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Road and Rail Infrastructure II

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FOREWORD

The 2nd 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, 2nd 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 2nd 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
May, 2012.
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## CONTENTS

### FOREWORD

5

### KEYNOTE LECTURES

**INNOVATION WITHOUT IMPLEMENTATION EQUALS ZERO**  
Klaus Riessberger  .............................................................................................................. 19

**LIFETIME ENGINEERING FOR ROADS**  
Laszlo Gaspar  .................................................................................................................................................... 25

**ENERGY AND ENVIRONMENTAL ASPECTS OF HIGH–SPEED RAIL**  
Roderick A. Smith, Robert Watson, Jing Zhou  ........................................................................................................ 35

**NECESSITY TO SUPPORT THE FINANCING OF THE ROAD INFRASTRUCTURE**  
Christophe Nicodème  ......................................................................................................................................... 45

### 1 EDUCATION

**RESEARCH ON COMPETENCES OF STUDENTS OF CIVIL ENGINEERING**  
STUDIES IN THE FIELD OF ROAD CONSTRUCTION  
Zlata Dolaček–Alduk, Sanja Dimter  ..................................................................................................................... 59

**NEARLY 10 YEARS OF TEACHING RAILWAY SIMULATION AT THE VIENNA UNIVERSITY OF TECHNOLOGY**  
Katalin Jurecka  ................................................................................................................................................... 67

### 2 TRAFFIC PLANNING AND MODELLING

**THE ROLE OF A POLICY MADE ROAD CATEGORISATION FOR SUSTAINABLE ROUTE NAVIGATION UNDER NORMAL AND CONGESTED TRAFFIC CONDITIONS**  
Koen De Baets  ................................................................................................................................................... 75

**BEHAVIORAL ANALYSIS OF DEPARTURE TIME DECISION CONSIDERING REDUNDANCY OF RAILROAD NETWORK**  
Kazuyuki Takada, Makoto Fujiu, Shigeki Sugiyama  ................................................................................................ 81

**TRUCK TRIP GENERATION RATES FOR DIFFERENT TYPES OF FACILITIES IN POLAND**  
Tomasz Kulpa  ................................................................................................................................................... 89

**CAPACITY VS. RELIABILITY IN RAILWAYS: A STOCHASTIC MICRO–SIMULATION APPROACH**  
Giovanni Longo, Giorgio Medeossi  ...................................................................................................................... 97

**USING SIMULATION TO ASSESS INFRASTRUCTURE PERFORMANCE IN MULTICRITERIA EVALUATION OF RAILWAY PROJECTS**  
Giovanni Longo, Giorgio Medeossi, Elio Padoano  ............................................................................................... 105

### 3 INFRASTRUCTURE PROJECTS

**SPECIFICITIES OF PROJECT FOR RAILWAY LINE ON CORRIDOR VIII**  
Zoran Krakutovski, Darko Moslavac, Zlatko Zafirovski  .......................................................................................... 115

**MODERNIZATION OF RAIL ROUTE 10 – KOSOVO RAILWAYS**  
Fitim Shala  ................................................................................................................................................... 123
4 INFRASTRUCTURE MANAGEMENT

EFFICIENT AND CUSTOMER FRIENDLY LUGGAGE LOCKING
Bernhard Rüger, Hans-Christian Graf, Burkhard Stadlmann .......................................................... 133

PUBLIC BUSES ON EMERGENCY LANES — A VERY SPECIAL USE OF A MOTORWAY IN AUSTRIA
Wolfgang Josef Berger .................................................................................................................. 141

THE POLISH SCIENTIFIC RESEARCHES ON ELECTRONIC TOLL COLLECTION AREA
Gabriel Nowacki .......................................................................................................................... 149

THE FIRST EXPERIENCE OF ETC USAGE IN THE SILESIAN REGION
Aleksander Slądkowski, Grzegorz Twardoch .............................................................................. 155

TRACK ACCESS CHARGE ALGORITHMS IN EU RAILWAYS: A DYNAMIC BENCHMARKING
Francesca Ciuffini, Stefano Ricci, Giulio Rocco Sitongia .................................................................. 161

A NEW METHODOLOGY FOR ASSESSING THE PERFORMANCE OF ROAD SURFACE MARKINGS
Francesco Asdrubali, Cinzia Buratti, Elisa Moretti, Francesco D'Alessandro, Samuele Schiavoni ....... 169

A TENTATIVE TOLL MOTORWAY SOLUTION ON DURRES—TIRANA—ELBASAN ROAD CORRIDOR
Faruk Jusuf Kaba ......................................................................................................................... 177

UNDERSTANDABLE, VISIBLE AND CLEAR INFORMATION TO THE DRIVER — DO WE KNOW HOW TO PROVIDE IT?
Uroš Brumec, Aleš Merkun, Nina Verzolak Hrabar ......................................................................... 185

5 ROAD INFRASTRUCTURE PLANNING

APPLICATION OF MULTICRITERIA ANALYSIS FOR SELECTION OF ALTERNATIVE IN THE ROAD PROJECTS
Aleksandar Glavinov, Zoran Krakutovski, Slobodan Ognjenovic, Katerina Mitkovska—Trendova ........ 195

