CETRA 2014

3rd International Conference on Road and Rail Infrastructure
28–30 April 2014, Split, Croatia

Road and Rail Infrastructure III

Stjepan Lakušić – EDITOR

Organizer
University of Zagreb
Faculty of Civil Engineering
Department of Transportation

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FOREWORD

The 3rd International Conference on Road and Rail Infrastructure – CETRA 2014 was organized by the University of Zagreb - Faculty of Civil Engineering, Department for Transportation Engineering. The Conference was held in Split, Croatia. Split is the largest city in Dalmatia and the second largest city in Croatia, and it is also one of "Croatian Champions of Tourism". The 1st International Conference on Road and Rail Infrastructure (CETRA 2010) was held on 17-18 May 2010 in Opatija. The 2nd International Conference on Road and Rail Infrastructure (CETRA 2012) was held on 7-9 May 2012 in Dubrovnik. A great interest of participants in topics and themes from the field of road and rail infrastructure, as shown during the CETRA 2010 conference (140 papers from 29 countries) and CETRA 2012 conference (142 papers from 39 countries), justified the Department of Transportation Engineering's decision to organise once again an international event of such great significance. Positive comments received from participants in past conferences motivated the Department for Transportation Engineering of the Faculty of Civil Engineering - University of Zagreb to continue with the organization of this international event.

The CETRA conference has established itself as a venue where scientific and professional information from the field of road and rail infrastructure is exchanged. The idea on linking research organisations and economic operators has been the guiding concept for the realisation of this conference. Conferences of this kind are undoubtedly a proper place for bringing closer together the economy and university operators, and for facilitating communication and establishing greater confidence that might result in cooperation on new projects, especially those that contribute to greater competition. Lectures organized in the scope of the conference are based on interesting technical solutions and on new knowledge from the field of transport infrastructure as gained on already realised projects, projects currently at the planning stage, and those now under construction, in all parts of the world. In addition to authors from the academic community, lectures were also presented by practical authors, the idea being to ensure the best possible synergy between the theory and practice. Because of a great interest for the themes from the field of road and rail infrastructure, as shown during the past two conferences (CETRA 2010 and CETRA 2012), the Department for Transportation Engineering of the Faculty of Civil Engineering – Zagreb assumed the responsibility to organise the CETRA conference in this year as well.

Our goal for the International Conference on Road and Rail Infrastructure – CETRA is to have all published papers indexed in scientific databases in order to achieve greater recognition for the conference itself, for published papers, and for their authors. As the serial publication entitled Road and Rail Infrastructure has been achieved with this third conference, the precondition has been fulfilled to obtain the International Standard Serial Number (ISSN), which was the condition for starting procedure for registering this publication in scientific databases. The procedure has already been initiated.

The third International Conference on Road and Rail Infrastructure – CETRA 2014 - is organised in this year in order to bring together scientists and experts from the fields of road and railway engineering, and to present them with yet another opportunity to share results of their research, findings and innovations, analyze problems encountered in everyday engineering practice, and offer possible solutions for a more efficient planning, design, construction, and maintenance of various transport infrastructure facilities and projects.

CETRA 2014 covers many areas: traffic planning and modelling, infrastructure projects, infrastructure management, road pavements, rail track superstructure, construction and

