
Preface

This book is essentially a translation of the book “Vereinfachte Fließzonentheorie”, published by Springer-Vieweg in 2015. However, some changes have been made, for example, to minimize references to literature in German.

It describes the Simplified Theory of Plastic Zones (STPZ), developed in my time as professor at the Fachhochschule Lausitz starting in 1996, based on the simplified elastic-plastic analysis method developed by Prof. Zarka et al. at the École Polytechnique in Palaiseau, often simply referred to as Zarka’s method. Its goal is the simplified determination of the plastic behavior of structures, the calculation of which would otherwise be very complicated.

The development of the STPZ was inspired by the fact that I was confronted with a dilemma in my professional practice. On the one hand there was the need to be able to demonstrate a sufficient service life of structures under repeated plastic straining. On the other, the computational effort required for a conventional application of the flow zone theory was so huge that a comprehensive proof of the life of all components of a nuclear power plant subjected to cyclic thermal loading was illusory.

The simplified analysis methods for the estimation of elastic-plastic distortion available in the 1980s had, however, no or at best a very weak theoretical foundation or were applicable only for special configurations of component geometry and loading conditions. Thus the desire arose for better founded simplified elastic-plastic analysis methods.

The need for them has not diminished in recent decades despite massively improved hardware and software. Rather, a reduction of calculation time remains desirable, considering the ever-increasing finite-element models, the development of design codes, which require a better capture of the inevitable nonlinear limit states of a structure, as well as calculating the remaining life in service on the basis of online monitoring systems.

That “simplified analysis methods” are called “simplified” can, in a certain way, be considered a euphemism. In truth, they are in fact more difficult to understand than the “exact” methods because they are derived from those by additional assumptions, which in turn require appropriate justification. Thus the simplification refers not to the fact that complicated theoretical issues could be avoided but to the fact that the amount of computations required may be reduced.

The purpose of this book is to present the STPZ so that a graduate student in civil engineering or mechanical engineering can develop an understanding of it. Other readers may skip some parts of the book, in particular Chaps. 1 and 2, dealing with basic knowledge concerning elastic-plastic material models and the phenomenon of ratcheting. The basics of the STPZ are initially explained in Chap. 3. Here, and after each of the subsequent extension steps of the STPZ (cyclic loading, temperature-dependent material data, multilinear hardening, limit load analysis), examples are presented in detail. Some examples use physical quantities without units, so that they are to be understood in any arbitrary consistent set of units.

Beyond the status of the STPZ described in this book, many extensions appear possible, so that the STPZ cannot be considered as completed.

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Based on Zarka's Method

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