The DESTinationRAIL project team convened at NTNU in Trondheim on 18/19 May to review progress in the project which is now entering it’s final year. These 2 days provided an opportunity for the Work Package groups to meet and to discuss the final phase of the project. The opportunity was also taken to organise meetings of the Executive Board and the Exploitation Sub Committee to review progress against the project deliverables, to give guidance to the Work Packages and to assess future exploitation opportunities.

The Executive Board confirmed 2 actions:

• A Decision Support Tool (DST) half day workshop will be organised in Ljubljana on 30th November which will provide an opportunity for Infrastructure Managers to see the DST being demonstrated and to ask questions. The venue for the workshop will be the Slovenian National Building and Civil Engineering Institute (ZAG). Further details concerning this event will be published on the DESTinationRAIL website www.destinationrail.

• The venue for the DESTinationRAIL final conference, to be held on 26/27 April 2018, will be Zagreb. The final conference will also provide the opportunity to launch a book covering the major achievements of the project, which is being supported by the University of Zagreb.

The following 2 articles illustrate the progress of the various work packages.
Review of Progress for WP1 (Find) and WP2 (Analysis)

Various work groups provided feedback on progress on topics ranging from the use of GPR for ballast condition monitoring and finding the location of hot spots (Photo 2), to the use of drones to provide remote monitoring of networks in particular earthworks. The work package is currently preparing a report entitled “Guidelines on methods to find hot spots on rail networks”. This report will be published on the DESTinationRAIL website [www.destinationrail.eu](http://www.destinationrail.eu).

The team presented the work which has been carried out on the use of sensors to measure track performance. A key part of this work has been on understanding how the track and switches are performing but also in using “off the shelf” sensors which are much cheaper compared to the type usually specified by the infrastructure managers (Photo 3). A report on the Monitoring of Switches and Crossings is in the course of preparation and will be published on the DESTinationRAIL website.

Another team within the work package has completed analysing the data which was obtained from the Boyne railway bridge (Photo 4) and from laboratory research into bridge scour, an example of bridge scour is shown in Photo 5. The results of this research and other monitoring will form an input into a report entitled “Guidelines for Probability Based Multi Criteria Performance Optimisation of Railway Infrastructure” which will be published on the DestinationRAIL website.
Review of Progress of WP3 (Classify) and WP4 (Treat)

Work package 3 presented the risk assessment work along with the data on the condition of assets which is being obtained from Irish Rail. This information will be used within the Decision Support Model. The work on testing new materials is progressing and the report entitled “Guidelines on the use of novel construction techniques within the operational railway environment” is in the course of preparation and will be available on the DESTinationRAIL website. The major discussions were about WP4, Task 4.4 the development of the Decision Support Tool.

WP 4.4 Rail Network Whole Life Cost Model
A network level whole life cost model is the key output from Task 4.4 of the “Treat” Work Package (WP4). The model will provide key inputs to the Decision Support Tool on the whole life costs of alternative strategies. Specific innovations with regard to the development of the model are the ability to examine assets at the network level and also the additional costs to railway users (passengers and freight) of the disruption to operations resulting from maintenance (e.g. delays and carbon dioxide emissions).

Network level Maintenance Strategies
A whole life cost approach increases the effectiveness of decision making with regard to infrastructure maintenance strategies as a large proportion of the total costs over the lifetime of infrastructure assets is incurred after construction. The pressure on budgets available to infrastructure managers has continued to increase over the past years. The ability to examine the whole life costs of alternative maintenance strategies of not just individual asset types but to also take into account the interaction between the strategies for the different asset types has the potential to support effective decision making and deliver better overall value for money from the investment into the management of the assets. Figure 1 sets out an overview of the whole life costing process.
Railway networks contain many different types of infrastructure assets, including track, bridges, tunnels, earthworks, signalling systems, buildings etc. Even within a type of asset, characteristics are not uniform, e.g. networks include bridges constructed with different materials, with different ages, deterioration profiles, condition and traffic carried, etc. Consequently, the type and urgency of the maintenance required by an asset on the network can differ significantly at any given time. In addition, the choice of maintenance work carried out on one asset can not only affect the condition and future maintenance requirements of that asset but can also have an impact on other assets located within its zone of influence.

