Infrastructure diagnostics

In modern structural engineering, diagnostics and identification are fundamental tools for infrastructure life cycle management. The Diagnostics Department is responsible for in situ activities aimed at gathering and processing data to support the various disciplines. The surveys and investigations are carried out using proprietary technologies and algorithms, cutting-edge techniques and an interdisciplinary approach, ETS is the owner of ARCHITA, an innovative multidimensional mobile mapping system, with built-in survey instrumentation and position sensor, all installed on a single bimodal vehicle (road/rail). Multiple pieces of information (geometry, condition, structural conditions) are obtained in one step and integrated into a single environment for infrastructure maintenance, design and management and MIRET (Management Identification Risk for Existing Tunnels) a new method for diagnostic of existing tunnels through multi-dimensional mobile mapping systems, and a new approach for the Management and Identification of the Risk for Existing Tunnels supported by artificial intelligence. Data reliability, increased safety, and cost efficiency are just some of the benefits of the system. Innovation is instrumental, in terms of process and management, and enables the creation of a state-of-the-art IT environment for infrastructure maintenance, design and operation. AI-supported defect mapping and virtual tunnel inspection complete the range of new opportunities offered by the ETS approach to infrastructure diagnostics.

MIRET infrastructure digitalization

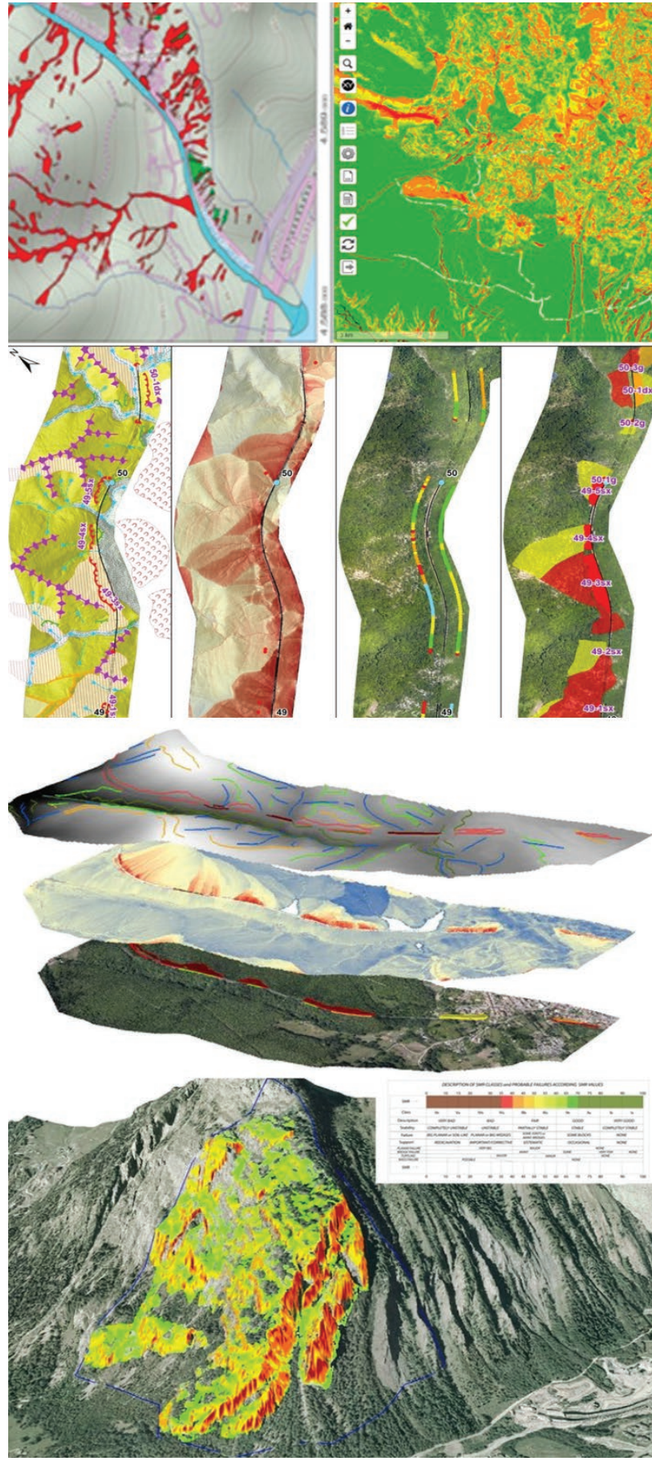
The knowledge, the preservation and the maintenance of heritage infrastructures is one of the most challenging matters facing modern civilization. It involves, in inextricable patterns, factors belonging to different fields (cultural, humanistic, social, technical, economical, ad-ministrative) coupled with the requirements of safety that can be in conflict with the integrity of part of the infrastructure. For these reasons, it is fundamental to carry out investigations and new planning strategies to know and predict the conditions of very old structures. ETS introduced MIRET (Management Identification Risk for Existing Tunnels) a new method for diagnostic of existing tunnels through multi-dimensional mobile mapping systems, and a new approach for the Management and Identification of the Risk for Existing Tunnels. The approach belongs to the digital strategies for infrastructure maintenance that are very fast and minimally invasive.

