

**ZBORNİK RADOVA
1. KONGRESA HRVATSKOG DRUŠTVA ZA
MEHANIKU**

**PROCEEDINGS
OF THE 1st CONGRESS OF CROATIAN
SOCIETY OF MECHANICS**

Pula, Croatia, 14-17. rujna / September 1994

ZBORNİK RADOVA / PROCEEDINGS
1. KONGRESA HRVATSKOG DRUŠTVA ZA MEHANIKU
OF THE 1st CONGRESS OF CROATIAN SOCIETY OF MECHANICS

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PREDGOVOR

Prvi kongres Hrvatskog društva za mehaniku prvo je organizirano druženje znanstvenika iz područja mehanike krutih i deformabilnih tijela i mehanike fluida u neovisnoj Hrvatskoj nakon osamostaljivanja i međunarodnog priznanja. To je prilika da se uz prikaz rezultata istraživanja razmjene znanja i iskustva iz područja teorijske i primijenjene mehanike, gdje su obuhvaćene analitičke, numeričke i eksperimentalne metode.

Ovaj Zbornik sadrži radove koji su izloženi u vremenu od 14. do 16. rujna 1994. godine u Puli. Uvjereni smo da će prikazani rezultati pridonijeti upoznavanju čitatelja s novim metodama koje omogućuju efikasno rješavanje problema u raznim znanstvenim područjima kao što su strojarstvo, građevinarstvo, brodogradnja, rudarstvo i ostala područja. Najveći broj radova predstavlja doprinos numeričkim metodama analize konstrukcija. Nagli razvoj računala omogućio je uspješno rješavanje statičkih i dinamičkih nelinearnih problema. Pokušaji su što točnijeg opisivanja fenomena fizikalne i geometrijske nelinearnosti uz poboljšanje efikasnosti numeričkih algoritama. Nešto manje su zastupljeni radovi koji spadaju u područje analitičkih i eksperimentalnih metoda.

Budući da radovi na Kongresu nisu bili podijeljeni na sekcije, ni u Zborniku nisu grupirani po strogo odvojenim područjima i znanstvenim disciplinama. Tiskani su direktno u obliku koji je dobiven od autora bez prethodne lekture, stoga Organizacijski i znanstveni odbor ne preuzima odgovornost za eventualne pogreške i nejasnoće.

Veliku zahvalnost dugujemo svim sudionicima iz zemlje i inozemstva koji su svojim radovima pridonijeli realizaciji našega Prvog kongresa, koji će, vjerujemo, biti poticaj za daljnje druženje znanstvenika iz područja mehaničkih znanosti a predstavlja početak organiziranja skupova Hrvatskog društva za mehaniku.

Zahvaljujemo sponzorima koji su pružili financijsku potporu kao i svima koji su na bilo koji način pomogli organiziranje Kongresa.

Organizacijski i znanstveni odbor

IX

PREFACE

The first Congress of the Croatian Society of Mechanics is the first organized gathering of scientists in all fields of theoretical and applied mechanics. It provides an opportunity to present research results in the fields of general mechanics, mechanics of solids and mechanics of fluids, using analytical, numerical and experimental methods.

The Proceedings contain papers that will be presented in Pula between September 14th and 16th. We are convinced that the results presented will enable readers to get acquainted with modern methods of analysis that can serve as an efficient tool for solving problems in different fields of science and engineering such as Mechanical Engineering, Civil Engineering, Naval Architecture, Mining and Petroleum Engineering, etc. The overwhelming majority of papers deals with numerical analysis of structures. The rapid development of computers has significantly contributed to solving not only static but also dynamic nonlinear problems. Efforts have been made to describe both physical and geometrical nonlinearities. At the same time the efficiency of numerical algorithms has substantially improved. Nevertheless, papers dealing with analytical and experimental methods are included too.

Since the papers have not been grouped in sections for presentation at the Congress, they have not been assigned to definite sections in the Proceedings either. The authors were asked to prepare camera-ready copies and they were printed as such without any corrections. Therefore, the Organizing and Scientific Committee does not assume liability for errors or inconsistencies.

We are grateful to all participants from Croatia and abroad for their contribution to the success of our first Congress. We hope that this will be the first in a series of equally successful congresses to be held in our beautiful country.

Finally, we wish to express our great gratitude to our sponsors for their financial support and to all those who helped in any way in organizing this Congress

Organizing and Scientific Committee

THE CROATIAN SOCIETY OF MECHANICS

Brief Historical Review

1969 - 1994

This year we celebrate three important jubilees: the 75th anniversary of teaching engineering mechanics at the newly established School of Engineering in Zagreb, the 40th anniversary of the foundation of the Zagreb Section of the former Yugoslav Society of Mechanics and the 25th anniversary of the Croatian Society of Mechanics.

