The AFGC Editorial

Thierry Kretz was the president of the AFGC Scientific and Technical Counsel when the finite element task force was launched. He shares his vision of this project.

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Finite Element (FE) calculations – a paradigm shift

Finite Element (FE) calculations – a paradigm shift

It is no exaggeration to say that FE calculations applied to civil engineering structures are a paradigm shift for structural analysis. Indeed, it is possible to transpose to structural engineering the concept of paradigm as defined by Thomas Kuhn in The Structure of Scientific Revolutions. According to him, paradigms are “universally recognized scientific discoveries, which provide to a community of researchers typical problems and their solutions for some time.”

Despite its seemingly trivial aspect, the appearance of FE calculations truly is a revolution. The ancient world is one of the classical Strength of Materials based on the hypotheses of Saint Venant and Navier-Bernoulli. The latter translate into the beam and thin plate theories. Thus, the ancient world relies on a coherent set of hypotheses and resolution methods, whose results are then transformed into design principles for structures and their reinforcements.

The new world that uses FE calculations is built on other foundations. The behaviors of the materials themselves are not questioned, but the structural analysis hypotheses are. They affect, on the one hand, the meshing (the principle and precision of discretization of the structures,) and on the other hand, the choice of the types of elements (the range of displacements considered.) The results require new analytical methods to allow the accurate design of the structures and their reinforcements.

The calculation rules, mainly the Eurocodes, are largely established in the logic of the classical Strength of Materials theories. They propose simple rules mostly based on experience with well-recognized validity domains. Some examples are the strut-and-tie method, the dimensioning of consoles, punching control, etc... These regulations allow the FE computations of the structures but give shallow explanations concerning the methods used (meshing, choice of elements) and the interpretation of the results. Various technics exist to transcribe results in terms that are compatible with the regulations. However, the “finite elements calculations doctrine” is certainly still in the development phase.

The AFGC guide that you are reading aims to participate in establishing this new doctrine. It reflects the AFGC's willingness to accompany the development and innovation in the field of civil engineering by representing a place of sharing and transmission of knowledge and technological advancement.

I want to thank the redaction group and particularly the two facilitators Didier Guth and Claude Le Quéré for their incredible work. I am convinced that this guide along with the website will remain for a long time a point of reference to the engineers working in design offices.

Thierry Kretz – May 2020

Preface - Words from the Scientific and Technical Council

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Emmanuel Ferrier is the president of the AFGC Scientific and Technical Council. He shares with us his foreword.

Preface

Numerous students, engineers, scientists, and researchers use numerical methods to develop or use software that will solve engineering problems related to construction. These numerical methods rely on FE calculations. The AFGC wished to contribute to the field and has proposed in 2016 the creation of a task force focusing on the FE calculation methods related to the field of construction. The main objective of this task force is to meet a need that is often expressed: to have an educational document, like the former SETRA guidelines, discussing the FE computational modeling (beams, plates, shells,…) of civil engineering structures. This project is aimed towards, among others, young engineers in TP/GC design offices.

The FE analysis is a fundamental subject that all engineers working in major companies and design offices need to understand to create essential designing tools.

This document introduces the FE analysis with an overview of the various concepts and applications. It brings forward the primary concepts of the FE method along with analysis examples using consistent procedures. The FE concepts involving 1D problems are discussed in detail so that the reader can make sense of the methodology and progressively understand to better analyze 2D and 3D problems.

Since this field is in a constant state of advancement, the AFGC did not wish to freeze the document as a set of recommendations like it usually does. Instead, it proposed for the first time a numerical format that is dynamic and evolving with time. Those are, therefore, unlike many AFGC guidelines, not pre-normative recommendations but rather documents to understand and practice FE calculations in the field of construction.

The CST of the AFGC would like to thank the facilitators of the task force, **Claude Le Quéré and Didier Guth, and all the other participants, who rendered it possible through their work to publish this document.**

Emmanuel Ferrier – May 2020