maintenance, transport geotechnics, tunnels and bridges, structural monitoring and maintenance, computer techniques and simulations, noise and vibration, innovation and new technology, urban transport, integrated timetables on railways, rail traffic management systems, vehicle dynamics, traffic safety, and bicycle traffic.
CETRA 2014 attracted a large number of papers and presentations from 35 countries and 47 universities. More than 146 papers were presented at the conference and are grouped together in these proceedings entitled Road and Rail Infrastructure III. The papers are conveniently divided into twelve chapters: Rail Infrastructure Projects Design, Construction, Maintenance and Management, Road Infrastructure Projects Construction, Maintenance and Management, Road Traffic Planning and Modelling, Road Pavements, Rail Vehicle-Track Interaction, Structural Monitoring and Maintenance, Transport Geotechnics, Integrated Timetables on Railways, Traffic Safety, Environmental Protection, Urban Transport and Passenger services: baggage storage and boarding.
The organizers of the conference wish to express their thanks to all businesses and institutions that provided their valuable support to this Conference. Special thanks are extended to the University of Zagreb, Croatian Railways – HŽ Infrastruktura, and Ministry of Maritime Affairs, Transport and Infrastructure, for their assistance in organizing the workshop on Implementation of European Rail Traffic Management System (ERTMS) in South and East Europe.
The Editor commends all authors for excellent papers contributed to these proceedings, and wishes to thank members of the International Academic Scientific Committee, and numerous experts who participated in the review process. The gratitude is also extended to all participants for deciding to come to Split and take part in CETRA 2014. We believe that these CETRA 2014 proceedings entitled Road and Rail Infrastructure III will be, just like the preceding two proceedings from the CETRA cycle, highly interesting and useful to all experts exhibiting a scientific and professional interest in road and rail infrastructure.

THE EDITOR
Prof. Stjepan Lakušić
April, 2014.

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CONTENTS

KEYNOTE LECTURES

1 RAIL INFRASTRUCTURE PROJECTS DESIGN, CONSTRUCTION, MAINTENANCE AND MANAGEMENT

2 ROAD INFRASTRUCTURE PROJECTS CONSTRUCTION, MAINTENANCE AND MANAGEMENT

5 RAIL VEHICLE-TRACK INTERACTION

6 STRUCTURAL MONITORING AND MAINTENANCE

7 TRANSPORT GEOTECHNICS

PUBTRANS4ALL – ACCESSIBLE BOARDING INTO OLDER COACHES

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Vienna University of Technology, Austria & Belgrade University, Serbia

Abstract

Regarding to EU regulations today's public transportation systems must be accessible for everyone without any restrictions. The relevant question is: How can trains be accessible for everyone? The huge variety of different vehicles and different platforms does not allow level boarding everywhere, only in so called "closed" systems. The paper gives an overview about the requirements for new boarding assistance systems and about the decision making process referring to a new developed lift system for UIC-coaches. This lift system is developed in the EU-founded project PubTrans4All.

Keywords: trains, older coaches, boarding assistance system

1 Introduction

The result of the previous work in the PubTrans4All-project, founded by the EU, led to the decision that the most important step towards an accessible rail system at the moment is the development of a boarding assistance system (BAS) for existing UIC wagons. These cars are still in use in large number all over Europe. Due to design limitations it is not possible to retrofit these types of vehicles in order to use existing BAS. So at the moment only platform based BAS can be used for wheel chair users. For all other types of vehicles some kind of BAS exists (lifts for high speed trains, ramps for low floor trains). The aim of further research in this project was to develop a BAS that can be used for installation in UIC wagons.
The layout of older UIC coaches and modern high speed trains that are designed for wheelchair users and other PRMs in general is similar. UIC coaches has small doors with a width of 800, while in modern trains the door width is increased to 900 mm. The difference is that there are already lift solutions for a door width of 900 mm but none for narrower doors. The UIC coach has doors located at the end of the coaches. Because of the folding or sliding steps as vicinity of the buffers as well as other constraints, there is no space under the steps for the installation of a BAS. Additionally, the space at the coach end is occupied by mechanisms of the head doors leading to the next coach, fire fighting equipment, some electrical components etc. Typical for these coaches is that the passageway is in majority cases at one side outside the longitudinal centre line of the vehicle because of the neighbouring toilet cabins adapted for people with handicaps and persons with reduced mobility. Finally, there are usually only two potential positions left which could be used for stowing the BAS.

2 General requirements for a new boarding assistance system

The general requirements provide an overview of all relevant parameters that must be considered when designing a new boarding assistance system. Table 1 presents the importance scores used in order to rank the evaluation criteria. Table 2 summarises the requirements. Features rated as not important, are not shown herein.

