BRIDGE SMS
Bridge Scour Management System

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Project partners:

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1. Background to the project idea

2011-2013: Irish Rail - Bridge Scour Management Programme
- Development of methodology for bridge scour inspection for Irish Rail
- Bridge Scour Inspections for various bridges
- Design of scour protection measures

2009-2014: Croatian Railways - Bridge scour inspections and scour protection
- Collapse of bridge on Sava River in 2009
- Detailed inspections and recommendations

2009-2012: Irish Rail - Malahide Viaduct Reinstatement
- Investigation of a root cause of bridge collapse
- Hydrology, Hydraulic, Morphology, Environment
- Physical + Mathematical model
Causes of bridge failure

• Experiences from USA (Biezma 2007)
  o A 83% of all bridge collapses are due to the natural causes
  o The bridge scour (flooding) was the cause at 58% of bridge failures out of all natural causes.
2. Project details

• “Intelligent Bridge Assessment Maintenance and Management System” (BRIDGE SMS) is an EU Marie Curie FP7 project, under the Industry Academia Partnerships and Pathways (IAPP).

• Budget: € 1.418.821

• Project partners:

![UCC](#) ![Cork County Council](#) ![arctis](#) ![Infraestruturas de Portugal](#)

• Supporting institutions:

![Dublin City Council](#) ![South Dublin County Council](#) ![Department of Transport, Tourism and Sport](#) ![Universidade de Minho](#)
# Work packages and tasks

<table>
<thead>
<tr>
<th>WP 1 Project Mng</th>
<th>Website, Coordination, Quality Assurance, Reporting</th>
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</table>
| WP 2 Technical Research | T.2.1 Identification of input bridge and scour data sets.  
                      | T.2.2 Development of methodologies and tools for Bridge Scour Management System.  
                      | T.2.3 Development of requirements for Decision Support System. |
| WP 3 Development of Bridge Scour Management System | T.3.1 Development of Inventory Module.  
                      | T.3.2 Development of Scour Inspections Module.  
                      | T.3.3 Development of Maintenance and Repair Module.  
                      | T.3.4 Development of Monitoring and Predictions Module.  
                      | T.3.5 Development of Decision Support Module. |
| WP 4 Knowledge Transfer and Training | T.4.1 Appointment of Transfer of Knowledge Director.  
                      | T.4.2 Training Seminar organised by seconded staff in host organisations.  
                      | T.4.3 On-going training activities and debriefing.  
                      | T.4.4 Organization of internal workshops at key dates.  
                      | T.4.5 Develop sample pilot as a means to educate and train staff-simulator training. |
Research and industry collaboration

**END-USER - Bridge owner and operator**
- Expertise in day to day management of bridge structures over water
- End User perspective
- Test-bed for new system development

**ACADEMIC EXPERTS**
- River hydrology & hydraulics
- River & bridge modelling
- Scour protection design & installation
- Risk modelling and quantification
- Foundation and Structural Engineering

**SOFTWARE DEVELOPERS**
- Software platform experts
- New software system integration
- Open Source experts

**Intelligent Bridge Management System**
**BRIDGE SMS**
Existing procedures (standards) for bridge scour inspection and evaluation

- Bekić D., et al.: „Experiences from Bridge Scour Inspections by Using Two Assessment Methods on 100 Railway Bridges“, CETRA 2012, Dubrovnik.
Bridge Scour Evaluation in Standards

- Key elements for scour safer bridges
  - Input data → Bridge Inspection
  - Collection and storage of structured data
- Scour Risk Assessment
  - Some standards → Not enough input data
  - Requirements for too many input data (increase in time and costs)
3. An overview of new concept

- File manager
- Bridge database
- Integration with existing systems
- Integrated GIS
- Inspection management
- Environmental monitoring
- Structural health monitoring
- Mobile apps
- Decision support tool
- Repair and maintenance
- Financial planning
- Reporting
A. New Standardised Inspection and Evaluation of bridge scour

- Inspections include
  - Structural
  - Scour

- Two different Condition Rating
  - Structural, StCR:0 to StCR:5
  - Scour, ScCR:0 to ScCR:5

- StCR = CR from PI
  - if PI in the last 5 years

- ScCR, new inspections required
B. New Mobile App for bridge inspection

- Structural Inspection and Assessment.
- Scour Inspection and Assessment.
- Condition rating.
- Maintenance costs.
- Time to next inspection.
- Photo documentation.
- Inspection Report.
C. Flood and Scour Early Warning System

- A flood and scour forecasting system.
- Magnitudes and locations of floods up to 10-days in advance.
- Operational and fully automated forecasting system for bridges in the Bandon River catchment.
- Delft-FEWS platform on 94 sub-catchments.

Meelon bridge  Baxters bridge  Ahakeera bridge
D. New real-time monitoring system

- Weather monitoring WILD device (rain, temperature, soil moisture).
- Water level monitoring BIRD device.
  - Atmel microcontrollers
  - Telemetry
  - SD card module
  - RTC module
  - IP67 certified casing
E. Database and software platform

• The platform modules: bridge inventory, bridge inspection module, bridge maintenance, weather monitoring, flood forecasting and decision support modules.

• The platform can be easily integrated with other systems.

• Web-based access, GIS and BIM support (today at 15:00hrs)
Effective solution for safer bridges

A. Guidelines for Bridge Inspection.
   - A new bridge scour inspection procedure
   - Structural + scour evaluation, maintenance costs, etc.

