Tampere University

PHOTO Tuukka Uimonen

Research Centre

TERRA Geo Road Rail

Building a functional future

INFRASTRUCTURE IS THE BASE OF A FUNCTIONAL SOCIETY. Watch the video!

What are infrastructures?

Infrastructure includes roads, streets, railways, various public utility networks as well as green and sports areas. Together they form infrastructure, which is the basis and necessary prerequisite of a functioning society. Functional infrastructure enables the smooth movement of people, goods and information, as well as all the other basic conditions for a good life – that water comes from the tap, electricity comes from a wall socket, and the sewers work.

The needs of society are constantly changing, and therefore new infrastructure must be built continuously. Still, it is good to note that most of the necessary infrastructure already exist. This valuable property is also important to take good care of.

The Terra research center focusses on researching and teaching the design, construction, maintenance and repair of various types of infrastructures.

WITHOUT ALL THIS FINNISH SOCIETY WILL NOT WORK:

2 x * **78 000 km**
public roads

10 x **405 000 km**
electric power network

9 x **> 350 000 km**
private and forest roads

3/4 x **28 000 km**
streets

1/3 x **14 600 km**
district heating network

5 900 km
railway lines

43
seaports

>2,5 x **107 000 km**
water supply network

>1 x **50 000 km**
sewer pipelines

22
airports

145
landfills

... and much more

* Earth's circumference is 40 000 km. Source: "Rakennetun omaisuuden tila 2017" report, Finnish Association of Civil Engineers, RIL

THINGS WHICH MAKE INFRASTRUCTURE VERY TOPICAL AND IMPORTANT:

- The appreciation of a pleasant and functional living environment is constantly growing
- Infrastructure plays a major role in achieving the goals of the circular economy and emission reduction
- Infrastructure needs to be adapted to the impacts of climate change
- Digitalisation enables completely new ways of operation in the construction and maintenance of infrastructures
- High-speed rail traffic and traffic automation set completely new requirements for infrastructures

www

Examples of modern ways of operating and working environments in the infrastructure sector can be found here (in Finnish): https://youtu.be/87zQSgPEAAE

What is the Research Centre Terra?

Part of the Faculty of Built Environment at Tampere University, Research Centre Terra is Finland's leading expert in infrastructures. Founded in 2020, Terra continues the work of the Research Group on Foundation, Earth and Railway Structures at Tampere University.

OUR BASIC MISSION – WHY WE EXIST

We promote the realization of a functional, safe, and sustainable living environment through high-quality research and education.

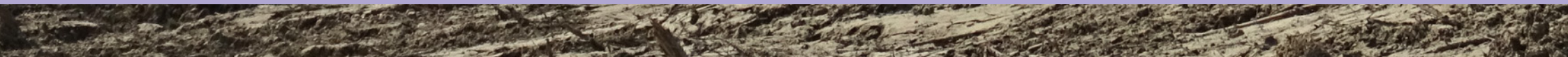
We develop life-cycle-efficient infrastructures in close cooperation with industry players. We study the use of new materials, innovate new methods for structural design and renovation, as well as promoting the implementation of digitalised modes of operation and the principles of sustainable development in infrastructure management.

PRIORITIES FOR OUR OPERATIONS

The focus areas of our operations are geotechnical engineering, earth structures, track structures, digitization of the infrastructure sector and laboratory and measurement services. Our activities are organized into four research groups: TerraGeo, TerraRoad, TerraRail and TerraDigi, as well as GeoLa, a research laboratory supporting their activities.

Terra's main tasks are:

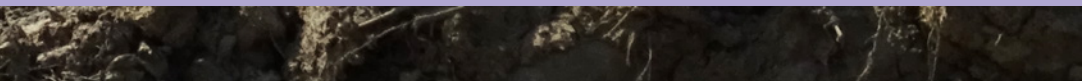
- Produce research-based information that enables the safe construction and operation of infrastructures, and their efficient and sustainable life-cycle maintenance
- Train qualified civil engineers and doctors with up-to-date skills for various tasks in the infrastructure sector
- Participate in the development of the infrastructure sector in close cooperation with other actors.



