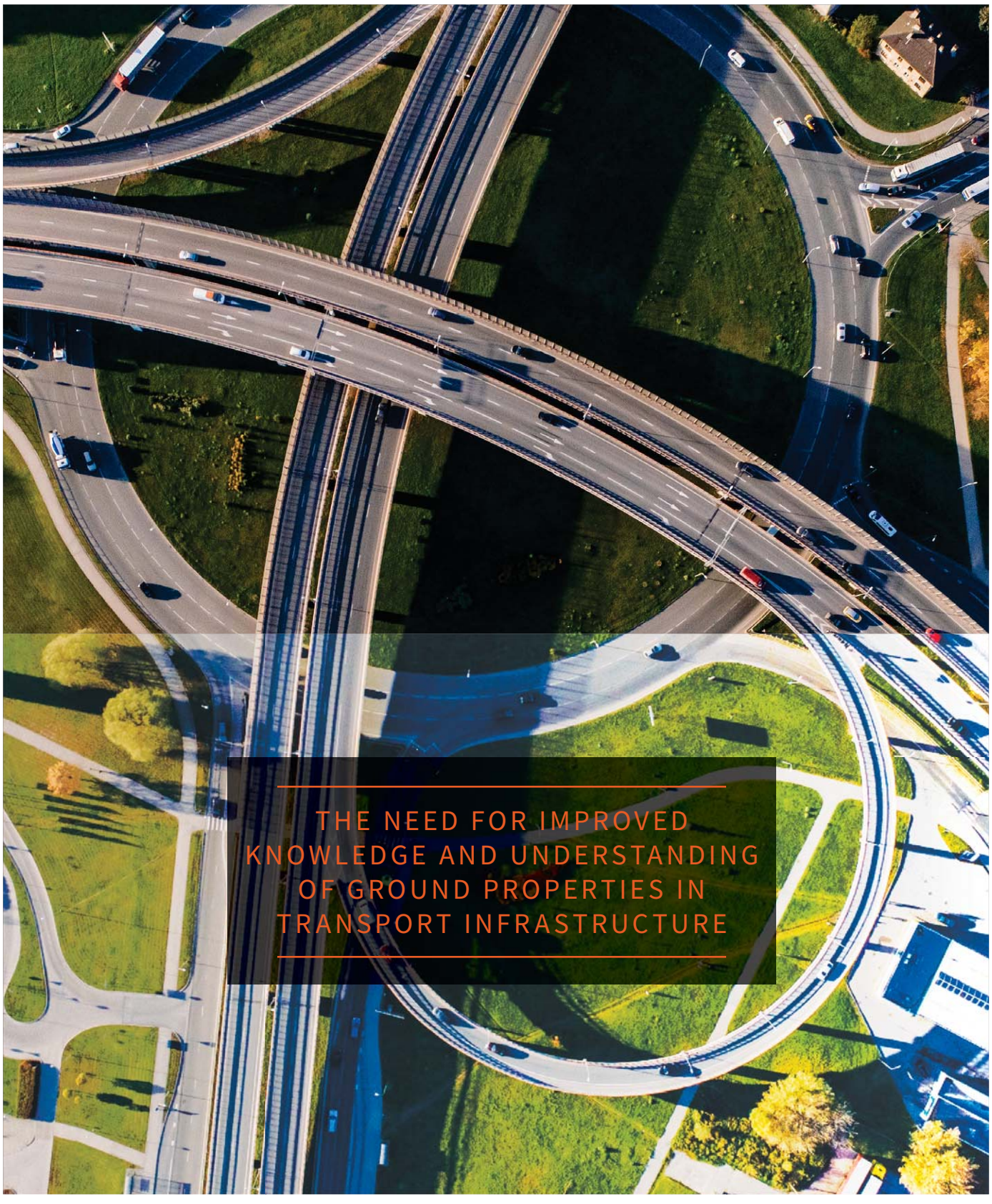
elgip
European Large Geotechnical Institutes Platform

Position Paper



THE NEED FOR IMPROVED KNOWLEDGE AND UNDERSTANDING OF GROUND PROPERTIES IN TRANSPORT INFRASTRUCTURE

Introduction

Reducing the vulnerability of our transport infrastructure to climate change and the disastrous consequences of natural hazards is a societal responsibility and an achievable policy imperative.

Uncertainties and lack of knowledge when dealing with subsurface variability leads to unnecessarily expensive and less sustainable infrastructure design. A considerable value to society can be achieved if geotechnical issues are included in practical strategies. This will improve the overall resilience of transport infrastructure.

Modern society faces a continuous challenge to provide a safe and efficient transportation network for people and goods. New transport infrastructures must be designed in a more resilient, sustainable and affordable manner. Simultaneously, existing structures need to be maintained, retrofitted and repurposed. The European Large Geotechnical Institutes Platform (ELGIP) urges policy makers, transport engineers, risk managers, geoscientists and engineers, to collaborate at early stages when planning, building and maintaining transport infrastructure.