STRATEGIC TRANSPORT INFRASTRUCTURE IN SOUTH EAST EUROPE: PLANNING EXPERIENCE
AND PERSPECTIVES IN THE CONTEXT OF THE EUROPEAN TRANSPORT POLICY
Marios Miltiadou, Socrates Basbas, George Mintsis, Christos Taxilariás, Anthi Tsakiropoulou .......... 203

HIGHWAY A8, SECTION ROGOVIĆI—MATULJI, INFLUENCE OF GENERAL PUBLIC ON DESIGN SOLUTIONS
Nebojša Opačić, Tomislav Kraljić ................................................................................................. 213

DECISION MAKING PROCESS ON THE ANTWERP OOSTERWEEL LINK: LESSONS LEARNT
Dirk Lauwers ................................................................................................................................... 221

6 ROAD PAVEMENT

PAVEMENT WIDENING ON ROAD CURVES
Željko Korlaet, Tomislav Dobrica, Ivica Stančerić .......................................................................... 229

VERTICAL DYNAMIC LOAD IMPACT ON THE PAVEMENT OF AN URBAN FRONT ENGINE BUS
Pablo Yugo Yoshiura Kubo, Cassio Eduardo Lima Da Paiva .......................................................... 237

PAVEMENT DESIGN OPTIMISATION CONSIDERING COSTS AND PREVENTIVE INTERVENTIONS
Adelino Ferreira, João Santos ........................................................................................................ 243

DEPENDENCY BETWEEN ROAD SURFACE GEOMETRY AND SKID RESISTANCE
Markus Weise, Wolfram Ressel ....................................................................................................... 251

RESISTANCE OF ASPHALT COURSES TO PERMANENT DEFORMATIONS IN THE FORM OF RUTS
Miroslav Šimun, Andrea Strineka, Tatjana Rukavina ...................................................................... 259

APPLICATION OF INFRARED CAMERA FOR QUALITY CONTROL DURING PAVING
Bojan Milovanovic, Josipa Domitrovic, Tatjana Rukavina ............................................................ 267

PAVEMENT SURFACES IN URBAN AREAS
Marijana Cuculić, Sergije Babić, Aleksandra Deluka—Tibljaš, Sanja Šurdonja .......................... 273

PERMANENT DEFORMATIONS OF ASPHALT MIXTURES FROM PAVEMENT WEARING COURSES
Adrian Burlacu, Carmen Răcănel .................................................................................................... 281

LABORATORY TESTS CONCERNING FATIGUE BEHAVIOR OF ASPHALT MIXTURES
Carmen Răcănel, Adrian Burlacu ..................................................................................................... 287
AIRPORT ASPHALT MIXTURES BEHAVIOUR TO FATIGUE AND PERMANENT DEFORMATION
Claudia Petcu, Carmen Răcănel ......................................................... 295

THE INFLUENCE OF COMPACTION METHODS ON PROPERTIES OF ASPHALT MIXTURES: IMPACT COMPACTION VS. SLAB COMPACTION
Mizan Moges, Carsten Karcher .......................................................... 301

BINDER MOBILIZATION IN RAP AND ITS CONTRIBUTION TO MIX PERFORMANCE
X. Carbonneau, F. Lubineau, B. Yvinec, Jean Paul Michaut .................. 309

PERMANENT DEFORMATION OF POLYMER MODIFIED BITUMEN
Vesna Ocelić Bulatović, Vesna Rek, Kristina Jurkaš Marković ............. 317

THE COMPARISON BETWEEN WHEEL TRACKING AND TRIAXIAL CYCLIC COMPRESSION TEST ON DIFFERENT ASPHALT MIXTURES
Natasa Zavrtanik, Roman Bašelj, Mitja Kozamernik, Goran Turk, Marjan Tušar .................................................. 327

CREEP RECOVERY BEHAVIOUR OF BITUMINOUS BINDERS—RELEVANCE TO PERMANENT DEFORMATION OF ASPHALT PAVEMENTS
Georges A. J. Mturi, Matsopole Nkgapele, Johan O’Connell ................ 335

EVALUATION OF THE EFFECT OF AGGREGATES ANGULARITY ON THE SURFACE PROPERTIES OF HOT MIX ASPHALT
Amir Onsori, Burak Sengoz, Ali Topal, Cagri Gorkem ....................... 343

COMPARISON OF LOW—TEMPERATURE BITUMINOUS MIXTURES SELECTED PROPERTIES
Josef Zak, Jiri Vavricka, Silvia Stefunkova ........................................ 351

RESEARCH OF ASPHALT LAYERS BONDING IN LITHUANIAN PAVEMENT
Audrius Vaitkus, Donatas Ėygas, Alfredas Laurinavičius, Viktoras Vorobjovas, Rita Kleizienė ........................................... 357

ANALYSIS OF THE FLEXIBLE PAVEMENTS TRANSITIONS USING FINITE ELEMENT METHOD
Cassio Eduardo Lima De Paiva, Leandro Cardoso Trentin .................... 365