OUR VISION OF THE FUTURE TERRA

Terra is a working community of motivated and forward-looking people who carry out top-level international research, provide inspirational training, and contribute to the positive development of society.

MORE DETAILED INFORMATION ABOUT THE ACTIVITIES OF TERRA CAN BE FOUND IN THIS BROCHURE AND OUR WEBSITE research.tuni.fi/terra-en/



MORE INFORMATION ABOUT STUDYING AT TAMPERE UNIVERSITY YOU CAN FIND HERE:
www.tuni.fi/en/study-with-us

GET TO KNOW TAMPERE!
visittampere.fi/en/

Is your future dream job to design railways, roads or tunnels, or to find solutions for challenges in the circular economy or soil protection?

Studying in Tampere

On the Civil Engineering degree programme at Tampere University you can study courses on geology, geotechnics, earth and rock structures, structural engineering, and building economics. Courses provide you with the tools necessary to design and build even the most demanding infrastructures.

Our bachelor's, master's and doctoral graduates are employed in various design and construction projects as developers, design engineers, project engineers and other types of experts. You can read some of their career stories in this brochure. The most important employers are consulting and construction companies, municipalities and government agencies, such as The Finnish Transport Infrastructure Agency, which is responsible for developing and maintaining the state-owned road, rail and waterway networks; and there's plenty of work to be done!

On the Civil Engineering bachelor's degree programme lectures are mostly in Finnish. However, on the master's programme there are courses in English, and it's also possible to study individually based on literature. Our teaching is based on learning by doing in a modern learning environment that includes our teaching laboratory and testing equipment, together with modern design software. We have several Erasmus students every year and international students can work on their master's or doctoral thesis in collaboration with our research groups.

Based on recent studies, Tampere's attractiveness is constantly growing among students. There is an active Civ. Eng. Student guild (TARAKI), several hobby clubs, together with the sports facilities and activities of SportUni, all providing a host of opportunities to be active and meet new people.

MSC CIV.ENG.
ANTTI SIPILÄINEN
SITOWISE OY

I graduated in Civil Engineering (MSc) at the end of 2015. My current duties mainly consist of various tasks involving railway superstructures. In my opinion, my studies gave me an excellent cross section of the extent of the infra sector. Mathematical knowledge provides the foundation needed in my daily work.

READ THE FULL INTERVIEW:
research.tuni.fi/terra-en/teaching-and-career/

Welcome to study infra construction in Tampere University!

Learning by doing

In addition to theory, studies involve concrete practice such as design calculations and drawings, material and structural testing, and site visits and field training. For example, geological and geotechnical laboratory testing methods are practiced independently in our learning laboratory GELLab. Visiting lectures from companies, construction site visits and Research Centre Terra's research projects ensure that teaching content is up-to-date. During your studies you can concentrate, for example, on foundation engineering structures, rock engineering, road and railway engineering, environmental geotechnics, or the digitalisation or circular economy of infra construction. You can also include courses from foreign universities into your degree.

Summer training is an essential part of studying, and construction companies provide a wide variety of training opportunities. In addition, many master's students work in parallel to their studies, which supports the development of professional skills and identity. The construction industry offers current topics and funding or even vacancies for thesis work. Our graduates find employment easily.

MSC CIV.ENG.
ANNE SAILARANTA
PROXION OY

I graduated from Tampere University in the early summer of 2020 and now work as a geotechnical engineer in Proxion, a consulting company concentrating on railways. The infra construction degree has met the needs of my present duties really well. In university they teach the theory of civil engineering, and especially the reporting, which is part of a designer's daily work.

Studying civil engineering was not an obvious choice for me, but now I couldn't see myself in any other profession.

