POLYTECHNIC OF TORINO
FACULTY OF ARCHITECTURE 2
Degree in Architecture
Honors theses

Caisson bridges: calculation methods and design guidelines
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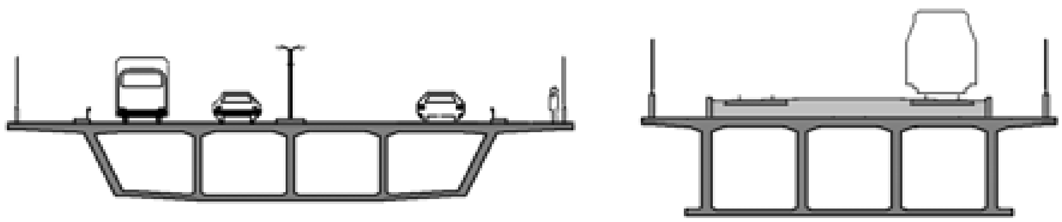
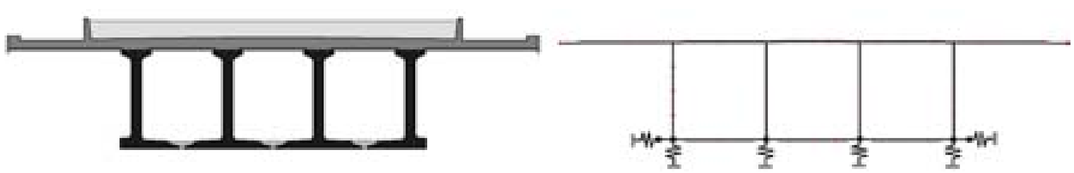
Subject of this University Dissertation is the analysis of the structural behaviour of caisson bridge floor systems with thin wall multicellular section.
Due to their good behavioural features towards twisting actions, bridges with caisson section are widely used for the construction of big span viaducts and railway bridges, being the latter particularly influenced by dissymmetrical loads of great strength.



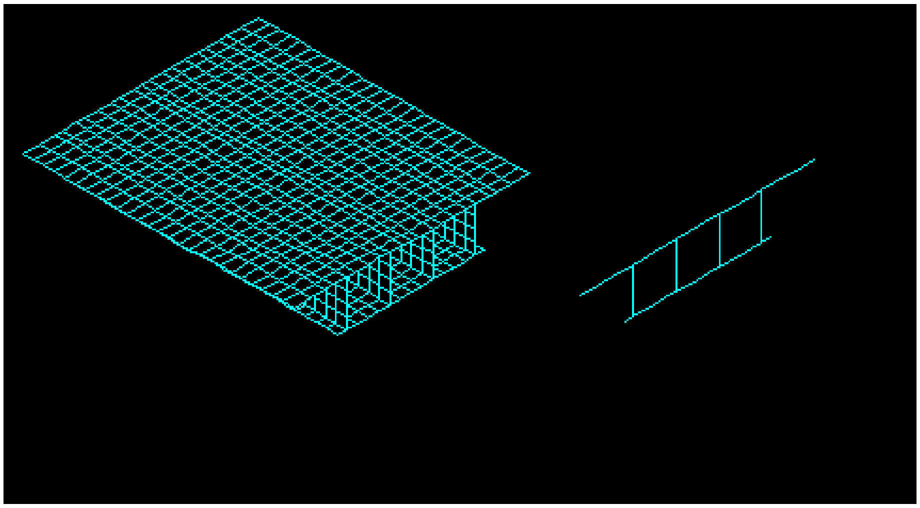
Picture 1: multicellular caisson bridge floor system cross sections

Constant construction innovations, ranging from mass pre-casting to technology of cast-in-place and push launched bridges, together with a continuously higher quality of the employed materials, led to drastically reduce the thickness of caisson walls in the latest years. Furthermore, modern construction methods made possible the complete removal of span diaphragms and the weakening of the header ones.
All this has considerably reduced the transversal stiffness of the section, which can therefore loose its initial shape. These distortions cause secondary inflexional stresses, both longitudinal and transversal, typical of slab structures. Such stresses have often considerable strength and can't be a priori neglected.
In the light of what above, problems relevant to section deformation can put on significant implications in the transversal static behaviour of the structure.
The study target is the setting of a calculation instrument, easily applicable by the designer, for the analysis of the multicellular bridge floor systems. This instrument is composed by a flat frame model with elastic constraints, suitable to effectively simulate the static and distorting behaviour of the actual section.



Picture 2: frame model with elastic constraints

The definition of the frame characteristic parameters has been made carrying out a kinematics analysis with the finite element calculation method (FEM), by comparing the frame with a SCHELL's element tridimensional model.



Picture 3: kinematics behaviour simulation - comparison between the two models

This dissertation breaks down into eleven chapters:
Chapter 1 describes in details the reasons of the study and the results to be reached, outlining a general view of the state of art in the design practice.
Chapter 2, in order to introduce the study purpose, describes the structural typology of the caisson bridge dwelling particularly on its historical development, on the possible shapes, on the strains they are subject to and on the structural behaviour as far as its static and kinematic features are concerned.
In chapter 3 are critically shown the calculation methods so far developed pointing out theoretical background, actual applicability and, where necessary, approximation degree. In particular the potential applications of the multicellular floor system are investigated, highlighting their suitability to global behaviour analysis and possible local effect.
Chapter 4 describes the calculation instrument to be attained, its basic preliminary hypothesis and the analysis method that enable its processing.
Chapter 5 describes the type of structure chosen for the application and the calculation instrument used for the study development.
Chapter 6 illustrates the structure modelling phase stating the reasons for the choices of both, model geometry definition and preliminary values of the specific variable. Once modelling has been completed, a first simulation is carried out in order to schedule the next optimisation stage.
Chapter 7 treats about model optimisation relevant to the case dealt with, defining the correct values of the aforesaid variables.
Chapter 8 presents a parametric study referred to some variables specially meaningful for the floor system geometry, paying particular attention to the formulation of some explanatory hypothesis of phenomena detected during the result analysis stage.
Chapter 9 deals with the analysis instrument formulation as resulting from the aforesaid studies and dwells on the employ instructions for the users.
Chapter 10 validates the analysis instrument for its application to other actual cases.
Finally, chapter 11 on one hand deals with the conclusive synthesis of the study results and, on the other, points out possible further developments.

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