COMPARISON OF THE LABORATORY AND FIELD TESTS USED FOR PAVEMENT DESIGN
Lenka Sevelova, Jaroslav Hauser, Alice Kozumplikova ....................... 373

7 ROAD MAINTENANCE

WORLD—CLASS PERFORMANCE BASED MAINTENANCE CONTRACTS — RECENT TRENDS
Pekka Pakkala, Antti Talvitie ............................................................ 383

PREDICTION MODEL FOR THE COST OF ROAD REHABILITATION AND RECONSTRUCTION WORKS
Jelena Čirilović, Nevena Vajdić, Goran Mladenović, Cesar Queiroz .......... 389

PRINCIPLES OF ROAD MAINTENANCE BASED ON PERFORMANCE CRITERIA
Mihai Dicu, Carmen Răcănel, Adrian Burlacu, Štefan Marian Lazăr, Claudia Petcu ......................................................... 397

EFFECTIVE ROAD MAINTENANCE WORKS PLANNING
Ján Mikolaj, Lubomír Pepucha, Peter Časnocha, Luboš Remek ................ 405

MICRO—SURFACING ON FRENCH HIGHWAYS: RECENT SUCCESSFUL EXPERIENCES
Jean—Etienne Urbain, Mario Medved, Eric Layerle, Ivan Kolaric .................. 413

ON A NOVEL OPTIMISATION MODEL AND SOLUTION METHOD FOR TACTICAL RAILWAY MAINTENANCE PLANNING
Franziska Heinicke, Axel Simroth, Roberto Tadei .................................. 421

SMART MAINTENANCE AND ANALYSIS OF RAILWAY TRANSPORT INFRASTRUCTURE (SMART RAIL)
Kenneth Gavin, Irina Stipanović Oslaković, Marko Vajdić, Goran Puž, Velimir Šporčić .......................................................... 429

8 STRUCTURES AND STRUCTURAL MONITORING

EXTENDING LIFE OF CONCRETE BRIDGE DECKS THROUGH EARLY DETERIORATION DETECTION BY NDE METHODS
Nenad Gucunski, Ali Maher, Hamid Ghasemi .................................... 439

VIADUCT DESIGNS ON THE SECTION OF THE PAN—EUROPEAN CORRIDOR X IN SOUTH SERBIA
Slavica Vucetic—Abinun ........................................................................ 447
10 RAIL TRACK STRUCTURE

LIGHT RAIL TRACK STRUCTURE COMPARATIVE ANALYSIS
Mirjana Tomičić–Torlaković, Vladan Branković

TECHNICAL PARAMETERS FOR SELECTION OF ELASTIC RAIL FASTENINGS
Tatjana Simić

FWD APPLICATION TO RAILWAY TRACK–BED LAYERS CHARACTERIZATION
Simona Fontui, Govind Kamlesh, Francesca De Chiara, Eduardo Fortunato

TRANSITION ZONES ON THE RAILWAY TRACK – OVERVIEW
Marko Vajdić, Irina Stibanović Oslaković, Stjepan Kralj

INFLUENCE OF USPs ON THE QUALITY OF TRACK GEOMETRY IN TURNOUT
Miroslava Hruzíková, Otto Plasek, Jaroslav Smutny, Richard Svoboda

CONTINUOUSLY WELDED RAIL (CWR) TRACK BUCKLING AND SAFETY CONCEPTS
Sanjin Albinović, Mirna Hebib–Albinović

EFFECTS OF TRAM TRACK DESIGN AND EXPLOITATION PARAMETERS ON GAUGE DIVERGENCE
Stjepan Lakušić, Maja Ahac, Ivo Haladin

ARC WELDING OF GROOVED RAILS – MANUAL METAL ARC WELDING VERSUS FLUX CORED ARC WELDING
Stjepan Lakušić, Tamara Džambas, Maja Ahac, Ivo Haladin, Ivan Duvnjak

11 INNOVATION AND NEW TECHNOLOGY

INNOVATIVE MATERIALS FOR SUSTAINABLE RAILWAY TRACKS – ECOTRACK
Stjepan Lakušić, Dubravka Bjegović, Ana Barčević, Ivo Haladin

GREEN TRACK – ENVIRONMENTAL PERFORMANCE EVALUATION FOR ‘GREEN’ TRAMWAY SUPERSTRUCTURE
Paul Steckler, Brigitte Klug, Florian Gasser, Werner Wehr

ENERGY CONSUMPTION INDUCED BY OPERATION PHASE OF RAILWAYS AND ROAD INFRASTRUCTURES
Alex Coiret, Pierre–Olivier Vandanjon, Romain Bosquet, Agnès Jullien

RUCONBAR – GREENING THE MARKET OF NOISE PROTECTION SOLUTIONS
Stjepan Lakušić, Dubravka Bjegović, Ivo Haladin, Ana Barčević, Marijana Serdar

FEM DRIVEN DESIGN PROCESS OF INNOVATIVE INTERMODAL TRUCK–RAIL SOLUTION
Wiesław Krasoń, Tadeusz Nizezga, Krzysztof Damaziak

