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ABSTRACT

Recent and dramatic events occurred on the Italian transport networks have pointed out the urgent need for assessing the actual state of health along the national transport assets. Analogous considerations can be addressed towards the high exposition and vulnerability of the transport system to major natural events, such as floods or earthquake.

Recently, the administrations and managing companies have increasingly made use of nondestructive techniques for achieving a denser knowledge about the health of the asset. However, one of the major limitations concerning these methods is that each technology, according to its specific features, is usually suitable for a single specific application and has very limited for effectiveness other tasks. Accordingly, the integration of datasets collected with different NDTs stands as a viable approach to fill technologyspecific gaps, thereby ensuring a more comprehensive assessment of the infrastructure.

Data fusion logic can also potentially allow for further data interpretation from merging different information.

EXTRATN project aims at The overcoming the state-of-the-art research field of nondestructive in the monitoring of linear infrastructures and, through a "data fusion" logic, at achieving a comprehensive rate of knowledge about the actual condition of the asset. Specifically, interferometric synthetic aperture radar (DInSAR), Laser Imaging Detection and Ranging (LiDAR), Ground-penetrating Radar Weight (GPR) Falling and Deflectometer (FWD) are considered to the purpose.

This system includes a motorway, a rural highway and a railway.

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land transport structures. especially painful after extreme events. scheduling of the maintenance.

The major goal of the research is to greatly improve the extended concept of resilience of transport infrastructure. New hardware systems and development of numerical models are analysed for comprehensively sensing the linear infrastructures, with the aim of identifying local vulnerabilities in safety, strength and functionality conditions. Such a task will be tackled by providing innovative asset management strategies to the network administrators, suited to their needs and based on the simultaneous management of data collected by multi-method surveys.

The project has been divided into 5 working packages (WP), gathering and integrating the different competences of the participants.

CC DY

EXTRA-TN: A novel approach for an extended resilience analysis of transport networks

Engineering Department, Roma Tre University – ^(*) fabrizio.damico@uniroma3.it

BACKGROUND

Besides the unavoidable damaging suffered by the asset over its service life, ordinary transport elements are the most vulnerable to extreme weather events, while bridges and tunnels are among the most critical

Many of these lifelines have been in operation for more than half a century and there are widespread signs of deterioration.

They require inspection, vulnerability assessment and, when needed, appropriate interventions. However, inspection is usually expensive, time consuming, potentially dangerous and frequently traffic interrupting; structural/vulnerability assessment is a lengthy process which is

In such a framework, the complementary integration of various NDTs stands as a promising way to overtake such limitations by exploiting the advantages of each technology, while avoiding its drawbacks through the use of other techniques. As a major advantage with respect to the state-ofthe-art, such a methodology allows for analysing the evolution trend of the on-going distresses, meaning a significant upgrade of the monitoring activities that may provide valuable information for a priority-based

This integrated data management eventually leads to an extended concept of infrastructure resilience, spanning from the resistance to major external events to the ordinary surface maintenance.





METHODOLOGY

MAIN OBJECTIVES

WORK PACKAGES



A system of transport infrastructure within an area subjected to hydrogeological risk, has been selected as a study case for the integrated approach.



- Ground investigations

Fabrizio D'Amico (*), Chiara Ferrante, Luca Bianchini Ciampoli, Alessandro Calvi and Andrea Benedetto

CONCEPTS & PARTICIPANTS

CASE STUDY

• Aerial and terrestrial optical inspections

- Artificial Intelligence (AI) Data Fusion
- Highway (10 km)
- Railway (8 km)

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DESCRIPTION & AIMS

This project aims at evaluating the best methodological approach for achieving a comprehensive knowledge about the assets' conditions at the network-scale, with particular concern to its resilience to both exogenous and endogenous occurrences.

Specifically, the proposed methodology is based on a data-fusion platform capable of integrating dataset collected through space-borne, air-borne and ground-launched sensing devices.

The following objectives will be pursued:

I. definition of most effective earth surface monitoring methodologies to use as input for the risk analysis related to the occurrence of major natural events hitting the transport network;

II. definition of most effective space-, air- terrestrial- and ground-borne **models** for assessing the health of the asset, while keeping monitoring its attitude to be damaged in case of extreme events;

III.integration of the datasets through data fusion techniques, for a fullscale assessment of the complex resilience of the network;

IV.implementation of a preliminary-stage data integration platform for an easier technology transfer to final users (e.g. public administration, managing companies, ...)

EXPECTED RESULTS

The expected results, with particular mention to the significant advance ond the state-of-the-art, particularly in terms of monitoring practices:

the **risk exposition** of the transport networks is currently taken into account by referring to risk maps that rely on hydrogeological historical archives and theoretical applications, and is typically focused on the lifelines (tunnels, viaducts) safeguard. The proposed methodology allows at observing the up- and down-lift of the surface, which involves an updated and quasi-real-time monitoring of the geomorphological occurrences;

at the state of the art, only a sparse number of **models** evaluating the conditions of specific infrastructure's elements are available. The project, according to the competences of each Research Unit aims at selecting and perfecting the most reliable ones, in view of a final integration.

the **data fusion** is expected to allow a comprehensive full assessment of the actual condition of the transport network, which stands as a major break-through with respect to the knowledge acquirable through the current monitoring techniques;

the **implementation** of the integrated datasets onto a geo-referenced platform will provide a **preliminary technol**ogy transfer suited for administrating and managing companies aiming at effectively prioritising the funds allocated on maintenance, while maximising the overall resilience of the managed asset.