READ THE FULL INTERVIEW:
research.tuni.fi/terra-en/teaching-and-career/

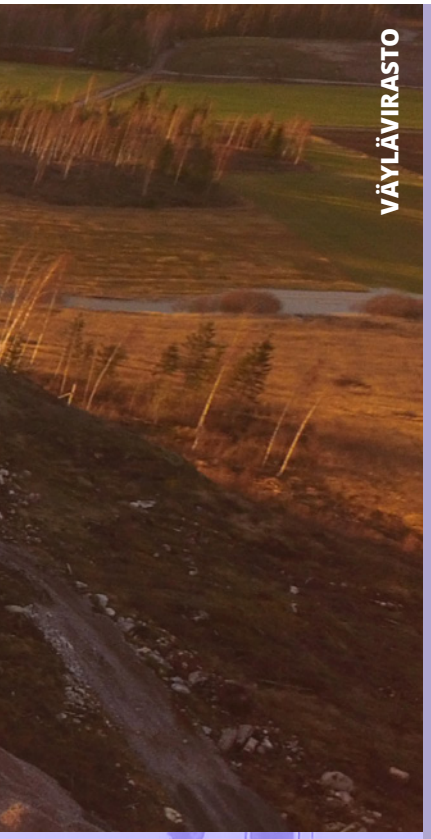
www research.tuni.fi/terrageo-en/

TerraGeo knows soil

TerraGeo – on safe ground

The geotechnical research group TerraGeo studies the properties of soil to enhance safer and more sustainable earth/foundation construction. We develop tools to answer questions like how to build on a certain place safely, or how much a house will settle. Soil properties vary greatly spatially, and the behaviour of soils under load is very complex. Finding answers requires a holistic understanding of how the soil and structures interact. For this reason we develop soil investigation methods and use them to better understand the mechanical behaviour of soil, analyse full-scale experimental sites, and based on these, develop calculation methods and models. The introduction of innovative technologies, constantly increasing volume of data, and new methods based on various forms of artificial intelligence, create completely new possibilities to find better solutions.

Structures must be designed not only to be safe, but also economical, considering the requirements of sustainable development. This requires active participation in the development of guidelines and regulations so that our design systems guarantee the chosen level of reliability in different conditions. We always try to combine theory with practice and our research results are widely used in geotechnical design and guidelines.



MSC CIV.ENG.
MATIAS NIEMELÄINEN
DESTIA OY

I have served as a foreman for three years.

One of the biggest challenges in working life has certainly been learning and embracing new things, even with a busy schedule. However, my studies at TAU gave me good skills, so there is no need to be afraid of this.

The new challenges also make the work interesting!

www **READ THE FULL INTERVIEW:**
research.tuni.fi/terra-en/teaching-and-career/

www research.tuni.fi/terraroad-en/

TerraRoad knows how roads perform

TerraRoad – on the right road

The TerraRoad research group studies the soil materials and aggregates used in various types of earth structures and the performance of earth structures. The subjects studied include loads acting on infrastructures, sustainable material alternatives and functional structural solutions for new and renovation construction. Very often, material research is carried out in the GeoLa research laboratory, in addition to which we make a lot of monitoring measurements of real infrastructures in their actual operating conditions.

Our research objects are very diverse: they can include structural layers and pavements of roads and streets, structures for green and sports areas, or landfill structures. Studies may also aim to demonstrate the technical feasibility of recycled material, or to assess the impacts of future changes - for example the impact of climate change, or an increase in the total weight of trucks on the service life of a road structure.

Our research results are used in the development of many guidelines applied in the infrastructure sector. That is why we are actively involved in committees creating them.

CURRENT RESEARCH THEMES IN THE TERRAROAD GROUP INCLUDE:

- Loading effects of heavy trucks on the road and street network. The heaviest vehicle combinations currently operating on Finnish roads are almost double in total weight compared to most other European countries.
- The impacts of climate change and seasonal variations on the functioning and sustainability of infrastructures.
- Modern digital measurement technologies and integrated analysis of measurement data collected using them in the proactive maintenance of roads and streets; structures should start to be strengthened before they are badly broken.
- Development of more sustainable and environmentally friendly road pavements

MSC CIV.ENG.
ANNELE MATINTUPA
ROADSCANNERS OY

I graduated with an MSc in Civil Engineering specializing in Municipality Engineering in August 2007. I feel the modules included in my studies were quite comprehensive and have provided a good starting point for working life.