12 ENVIRONMENTAL PROTECTION

DYNAMIC EFFECT OF MOVING LOAD ON ASPHALT PAVEMENT
Jozef Melcer, Gabriela Lajčaková

THE FEASIBILITY OF PIEZOELECTRIC ENERGY HARVESTING FOR CIVIL APPLICATIONS
Simon C. Bos

RAIL ROUGHNESS MEASUREMENT AND ANALYSIS IN FRAME OF RAILVEHICLE PASS–BY NOISE MEASUREMENTS
Stjepan Lakušić, Ivo Haladin, Ante Jukić, Nikola Andraši, Petar Piplica

LOW NOISE PAVEMENTS: AVAILABLE SOLUTIONS
Jean Paul Michaut

INTEGRATED NOISE PROTECTION BARRIERS AND SOLAR POWER PLANT ON RIJEKA BYPASS
Boris Huzjan, Sanjin–Velebit Pešut

ROAD TRAFFIC NOISE MODELING AT ROUNDABOUTS
Saša Ahac, Vesna Dragčević

MODELLING THE IMPACT OF TRAFFIC ON QUALITY OF LIFE: SCENARIO EVALUATION FOR THE CITY OF GHENT
Dominique Gillis, Dirk Lauwers, Luc Dekoninck, Dick Botteldooren
<table>
<thead>
<tr>
<th>13 GEOTECHNICS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AN ALTERNATIVE ANALYSIS FOR DEVELOPING THE SWELLING MODEL FOR EXPANSIVE CLAYS</strong></td>
</tr>
<tr>
<td><strong>EXPRESSWAY CONSTRUCTION ON YOUNG KARST IN BRECCIA (VIPAVA VALLEY, SLOVENIA)</strong></td>
</tr>
<tr>
<td><strong>LARGE EMBANKMENT NEAR SUHAREKÈ ON THE KOSOVO MOTORWAY</strong></td>
</tr>
<tr>
<td><strong>THE STUPIČA TUNNEL – ROCKFALL PROTECTION</strong></td>
</tr>
<tr>
<td><strong>A COMPARISON OF 2D AND 3D NUMERICAL SIMULATION FOR TUNNEL EXCAVATION ACCOMPANIED BY MEASUREMENT RESULTS</strong></td>
</tr>
<tr>
<td><strong>PROTECTION MEASURES AGAINST DEBRIS FLOWS, USING FLEXIBLE RING NET BARRIERS IN THE TEUFELSKADRICH, GERMANY</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>14 INTEGRATED TIMETABLES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PERIODIC TIMETABLE CONCEPT FOR THE BOSNIA AND HERZEGOVINA RAILWAY NETWORK</strong></td>
</tr>
<tr>
<td><strong>ON THE DELIVERY ROBUSTNESS OF TRAIN TIMETABLES WITH RESPECT TO PRODUCTION REPLANNING POSSIBILITIES</strong></td>
</tr>
<tr>
<td><strong>INTEGRATED PERIODIC TIMETABLE IN HUNGARY – EXPERIENCES, HELP FOR VISION</strong></td>
</tr>
<tr>
<td><strong>TECHNICAL AND TECHNOCLOGICAL PRECONDITIONS FOR IMPLEMENTATION OF INTEGRATED TIMETABLE IN REGIONAL PASSENGER TRANSPORT WITH THE REPUBLIC OF SLOVENIA</strong></td>
</tr>
<tr>
<td><strong>TECHNICAL AND TECHNOCLOGICAL PRECONDITIONS FOR IMPLEMENTATION OF THE INTEGRATED TIMETABLE IN REGIONAL PASSENGER TRANSPORT IN THE REPUBLIC OF HUNGARY</strong></td>
</tr>
<tr>
<td><strong>INTEGRATED PERIODIC TIMETABLE SCHEDULING – TOWARDS AN INTEGRATED TIMETABLE ACROSS CENTRAL EUROPE</strong></td>
</tr>
<tr>
<td><strong>THE DEVELOPMENT OF THE INTEGRATED PERIODIC TIMETABLE IN AUSTRIA</strong></td>
</tr>
<tr>
<td><strong>DEVELOPMENT OF PERIODIC TIMETABLE IN THE CZECH REPUBLIC</strong></td>
</tr>
<tr>
<td><strong>IMPLEMENTATION OF PERIODIC TIMETABLE IN REGIONAL PASSENGER TRANSPORT OF REPUBLIC OF CROATIA</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>15 URBAN TRANSPORT PLANNING AND MODELLING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>INFRASTRUCTURE INVESTMENTS AND ITS IMPACT ON REGIONAL ECONOMY – EVIDENCE FROM TWO CASE STUDIES AS STARTING POINT FOR A PLANNING TOOL</strong></td>
</tr>
<tr>
<td><strong>THE IMPACT OF THE IMPLEMENTATION OF GREEN WAVE IN THE TRAFFIC LIGHT SYSTEM OF A TRAMWAY LINE – THE CASE OF ATHENS TRAMWAY</strong></td>
</tr>
<tr>
<td><strong>PROGRAM FOR DEVELOPMENT OF BICYCLE TRAFFIC IN THE CITY OF ZAGREB</strong></td>
</tr>
</tbody>
</table>
MODEL FOR A SHORT – TERM FORECAST OF VEHICLES IN BITOLA TOWN
Vaska Atanasova, Lidija Markovik ................................................................. 907