School of Engineering 1919-1994. Since the end of XIX century there had been demands for a school of engineering in Croatia. The first initiative for founding such a school came from the Society of Engineers and Architects in Zagreb. The Society stated formally their demand on September 19, 1881. Due to many obstacles, political and financial, these demands were not met until December 10, 1918, following the fall of Austria-Hungary as a result of the efforts of Dr. Milan Rojc, the energetic Secretary of Education of the Croatian Government. The school was named VISOKA TEHNIČKA ŠKOLA (High Technical School, Technische Hochschule). Regular studies began in 1919. Ing. Milan Čalogović, Ing. Jaroslav Havliček and Architect Ing. Martin Pilar were elected as the first professors at the School. The first Chancellor of the School was architect Edo Šen. In 1926 the school was incorporated into the University of Zagreb under the name of TECHNICAL FACULTY.

Dr. Milivoj Prejac was the first Professor of Engineering Mechanics and Dr. Mirko Roš of Statics. They were elected in 1919. However, Professor Roš left for ETH Zürich in 1924. Meanwhile, Stephan Prokofievich Timoshenko, former professor at the Institute of Engineers of Ways of Communication in St. Petersburg arrived as a refugee in the Kingdom of Serbs, Croats and Slovenes in March 1920. The Professor's Council of the School of Engineering in Zagreb invited him as a Professor of Mechanics and Strength of Materials. S. P. Timoshenko accepted the invitation and arrived in Zagreb in May 1920.

After several years of interruption Timoshenko resumed his scientific work in Zagreb and prepared several papers. These he wrote in English and with the help of R. V. Southwell and E. H. Love they were published in the Philosophical Magazine and the Proceedings of the London Mathematical Society. At the end of his second academic year he left Zagreb, leaving Dr. Konstantin Čališev as his successor. In fact K. Čališev was the first scientist to receive a doctors degree at the newly founded School of Engineering on March 10, 1921. Dr. Rajko Kušević was elected as Assistant Professor of Engineering Statics in 1928 and of Metal Structures in 1929. Professor Prejac had been the head of the Chair for Engineering Mechanics since its foundation in 1919 until the end of the Second World War in 1945.

After the war new professors were elected: Davorin Bazjanac for Engineering Mechanics for students of Mechanical Engineering (ME), Electrical Engineering (EE) and Naval Architecture (NA), Vasilij Andrejev for Engineering Mechanics for students of Civil Engineering (CE), Architecture (A) and Geodesy (G), Dragutin Horvat for Fluid Mechanics for students of ME, EE and NA, Josip Grčić for Fluid Mechanics for the students of CE, A and G, and Mladen Hudec for Engineering Mechanics for students of Mining, Petroleum Engineering and Geology.

Zagreb Section of Mechanics 1954-1994. The first Yugoslav Congress of Applied and Theoretical Mechanics was held at Bled in the Republic of Slovenia in February 1952. At the Congress an initiative was advanced to establish the Yugoslav Society of Mechanics. In 1954 The Yugoslav Society of Mechanics (YSM) was founded. The first President of the Society was Jakov Hlitičijev and the first Secretary General, Vlatko Brčić. That same year the Zagreb Section of the YSM was founded in Zagreb.

The Croatian Society of Mechanics 1969-1994. In 1969 the Zagreb Section of YSM was transformed into the Croatian Society of Mechanics (CSM). The founding Assembly of the Croatian Society of Mechanics was held on April 18, 1969. The first President and the first Secretary of the Society were Davorin Bazjanac and Ivo Alfirević. All the presidents and secretaries of the Society and the dates of their elections are listed in Table 1.

Nineteen Yugoslav Congresses of Theoretical and Applied Mechanics were held between 1952 and 1990. These are: Bled 1952, 1954, 1956 and 1960, Opatija 1958, Split 1962, 1966 and 1968, Vrnjačka Banja 1964 and 1988, Baško Polje 1970 and 1970, Ohrid 1974 and 1990, Sarajevo 1976, Portorož 1978, Kupari 1981, Bečići 1984, Zadar 1986. Members of CSM at all Congresses participated with a number of papers and CSM helped substantially in organizing many of them.

After the recognition of the Republic of Croatia as an independent and sovereign country, CSM ceased to be a part of YSM. The same happened to the Slovenian Society of Mechanics as well as to other societies of mechanics in former Yugoslav Republics. In this way YSM ceased to exist.

Two members of CSM were presidents of YSM: Davorin Bazjanac in two terms 1970-72 and 1972-74, and Zlatko Kostrenčić 1978-81. In 1976 D. Bazjanac was appointed first honorary member of YSM. Another two members of CSM were honorary members of YSM: V. Andrejev 1978 and Z. Kostrenčić 1986.