Working life has been very varied and diverse. With interest and hard work you can go far, and over the years I myself have appropriately gained more responsibility as my skills and abilities have developed.

READ THE FULL INTERVIEW:
research.tuni.fi/terra-en/teaching-and-career/

www research.tuni.fi/terrarail-en/

TerraRail knows track structures and loads

TerraRail – stay on track

The research group TerraRail studies railway track structures with the aim of improving the life-cycle efficiency of tracks. The research area includes all track structures from the subsoil to the rails. The goal is to develop better tracks that are easy to use and maintain. It is important to have a thorough understanding of the loads coming from the rolling stock and their effect on the railway. Loads are increasing as a result of ever-faster passenger train speeds and the higher axle loads of freight trains.

Our strength lies in experimental research, which is conducted both in the laboratory and in full-scale. The measurements are complemented by computational calculations and the modelling of structures, simulations and reviews of international research results. Ensuring the proper functionality of new components to be placed on the track sometimes requires the use of all these research methods.

TerraRail research activities are based on close co-operation with the Finnish Transport Infrastructure Agency. The aim is to increase know-how, optimize life cycle costs, increase the punctuality and attractiveness of train traffic and reduce the environmental impact of railways. Our goal is to produce research results and facts to enable informed decision-making. Companies in the sector are also involved in developing functioning railways.

TOPICAL RESEARCH THEMES INCLUDE:

- Addressing the challenges of higher train speeds
- Addressing the challenges posed by heavier axle loads
- Fast passenger traffic and slow freight traffic on the same railway line
- Reduction of rail traffic induced vibrations
- Railway track asset management

MSC. CIV.ENG.
OSSI PELTOKANGAS
ARKOS OY

I graduated in 2012 with a major in infra construction. I work as a project manager in railway-related project management consulting and as a partner in Arkos Oy. In working life I have benefited the most from the information retrieval and structuring skills acquired through my studies. My studies generally prepared me well for working life, but it is only at work that the most job specific skills required are eventually learned - and this is how it should be.

www **READ THE FULL INTERVIEW:**
research.tuni.fi/terra-en/teaching-and-career/

www research.tuni.fi/terradigi-en/

TerraDigi knows the steps for the digital leap

TerraDigi – on a digital leap

Problems are often faced on road and street construction sites, and more broadly in the entire infrastructure sector. Construction takes a long time, work machines are inactive on sites, data is lost, schedules are late, costs are exceeded, cooperation is lacking and attitudes should be improved. Maintenance backlog of the Finnish road network is EUR 5 billion and should be reduced in the near future.

Fortunately, the situation on construction sites, and maintenance, is often not as bad as that described above. However, there are problems in our industry that need to be addressed. Digitalisation opens up new opportunities for the further development of the infrastructure sector, the elimination of problems and the improvement of productivity. The TerraDigi research group promotes the use of digitalisation in the entire infrastructure sector. The focus is on road, street and rail infrastructure design, construction, maintenance and asset management.

The development of technology alone is not enough to solve the problems, it is also necessary to develop work processes and operating models in order to get the full benefits of digitalisation. TerraDigi conducts interdisciplinary research in areas such as information management, construction economics, production economics and management sciences. The research is related to developing the planning process, speeding up street construction sites, enhancing proactive maintenance, and improving asset management. One of the main themes is to increase life cycle thinking.

TerraDigi works closely with the Finnish Transport Infrastructure Agency, cities, and companies. The corporate pool includes key design consultants, construction and maintenance contractors, and hardware and software suppliers. We also work closely with the various faculties and units of our university, as well as with other research institutes in Finland and internationally.

MSC. CIV.ENG.
EMELIINA KORTESNIEMI
SITOWISE OY

I graduated in the summer of 2019, and I am currently working as a traffic planner. I work a lot on data modelling.

Prior to my current position, parallel to my studies, I worked for a few years as a software specialist in a company that provides software for the infrastructure industry. The challenges of working life have been more diverse than I could have expected.

www **READ THE FULL INTERVIEW:**
research.tuni.fi/terra-en/teaching-and-career/

www research.tuni.fi/geola

Our service price list, our contact persons and instructions for the delivery of sample materials can be found on the GeoLa website in Finnish.