E–MOBILITY IN URBAN AREAS AND THE IMPACT OF PARKING ORGANISATION
Harald Frey, Anna Mayerthaler, Paul Pfaffenbichler, Tadej Brezina .................... 915

DEMOGRAPHIC MODEL 'AGE–COHORT' FOR MODELLING OF URBAN MOBILITY IN LONG TERM
Zoran Krakutovski .......................................................................................... 923

APPROACH TO DEALING WITH THE TRANSPORT DEMAND MANAGEMENT
IN CITIES WITH THE REVIEW ON CITY OF ZAGREB
Marko Slavulj, Davor Brčić, Ljupko Šimunović ............................................... 929

NEW TRANSPORTATION SYSTEM OF THE CITY OF DUBROVNIK
Damir Pološki, Željko Stepan, Igor Majstorović ............................................. 937

TRAFFIC LIGHTS ON CONSECUTIVE INTERSECTIONS AND PEDESTRIAN CROSSINGS
ALONG LINEAR SETTLEMENTS LOCATED ON NATIONAL ROADS
Alina Burlacu, Mihai Dicu, Valentin Anton ..................................................... 945

REQUIREMENTS FOR HIGH QUALITY CYCLING INFRASTRUCTURE DESIGN
Tadej Brezina, Nikolaus Ibesich, Martin Niegl, Helmut Lemmerer ...................... 953

CRITICAL PLANNING AND DESIGN PARAMETERS FOR GARAGES
Rudolf Eger ....................................................................................................... 961

FUTURE TRANSPORT NETWORK OF THE CITY OF DUBROVNIK
Igor Majstorović, Mario Njegovec, Ana Rigo .................................................. 969

16 URBAN TRANSPORT INFRASTRUCTURE

SPEED AS AN ELEMENT FOR DESIGNING ROUNDABOUTS
Hrvoje Pilko, Davor Brčić, Nikola Šubić .......................................................... 981

DEVELOPMENT OF METRO ZAGREB PROJECT
Davorin Kolić ..................................................................................................... 989

MINI–ROUNDABOUTS IN URBAN AREAS
Sanja Šurdonja, Sergije Babić, Aleksandra Deluka–Tibljaš, Marijana Cuculić ........ 997

DESIGN ELEMENTS OF MODERN ROUNDABOUTS
Mario Njegovec, Željko Stepan, Ana Rigo .................................................... 1005

RENAISSANCE OF THE RAILWAY CONNECTION TRSTENA–NOWY TARG
Juraj Muzik, Zuzana Gocálová, Andrej Villim, Janka Šestáková, Ľubomír Pepucha .......... 1013

17 VEHICLES

BOARDING ACCESSIBILITY TO TRAIN VEHICLES FOR EVERYONE
Bernhard Rüger, Goran Simic ........................................................................ 1019

RAILWAY INTERIORS IN ORDER TO REDUCE DWELL TIME
Bernhard Rüger ............................................................................................... 1027

VIRTUAL ROAD MODELS FROM DYNAMIC MEASUREMENTS
Kai Tejkl, Wolfram Ressel ............................................................................. 1033

IDEA AND TESTS OF THE RAILWAY WAGON WITH A ROTATABLE PLATFORM FOR INTERMODAL TRANSPORT
Tadeusz Niezgoda, Wieslaw Kraison, Wieslaw Barnat ............................................. 1041

18 TRAFFIC SAFETY

SAFETY MEASURES ON RAIL AND ROAD ENGINEERING STRUCTURES – A COMPARATIVE ASSESSMENT
Christos Pyrgidis, Fotini Kehagia ................................................................ 1051

CONTROL SYSTEM FOR TRAINS IN MOVEMENT
Dobrinka Atmadzhova, Emil Dimitrov, Nencho Nenov ................................... 1059
ENSURING SAFETY OF OPERATION BY AUTOMATIC MEASUREMENT
OF ROLLING STOCK WHEELS GEOMETRY
Janusz Madejski ............................................................................................................................................. 1067

THE ANALYSIS OF TRAFFIC ACCIDENTS ON LITHUANIAN STATE ROADS
Stanislav Mamčic, Henrikas Sivilevičius ............................................................................................................ 1077

ANALYSIS OF ROAD TRAFFIC SAFETY AFTER THE CONSTRUCTION OF
THE FULL PROFILE OF THE RIJEKA–ZAGREB MOTORWAY
Željko Denona, Boris Huzjan, Tatjana Matković ................................................................................................. 1085

INTEGRATING HUMAN FACTOR IN THE ANALYSIS OF THE INTERACTION 'TRAM — CAR DRIVERS'
Fatiha Moutchou, Abdelghani Cherkaoui, El Miloudi El Koursi ............................................................................. 1093

