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BOOK REVIEW

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KARL-EUGEN KURRER: THE HISTORY OF THE THEORY OF STRUCTURES – SEARCHING FOR EQUILIBRIUM ERNST & SOHN, BERLIN 2018

Ten years ago that book appeared in its virgin form. The reviewer had the favour to comment on it in this journal [ACE 54(2008), 3, 649-650]. At present, the second edition of that book has been issued – now greatly deepened and supplemented. K.-E. Kurrer has mastered a meaningful monograph in world scale – on the beginnings, development, and state-of-the-art of the civil end structural engineer's technical knowledge; even more – the new version, uncommonly, activates his philosophical feelings, referring also to the humanistic background of technology. By the subtitle of the present edition, the book points also at its aspiration to underline the junction between pure theory and its practical consequence and responsibility. Altogether, the book fills skilfully the gap between the past and the present of civil and structural engineering – stressing the effect of history and heritage in its factual existence and interpretation.

When comparing both the editions by the number of their pages alone (848 versus 1241), it is evident that the book volume increased significantly. Now, the contents contains 15 main chapters, preceded by three forewords and closed by a rich list of biographies (260), abundant references (ca. 8700), and the name along with the subject indexes.

Chapter 1 presents the tasks and aims of a historical study in the analysis of engineering science and practice. Chapter 2 shows what can be learnt from the civil and structural engineering history. Hereby, several time intervals have been established – in form of the preparatory (1575-1825), discipline-formation (1825-1900), consolidation (1900-1950), and the integration (1950 to date) periods. Additionally, certain specific occurrences have been raised: the lever and trussed framework, higher engineering education, earth pressure on retaining walls, bridges and theory of structures in the 19th century, bridge building industrialization (1850-1900), appearance of influence lines, beam on elastic supports, displacement method, second order theory, ultimate load states, and the structural and aesthetic essence. Chapter 3 concerns the first fundamental disciplines of engineering science: theory of structures and applied mechanics – what is the meaning of that science and how its development took place. Chapter 4 concentrates on the passage from masonry to the elastic arch. Here, the initial concepts of solid arches and of their adequate geometrical descriptions have been recalled – together with the discussion of the wedge theory, collapse mechanisms, line of thrust theory, breakthrough towards the classic theory (Navier), ultimate load theory, and the finite element method (FEM).

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Chapter 5 has been devoted to the history of earth pressure concepts – from those followed in design of fortifications (military engineering), over the modification of Coulomb, to the contributions of continuum mechanics. Also, the effects conform with the theories applied in 1875-1900, and the consequences of geotechnical engineering, have been discussed. Moreover, the corresponding experimental investigations have been shown. Chapter 6 describes the beginnings of the theory of structures – from that of

Renaissance, practised by Galileo and later developed until 1750, as well as – that characteristic for the late 18th century. Furthermore, the formation of the theory of structures has been shown – according to Eytelwein and Navier (continuous beam). Chapter 7 considers the period of the theory of structures formation. The contributions of Clapeyron, Lamé, Culmann, Rankine, Maxwell, Cremona, Bow, and Winkler, have been exposed. On the motion to the consolidation period, the achievements of Castigliano have been underlined. Next, the accopolishments of Rayleigh and Kirpiczew, as well as – of Müller-Braslau, have been displayed – in order to present the foundations and farther progress of the classic theory of structures. Chapter 8 indicates the path followed by the iron towards the steel constructions. It also describes the events characteristic for their farther development within the period 1925-1975. Hereby, at first the torsion theories of St. Venant, Bach, and Bredt, have been discussed, as well as – their farther progress, typical for the time of 1850-1900 and for that of 1900-1950, has been examined. The problem of the shear centre (Bach, Potterat, Eggenschwyler, Maillart) was studied and the buckling theory explored; hereby, the mature German DIN 4114 standard was the corresponding foundation. Farther, the idea of the two-dimensional structures was raised (theory of effective width, grid-works, orthotropic plates, Huber's plate theory and Guyon-Massonnet's grid approach). The origin of the composite constructions (column and beams, bridges) and of the light weight steel structures, has been touched. The structural friendship of steel and glass has been exhibited. Chapter 9 presents the achievements of the structural third dimension – by introducing the performance of the spatial framework. The design theory and the production technology of those structures has been explained, as well as – the synthesis of the individual structures and of its large scale production technology, presented. Chapter 10 points at the appearance of reinforced concrete and at its effect on the development of the theory of structures. Adequate design methods were discussed, underlining their revolutionary character. Also the idea of prestressed concrete (Freyssinet) was introduced. Finally, the trussed framework model of reinforced concrete, proposed by Hennibique and Mörsch was found to be relevant for a proper structural design. Chapter 11 developes, in detail, the pecularities of the theory of structures consolidation era. It has been shown – in which manner such theory should be taught, taking advantage of the corresponding text, image, and symbol. In continuation, the particulars of the displacement method – the request for its routine matrix formulation, rationalization, and automation – has been explained. In Chapter 12 the impression was given in which manner the development and establishment of computational statics took place. At the beginning, the maxim of Argyris "The computer shapes the theory" has been recalled. It was looked back to matrix algebra and to its effect on the contemporary shape of structural mechanics, and on its practical tool in form of the finite element method (FEM) – as the general conception of modern structural analysis and science. Also, its relations with the variational background of mathematics has been accentuated. In Chapter 13 thirteen scientific controversies in mechanics and the theory of structures have been presented, for example: Galileo's *Dialogo*, the philosophical dispute about the true measure of force and about the principle of least action, the peculiarities of continuum and discontinuum, graphical statics versus pure theory, as well as – the animosity between the schools of Mohr and Müller-Breslau, and of Fillunger and Terzaghi. Also, the question of elasticity and plasticity within the kinematic approach (Stüssi-Thürlimann) was discussed. In Chapter 14 the perspectives for a historical theory of structures became first topic. Also the conditions of a proper engineering

education have been specified. Chapter 15 contains 260 detailed biographies of the theory of structures protagonists in world scale. The Polish reader can find there the following native scholars: Maciej Bieniek (1927-2006), Roman Ciesielski (1924-2004), Ryszard Dąbrowski (1924-2004), Maksymilian Tytus Huber (1872-1950), Feliks Jasiński (1856-1899), Witold Nowacki (1911-1986), Wacław Olszak (1902-1980) and Witold Wierzbicki (1890-1965).

Once more, it must be stated that the examined book has all virtues of an outstanding, excellent work. Therefore, the reviewer recommends it very strongly also to the Polish readers – similarly to the subject specialist, as to the students of civil, environmental, and architectural engineering.

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