Application of unmanned aerial vehicles on railway infrastructure

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Danijela Juric Kacunic & Marijan Car
Faculty of Civil Engineering, University of Zagreb
Railways in Croatia: past, present & future

• Since the first line opened in Croatia (1860), railways are considered as important way of transportation of people and goods.

• However, due to different historical circumstances which occurred in Croatia, level of importance has been significantly changing. First railway line was constructed in north Croatia in 1860. It was 41 km long and it connected Nagykanizsa in Hungary with Pragersko in Slovenia.

• By that time, in other parts of Austro-Hungarian Empire, thousands kilometers of railway tracks were in operation.

• However, ‘a real birth’ of Croatian railway occurred in 1862 when a railway line through Zagreb opened (line Zidani Most – Zagreb – Sisak).
Railways in Croatia: past, present & future

- From then, a railway network expanded mostly until WWII. After WWII, only cca 200 km of new railway line was constructed but most of existing lines were electrified.

- After the war in 1990’s, big part of network was damaged (damage estimation cost was cca 1.2 billion of USD).
Today, there are 2,976 km of rail lines in Croatia and 215,400 km of rail lines in the EU.
Railways in Croatia: past, present & future

• However, Croatian railways have been neglected for more than 30 years - no investments, no strategy, and with long-standing voluntary approach, the economic crisis has only worsened the situation.

• According to document ‘Strategy of transportation development of Croatia’ (1999), 5 percent of GDP was planned to be implemented for transport development.

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>ROADS</td>
<td>40 %</td>
<td>85 %</td>
</tr>
<tr>
<td>RAILWAYS</td>
<td>25 %</td>
<td>10 %</td>
</tr>
<tr>
<td>OTHER</td>
<td>35 %</td>
<td>5 %</td>
</tr>
</tbody>
</table>
Railways in Croatia: past, present & future

During the last 20 years, and especially after 1999, a large road and motorway network was constructed in Croatia. As consequence, Croatia today has modern, safe and functional network with cca 6900 km of state roads and cca 1300 km of motorways.
CONSEQUENCES OF NEGLECTING RAILWAY NETWORK:

• Today, infrastructure is old, the average speed is 40-60 km/h, on some sections barely 20 km/h. On many lines, safety and functionality aspects don’t meet criteria!

• But thanks to European funds and new projects, the situation should drastically change in the next few years.

• By the 2020, 6 billion EUR will be invested for the modernization of railway network, resulting in speeds up to 160 km/h. Such renewed railway network of corridors Vb and X will be integral part of European transport network.
Railways in Croatia: past, present & future

**New railway lines**

**Upgrade and reconstruction**

<table>
<thead>
<tr>
<th>Description</th>
<th>Nr.</th>
<th>Value [€]</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMPLETED PROJECTS</td>
<td>2</td>
<td>71,6 mil. €</td>
</tr>
<tr>
<td>WORKS IN PROGRESS</td>
<td>1</td>
<td>35,8 mil. €</td>
</tr>
<tr>
<td>COMPETITIVE BIDS FOR WORKS IN PROGRESS</td>
<td>2</td>
<td>230,5 mil. €</td>
</tr>
<tr>
<td>DESIGN IN PROGRESS</td>
<td>9</td>
<td>2263,55 mil. €</td>
</tr>
<tr>
<td>COMPETITIVE BIDS FOR DESIGN IN PROGRESS</td>
<td>2</td>
<td>555,0 mil. €</td>
</tr>
<tr>
<td>COMPETITIVE BIDS FOR DESIGN IN PREPARATION</td>
<td>2</td>
<td>975,0 mil. €</td>
</tr>
</tbody>
</table>
Railways in Croatia: past, present & future

• Both construction of new and remediation of existing railway network have already begun with significant number of projects ongoing or planned.

• Faculty of Civil Engineering University in Zagreb is actively involved in all phases of construction of new and remediation of existing critical infrastructure:
  I. investigation works
  II. design
  III. quality control
  IV. review
  V. consultancy
Drones (UAVs)

- Drones are a relatively new technology that has resulted from improved global positioning systems (GPS), better software, smaller computers, sensors and advance in material.
- In recent times, for the purpose of photogrammetric recording and mapping, using of UAV’s (Unmanned Aerial Vehicle) is becoming more affordable, accurate and safer.

Different types of drones which can be monitored remotely or fly autonomously using a pre-programmed flight plan.
Different types of sensors that can be used with drones:

- Thermographic camera
- LiDAR laser scanner
- Gas detector
- Multispectral camera
Helping railways: new assessment methodology

- 'standard' means of visual examination is walking along the railway and noticing irregularities
- in the case of high or steep slope embankments, important information can easily be overlooked

Typical problem of embankment instability - image recorded with UAV, as a part of the repair project on railway track in Croatia

DESTination RAIL
Decision Support Tool for Rail Infrastructure
EU Project No. 636285
Helping railways: new assessment methodology

• increasing failure of critical sections on rail infrastructure
• response: fixed when they occur
• location becomes hotspot on the network

• need for the planned condition assessment of potential excessive deformation and stability
• develop a long-term strategy for railway maintenance works
• identify hotspots on the network before an asset failure
• take preventative measures on time
Helping railways: new assessment methodology

<table>
<thead>
<tr>
<th>Instrument / measurement technique</th>
<th>Observed physical parameter</th>
<th>Usage</th>
<th>Disadvantage</th>
<th>Speed</th>
</tr>
</thead>
<tbody>
<tr>
<td>UAV / drone</td>
<td>Topography</td>
<td>Collection of 3D coordinates – geometry and detection of settlements, soil movements, ...</td>
<td>Cannot detect anomalies and potential failures located in in embankment and subsoil (subgrade) composition</td>
<td>Depends on capacity of batteries and distance from operator. Up to 20 km/h</td>
</tr>
</tbody>
</table>
Collection of data using unmanned aerial vehicle

- railway embankments are linear structures which can be long dozens and even hundreds of kilometers
- potential problem of the performance and quality of the visual inspection
- standard visual inspection consists of personnel walking along the track which is being assessed
- in some cases the track is located on high and/or steep embankments so very important information can be missed
- to achieve high quality visual assessment of the condition of existing railways the use of unmanned aerial vehicle (UAV), known also as drones is being investigated
Collection of data using unmanned aerial vehicles
Interactive procedure of visual assessment using UAV
Collection of data using unmanned aerial vehicle

Flight plan:
Collection of data using unmanned aerial vehicle

Generating point cloud:
Collection of data using unmanned aerial vehicle

Generating point cloud:
Collection of data using unmanned aerial vehicle

Video animation:
Collection of data using unmanned aerial vehicle

Generating cross sections, areas and volumes:
Collection of data using unmanned aerial vehicle

Export of geometry to any CAD or design software:
Collection of data using unmanned aerial vehicle

Generating hi resolution 2D orthophoto map:

- resolution [cm/pixel] : 1.5
Collection of data using unmanned aerial vehicle

Advantages:
• ability to customize to user needs
• in case of loss of the aircraft, the pilot life is not in danger
• provides research and recording inaccessible areas

Disadvantages:
• high costs in the case of crash or damage
• inability to measure in all weather conditions
• legislation
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Thank you for attention!
Questions?
Discussion?

Danijela Juric Kacunic
University of Zagreb
djk@grad.hr

Marijan Car
University of Zagreb
mcar@grad.hr