METHODOLOGY FOR SAFETY PERFORMANCE ASSESSMENT OF HIGHWAY
INFRASTRUCTURE — ISSUES, RECENT APPLICATIONS AND FUTURE DIRECTIONS
Bhagwant Persaud .......................................................................................................................................... 1101

DRIVER’S DISTRACTION AND INATTENTION PROFILE IN TYPICAL URBAN HIGH SPEED ARTERIALS
Eleni Misokefalou, Nikolaos Eliou ..................................................................................................................... 1109

SIGHT DISTANCE TESTS AT ROAD INTERSECTIONS WITH UNFAVOURABLE ANGLES
Ivica Stančerić, Željko Korlaet, Vesna Dragčević ................................................................................................ 1117

THE BEHAVIOUR OF PASSIVELY SAFE ROADSIDE COLUMNS IN IMPACT WITH VEHICLES
Višnja Tkalčević Lakušić, Stjepan Lakušić ......................................................................................................... 1129

ACCIDENTS AT THE LEVEL CROSSINGS IN LITHUANIAN RAILWAYS
Inesa Gailienė, Vaidas Ramūnas, Kęstutis Skerys ............................................................................................... 1139

ANTI–SLIP RUBBER BASE FOR PEDESTRIAN CROSSINGS
Marko Hoić, Igor Keser ..................................................................................................................................... 1147

A MODEL FOR ASSESSING COLLISION RISK ON AUTOMATIC LEVEL CROSSINGS
Mohamed Ghazel ........................................................................................................................................... 1151

SAFETY OF TRAFFIC ON RAIL-ROAD CROSSINGS WITH SPECIAL REVIEW OF EU
DIRECTIVES ON TRAFFIC SAFETY— PROPOSALS FOR IMPROVEMENTS
Georg–Davor Lisicin, Igor Novačić .................................................................................................................... 1159

AUTHOR INDEX .............................................................................................................................................. 1169
Program for Development of Bicycle Traffic in the City of Zagreb

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Abstract

The City of Zagreb, like most of the European cities and cities in developed countries, experienced a rapid motorized growth. On a long term, this cannot be successfully solved by building an infrastructure which is exclusively designed for individual motorized traffic. By following recommendations and guidelines of the European Commission, relating to the future sustainable development of cities and the mobility of their inhabitants, as well as positive examples of European cities and regions, the City of Zagreb, in the last 10 years, increasingly commits to and directs the development of alternative forms of transport. This primarily refers to urban public passenger transport and the development of bicycle traffic. Taking this into account, this paper contains a review of previous program activities and future plan actions relating to the development of bicycle traffic in the City of Zagreb, mainly relating to: development and arrangement of bicycle traffic network, establishment of a public bicycle service, innovation and adaptation of legislation related to design of bicycle paths and lanes, and general safety of bicycle traffic.

Keywords: bicycle path / lane, bicycle rack, public bicycle service, legislative regulations, European and international examples and guidelines

1 Introduction

In recent years, City of Zagreb, as most European and world capitals, increasingly experiences negative consequences of a permanent increase in the volume of individual motor traffic. This ultimately results in increased noise, emissions of toxic gases and significant deterioration of climatic conditions and quality of life of its citizens.

Despite the continuous rise of individual motorized transport, the city also recorded an increased share of bicycle traffic in the overall travel. Apart from the general recession impact, the level of development and quality of cycling areas is also responsible for the increased number of bicycle users in the cities.

Appeal for bicycle traffic is increased by systematic expansion of cycling network, upgrade and adaptation of new lanes and connections and the installment of bicycle racks. Unfortunately, this also increases the security risk of bicycle traffic.

Pursuant to the above, this paper will analyze the existing regulatory legislation, current cycling infrastructure, features and characteristics of the problem situation, from the standpoint of the volume of bicycle traffic. The result will be used as a foundation in the process of drafting the program for bicycle transport development in the area of Zagreb.
2 Features of bicycle traffic in the City of Zagreb

Following recommendations and guidelines of the European Commission, which are relating to the future sustainable development of cities and the mobility of their inhabitants, as well as positive examples of European cities and regions, Zagreb is, in the last 10 year, increasingly opting for the development of alternative forms of transport, primarily for the urban public passenger transport and the development of bicycle traffic. Accordingly, for the last 15 years, there are ongoing measures to improve and encourage bicycle traffic in the overall travel, in order to increase its participation and limit motor traffic, prevent environmental pollution and to promote generally healthier life for citizens.

Systematic planning of bicycle traffic in the city dates to the mid 80s, when the Master Plan (gup), in which bicycle traffic corridors were planned, was first adopted. At the beginning, the bicycle traffic and bicycle–oriented surfaces were intended exclusively for recreational and sporting purposes. Jarun is one of the first examples of building biking trails for recreational sporting purposes in the City of Zagreb (bike path around Jarun was arranged before the Univerzijada 1987). From 1995 to 2010, there was a gradual approach towards the future network planning of bicycle lanes and trails, by renewing the existing and building the new ones, as well as equipping certain zones and locations with bicycle racks. During this period, approximately 220 km of cycling trails were renewed and built. Plotting bicycle paths / lanes began on the city’s main roads, whose cross section was sufficient for the interpolation of bicycle paths and for which there was no need to accede major construction projects.

