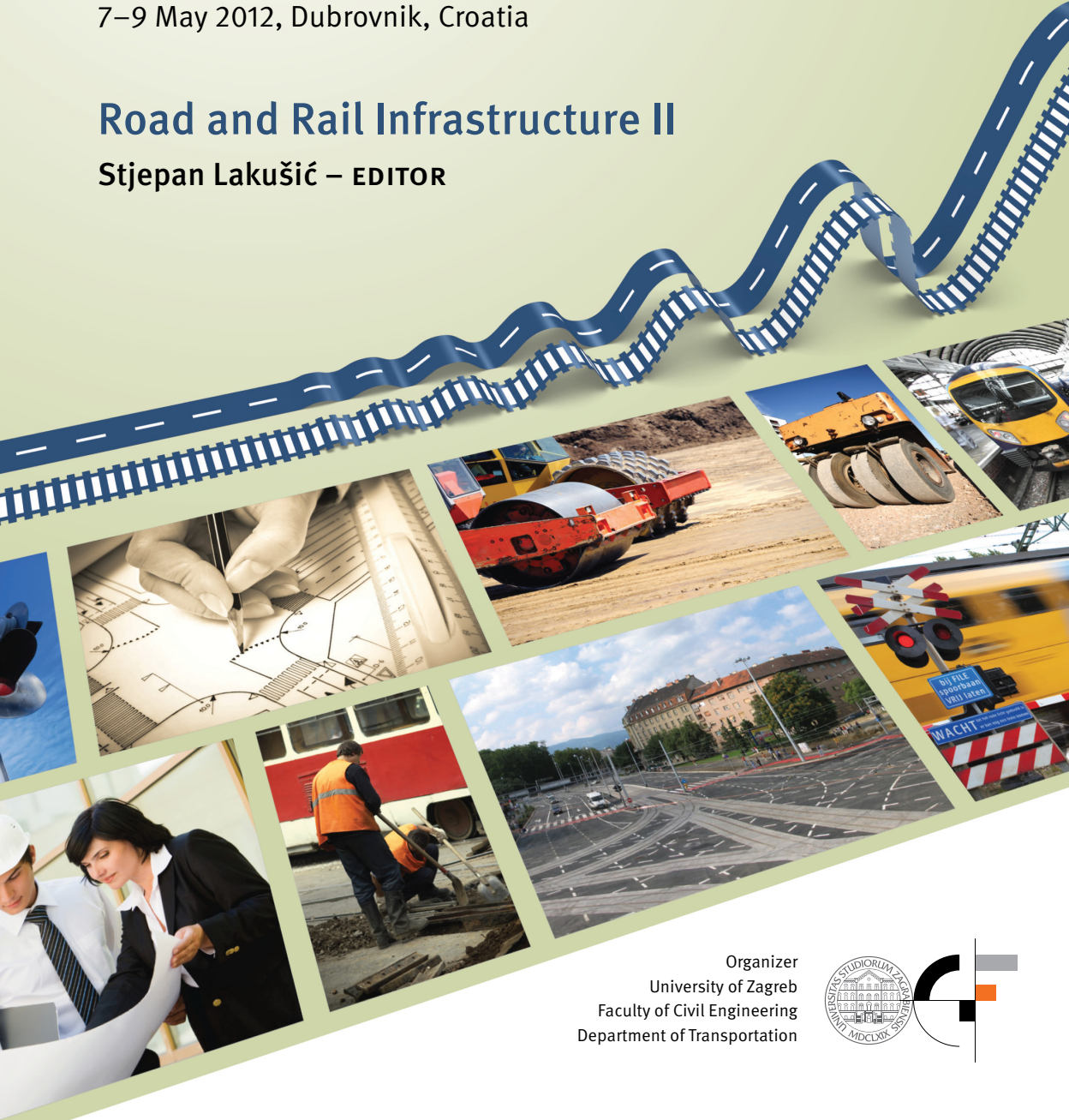


**CETRA**<sup>2012</sup>

2<sup>nd</sup> International Conference on Road and Rail Infrastructure  
7–9 May 2012, Dubrovnik, Croatia

## Road and Rail Infrastructure II

Stjepan Lakušić – EDITOR



Organizer  
University of Zagreb  
Faculty of Civil Engineering  
Department of Transportation



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# Road and Rail Infrastructure II

EDITOR

Stjepan Lakušić

Department of Transportation

Faculty of Civil Engineering

University of Zagreb

Zagreb, Croatia

CETRA<sup>2012</sup>

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## FOREWORD

The 2<sup>nd</sup> International Conference on Road and Rail Infrastructure – CETRA 2012 was organized by the University of Zagreb – Faculty of Civil Engineering, Department of Transportation. The Conference is held in Dubrovnik, Croatia. Dubrovnik is the “pearl of the Adriatic coast” and well known phrase related to it states “Those who seek paradise on Earth should come to Dubrovnik and see Dubrovnik”. The First International Conference on Road and Rail Infrastructure – CETRA 2010 is held in Opatija, Croatia. Great interest of participants in topics from the field of road and rail infrastructure during the conference CETRA 2010 in Opatija, where 140 presentations of papers from 29 countries took place, confirmed the soundness of Department for Transportation Engineering's decision on organizing such international event. Positive comments of the participants after the past Conference motivated the Department for Transportation Engineering, Faculty of Civil Engineering at University of Zagreb to continue the organization of such an event in the upcoming years (on a biennial basis).

In the year 2012, 2<sup>nd</sup> International Conference on Road and Rail Infrastructure – CETRA 2012 has been organized, with the intention of bringing together scientists and experts in the fields of road and railway engineering, giving them another opportunity to present the results of their researches, findings and innovations. Road and railway infrastructure is closely related, but scientific and professional gatherings covering both fields simultaneously are rarely being organized. 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 2<sup>nd</sup> International Conference on Road and Rail Infrastructure – CETRA 2012 covers many areas: traffic planning & modelling, infrastructure projects, design of road and rail substructure and superstructure, construction and maintenance process, structural monitoring, urban transport infrastructures, application of recycled materials, innovation and new technology, environmental protection – noise and vibrations and, above all, education, which today has an increasingly important role.

This second Conference CETRA 2012 attracted a large number of papers from 39 countries and 52 Universities. More than 142 papers were presented at the Conference and are contained in these proceedings Road and Rail Infrastructure II. The papers are divided into the following sections: Education, Traffic planning and modelling, Infrastructure projects, Infrastructure management, Road infrastructure planning, Road pavement, Road maintenance, Structures and structural monitoring, Innovation and new technologies, Design of road and railways, Rail track structure, Environmental, Geotechnics, Integrated timetables, Urban transport planning and modelling, Urban transport infrastructure, Vehicles, Traffic safety.

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 Dubrovnik and take part in CETRA 2012.

### THE EDITOR

Prof. dr. Stjepan Lakušić  
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