The integrated instrumentation allows to have almost all the information necessary for the diagnostics of a structure with non-destructive tests, preserving the integrity of very old structures in a phase of preliminary assessment. In such a way, the process of visual inspection is automatized and back-officed. The results, in terms of defects on the structures, are digitalized and manipulated in different IT environments. The results can be incorporated in the information modelling and virtual reality inspections. The use of artificial intelligence will be necessary to speed-up the back-office phase and introduce the technologies as a new inspection standard.

Assets and service solutions

The planning and the management of existing tunnels is already a central challenge for industrialized countries. Infrastructure inspection and diagnostic are a crucial task in providing reliable predictive maintenance at cost with time consuming and error-prone process if based on human operations only. Therefore, the diagnostic inspection process and the relevant analytical procedures are suitable to automation. ETS and its partners have carried out the diagnostic and the maintenance of existing infrastructure through an innovative instruments and services. **ARCHITA**: To complement the innovative multi-dimensional mapping of ARCHITA and its integration by non-destructive diagnosis techniques. ETS with her partner developed a two fold techno-logical solution: Tunnel Scan (an instrumental apparatus) and Tunnel Review (dedicate software). The mapping of the defects is carried out combining the high-resolution photos, taken by three high-definition cameras and the point cloud.

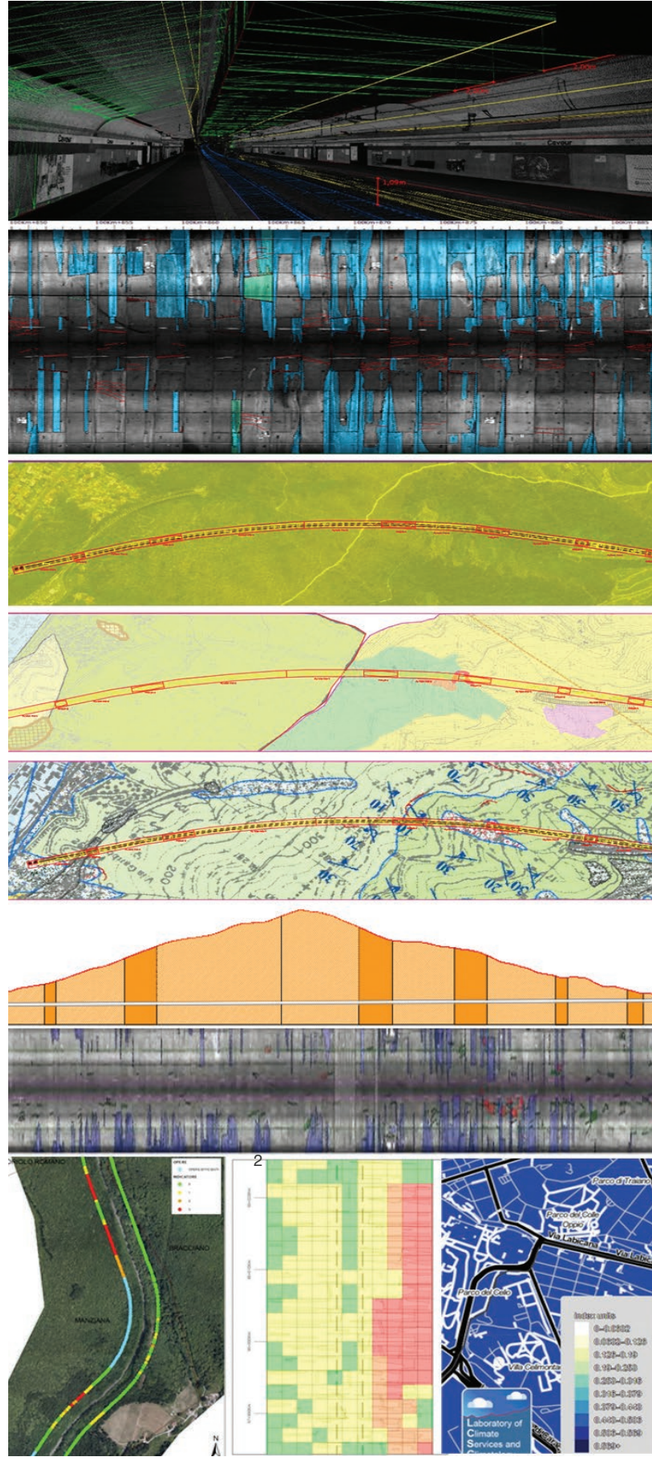
The combination of the two technologies made the images measurable, with the possibility of positioning, measuring and quantifying the defects identified on the tunnel lining **B-SHAPE**: ETS has also implemented and deployed a marine Unmanned Surface Vehicle (USV) for the bathymetric survey. The processed data are integrated with the topographic survey to obtain a 3D reconstruction of both the above-sea and undersea surface. The aforementioned data are used for the study, the characterization of the materials and the design of the solution to reinforce the existing structures and mitigate the erosion effect near the line. All data acquired, engineering and geology analisys are integrated into our innovative B-SHAPE software. **SLOPE and LANDSCAPE** ETS has been developing a methodology called MIRETS (Management and Identification of the Risk - ETS). The approach can be applied in a wide field of civil engineering works, where a common application is for slopes and landslides that interest infrastructures. **MIRET - MIRETS** approach the analysis of the elements focusing on an integrated workflow to connect survey-inspection data for geology, digitalization, diagnostics and design. This approach can be defined through the following milestones: Survey and Inspection (SI), Infrastructure/Slope Digitalization (DI), Priorities Analysis (PA), Planning and Design (PD), Works and Maintenance (WM), Monitoring (MO).



