ABSTRACT

The present thesis contains the main results obtained during the study and research conducted in order to determine the intervention measures at the bridges with the superstructure of prestressed precast beams, for bringing them to the current requirements.

The actuality of the theme is justified by the large number of requested rehabilitation projects that, in conjunction with changing standards and lack of data on existing work, raises particular problems in making a decision on intervention.

As a result, to make a decision, is necessary to know the intervention solutions and the criteria to adopt them, elements that are covered by the present thesis.

The doctorate thesis is structured on seven chapters and an appendix, being completed with 96 bibliographical references from the technical literature, including a list of the own published papers. The thesis has 146 pages.

The first chapter, “GENERAL CONSIDERATIONS“, presents the importance of the bridge works, emphasizing the advisability of the study and the actuality of the theme. It is also an overview of the content and goals of the work.

The second chapter, entitled “THE RESEARCH PROCESS”, consists of presentation of the bridge superstructures and the evolution of the structural forms, respectively of the design standards.

The chapter includes a bridges superstructures classification and a presentation of the superstructures with beams made of reinforced concrete and prestressed concrete, used in construction of the road bridges in our country.

However, the processing the statistical data showed that about 70% of the bridges built in Romania until 1991 had in 2010 the average age of 39 years, moment that requests an intervention, a reconstruction work. The data analysis also showed that the most bridges have a beam structure and the preponderant material is the prestressed concrete. These facts confirm that the repair/rehabilitation of the bridges with prestressed
concrete beams is a topical issue that must be carefully analyzed, in order to adopt a national technical intervention strategy on bridges.

This chapter also includes a presentation of the evolution of design standards and loads used nowadays at the design of the road bridges - according to SR EN 1991-2:2004.

The third chapter “DEFECTS AND DEGRADATIONS AT THE BRIDGES MADE OF REINFORCED – AND PRESTRESSED CONCRETE” synthesizes the encountered degradations and their causes, depending on: origin, nature and type. It includes also a centralized scheme that presents how the defects at bridges appear: starting from elements and materials defects in conjunction with the action of external factors.

In the fourth chapter, “TECHNICAL DOCUMENTATIONS AND INVESTIGATIONS UNDERLAYING THE ANALYSIS OF THE INTERVENTION AT BRIDGES” is presented the content of the technical documentations used for the intervention on bridges and the technical investigations to be taken, due to the lack of data regarding the execution and other interventions. Besides presenting the necessary field studies (topographic, geological, hydrological) and the tests made to determine the characteristics of the materials from the structure, it is highlighted the importance of the static and dynamic tests under test vehicles load, tests that can reveal the behavior of the structure and can help to determine the potential bearing capacity reserves.

The chapter includes a detailed description of the content of the "Test project" and how to make dynamic and static testing, with emphasis on the main issues to be pursued.

Chapter five entitled “THE TEST WITH WORKING LOADS OF THE SUPERSTRUCTURE. CASE STUDIES”, consists of a presentation of the tests performed on two bridges and a comparison between results.

The tested bridges had the same loading class, constructive system and relatively equal spans, the major differences being given by the number and dimensions of the main beams, the dimensions of the monolith plates, the type of composition and number of cross beams.

In the Appendix 1, included in the thesis, is presented an excerpt from a bridge testing project that contains the calculus underlying the test, the instructions for carrying out the test and the results of the test.

Analysis of the results obtained in the two case studies presented, showed that the superstructure of similar in type and span bridges can have a totally different behavior under tests with dynamic loads. This clearly demonstrates the utility of tests with working loads in the design stage of bridges rehabilitation, in order to determine the peculiarity of each work, especially at bridges with a different composition than the typical project.

Chapter six, „PRESENTATION OF THE INTERVENTION OPTIONS”, presents the potential options, taken in account in the development of interventions on existing bridges. So, there are three options: Option 1 – Rehabilitation of the existing bridge while maintaining the load class E; Option 2 – Rehabilitation works with consolidation of the
existing bridge to support loads according to Eurocode; Option 3 – New bridge, designed for loads according to Eurocode.

For the named options, were shown the decisive factors regarding the applicability, advantages and disadvantages and comparative costs. In case of Option 2 - Rehabilitation works with consolidation of the existing bridge to support loads according to Eurocode – were presented the potential intervention methods used more or less in practice.

This chapter also includes a comparative study regarding the differences of tensions and deformations that appear at the superstructure of a bridge, calculated in two options: loads for E class and loads according to Eurocode. The study revealed significant increase of the sectional tensions for the loads from Eurocode.

The last part includes the analysis, by calculus, of an option for the consolidation of the superstructure through a method that modifies the static scheme – respectively by introducing intermediate elastic bearings, disposed on an additional structure – a method that is rarely used, due to the complexity of the calculation and execution.

Chapter seven, „CONCLUSIONS AND PERSONAL CONTRIBUTIONS OF THE AUTHOR“, contains the conclusions of the study, presents the personal contributions and recommendations for future research.

There are presented the author’s contributions regarding the synthesis of requested data for the different types of bridges analysis (structural, technical-physical condition, functional and traffic levels, architectural and urbanistic, respectively technical-economic analysis), to ensure the traffic safety and comfort criteria, urbanism and environment protection criteria, respectively economic criteria.

The details offered by the case studies regarding the test with working actions helps to the preparation of further documentation, establishing clearly the stages and highlighting the elements that should be pursued.

The results of the study, regarding the increase of the sectional efforts and displacing obtained under the Eurocode actions, compared to those from the loads of class E, represent a warning signal to the administrators of bridges, regarding the developing and implementing of a strategy for bringing the bridges to the current traffic requirements.

It is worth mentioning the synthesis regarding the potential intervention methods for the consolidation of a superstructure and especially the analysis, by calculus, of one of the consolidation options through a seldom met method, due to its complexity regarding the calculation and execution.

There were noticed lacks in the current legislation regarding the definition of criteria to choose the value of the actions reduction factors \((\alpha_q; \alpha_Q)\) and of a national norm which, on the basis of a classification in terms of the dynamic behavior of the structures, should make recommendations of the required measures.