The purpose of this position paper is to:

1. Show the relationship between the pressing challenges on European transport infrastructure networks and the crucial role that geotechnical engineering plays in solving them,
2. Promote the invitation of geotechnical engineers to participate active in implementing public policies dealing with Europe's transport infrastructure networks, and
3. Define the strategic development direction for research, development and innovation required for leading-edge technologies in the built and natural environment.

ELGIP

ELGIP is a group of 14 European research organisations, leading in geotechnical engineering, which aims to promote internationally the profession, its network and its societal relevance.

Transport infrastructure in numbers

Transport is a key factor in modern economies. Mobility is essential for the European quality of life, vital for the European Union's competitiveness and is a significant employer.

Building and maintaining infrastructure is a critical and sometimes even lifesaving undertaking. McKinsey (2015) estimates that the world needs investments of about $57 trillion on infrastructure by 2030 to enable the anticipated levels of GDP growth globally.

However, nine out of ten infrastructure projects have cost overruns averaging 28% (Flyvberg et al. 2004). Studies by Lind & Burns (2015) show that most cost overruns occur in the initiation and planning stages up to the final design, and are related to design changes and increases in the amount of data needed because of unforeseen technical problems and uncertainties in ground conditions and design parameters.

4.6% of GDP

The European transport industry directly employs more than 10 million people, accounting for 4.5% of total employment, and represents 4.6% of GDP

€7.1 - €90 million

It can take up to 20 years to build a motorway, from planning to construction. The average cost per km varies depending on the location and complexity of the route. It can be as low as €7.1 million and as high as €90 million or even more!

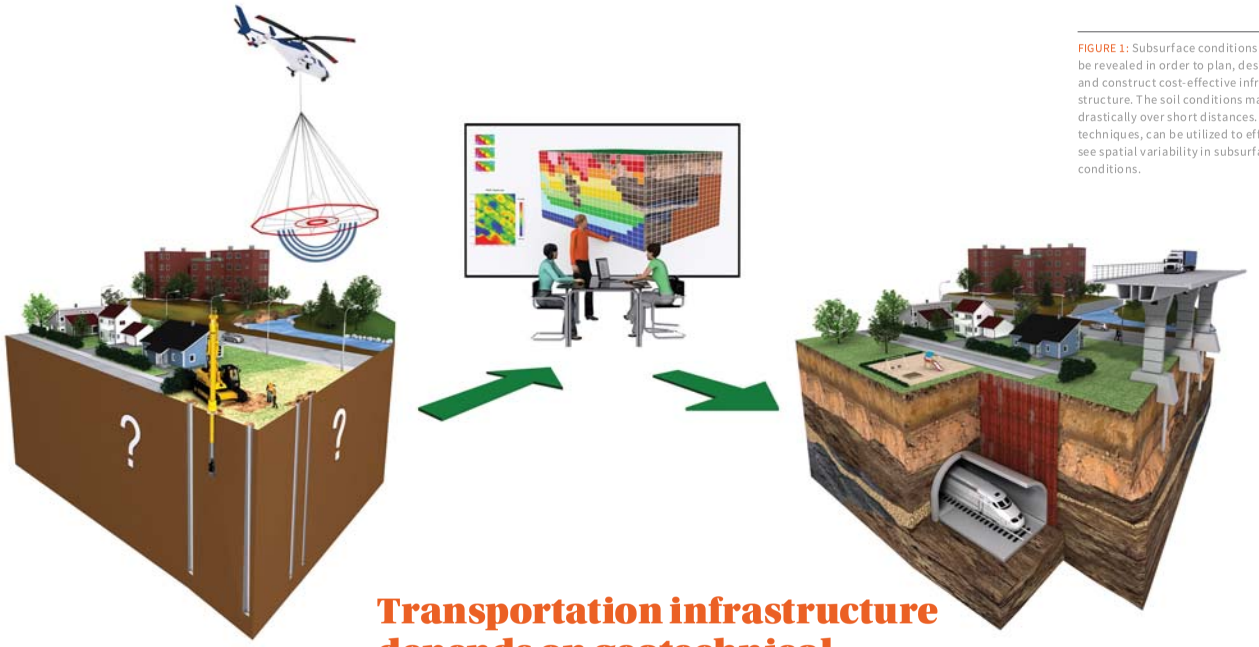


FIGURE 1: Subsurface conditions must be revealed in order to plan, design and construct cost-effective infrastructure. The soil conditions may vary drastically over short distances. Modern techniques, can be utilized to effectively see spatial variability in subsurface conditions.

Transportation infrastructure depends on geotechnical engineering

All infrastructures and transportation hubs are either built on or within the subsurface consisting of soils and rock (Figure 1). Geotechnical engineering is therefore the foundation of all transportation infrastructure projects.