B. Tablet APP for on-site inspection.
   - All components for Level 1 Structural/Scour Inspection
   - Automated calculation of condition rating and time for next inspection
   - Collects photos, voice notes, cost of maintenance works (structural/scour)
Effective solution for safer bridges

C. Weather monitoring and flood forecasting.
   - Low-cost solution for weather and bridge monitoring
   - Effective flood and scour forecasting (preparatory activities, preventative maintenance, etc)

D. Decision-support tools.
   - Web-based on-line system with GIS support (includes info on inspection, weather, flood forecasts)
   - Short-term and long-term activities
   - On-going and planned works
   - Issue alerts on severe weather condition and locations
4. Road and bridge asset in Cork County

- Cork County Council:
  - 12,419km (7,718 miles) of roads
  - ~12% of the roads in the country
- Cork - National Roads: 525km
- Cork - Regional & Local Roads: 11,894 km
  - Regional Road: 1,381 km
  - Local Road: 10,513km
- There are approximately 3,000 road bridge structures in County Cork
Bridge Programme 2014 - 2016

- Funding application to DoT
- 470 no. PI Reports completed (Regional & Local Roads)
- 943 no. PI Reports completed (Local Roads)
- 20 no. Bridge Repair/Replacements
- 49 no. Bridge Repairs/Replacement (including Emergency Works)
- 35 no. Bridge Repair/Replacements
## Bridge Condition Rating of 1413 Principal Inspections

<table>
<thead>
<tr>
<th>Condition Rating</th>
<th>Definition</th>
<th>Number of Structures</th>
<th>(Total = 1413 surveyed)</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>No or insignificant damage</td>
<td>45</td>
<td>3%</td>
</tr>
<tr>
<td>1</td>
<td>Minor damage, but no need of repair</td>
<td>198</td>
<td>14%</td>
</tr>
<tr>
<td>2</td>
<td>Some damage, repair needed</td>
<td>770</td>
<td>55%</td>
</tr>
<tr>
<td>3</td>
<td>Significant damage</td>
<td>285</td>
<td>20%</td>
</tr>
<tr>
<td>4</td>
<td>Damage is critical</td>
<td>83</td>
<td>6%</td>
</tr>
<tr>
<td>5</td>
<td>Ultimate damage</td>
<td>32</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>1413</strong></td>
<td></td>
</tr>
</tbody>
</table>
Bridge repairs/replacements
5. CCC activities in the BRIDGE SMS project

- A life-time of engineering design and construction experience brought to the Research Team.
- Access to our Data Base of Principal Inspections for over 1,400 bridges.
- Access to the Councils Consulting Engineers and Contractors with expertise in bridge works – knowledge transfer between Industry Partners.
- Sharing our experience of delivering repair projects on the ground, including:
  - Dealing with stakeholders & land owners
  - Dealing with statutory undertakers
- Offered advice / experience on Safety and Health issues to the Research Team.
Testing of New Guidelines for Bridge Scour Inspection

• Training and field testing for Council Engineers
Installation of WILD

- Off the shelf components:
  - IP67 and IP58 cases
  - Sensors (TBRG rainfall, Resistive soil moisture sensor, Air temperature and humidity)
  - Modem - 3G module and SD card
  - Real Time Clock
- Customised components:
  - Circuit board
Installation of BIRD
Knowledge increase by the Council Engineering Team

• Knowledge Sharing by the Research Team with Council Engineers.

• Learning the important role that Scour plays in the deterioration of bridges.

• BRIDGE SMS project has assisted the Council Engineers in identifying bridges that are susceptible to scour and subsequent damage.

• Engineers have learnt to be proactive rather than reactive in relation to extreme weather events in checking for scour.

• Bridge Asset Management Tool being developed for benefit of Council.

• Important that the end user (i.e. Council Engineers) are part of the BRIDGE SMS Development Team.
Workshop in Cork on the Bandon Flood Early Warning System

• Attended:
  – Cork County authorities
  – EPA
  – OPW
  – Department of Transport
  – Consulting Engineers
Collaboration with Department of Transport

• BRIDGE SMS project was explained to DOT Personnel and to the experts working on Bridge Asset Management Project (BAMP).

• DOT is keenly interested in developing Systems for all aspects of Bridge monitoring.
  o Including development of “Guidelines for Structural and Scour Inspection of Bridges“ and associated software.
  o And developing methods of categorising condition of bridges (condition rating). This includes Condition Rating for Structure, Weather monitoring, Scour Monitoring, Decision Support System
  o GIS based data of numbers and location of all bridges on all road types.

• Collaboration with DOT is currently ongoing.
6. Summary

- **Knowledge sharing**
  - Council Engineers have learned significantly from exposure and interaction with researchers.
  - Participation has opened up the minds of Council Engineers to new ways and methods of carrying out their work.
  - It has demonstrated the importance of being adaptable to change.
  - It has demonstrated the important role that research has played in developing Asset Management Systems for bridges.
6. Summary

• BRIDGE SMS solution
  o Importance that scour plays in the bridge safety.
  o BRIDGE SMS will assist Council Engineers in focussing limited resources on the bridges that require immediate attention at any given time (including after weather event).
  o Council Engineers are looking forward to implementing better systems for managing the Council's 3,000 + bridges.
  o In Summary Council's participation in BRIDGE SMS project has been both exciting and very rewarding.
THANK YOU FOR YOUR ATTENTION!

www.bridgesms.eu