



## **New scenarios for transport infrastructures: transition to inclusivity, resilience and sustainability**

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### **Editorial**

New challenges and important changes are re-shaping the entire system of transport infrastructures and mobility all around the world. Climate change (Moretti & Loprencipe, 2018) and pandemic effects (Cheshmehzangi, 2021), in particular, have raised new and special needs in order to make the mobility system more oriented to decarbonisation, inclusivity, resilience and sustainability.

The opportunities proposed by scientific and technological advancements in the fields of materials (Hu et al., 2019), design (Tang et al., 2020; Cantisani et al., 2020), construction (Oad et al., 2021) and management (Sinha, 2017; Moretti et al., 2019) of transport infrastructures, allow to explore innovative solutions and contribute to ongoing transition processes.

From another perspective, the evolution of the demand for mobility towards more sustainable modes entails the need to rethink the performance objectives of existing transport infrastructures.

All these changes involve social and economical issues and they deserve the utmost attention by the whole community of researchers, policymakers, professionals and stakeholders.

In order to prefigure *New scenarios for transport infrastructures*, with special attention to their *inclusivity, resilience and sustainability* performances, this special issue collects some of the papers presented at the AIIT 3<sup>rd</sup> International Conference on Transport Infrastructure and Systems (TIS ROMA 2022), which was held in Rome on 15<sup>th</sup>-16<sup>th</sup> September 2022 (<https://tisroma.aiit.it/>).

TIS Roma 2022, organized by AIIT, the Italian Association for Traffic and Transport Engineering, and hosted by ACI, Automobile Club d'Italia, was aimed, indeed, at exploring and discussing new foreseeable conditions and constraints for transport systems

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and infrastructures to better address the future policies and strategies. The third edition of the AIIT International Conference provided a forum for discussion, interactions and exchange among researchers, scientists and engineers whose fields of interest concern transport and infrastructure engineering.

Two Keynote Speakers discussed their perspectives related to new scenarios for transport infrastructures and systems: Rik Nuyttens, President of European Union Road Federation (ERF) discussed the presentation titled: “*A fast road to a better future?*”, while Maria Attard, Professor in Transport Geography, head of Department of Geography and manager of the Institute for Climate Change and Sustainable Development at the University of Malta, spoke about: “*Active travel: achieving sustainability, resilience and inclusivity*”.

During the two days of the Conference, 140 papers were presented in 21 parallel sessions and 2 special sessions focused on innovations in last mile logistics.

All the papers were peer-reviewed before being approved for presentation at the conference.

Based on the results of the review process, 19 papers were selected to be included in two special issues of “European Transport \ Trasporti Europei”.

The present special issue focuses on “*New scenarios for transport infrastructures: transition to inclusivity, resilience and sustainability*”. It is composed by 10 papers that cover various topics and issues related to transport infrastructures: materials and technologies for road and pavement construction and maintenance; infrastructure design and digital modelling tools; sensors, systems and methodologies for traffic and accident data collection and analysis; road accidents prediction models; driving simulation for exploring the user behaviour.

More in detail, Elena Gaudenzi, Francesco Canestrari, Xiaohu Lu and Fabrizio Cardone present a paper titled “***Performance Analysis of Bio-Based Asphalt Mixtures Containing Lignin***” in which lignin is proposed as a component of asphalt mixes in order to promote circular economy and sustainability. One of the main current trends in road materials construction, in fact, is to employ industrial residues and by-products deriving from renewable sources as extender, replacement or modifier of bitumen, obtaining the so-called “bio-binders”. The research evaluates various mixes containing two different lignins as partial replacement of bitumen; the results show that despite the bio-based mixtures revealed a slightly penalized workability, the performances are fully comparable to the reference one, so allowing a reduction of the effective bitumen content.

In another paper titled “***Interlayer bonding properties of warm recycled asphalt pavements***”, Gilda Ferrotti, Lorenzo Paolo Ingrassia and Francesco Canestrari focus on the topic of Warm Mix Asphalt (WMA) and interlayer mechanical performances. WMA ensures lower emissions and is also beneficial in the recycling of Reclaimed Asphalt (RA) deriving from the milling of end-of-life pavements, but it can induce possible poor adhesion between the pavement layers because of the reduced working temperatures in paving operations. The results of the study highlight that the interlayer bonding properties of WMA pavements are comparable to HMA pavements and are not affected by the WMA additive type; moreover, Interlayer Shear Strength depends on the properties of the tack coat applied between the layers and increases over time due to aging effects, especially when the interface is below an open-graded friction course (OGFC).

About the topics of road design and driving behaviour, Abrar Hazoor, Juan Daniel Perdomo C. and Marco Bassani with their paper titled “***Adapting V ISA Technology: Driver Behaviour along Interchange Ramp and Merging/Diverging Terminals***” present an original in-vehicle Intelligent Speed Adaptation System for Visibility (V-ISA), designed to promote compliance with real-time speed management. The functionality of V-ISA is based on the prevailing sight conditions along the road, and operates by providing visual information and/or by modifying vehicle speed. An experiment involved 32 participants and a vehicle equipped with the experimented system under different operating conditions; it demonstrated that V-ISA had a significant positive effect on the drivers’ longitudinal performance along ramps, without effect on merging and diverging manoeuvres. V-ISA also had a positive impact on driver speed behaviour in such complex road environment and assisted drivers to modulate the operating speed towards the safe dynamic limits.

