Preface

The new is the old and the old is mightier than ever before.

The subject of this book are influence functions and the role they play in finite element analysis of structures. Influence functions are a classical tool of structural analysis and dearly loved by ‘old school’ engineers since with some clever sketches—if need be on a beer mat—it is easy to understand the behavior of a structure or to find the weak spots in a design.

Unfortunately, with the advent of finite element programs though, the application of influence functions has faded into the background. When in doubt, one rather studies the variants in a design with the computer than to strive for a deeper understanding which the study of influence functions can provide so easily and so well.

But new results have rekindled the interest in influence functions because we know today that in linear analysis, finite elements compute ‘everything’—as we are tempted to say—with influence functions. This equals a loop backward. Classical hand methods seemed outdated and old-fashioned, but in finite elements, they have risen like Phoenix from the ashes. FE-analysis is more classical than we ever imagined.

In the old days, the subject of influence functions mostly focused on the analysis of frames with the Müller–Breslau principle, but in FE-analysis, the concept of influence functions has a much broader and wider scope.

The key word is *functionals*.

The deflection at the midspan of a beam, the bending moment at a fixed edge, and the force in a pier—all these are functionals. Anything you can calculate with finite elements is considered a functional. And to each linear functional belongs a Green’s function, an influence function.

Influence functions, too, are displacements, they are the reaction of a structure to special point loads, to Dirac deltas, but normally, a mesh is not that flexible enough to generate the exact intricate shape and exact peaks of these influence functions.

This is why FE-results are not exact. FE-programs operate with approximate, with substitute influence functions.

The influence functions are the ‘real’ shape functions, the *physical shape functions*. A good approximation of these functions is the key to good FE-results.

So in structural analysis—and we dare say all of linear computational mechanics—influence functions play a dominant role. This is why we have written this book.

It is not a book for a first course in structural mechanics, the reader should be acquainted with the basic principles, and the reader should have seen influence functions in action.

We treat the topic also, as it seems, with a rather sharp pencil, but this is more or less self-defense because in the advent of time many things in structural analysis have so much settled in that it is hard to discover the mathematics behind the formulas—all too often the ubiquitous $\delta W_e = \delta W_i$ is considered sufficient proof.

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