GeoLa produces information by testing

Research laboratory GeoLa – comprehensive information on soils and aggregates

The characterization of soil and aggregate materials in the research laboratory GeoLa forms the key basis for most of the research projects carried out by Terra's other research groups. As a result of more than 30 years development work, GeoLa has comprehensive capabilities to investigate the properties of soils and aggregates for the widest possible range of applications. We have about 150 different tests that are carried out according to international standards.

In addition to the needs related to Terra's own research projects, GeoLa also serves external small service customers by offering the most comprehensive laboratory service in our field in Finland. We can commission tests on soils and aggregates, asphalt and recycled materials. GeoLa is a PANK-approved testing organization regularly assessed by Inspecta Sertifiointi Oy.

OUR RANGE OF SERVICES INCLUDES THE FOLLOWING RESEARCH CAPABILITIES:

- Physical and geometrical properties of soils and aggregate materials
- Water permeability properties of soils
- Compressibility properties of soils
- Strength and deformation properties of soils at different stress and deformation levels
- Strength properties of aggregates
- Testing the properties of aggregates' fines fractions
- Properties of asphalt materials
- Mineral composition and suitability assessment of soils and aggregates
- Investigations related to environmental assessment
- Investigations of green and sports areas
- Testing the technical suitability of recycled materials

MSC CIV.ENG.
ELINA LÄTTI
AFRY FINLAND OY

I graduated from TAU in the summer of 2016 and work as a geotechnical engineer. In the infrastructure sector, I was fascinated by the diversity of the field and the wide range of tasks. My studies provided a good theoretical basis for design work, which in itself is problem solving. Few projects go through with standard solutions - there is always some bigger or smaller application and innovation included.

www

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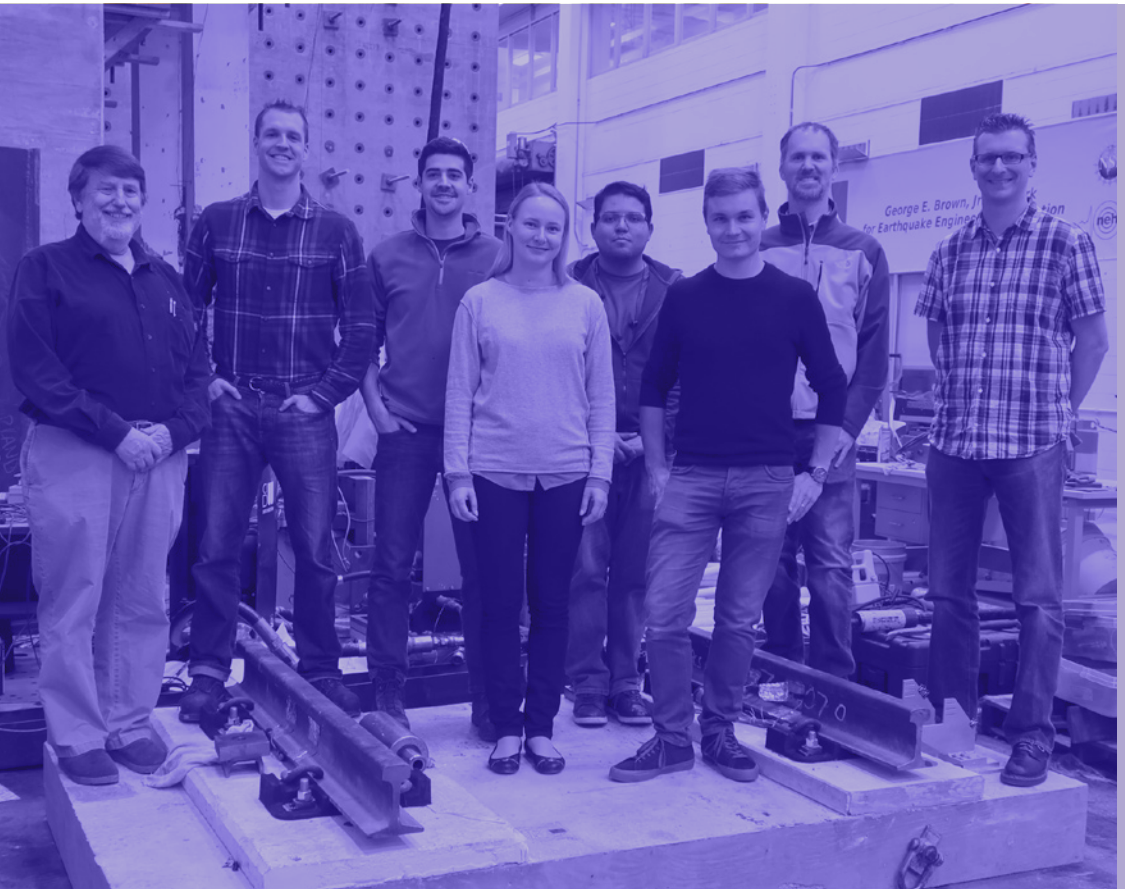