The paper by Alessandro Calvi, Fabrizio D’Amico, Chiara Ferrante and Claudio Petrella, titled “***Assessing the Impact of Safety Countermeasures on Dilemma Zones at Signalized Intersections of Urban Roads: a Driving Simulator Study***” proposes the use of driving simulator to observe the behaviour of drivers when approaching a signalized intersection. At the start of the yellow signal, they have to decide whether to stop or go through the intersection due to the dilemma zone, with the consequent risk of improper behaviours that can lead to rear-end collisions and right-angle crashes. Three different countermeasures were specifically designed and tested: Green Signal Countdown Timers; a new scheme of vertical and horizontal warning signs; an in-vehicle advanced driving assistance system based on Augmented Reality and connected to vehicle technologies. Some of the tested countermeasures revealed themselves to be a good way to improve safety and operations at urban signalized intersections and cut down on the number of drivers who aren’t sure what to do when the yellow light comes on.

Giulia Del Serrone, Giuseppe Cantisani and Paolo Peluso address the topic of smart mobility and different data sources available for the representation of traffic flow operating parameters, in their paper titled “***Blending of Floating Car Data and Point-Based Sensor Data to Deduce Operating Speeds under Different Traffic Flow Conditions***”. They consider in particular the operating speed data extracted from the so-called Floating Car Data (FCD) in comparison with the ones obtained by point-based traffic sensors (inductive loop detectors and microwave radar sensors), both under constrained and unconstrained traffic conditions. The study analyses opportunities and limits of the two sources of data and proposes the fusion between them, highlighting that the best results can be obtained from the combined use of different sensors and systems able to survey and monitor road traffic and users’ speeds.

Nicola Baldo, Valentina Indri, Fabio Rondinella and Fabiola Daneluz focus on the topic of road safety analysis by proposing the development of an accident prediction model for rural road segments of Friuli-Venezia Giulia (FVG) Region in their paper titled “***Multivariate Regression of Road Segments’ Accident Data in Italian Rural Networks***”. On the basis of Empirical Bayes (EB) method, the proposed model predicts the accident frequency as a function of Annual Average Daily Traffic (AADT), segment length, and both geometrical and environmental features related to the targeted road

segment. The results show high reliability of the model in predicting accident dataset for AADT up to 12500 vehicles per day.

Luca Tefa and Marco Bassani present a paper titled ***“Stress dependent behaviour of unbound layers of unselected construction and demolition waste aggregates by lightweight deflectometer tests”***. They consider that the use of construction and demolition waste (CDW) aggregates in unbound road pavement layers is increasing but there is a lack of data on performance in field. The proposed tests use a lightweight deflectometer (LWD) for estimating the elastic modulus of unbound pavement layers. To assess the stress-strain non-linear behaviour, several LWD drops were performed on the same location by varying the test parameters. A stress-hardening behaviour of in-situ CDW aggregates was observed, consistent with the evolution of resilient modulus commonly recorded in laboratory tests. This typical behaviour should be considered for unbound CDW granular materials at both the design stage and when devising quality acceptance procedures.

The use of a Heritage BIM (H-BIM) approach to create an archaeological road model in order to accomplish the disruption analysis of stone pavements is proposed in the paper by Salvatore Antonio Biancardo, Mattia Intignano, Diego Menegusso Pires, Francesco Abbondati and Gianluca Dell’Acqua titled ***“Heritage BIM Approach for roman pavements”***. The conceptual model of the road and the digital terrain model (DTM) were generated by means of a commercial software; then the road corridor design process was performed and a visual programming application was adopted to extract and update corridor information. A workflow was developed to implement a disruption analysis of road stone pavements and the output of the calculation were inserted in the model. A tool is finally proposed to support the authorities and experts for road managing processes.

Vittorio Ranieri, Nicola Berloco, Stefano Coropulis, Giuseppe Garofalo, Paolo Intini and Michele Ottomanelli focus on the problem of Healthcare emergency management, that has to be considered also as an infrastructure problem in terms of accessibility and safety. Their paper is titled ***“Methods for infrastructure planning in areas close to hospitals at the regional level”*** and it aims at providing a methodological framework (tested in the case of Apulia region, Italy) to conduct accessibility and safety assessments at the regional level, both in case of existing and new hospitals. Accessibility and safety were studied setting specific metrics, like time to reach the hospital and accident analysis at macroscopic level to plan safety interventions. The results should be considered in order to plan the improvements needed for the least safe road sites in the obtained ranking.

The paper ***“Proposal for a Low-Cost Monitoring System to Assess the Pavement Deterioration in Urban Roads”*** by Salvatore Bruno, Giuseppe Loprencipe and Valerio Marchetti starts from the opportunity to use Pavement Management System (PMS) as a tool to assist the road manager in the decision-making process for maintenance activities, but considers the difficult use of PMS for urban road networks. Therefore, a prototype of low-cost inertial sensor-based system for monitoring the pavement conditions is presented, that is based on the use of vertical acceleration recorded onboard a riding vehicle as a Key Performance Indicator (KPI) useful to relate the road roughness to the human whole-body vibration (WBV) exposure on the road user. Field tests and comparison between the evaluation of the road deterioration using traditional visual

inspections and the proposed sensor embedded in test vehicles (at different speeds) were performed, in order to identify performance classes for the investigated pavements.

All the papers selected for the special issues and, overall, presented at the conference, propose new approaches, methods, technologies or case studies, aimed to increase the knowledge and the exchange of information in the scientific and technical community, allowing better perspectives for further researches focused on safer, more resilient and sustainable transport infrastructures.

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