NIKOLA HAJDIN
1923–2019

Academician Nikola Hajdin was born on 4 April 1923 in the village of Hajdini, Vrbovsko municipality in the Kingdom of Serbs, Croats, and Slovenes, present-day Croatia. He graduated from the Faculty of Civil Engineering in Belgrade in 1951 and received his doctoral degree in 1956. He was elected research associate at the Faculty of Civil Engineering in 1958, assistant professor in 1960, associate professor in 1961, and full professor in 1966. In addition to his subjects in undergraduate studies, Theory of Structures and Strength of Materials, he also taught the graduate courses Theory of Plasticity, Nonlinear Elasticity and Thin-Wall Structural Members Theory. He was elected Corresponding Member of the Serbian Academy of Sciences and Arts (SASA) in 1970 and Full Member in 1976. He was Vice President of the SASA from 1994 to 2003 and President of the SASA from 2003 to 2015. Prof. Hajdin was Chairman of the Yugoslav group of the International Association for Bridge and Structural (IABSE) and a member of the committee of that organization. Also, he was Chairman of the Yugoslav Committee of the International Union for Theoretical and Applied Mechanics, Dean of the Faculty of Civil Engineering in Belgrade and President of the Yugoslav Association of Structural Engineers. Professor Hajdin was a founding member of the Editorial Board of the Theoretical and Applied Mechanics and served on the Editorial Board of the journal continuously for 44 years.

Prof. Hajdin was a foreign member of the Athens Academy of Sciences, Slovenian Academy of Sciences and Arts, European Academy of Sciences, Arts and Literature (based in Paris), European Academy of Sciences and Arts (based in Salzburg) and European Academy of Sciences (based in Liège). He was elected Doctor honoris causa at the National Technical University of Athens in 2000. He was also a member of the Greek Metal Structures Research Society, Scientific Committee of *Costruzioni Metalliche* journal (Italy), Swiss Association for Steel Structures, International Association for Bridge and Structural Engineering (IABSE), and Scientific Committee of the International Association for

Steel Structures (Eurosteel). He was an honorary member of the Yugoslav Society for Mechanics, Yugoslav Association of Structural Engineers and Greek National Society for Theoretical and Applied Mechanics.

Prof. Hajdin's work can be roughly divided into the following areas in which he contributed to science and its applications: Integral Equation Method, Composite Construction, Thin-Walled Bars, Cable-Stayed Bridges, Vehicle Impact, Stability and Load-Capacity of Steel Girders.

He began his research work as a student. Thanks to Professor Hlitchiev, he published a paper entitled "Torsion of Triangular Tube" in the Proceedings of research papers of professors teaching at the Faculty of Technical Sciences in Belgrade. As a teaching assistant, he published a paper entitled "Contribution à la solution du problème plan", cited in the, at the time, reference book in the field of plates and shells (*Flächentragwerke*) by Girkmann, which was a recognition for a beginner and a relatively young scientist.

He proposed (1954) and developed a method of integral equations for the numerical solution to boundary-value problems of Elasticity Theory, which proved to be suitable in both Theory of linear girders and Theory of plates and shells. By converting basic differential equations into integral ones along the adopted lines of the network and solving them numerically, he obtained a system of linear equations that led to the solution to the problem.

The application of this procedure in the calculation of hydraulic structures is extremely valuable. Large arch dams such as *Grančarevo*, *Mratinje* and *Glažnja* were analyzed using this method.

A basic scientific problem that began to be studied more seriously after the Second World War was the phenomenon of creep and shrinkage of concrete, which over time leads to a redistribution of stress in a joint system consisting of steel and concrete. As a result of his work in this field, Professor Hajdin published several studies. On the other hand, in order to check some of these results, N. Hajdin went into the design and construction of composite structures that he originally designed. Thus, he designed the *Orašje* bridge over the Sava River, where for the first time in the world, together with the carriageway slab, a concrete slab was applied in the lower zone of the main girder above the supports. Such a constructive solution appeared in Germany, a leader in the field, as a novelty only after more than twenty years. The *Orašje* Bridge, in addition, had the largest span of all composite bridges in the world at that time.

The scientific field of the Theory of Structures to which Professor Hajdin made a remarkable contribution is thin-walled structures, which, because of their properties, are

Bridge over the Sava River in Belgrade

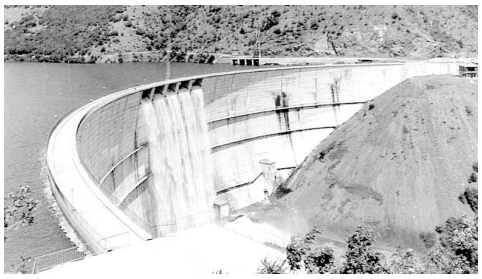
used in several technical branches such as civil engineering, mechanical engineering, shipbuilding, aeronautics and others. N. Hajdin's works in this area, published mostly abroad, are some of the most mature and significant works of this kind. They have appeared in a number of journals and reviews, and have been cited in a number of papers by foreign and domestic scholars. Exceptionally valuable among them are two monographs: *Dünnwandige Stäbe*, Bd. 1 and 2 (with Dr. C. F. Kollbrunner), published by Springer Publishing House in 1972 and 1975 respectively.