Table 1 Criteria importance scoring

Score	Meaning
1	Very important – critical to successful operation ("must have")
2	Important – high benefit for users and operators ("nice to have")
3	Less important – some benefit for users and operators, but not absolutely necessary

Table 2 BAS evaluation criteria – overview

User with devices	wheelchair, walking frame, baby prams	1-2
Physical impaired	Walking disabled, with crutch or sticks, elderly, diminutive people	2
User with special needs	Visual and hearing impaired	2-3
General passengers	Passengers with luggage, children, pregnant	2-3
Operation without staff	Operation by passengers themselves, automation	2
Operator		
Reliability of BAS	Prevention of Malfunction	1
Operational quality	Short dwell time, malfunctions must not influence train operations	1-2
Operational effort	Number of staff	1-2
Failure management	Problems easy to solve	1
Manufacturing/ Implementation		
Universalism	The system needs to be universal, retro-fitting allowed	1-2
Costs	Costs as low as possible	1
Manufacturing effort	The manufacturing effort needs to be low – especially when retro-fitting	1-2
Safety		
Safety risks	No safety risks to be tolerated	1
Safety features	Optical and audio signals	1-2
Maintenance		
Maintenance effort	Number of personnel required, special tool required	1
Costs		2
Sustainability	recyclability and energy consumption	3
Aesthetics		
Optical design	Aesthetics is important for customer acceptance	2-3
All regulations must be fulfilled (currently according to TSI-PRM) as a minimum standard. Some specifications in project PT4All have been set higher than required.		

3 Decision making process

At the beginning of the project the consortium consciously set the bar very high in order to get the best possible results. The primary defined goal of the project was to find a technical solution to provide accessibility to all passengers in all boarding situations. To get innovative and completely new ideas, a student competition was also initiated. The consortium believed that students don't have the detailed knowledge about railway vehicles and they are therefore more independent in their thoughts. Experts usually have a tunnel vision because they think too much about reasons why something cannot work.
After a long research and discussion process including the excellent ideas from the competition, the consortium concluded that many restrictions are necessary and the all-in-one

solution is not possible. At this point it must not be forgotten that the PubTrans4All project is a research project which also has the goal of demonstrating what is and is not possible.
In the first step, current and future plans of the different railway systems over the whole of Europe have been analyzed in order to identify the biggest gaps.
For all local systems (including busses, tramways, metros, urban and suburban railway traffic) a newly developed BAS is neither necessary nor meaningful. All these systems can be seen as so called "closed systems". Here the operators provide vehicles which correspond to the existing platform height; which means level boarding is provided. If level boarding is not yet provided, then operators plan to adapt the platforms and/or their vehicles. Local traffic operators in general don't want to use technical devices (BAS) because of operational time reasons. Level boarding is in general the best solution for travelers and for operators. It is the only situation which really offers accessibility to all passengers. Furthermore, the passenger flow in the station can be speeded up which means a shorter dwell time and therefore advantages for operators.
To offer level boarding it is necessary that the platform and the vehicle floor have a common height and the remaining horizontal gap between vehicle and platform is bridged. For that many technical solutions already exist. For all situations where level boarding is not possible, different approved technical solutions such as ramps or lifts already exist.
Compared to the local traffic systems; high speed, long distance and international railway traffic will not be able to offer level boarding for the following two reasons: The first reason is that because of static, high speed trains need a higher floor. The lowest floor height in high speed trains is offered in Talgo-trains (760 mm). All other vehicles have got higher floor height. The second reason is that in the TSI two different platform heights are defined as European standard (550 mm and 760 mm). That also means for the next decades all international trains will need to stop at both levels!
Furthermore, the investigation has also shown that actually within the next decades a huge number of high floor vehicles will run in European countries in long distance traffic. Due to the long life cycle of railway vehicles they can't be changed in a short or medium term. So the decision was to develop a BAS for all types of high floor vehicles. In general there are four possibilities – ramps or lifts, platform or vehicle based.
The operators' surveys clearly show that operators either plan to provide level boarding in the future or – everywhere they cannot – they strongly wish to have vehicle based systems. Two reasons can be identified for that wish: Firstly, operators want to be independent from the infrastructure and want to offer the possibility of accessible boarding everywhere. Secondly, it is very difficult to provide a platform based device at all (!) platforms in a railway network.
In order to provide accessibility to all passengers, ramps seem to be the only possibility because lifts cause a big bottle neck if every passenger trys to use one door. But here the big problem is that it was not possible to find a technical solution for installing a ramp system into existing vehicles. Furthermore, ramps must be very long if they will be used for high floor vehicles.
Because of the impossibility of finding any technical solution for ramps in existing high floor vehicles, the decision was to focus on lift systems for existing high floor vehicles. For the next steps of development two decisions have been necessary: Who the user will be and which vehicles are relevant.
The investigations show that for all types of high floor trains with an entrance door width of at least 90cm, different lift systems already exist. It is not meaningful to develop another system because passenger and operator surveys have shown that the existing systems work well enough. But there is one very big group of high floor railway vehicles in Europe, the so called UIC-wagons. This is a unique type of vehicle which will be running in many European countries for some decades more. In many countries the UIC-wagons form the backbone of the long distance railway traffic, especially in eastern European countries. But due to many construction limitations described in previous deliverables no technical solution has yet been

