment house affected by a gas explosion; reinforced concrete silos; strengthening of an industrial building; strengthening of frame structure at the Timisoreana Brewery; strengthening of a block of flats.

EXISTING MASONRY STRUCTURES present some important vulnerability in seismic zones: the overall lateral stiffness values along the two main axes are different; lack of seismic joints to divide building parts having different dynamic characteristics; lack of reinforced concrete straps at each level; defects of wall connections at corners, crossings and ramifications as well as the presence of cracks; inadequate bearing capacity at normal forces on the walls. On the other hand, structural weakness is characterised by various irregularities and discontinuities or by general structural vulnerabilities: irregular distribution of stiffness at lateral displacements; strength discontinuities; mass irregularities; vertical load discontinuities.

Experimental research was performed in order to develop new solutions for rehabilitation of old masonry buildings located in seismic zones.

The methods of strengthening existing masonry structures with the use of traditional technology are various: erection of RC cores appropriate distance combined with straps at each level, masonry lining with reinforced concrete, masonry confinement with steel profiles, interlocking of masonry walls at corners, crossing and ramifications with RC elements and/or some steel profiles, adding new inner walls and/or some outside abutments.

The modern rehabilitation solution Near-Surface-Mounted Reinforcement (NSMR) implies that steel bars/rods mainly of CFRP are bonded in sawn grooves in the masonry or concrete cover. The use of this technology has a lot of advantages: no requirement for surface preparation work, installation time is minimal, no change of the existing structure dimensions, the cost compared with traditional methods is lower even thaw the material costs are higher.

The masonry structures' rehabilitation case studies presented are: rehabilitation of the Banatul Museum, Timisoara – classic solution; retrofitting of historic masonry structures – modern solution; structural rehabilitation of historical masonry buildings: rehabilitation of a tower structure by modern solutions.