In order to adapt the existing transport infrastructure to the needs of the safe flow of bicycle traffic, regulation of bicycle areas also entailed the creation of specific design solutions of the reconstruction. In the previous period, City of Zagreb undertook a number of other traffic technical and regulatory interventions with the aim to improve conditions for bicycle traffic such as:

· removal of urban and architectural barriers (suspended curbs and construction of suspended ramps),
· adaptation – addition of signaling equipment on the intersections controlled with traffic lights (the introduction of LED lanterns for cyclists)
· marking of cycling areas with red filled (infill) lanes in the full profile, made of thermoplastics, in the areas of high traffic density,
· installation of fixed / flexible protective pillars and staples for the protection of bicycle paths,
· construction of bicycle path or lane during reconstruction and major road repairs.

![Figure 1](image.png) Setting of traffic signs and equipment for the regulation of bicycle traffic in the City of Zagreb
2.1 The amount of bicycle traffic

First official data regarding the volume of bicycle traffic was recorded and released in a traffic study of City of Zagreb [9], prepared by the famous English design and engineering consultancy firm mva in the year 1999. The research covered in this study shows that only 0.7% of the daily journeys are realized by bicycle. In this study, bicycle is classified as an underutilized mean of transport. However, it is interesting to note that 51% of households said that they have at least one bicycle, which represents a respectable potential for greater use of bicycles as a mean of travel.

Before the above mentioned traffic study, there was no comprehensive study of the transport demands or traffic volume measurements which could, by using the same pattern, be used as a basis for conclusions regarding changes in the participation in the actual daily journeys. There were, however, several measurements and surveys performed on a limited number of locations and selected population, which provided an approximate image for certain characteristic of the intensity of bicycle traffic.

In the study performed by the collaborating company ISIP-MG [1], a measurement of traffic at 16 locations was carried out, mostly on the city's busiest traffic corridors. This data is presented in the following graph (Figure 2). Based upon these limited measurements, it can be assessed that there is a certain amount of increase in bicycle traffic. This can be attributed to the major traffic infrastructure adaptations regarding bicycle traffic.

2.2 Cycling infrastructure

Most cycling routes (90%) are arranged as bicycle lanes on the pavements of urban roads, separated from the pedestrian walkway with color or in small part with the shallow curbs. Exceptionally, in the central part of the city, on one of the main longitudinal roads, a bicycle lane is established in the roadway profile of the road, in the length of approximately 1300 m. Separate bike paths are arranged only within the sporting and recreational complexes. The prevailing solution of bicycle routes on sidewalks was not met with enthusiasm from the cycling population. This is due to the fact that this solution exposes them to conflicts with pedestrians. Consequently, these solutions should be used only in the corridors of roads with the low intensity of pedestrian traffic. Parallel with the regulation of bicycle paths and lanes, and with the enhancement of bicycle traffic intensity, there was a need for additional cycling infrastructure in terms of bike rack and standpoints.

In recent years, there was a particularly intensive planning and equipping of bicycle parking lots. Initially, the zones within public institutions have been equipped with bicycle holders in the central part of the city. This encompassed approximately 50 locations. On the initiative of the owners and users of commercial services, a large number of sites was equipped with racks. One of the most problematic features in the network of bicycle paths in Zagreb is its lack of interconnectedness into the compact network.
3 Development and improvement of bicycle traffic in the City of Zagreb

Development and improvement of bicycle traffic in the city of Zagreb will be focused upon interventions that can be defined through the following program components:
· improving conditions in the existing bicycle network,
· further development and expansion of bicycle paths or lanes,
· implementation of the public bicycle service,
· amending legislation regarding regulation of bicycle traffic.

3.1 Program to improve conditions on the existing bicycle network

Within this program, it is necessary to establish conditions for the smooth flow of bicycle traffic on the existing cycling routes. This includes completion and restoration of traffic signals, connecting bike trails when there is an interruption in their continuity, lowering of the curbs in intersections and installation of signaling equipment on intersections adapted to the needs of bicycle traffic.

As a part of this program, it is necessary to remove all flaws and inconsistencies which are not compatible with the reality of the traffic situation on the field. First of all, this refers to the positioning of the bicycle lane within the road profile, the width of the lane, crossing the lane or path through the intersection etc.

Figure 3 shows examples of typical problem situations, such as: unfavorable positioning of utility infrastructure within the corridor of bicycle lanes, ignoring the need for lowering the curbs when building roads, unadjusted guidance of bicycle lanes through the intersection and more.
3.2 Expansion of bicycle lanes or paths

In the foreseeable planning period, of 15–20 years, it would be realistic to try to complete the network of bicycle routes planned by the city General master plan, which relates primarily to the regulation of bicycle routes within the corridors of the city's main roads.

Assuming equal development of future network, this would mean expanding the network of bicycle lanes for 5–7 km per year.

In this period, there will certainly be a need for regulation of bicycle lanes and paths on the road corridors of minor importance as these are, seen from the perspective of local areas, urban settlements or districts, recognized as potentially attractive cycling routes. These are the routes of the roads that connect building blocks with public amenities; schools, sport and recreational centers, etc.