developed. Therefore, the consortium came to the decision that the most important step to offer accessibility to all is to focus on UIC-coaches!
A lift system under very limited frame condition means many restrictions and compromises. In regard to user requirements, wheelchair users are the only passengers for whom a technical solution is an absolute must. For many other groups it would be very nice to have some technical devices; but if there is no chance, than other solutions are acceptable. As other solutions, special services at the entrance door are recommended within this project. There already exist good examples in different European countries which can be advanced. At the end of the decision process, it came out that the most important case is to develop a vehicle based BAS for UIC-coaches. Since there are many restrictions because of the vehicle design, it has also for this situation been necessary to define some “compromise solutions” regarding the construction. All recommendations for a vehicle based BAS for UIC-coaches are shown in the next chapter “Detailed technical requirements for a BAS for UIC wagons”.

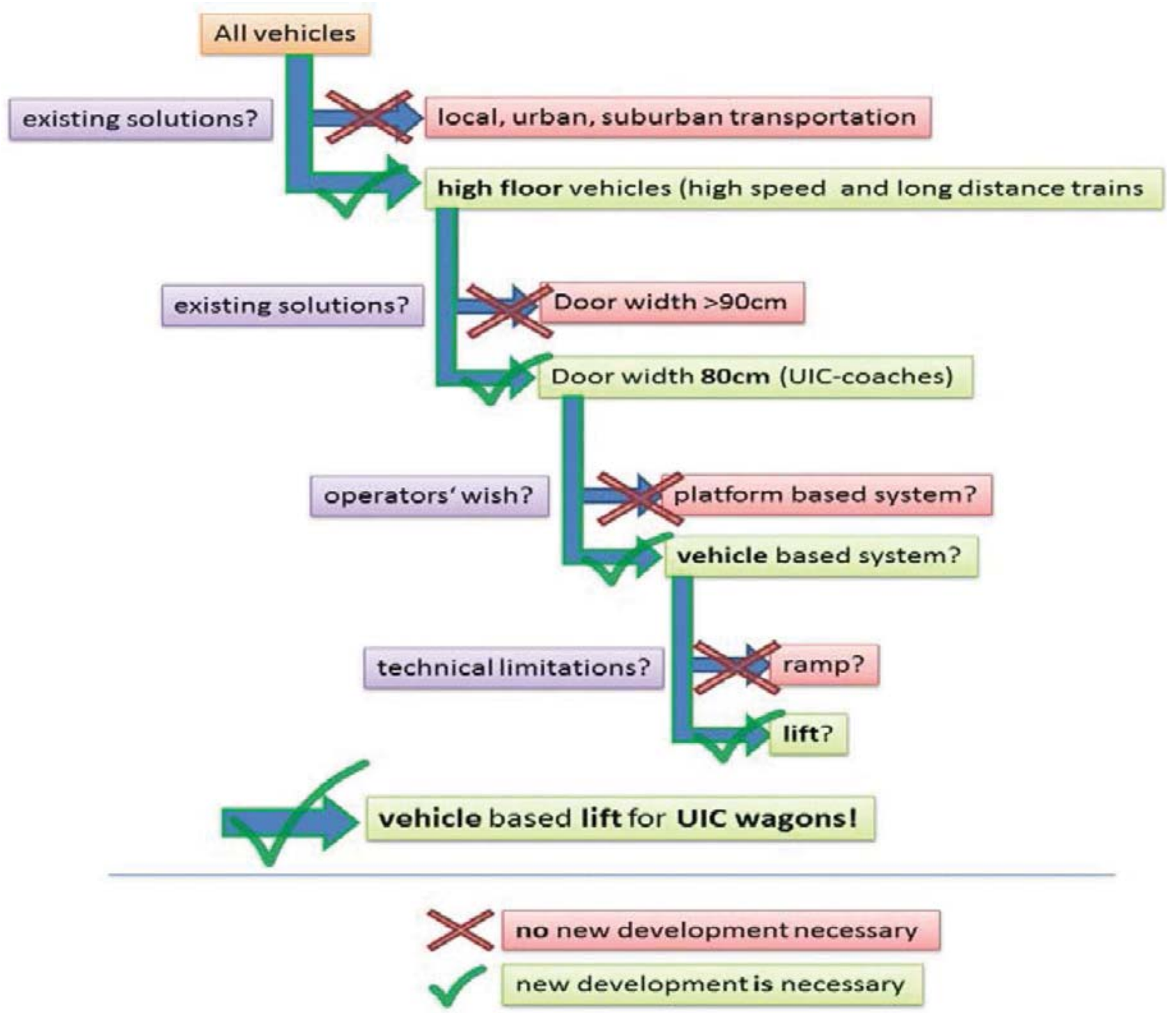

Figure 1 Decission making process

4 Technical requirements for a BAS for UIC wagons

As described in the chapter “decision making process” the consortium decided to focus on a BAS that can be implemented into UIC wagons, Table 3. Therefore, at this point all technical requirements that have been identified especially for the implementation into UIC wagons will be described in detail.

Table 3 Applicability of a BAS in different vehicles

Characteristic	Value	Comment
Carrying capacity	300 kg	Covers 99% of wheelchair users
Minimum clear width of lift platform	720 mm	Covers 96% of wheelchair users
Minimum platform length	1200 mm	
Maximum working height difference vehicle floor-platform	1300 mm	
Distance from the side of the coach when the lift platform is in lowered position:	as small as possible, but not less than 75 mm	The lowest foldable stair required to be lifted up before descending of the lift platform.