In general, in any year, due to limitations in the available resources and restrictions on the network, it may not be possible to carry out all of the required maintenance. It is therefore important to identify those maintenance works that will give the best value for money for the available budget.

**The Destination Rail Network Whole Life Costs Model (DR-NWLCM)**

The DR-NWLCM is being developed as part of the Decision Support Tool (DST) (Task 3.4). The model interfaces with different modules (e.g. the Information Management System, IMS) within the DST to import data related to the network selected for analysis (e.g. assets and associated properties, as well as analysis parameters such as treatment types, treatment thresholds, costs etc) and following the WLC analysis, exports WLC information on maintenance strategies to support the prioritisation of maintenance works at a network level. The DR-NWLCM model will be the first one to consider whole life costs rail infrastructure maintenance schemes:

- At the network level, taking account of the more than one type of asset;
- Link the analysis with a traffic flow model and evaluate the indirect costs of alternative operational options for traffic management during maintenance;
- Use probabilistic deterioration relationships to determine future costs.
Probabilistic Condition deterioration relationships have been defined in WP2 and these are used to determine deterioration on asset condition year on year. A traffic flow model has been developed as part of Task 4.3 to determine the change in journey times (minutes) and CO$_2$ emissions associated with maintenance schemes.

Figure 2 lists the properties and parameters underlying the network whole life cost analysis.

A condition state (1 to 4) for each asset is assigned in the WLC model from the condition data imported from the IMS. Maintenance needs of assets and the appropriate treatments are identified based on threshold condition state values. Figure 3 lists the properties and parameters underlying the whole life cost analysis. Alternative maintenance options (Do Something and Do Minimum) are identified, e.g. the Do minimum option may be to increase inspections and apply a speed restriction whereas the Do something option may be renewal. The model outputs whole life costs and the associated maintenance profiles for alternative strategies for assets over on the network to the DST. An overview of DR-NWLCM is given in Figure 3.

**Figure 3. Overview of DR - NWLCM**

Network level analysis can be used to determine the effects of combining maintenance schemes (of the same and of different assets) being considered as this can enable a reduction in the overall direct and indirect costs. For example, schemes can be considered for combination if they meet 3 criteria, i) they can be scheduled within the same financial year ii) they are separated by relatively short time intervals (e.g. within 2 years of each other) and iii) they are on the same section of the network between 2 nodes.
The rail network around Dublin, Ireland has been chosen as the case study network. A RailML file forms the basis of the network and is shown in Figure 4. The user can select any part of the network to carry out the analysis. WLC analyses are being developed for 4 asset types (Tracks, Slopes, Underbridges and Points & Crossings). Each asset type has been divided into sub-types related to their construction type to account for different characteristics, deterioration rates and treatment needs.

**Figure 4. Case study network**

A workshop will be held in Ljubljana to demonstrate the model on 30th November. Full details of the workshop will be available on the DESTinationRAIL website [www.destinationrail.eu](http://www.destinationrail.eu).

**Review of Progress WP5 Dissemination and Exploitation**

A number of presentations have been given at targeted events to update a variety of audiences ranging from researchers to politicians, from infrastructure managers to investors (Photos 5 and 6) These events have been held across Europe, from Stockholm to Arad. Face-to-face meetings with infrastructure managers have also been hosted at these events, e.g. IRFC in Prague (Photo 1).

**Photo 5. Presentation at the ISEP in Ljubljana**

**Photo 6. Stand at CEBIT in Hannover**
DESTination RAIL Ph.D. Students

As part of the DESTination RAIL proposal, the project committed to support a number of Ph.D. students in order to develop research capabilities. With this in mind a number of students have prepared articles describing how they are working with the project to try to encourage more students to join this area of research. This is the fourth article and features Andraz Gersak who is studying at The Faculty of Civil and Geodetic Engineering of the Slovenian National, Building and Civil Engineering Institute in Ljubljana. Andreas is working on Tasks 1.4. and 2.3 in the project.

