



CETRA<sup>2010</sup>

17–18 May 2010, Opatija, Croatia  
First International Conference on Road and Rail Infrastructure

# Road and Rail Infrastructure

Stjepan Lakušić – EDITOR



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Proceedings of the  
First International Conference on Road and Rail Infrastructures – CETRA 2010  
17-18 May 2010, Opatija, Croatia

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EDITOR

Stjepan Lakušić

Department of Transportation

Faculty of Civil Engineering

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Zagreb, Croatia

CETRA<sup>2010</sup>

First International Conference on Road and Rail Infrastructure

17-18 May 2010, Opatija, Croatia

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## FOREWORD

The First International Conference on Road and Rail Infrastructure – CETRA 2010 was organized by the University of Zagreb - Faculty of Civil Engineering, Department of Transportation. The Conference is held in Opatija, Croatia (“Opatija” is the Croatian word for “abbey”). Opatija is the leading tourist destination on the Adriatic Coast in the Republic of Croatia and for more than 160 years has been drawing tourists from Europe and all over the world.

The intention of CETRA 2010 was to bring together scientists and experts in the fields of road and railway engineering, especially those from the European continent and give them another opportunity to present the results of their research, their findings and innovations. Road and railway infrastructure are closely related, but scientific and professional gatherings covering both fields simultaneously have rarely been organized until now. At the present time, the development of a society, particularly its economic development, is unthinkable without a developed transportation infrastructure, specifically roads and railways. The growing volume of traffic, both passenger and cargo, demands not only the development of the vehicles themselves (increasing their cargo capacity and speed), but also the timely construction and regular maintenance of infrastructure. It is exactly for this reason that the International Conference on Road and Rail Infrastructure covers many areas: design, construction and maintenance, traffic planning & modelling, modes of transportation (vehicles), environmental protection, standardization and, above all, education, which today has an increasingly important role. This type of conference gives scientists and experts in the field of roads and railways an opportunity to analyze problems in everyday engineering practice and to offer possible solutions for more efficient planning, design, construction and maintenance in these areas.

The organizers of this conference attempted to create an opportunity for the exchange of ideas and information among various branches about what is being done in various countries in the field of roads and railways.

This first Conference attracted a large number of papers from 29 countries and 26 Universities. More than 140 papers were presented at the Conference and are contained in these proceedings. The papers are divided into the following sections: Education, Road Traffic, Road Design, Road Pavement, Road Maintenance, Geotechnical Works, Structural Monitoring, Railway Design, Permanent Way, Crossings & Junctions, Railway Traffic, Railway Maintenance, Vehicles and Environmental.

The organizers of the Conference express their thanks to all Businesses and Institutions who helped in organization of this Conference. The Editor is grateful to all the authors for the excellent papers contributed to this book and wishes to thank the members of the International Academic Scientific Committee who participated in the review process. Our gratitude also goes to all the participants for their willingness to come to Opatija and take part in CETRA 2010.

THE EDITOR

Stjepan Lakušić  
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