Geotechnical engineering largely involves defining the soil's strength and deformation properties. It includes specialist fields such as soil and rock mechanics, geophysics, hydrogeology and associated disciplines such as geology. Geotechnics is applied when planning infrastructure such as roads and tunnels as well as buildings and other constructions. Unlike steel and concrete, the material properties and behavior of soil are difficult to predict due to its variability. Knowledge of ground conditions depends on the extent and quality of the geotechnical investigations and these always follow a given budget. Furthermore, soil exhibits complex behavior, making the choice of reliable geotechnical design parameters all the more challenging and crucial for the final result.

ELGIP therefore urges policy makers, risk managers, transport planners, road and bridge engineers, among others to collaborate with geotechnical engineers at early stages when planning, building and maintaining infrastructure projects to ensure adequate information on ground conditions and soil-structure interaction.

Geotechnical engineers are willing to cooperate in developing knowledge and techniques that can greatly enhance this process.

FACTS

Between 80% and 85% of all building failures and damages in Europe relate to unforeseen ground conditions. A minimum figure for a typical site investigation is around 0.5% of the total construction costs of a given project (Hytiris et al. 2014). However, unforeseen ground conditions attributable to inadequate investigation can frequently increase costs of projects by 10% or more.

ELGIPs vision

One ELGIPs vision is that all transport infrastructure should aim for an optimal geotechnical design, construction, maintenance and upgrading. The field of geotechnical engineering will thereby contribute to EU's ambitions of sustainability, availability and affordability (see Figure 2 below).

Vision	Optimal geotechnical design, construction, maintenance and upgrading of transport infrastructure		
Values	Sustainable transport infrastructure by using innovative solutions.	Available transport infrastructure by guaranteeing secure & resilient solutions.	Affordable transport infrastructure by costs optimization.
Geotechnical solutions	Reuse of soil waste. Use of enviromentally friendly materials. Minimization of ecological footprints. Retrofitting and reuse of foundations. Efficient use of geosynthetics. Decrease energy and land consumption.	Hazards mapping. Geohazards mitigation. Reliability of geostructures. Risk management & monitoring. Sustainable maintenance techniques.	Modern technologies for soil investigations, permanen monitoring and new methods for soil parameter interpretation (e.g. advanced numerical design methods, machine learning, etc.).
Strategic objectives	Develop innovative techniques and methods for reduction of ecological footprints and waste during construction	Develop innovative techniques and methods for reduction of risk for disasters & adaptation to climate change	Develop innovative techniques and methods to increase knowledge in early stages of design for time and money savings
Expected impact	30% reduction in use of raw materials. 30% increase in use of secondary materiales.	25% reduction in delays due to infrastructure maintanence or reconstruction. 25% reduction in fatalities and severe injuries due to natural disasters.	20% reduction in total cost of ownership.

FIGURE 2: ELGIPs vision for the future of transport infrastructure.

Practical risk management

Failure to manage risk and uncertainties can result in dire outcomes. Geotechnical engineers have the responsibility to properly assess and manage the risk of the unpredictable and the unavoidable associated with the ground conditions.

On the path to manage risk and uncertainty, geotechnical engineers must develop innovative approaches, tools, techniques, policies, and business relationships to address impacts associated with natural and man-made threats. That work must find a prominent place in geotechnical engineering education and practice, and it must become part of the research agenda, regulatory and business policies, and an expectation for business and contractual relationships.

ELGIP believes that identifying, improving, and encouraging the use of innovative geotechnical technologies during planning and design will have an important impact on the sustainability, availability and affordability of Europe's transport infrastructure in the next decade.

Strategic development directions

Research, development and innovation within geotechnical engineering plays an important role in helping modern society in continuing to provide a secure, efficient and affordable transportation network. This ambition includes new as well as existing transportation networks.

Based on identified geotechnical demands proposed in ELGIPs vision document "Reduction of geotechnical uncertainties for infrastructure" (ELGIP, 2015), formulated by a number of geotechnical research institutes and universities across Europe, ELGIP proposed a research agenda 2017-2025 summarized in ELGIP (2017) for optimized geotechnical transport infrastructure. The following development directions invite policy makers, transport engineers, risk managers, geoscientist and engineers in general to collaborate in:

- **Encouraging civil engineers to more rapidly make use of new technologies.**
- **Promoting multinational exchanges between disciplines for development and application of successful innovations worldwide.**
- **Accelerating the integration of technology through effective partnerships of government, industry, academia, and practitioners in research, learning, leadership, and application.**
- **Encouraging collaboration between builders/clients and geotechnical engineering researchers to identify and evaluate promising construction techniques**
- **Incorporating systematic risk management techniques into the evaluation of new technologies to equitably share risk and more fully embrace these innovations.**
- **Exploring ways to enable early and safe adoption of new technologies in codes and standards, including the process used to revise codes and standards**

What's next?

When planning for new transport infrastructures, maintenance and retrofitting of existing ones, we urge planners and policy makers to put the money and efforts to where it makes a difference:

IMPROVED KNOWLEDGE AND UNDERSTANDING OF GROUND PROPERTIES!

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