Boarding/alighting parallel to the vehicle	recommended	Alternatively, exit sideways through lay down of the side fenders (required for narrow platforms)
Handrail bound to the platform on one side, should be at the height of	650 to 1100 mm from platform level	
Integrated folding seat for categories of users other than wheelchair users	Recommended	
Finger pressure for activation of control buttons	≤ 5 N	
Manual force to operate the lift by staff	≤ 200 N	For example for emergency mechanical activation.
Manual force to operate the lift by staff at movement start	≤ 250 N	Allowed only for short period at the start. For example for emergency mechanical activation.
Vertical speed in the operation	≤ 0.15 m/s	Movement should be smooth
Operating speed variation: empty-maximum loaded	±10 %	
Speed of any point of BAS without load	≤ 0.2 m/s	Up to 0,6m/s is allowed by EN 1756-2. To meet TSI PRM, maximum speed without load no more than 0,3m/s is recommended.
Acceleration during operation with load in any direction and at any point of the lift platform	≤0.3 g	
Tilting speed of the lift platform	≤ 4o m/s	In case of automatic adaptation to the relative angle between vehicle and platform, for example at superelevated track by platforms in curves.
Automatic roll-off protection height	≥100 mm	The barrier in front and at rear side of the wheelchair lift platform should be automatically erected during lift operation.
Lateral side guards height:	≥25 mm min ≥50 mm preferred	Prevention of the wheelchair side roll-off from the lift platform
End of travel mechanical limitation devices	yes	
Prevention of any unauthorized operation in the absence of the operator	yes	Locking and unlocking by a key or a code or similar.
Overload protection of the main power electrical circuit		Fuse, an overload cut-out or similar
In stowed position BAS must be safe against uncontrolled displacements. Mechanical securing devices dimensioning according to the accelerations:	alongitudinal: 5 g alateral: 1.5 g avertical: 1 g	These accelerations can arise in the exceptional case of occasionally buffing impact at coach staying in yard (without passenger) (UIC 566)
Activation possible only at:	V = 0 km/h	