Table 1 List of presidents and secretaries of the Croatian Society of Mechanics

Date of Assembly	President of the Society	Secretary of the Society
28.4.1969	Davorin Bazjanac	Ivo Alfirević
14.6.1971	Antun Vučetić	Ivan Heidl
25.1.1973	Mladen Hudec	Vilim Korošec
23.12.1974	Zlatko Kostrenčić	Vice Šimić
13.1.1977	Zlatko Kostrenčić	Vice Šimić
16.5.1979	Ivo Alfirević	Nikola Vranković
21.10.1981	Ivo Alfirević	Nikola Vranković
24.11.1983	Stjepan Jecić	Dragan Pustaić
21.11.1985	Stjepan Jecić	Željko Goja
16.12.1987	Aleksandar Kiričenko	Marijan Staneković
13.12.1989	Vilim Korošec	Zorislav Despot
28.11.1991	Osman Muftić	Zorislav Despot
17.12.1992	Ivo Alfirević	Jurica Sorić

The Croatian Society of Mechanics organized seven Yugoslav Symposia of the Theory of Plasticity: Plitvička Jezera 1981, 1982 and 1983, Tuheljske Toplice 1985, Lipik 1987, Opatija 1989 and Pula 1991.

In cooperation with the Austrian Society of Experimental Strain Analysis (ASESA) and the Hungarian Scientific Society of Mechanical Engineering, CSM founded the Danubia-Adria Committee (DAC) in 1982. The first members of the Committee were I. Alfirević, R. Beer, I. Huszar, S. Jecić, H.P. Rosmanith, F. Thamm. The Italian Association of Stress Analysis (AIAS) joined the DAC in 1986 and the Czechoslovakian Society of Mechanics in 1992. Later the Czechoslovakian Society split into two parts: the Czech Society of Mechanics and the Slovak Society of Mechanics. Since May this year both societies have been members of the DAC. Eleven Danubia-Adria Symposia on Experimental Methods in Solid Mechanics have been held to date: Stubičke Toplice 1984, Graz 1985, Budapest 1986, Plzen 1987, Udine 1988, Mösern 1989, Pula 1990, Gödöllo 1991, Trieste 1992, Meřin 1993, Baden 1994. CSM also organized three round table discussions about some important current issues: Stubičke Toplice 1976, Modern Methods in Teaching Mechanics; Split 1979, Application of SI Units in Engineering; Slavonski Brod 1989, Problems and Improvements in Teaching Mechanics. CSM was coorganizer of the third International Symposium on Numerical Methods for Non-Linear Problems, Dubrovnik 1986.

XIV

Inicijativni odbor za osnivanje
Društva za mehaniku SRH

Zagreb, 26.V 1969.

SEKRETARIJATU JAVNE SIGURNOSTI

Z a g r e b

Dvadeset i osmog travnja ove godine održana je osnivačka skupština Društva za mehaniku Socijalističke republike Hrvatske. Molimo Vas da izvršite upis Društva za mehaniku SRH u Registar udruženja građana i da odobrite njegov rad. Održavanje osnivačke skupštine Društva odobreno je potvrdom broj 14 - 3/2 - 7 od 18. IV 1969. Molbi prilažemo:

- a) dva primjerka Zapisnika osnivačke skupštine
- b) četiri primjerka Statuta društva
- c) dva primjerka spiska osnivača Društva
- d) spisak članova Upravnog Nadzornog odbora.

1. Prof.dr D. Bazjanac *D. Bazjanac*
2. Prof.dr Vasilij Andrejev *V. Andrejev*
3. Prof.dr Antun Vučetić *A. Vučetić*
4. Prof. Mladen Hudec *Mladen Hudec*
5. Mr Ivo Alfirević *Ivo Alfirević*
6. Inž. Krsto Draža _____
7. Inž. Ivo Heidi *Ivo Heidi*
8. Inž. Stjepan Jecić *Stjepan Jecić*
9. Inž. Vilim Knoch *Vilim Knoch*
10. Inž. Osman Muftić *Osman Muftić*

Figure 1 Facsimile of the founding document of the Croatian Society of Mechanics

1971 CSM has been supporting member of the International Centre for Mechanical Sciences (CISM) Udine, Italy. Croatian representatives in the Administrative and Scientific Council were Antun Vučetić, and Vasilij Andrejev and Zlatko Kostrenčić, respectively. On the proposal of and in cooperation with CSM, a course "Photoelasticity of Anisotropic Media" was organized at CISM Udine in 1983.

This is only a brief review of the activities and members of CSM. It was difficult to collect all the relevant information in such a short time and to present it in such a brief review. I can only hope that all relevant events and deserving members have been duly acknowledged. To all those whom I may have inadvertently omitted my most sincere apologies.

Ivo Alfirević

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