In the further expansion of the cycling network in the City of Zagreb, priority certainly belongs to directions and sections of the city center, which are not properly connected and in the areas where the integrity and continuity of a given direction is not ensured.

Within this central part of the network, the most important are the parts of the lanes by which the bicycle stops of the bicycle service would be connected, as that is a prerequisite to the future establishment of the mentioned service.

Expansion of the biking network from the city center to the periphery, should be implemented as a part of the reconstruction and increased maintenance of the roads. During these activities, it is possible to intervene in the construction works and thus ensure the necessary profile for the bicycle path, by reallocating or correcting parts of the profile or by expanding the corridor outside of the existing regular line.

3.3 Implementation of the public bicycle service

For a number of years, city's program documents indicate the need to establish public bicycle service. Relating to this topic, city offices started certain preparatory activities directed towards gathering various experiences in launching and operating public bicycle service.

A convenient and illustrative study was made, documenting certain European and other international experiences regarding launch and implementation of public bicycle service.

Visits and talks about specific experiences of Vienna and Ljubljana were carried out, and this indicated that the most successful public bicycle service is the one established and operated on the principle of public–private partnerships, or based upon granting concessions to companies whose core activity is related to the media, propaganda and marketing activities.

Cities normally give such companies the right to use 'for free' attractive advertising space for a number of years (20 years and over). In return, media company equips and maintains functionality of the city's public bicycle service within the concession period.

It refers mainly to the technical, technological and IT–wise high level of supply and reliability in the operation, which faces a positive response and approval from the citizens. In addition, cities that have modern and reliable public bicycle service are provided with the image of cities with high awareness of environmental and energy efficiency.

The basic role and importance of such a modern bicycle service relates to the promotion of a new life attitude towards the environment and the impact on behavioral change in citizens regarding the selection of means by which they travel.

3.4 Amending legislation regarding regulation of bicycle traffic

Since the traffic police reports have not registered alarming statistical indicators regarding road accidents and casualties of cyclists in the current low intensity bicycle traffic, it was considered that there is no need or justification for changes in this field. Consequently, the 'Law on Road Traffic Safety', which was so far amended on couple of occasions, mainly remained
unchanged in this section. However, the current regulations governing the area of bicycle traffic are not adequately adapted to the situations of intense bicycle transport in neither urban areas nor in general.

To ensure proper conditions for future expected growth of bicycle traffic, it will be required to intervene in the area of its control. The mentioned normative interventions must be made in the areas of planning and designing of cycling infrastructure, as well as in the planning of bicycle traffic and amendments to the regulations regarding the safety of bicycle traffic.

In the area of planning and designing the bicycle infrastructure, there is a lack of quality project instructions and guidelines for designing bicycle paths or lanes, mostly in the part that defines the position of a given bicycle path or lane within the road profile. There is no regulation or recommendation on guiding the bicycle paths through an intersection, and no regulation regarding the width of the lane with regards to the intensity of bicycle traffic. Furthermore, regulation is non-existent in regard to the designing traffic light plans or the amendment of the traffic signaling equipment needed for bicycle traffic.

There is a need to intervene in the traffic regulation relating to the bicycle traffic safety, mostly in regard to the ‘Law on Road Traffic Safety’ and relevant by-laws that accompany it. Mentioned interventions are necessary regarding areas relating to the prevention of potential security risks in terms of prescribing rules of behavior, speed limits, rules on giving priority, and in the following security risk situations and relationships among participants:

- relationship between cyclists and pedestrians, on the sidewalk where the established bike paths are located,
- relationship between cyclists and drivers of motor vehicles, on the road surface where the bicycle lanes are established,
- the relationship of cyclists / pedestrians and cyclists / driver of the vehicle, in crossing over traffic light controlled and uncontrolled intersections,
- movement of cyclists in the pedestrian zone,
- movement of cyclists at night and in poor visibility,
- equipment and functionality of bicycle,
- driving skills and knowledge of traffic regulations.

Future increase in the use of bicycle, as a mean of transport for daily travel, needs to be properly addressed when designing residential and other buildings. It is the fact that the existing residential buildings generally do not have enough common usable space for keeping bicycles. Consequently, in regard to their future design, it should be obligatory that apartment buildings provide adequate space to hold at least one bicycle per flat unit up to 50 m², and relatively larger space for larger flats.

4 Conclusion

In the context of achieving the preconditions for sustainable development of transport in the City of Zagreb, it is necessary to encourage the promotion of various forms of transportation that are alternatives to individual motorized traffic.

One of these alternative forms of transport is cycling. Its development must be intensified by continuous adaptation and regulation of transport infrastructure, by upgrading the cycling network, by linking existing bike corridors, realizing the project of public bicycle service and by conducting preventive activities.

All of the above mentioned measures, aimed at improving bicycle traffic, should provide conditions in which the bicycle traffic becomes a respectable form of daily travel. Consequently, its share in the total number of realized trips should be increased to form at least 5 percent of the total number of realized trips.
References