Diagnostic Slope Mapping

Catastrophic events like landslides and floods can cause significant social, economic and infrastructure damage. Damage can be avoided and made more manageable by a proper system of warning and planning of ordinary or extraordinary maintenance. The system must also work with respect for the environment and the historical and social value that infrastructure represents. To respond to these issues, ETS has tools, technologies and processes that can enable appropriate management and prioritization according to their potential manifestation. The infrastructure elements are digitized and the approach is based on logical and coordinated decisions in a digital and multidisciplinary environment for the management of risk scenarios, primarily for tunnels and hydro-geological instability.

Bibliographic analysis for reconstruction of the database of the events of the hazards and vulnerabilities from the bibliographic point of view. Airbone LIDAR survey: a LIDAR flight is taken along the railway line to obtain a high-resolution DTM and DSM of the area and detailed orthoimage. Mobile Mapping survey (ARCHITA): this multi-dimensional mobile mapping system is equipped with a laser scanner, thermal cameras, multi-channel GPR, high-resolution cameras and ground penetration Radar. In-Line Inspections: is the field geological survey along the line by specialized technician like geologist and engineer. Data processing and Priorities Analysis: data are georeferenced, they are processed in a GIS environment to extract all the input parameters needed for the SMCA analysis. Materials characterization: The characterization of the elements, such soil or rocks is a fundamental information which is integrated to perform advanced analyses. Data processing and stability evaluation to evaluate the stability index of each trench, both geomorphometric data and geological tests (on-site and lab tests) are generally used. Geomorphometric analyses: Thanks to the availability of a high-resolution DEM detailed geomorphometric analyses can be carried out, providing valuable data to evaluate the possible impact of landslides, both rock and earth fall, onto the railway. SMCA: Each input parameter is described by a georeferenced vector or raster layer, thus forming the geo-database needed to perform the Spatial Multi-Criteria Analysis.



MIRET - Process Workflow