What is particularly important in the field of design are Hajdin's cable-stayed bridges, which are considered to be a remarkable achievement. Cable-stayed bridges appeared, as a novelty, in bridge construction in the 1960s. Seeing this novelty as promising a revolutionary change, N. Hajdin immediately undertook theoretical studies of these structures and on the first occasion that arose, namely the railway bridge over the Sava River in Belgrade, set out to apply this system. At a time when there were barely twenty bridges of this type built in the world, he was the first to design a bridge of this kind for rail traffic, although it was widely believed among experts that such a relatively flexible system was not applicable to rail traffic. The cable stays are distributed in two vertical planes and they connect to the stiffening girder at about every fifth of the 254 m span. By adopting steel cables with parallel wires of the BBR construction system with extremely fatigue resistant Hi-Am anchor heads, along with measures to increase the bridge mass, extraordinary tension efficiency was obtained, excellent cable tension for constant loading and low impact of the cable elongation on deflection of the structure. It should be noted that this was one of the first applications of this type of cable structures in Europe. Since then, this type of cable has been the dominant form of cable-stayed bridges in the world. The bridge was completed in 1979 and, thanks to the innovations applied, showed all its good features.

After this project had been completed, N. Hajdin designed the *Sloboda* (*Freedom*) Bridge in Novi Sad. With a span of 351 m, the structure at the time of construction represented a world record for bridges of this kind, with pylons and cables in the median plane of the bridge. The bridge was completed and put into service in 1981. The bridge has been cited frequently in world literature, before and after its demolition during the NATO bombing in 1999. The bridge has been restored to its original form that is completely true to the original. It was completed in 2005.

Bridge in Novi Sad

Bridge in Płock



Glažnja Dam

In the series of bridges of this kind, the peak of the author's creation is the bridge over the Vistula River in the Polish city of Płock, awarded with the first prize in an international competition. With a record span of 375 meters, it represents a further improvement of the idea realized on the bridge in Novi Sad. The total length of the bridge is 1200 m, 615 m of which is the length of the main part of the bridge over the riverbed of the Vistula River, and 585 m is the length of the access part of the bridge above the inundation. The main bridge structure is a symmetrical steel structure, a bridge with sloping cables consisting of a continuous girder, sloping cables and two pylons.

In the late 1970s, special attention in the world began to be paid to the problem of so-called "patch loading", the concentrated tensile load of plate girder flanges or the load distributed over a small length in the web plane, which may first lead to local buckling in the loading zone, and depending on other conditions, also to the progressive fracture of the girder. Among other things, in addressing this problem, an analysis was made of the effect of longitudinal stiffeners in the load-bearing zone on plate girder buckling. In the paper written jointly with N. Markovic "A Contribution to the Analysis of the Behavior of Plate Girders Subjected to Patch Loading", which was published in the 1992 issue of the *Journal of Constructional Steel Research*, a formula which takes this effect into account was proposed. This formula was fully accepted in 2000 in a new version of the British Bridge Regulations (BS 5400-3: 2000 Steel, concrete and composite bridges - Part 3: Code of Practice for Steel Bridges Design. BSI, May 2001) in which previously only a calculation for girders without longitudinal stiffeners was covered. N. Hajdin's scientific opus includes more than 230 papers, about half of which were published abroad in the most prestigious journals or presented at important scientific conferences.

The 2007 edition of Chinese Yingliang Wang's encyclopedia of the most significant bridges in Europe and America for the last 200 years lists four bridges designed by Prof. Nikola Hajdin.

He was a Visiting Professor for the Thin-Walled Members Course at the Swiss Federal Institute (ETH) in Zürich from 1971 to 1973, and a visiting scholar at the Swiss Association for Steel Structures. He visited Switzerland several times and participated in research in the field of Thin-walled Members Theory. In addition, he delivered a series of lectures at scientific conferences, foreign universities, scientific and professional institutions, such as: University College London (United Kingdom), ETH – Lausanne (Switzerland), University of Prague (Czech Republic), University of Bratislava (Slovakia), University of Stuttgart (Germany), University of Dresden (Germany), Chinese Academy of Sciences, Beijing (China), Indian Institute of Structural Engineers, Calcutta, Bombay (India), Austrian Association of Engineers and Architects, Vienna (Austria), University of Baghdad (Iraq), Technische Hochschule Aachen (Germany), University of Hanover (Germany), National Technical University of Athens (Greece), Technical University of Timisoara (Romania), Accademia Nazionale dei Lincei, Rome (Italy) and others.

Prof. Nikola Hajdin headed or was a member of committees for 52 master's and 42 doctoral theses at the home faculty, and for a large number of theses at various faculties of the former Yugoslavia, the University of Athens and Helsinki. He led the scientific project "Theoretical and Experimental Investigations of Metal Structures and Their Impact on Contemporary Design and Construction" at the SASA. He was also a project leader for a number of scientific projects at the Faculty of Civil Engineering in Belgrade.

Among the major acknowledgments and awards that he received are the following: the City of Belgrade October Award in 1959, the City of Novi Sad October Award in 1981, the AVNOJ Award in 1987, several awards at anonymous contests for bridges in Yugoslavia, as well as the First Prize in an anonymous competition for the bridge over the Vistula River in Poland (1996). Professor Nikola Hajdin died in Belgrade on 17 July 2019.

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