Table 3 Applicability of a BAS in different vehicles (continued)

Activation of the BAS should introduce activation of the coach brake system.	yes	Movement of the train during BAS usage must be prevented
Minimum safety coefficient against yield strength	2.1	
The lift platform surface should be smooth and must have slip-resistant surface	yes	Slip resistance according to EN ISO 14122-2.
Easy removal of ice and snow must be possible	yes	
Gaps or holes in the platform area shall not accept a probe greater than:	15 mm diameter	
Illumination of the lift working zone	yes	
The warning devices should be fitted at edges that can come in contact with persons or injure passengers or personal.	yes	light / reflective stripes / reflective markings, visible at night also
Visual and audible warning signals during the lift movement must be activated	yes	
The operation control should be of type hold-to-run.	yes	Lift shall stop moving and remain motionless after the control is released.
Movement no more than 100mm for any part of the lift platform after release of the control is tolerable to slow lift down	yes	Mechanical drives with self-braking capability or with independent direct acting brakes, or hydraulic systems with normally closed valves etc. should be used.
Controls shall be designed to avoid unintentional lift actions.	yes	Recessed or covered buttons, two hand controls, etc.
One control position is recommended	yes	Conflicts of commands must be avoided
In any case of breakdown, it is acceptable that platform may decrease with controlled speed:	≤ 0,165 m / s	For example in hose or pipe failure by hydraulic systems or similar.
Safety devices shall preferably operate through active positive action.	yes	
A stop in overload protection should be present at overload more than	25%	
An emergency stop button within reach of the user should be present	yes	Release of the emergency stop button should only be possible by the personnel
Additional protecting measures such as obstacle detector, foot entrapment protection etc.	recommended	Although control of hold-to-run principle is used additional measures are recommended
During lift platform closing the risks of crushing or shearing of the arms or head must be avoided.	yes	Limitation of the closing force, security cut-off, etc.
Other technical details not covered in this table preferably should be based on:	TSI PRM, EN 1756-2, RVAR	

5 Outlook – Conclusions

Providing accessible rail transport to all passengers is nowadays a must. This is because of different national and European regulations but also because of ethical questions. That means every person must be able to use a public means of transportation. In light of this, the entrance to railway vehicles and the whole boarding process is a big challenge and causes huge difficulties.

In order to be able to provide accessible boarding to all passengers, the consortium tried to define the biggest gaps that must be closed. For mid and long term thinking the results can be summarized as follows: Because level boarding is in the process of being or will be offered soon for all types of local, urban and suburban traffic; no systems are required. At this point, only horizontal gaps need to be bridged. Therefore, enough technical solutions already exist. In the rare case that level boarding is not possible, existing technical solutions can be used. For all high floor vehicles with an entrance door width of at least 90cm, enough technical solutions such as different lifts exist. A new development is neither meaningful nor necessary. The intensive investigations of the consortium led to the result that for the huge number of UIC-wagons which are running and will be running within the next decades all over Europe no vehicle based BAS yet exists. There are too many design limitations.
Due to the fact that UIC-wagons will still form the backbone in many European railway networks within the next decades; it is absolutely necessary to develop a BAS for this operation.
Due to the different limitations resulting from the vehicle construction, it is also necessary to make several compromises. But the developed compromise allows about 99% of all actual wheel chair users to board a UIC-coach. In combination with a good personnel service at the entrance, which is also recommended in this project, the UIC wagons can also become accessible for nearly all passengers.

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