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Research Description:

Employed at the Slovenian National Building and Civil Engineering Institute (ZAG) at the Department of Geotechnics and Infrastructure/Section for Geotechnics, I am also a Ph.D. student at the Faculty of Civil and Geodetic Engineering, University of Ljubljana, under the Built Environment study programme. My main area of research is the influence of the geotechnical properties and geometry of discontinuities on the stability of geotechnical structures build on Karstic limestone, under the supervision of assistant professor Karmen Fifer Bizjak who is also actively involved with the DESTination RAIL project.

According to the “FACT” principle, on which the DESTination RAIL project is based, my research is linked to WP1, where one of the tasks is to identify the risk of potential slope failure before it occurs. By closely analysing the geometry of the failure plain and geotechnical characteristics of the embankment wall, the stability of potential unstable rock blocks, or shear strength of critical discontinuities can be assessed. One of the standard parameters for determination of the geometry of discontinuities is Barton’s Joint Roughness Coefficient (JRC), which is based on an empirical 2D assessment. In the laboratory at ZAG we are using an ATOS (Advanced Topometric Optical Sensor) scanner for capturing full 3D geometry of the area of rock discontinuities samples that are gathered in the field or produced in the laboratory itself. With detailed 3D scans of the surface we can determine geometrical parameters developed by different authors including Barton’s JRC.

To obtain correlation between discontinuity geometry and shear strength, shear strength tests must be produced. Shear strength of samples is tested in a direct shear apparatus, that is standard size (Robertson) or large scale (up to 60x60cm).
Producing replicas with similar mechanical properties than the natural sample, will allow us to recreate tests with different stress conditions on samples with sufficient similarity.

With the help of methods described above, a relation between peak shear strength and the roughness of joint surface can be determined. Over the last decade, various algorithms have been developed for the determination of shear strength of discontinuities by various authors. By using different methods to calculate shear strength of discontinuities, different results are produced that also deviate from data received with direct shear apparatus in the laboratory (Figure 5). The described problem demonstrated the need to develop a new algorithm for determination of peak shear strength of discontinuities.

Figure 5. Diagram of measured and calculated shear strength of rock joint with different algorithms on 12 samples.

By determining the correlation between the discontinuity surface and shear strength, an assessment of the slopes in the area of influence of the railway structures is possible that provides input to WP 2: Analyse; specifically Task 2.3: Assessment of Earthworks. Additionally, this provides input to as WP 3: Classify, to develop a risk assessment methodology for potential unstable slopes. Since the areas with potential failure plain are generally difficult to access by foot, there is need for a different approach to access and scan the part of the investigated slope. A research collaboration with the University of Zagreb (UZ) was developed in relation to this topic since UZ are researching the use of Unmanned Areal Systems that are equipped with different types of sensors, like GPS (Global Positioning System) and LiDAR (Light Detection and Ranging), which can produce quality point cloud data of the slope. These can be used as data inputs for ATOS. Being involved in the DESTination RAIL project gives me a great opportunity to work and develop new ideas with other experts involved on the project, as well as learning about various problems faced by European railway infrastructure managers / owners.
How to Follow DESTination RAIL Progress

There are a number of ways to follow the progress of the DESTination RAIL project:

• By searching our website (www.destinationrail.eu) where you will find copies of all our newsletters, presentations given at conferences along with copies of all the reports and guidelines produced by the team.

• Why not join our linked in group www.linkedin.com/groups/8428750 where you can participate in discussions on the project?

• You can contact us directly via either the Project Co-ordination Prof. Ken Gavin kgavin@gdgeo.com or the Project Administrative Manager Mrs Carla Soriano cmarina@gdgeo.com or by telephoning the Project Office on 00 353 1207 1000.

• If you would like to receive our Newsletter directly then please email your name, company and position to Michael Robson maralnwick@yahoo.co.uk who will add your name to the distribution list.

• We make regular presentations at conferences across Europe which provide an opportunity to meet members of the team (Photos 5 & 6).

  We plan to give presentations at the following conferences over the next 6 months:

  ➢ Urban Rail Asset Management Conference, 12/13 September, Amsterdam.
  ➢ Railway Pro Investment Summit, 3/4 October, Bucharest.
  ➢ DESTination RAIL Decision Support Tool workshop, 30th November, Ljubljana.