Design of Fire-resistant Concrete Structures

Kristian Hertz
DTU Byg
Kgs. Lyngby, Denmark
khz@byg.dtu.dk

Abstract

The paper presents a new textbook on "Design of Fire-resistant Concrete Structures" published in July 2019.

The book gives a coherent presentation of methods for proper fire safety design of concrete structures including the methods found by the author during the past 40 years research and implemented in practice and in teaching and for some of them also implemented in the Eurocodes.

The paper shows applications of the book as a basis for fire safety design, as a textbook in teaching structural fire safety design, and as a common reference about the knowledge on the subject for research and practice. This means that the book is intended for application of universities, consulting engineers, test institutions, precast concrete industry, municipalities and insurance companies. Since it is based on physics and not related to a specific code of practice, it may be applied in any region of the world.

An initial chapter explains high-temperature properties of building materials including strength, stiffness, and stress-strain curves for all kinds of reinforcement and all kinds of concrete including light concrete qualities. The material chapters in particular explains the nature of transient strain to be considered for deflections and stability of columns and walls and the mechanisms of explosive spalling of high-strength concrete and limitations to apply in order to avoid that.

The following chapters introduce design methods for all kinds of concrete structures. They present derivations of the methods as part of the documentation of their validity. The derivations also serve to increase the users' understanding and thereby to improve the users' proper application of the design methods.

Examples show how the methods are applied, and they present results for fire-resistance of typical concrete structures including typical prefabricated concrete elements.

The present paper in particular focuses on new design methods and new knowledge found in the book. This includes for example design methods derived for walls of heavy and light concrete, where the thermal deflection and the support conditions for application of the normal load are of a special importance to the load-bearing capacity of the structures. Conditions, which a designer must consider.

By writing the book and presenting it in the present paper, the author intend to give a coherent presentation of the methods for design of fire-resistant concrete structures and the data and properties needed for the design.

References

[1] K.D. Hertz, Design of Fire-resistant Concrete Structures. ICE Publishing, Thomas Telford Ltd. 2019. 248p.

[2] K.D. Hertz, Reinforcement Data for Fire Safety Design. Mag. of Concrete Research 56, No.8, 2004 pp.453-459.

[3] K.D. Hertz, Concrete Strength for Fire Safety Design. Mag. of Concrete Research 57, No.8, 2005 pp.445-453.

[4] K.D. Hertz, Quenched Reinforcement Exposed to Fire. Mag. of Concrete Research Vol.58, No.1. 2006 pp.43-48.

[5] K.D. Hertz, ConFire. Users Guide for the Free Program ConFire.exe. 3. Edition. DTU Byg 2019.

[6] K.D. Hertz, Limits of Spalling of Fire-Exposed Concrete. Fire Safety Journal. Vol.38, No. 2, 2003 pp.103-116.

[7] K.D. Hertz and L.S. Sørensen LS, Test Method for Spalling of Fire Exposed Concrete. Fire Safety Journal Vol.40, No.5. 2005 pp.466-476.

[8] K.D. Hertz, L. Giuliani and L. Schiøtt Sørensen, Fire Resistance of Extruded Hollow-core Slabs. Journal of Struct. Fire Engineering. Vol. 8. No. 3. 2017 pp. 324-336.

[9] K.D. Hertz, Parametric fires for structural design. Fire Technology. Vol. 48, 2012 pp. 807-823.

[10] K.D. Hertz, Fire Resistance of Concrete Walls with Light Aggregate. Journal of Structural Fire Engineering. Vol. 9, Issue 4, 2018 pp. 319-341.

[11] K.D. Hertz, ConWall. Users Guide for the Free Program ConWall.exe. 1. Edition. DTU Byg 2017.