PHD MARCO D'IGNAZIO
RAMBOLL FINLAND OY
& TAMPERE UNIVERSITY

I currently work as a geotechnical specialist at Ramboll and part-time as a PostDoc Research Fellow at Tampere University, where I am studying complex geomaterials.

Facing challenges is, in my opinion, the best way to meet expectations. The expectation is, for an engineer, to have challenges all the time.

READ THE FULL INTERVIEW:
research.tuni.fi/terra-en/teaching-and-career/

Learning from abroad

Terra's international research collaboration

We strive to approach challenges by thinking outside the box. Technology is constantly taking great leaps, and innovative solutions may well be found outside your own field. The fourth industrial revolution is largely about data, its volume is constantly growing, and we must boldly adopt new technologies and methods of analysis.

This also requires good international partners. Terra has an extensive network around the world, and together we work to create new innovative methods and ways to better meet the challenges of sustainable development. For example, determination of soil layer properties through magnetic resonance imaging, artificial intelligence-based vehicle tyre type identification, identifying the causes of rail network damage through data mining, construction site management based on situational awareness, utilization of information model in city property management, or frost damage prevention through digitalization. All these are examples of new solutions we are developing together with our network.

Case ROADEX

An excellent example of international co-operation that has enriched Terra's operations in many ways is the ROADEX network, in which we have been involved since 2003. ROADEX, which focuses on the specific issues of low volume road networks in the Northern European periphery areas, was launched in 1998 as an EU-funded research project and has expanded into a co-operation network funded by the road authorities, including Finland, Sweden, Norway, Scotland, Ireland, Iceland and Greenland.

The project consultant for the ROADEX project is Terra's long-term partner Roadscanners Oy, whose CEO Timo Saarenketo, PhD, is Terra's active adjunct professor. ROADEX co-operation has also produced a lot of e-learning material that is used in Terra's education. In addition, the research results of the project have been presented at seminars organized in the framework of ROADEX cooperation and at several other international events. In recent years, the ROADEX network has played a key role in many EU funding applications coordinated by Terra.

www **www.roadex.org/e-learning**

IN TERRA WE:

- are continuously involved in the preparation of several national and EU-level standards and guidelines.
- play an active role in numerous professional associations and committees in the infrastructure sector.
- offer our expertise to decision makers in a variety of decision-making situations that require our technical expertise.
- participate in the public discussion on the development of the infrastructure sector in many different forums.

Terra researches, educates and influences

Terra's societal impact

In addition to research and education, the third main task of universities, also defined by law, is societal influence.

The biggest impact of Terra's operations comes through the new infrastructure professionals we train as they move from their studies to working life. However, the implementation of the research results we produce also requires other diverse interactions with the surrounding society. We influence industry guidelines and standards, give presentations at many domestic and international seminars and in the public media, organize seminars and training events for professionals, collaborate with persons elected to positions of trust, and decision-makers, and provide expert assistance to cities and government organizations.

From Terra's point of view, a research project is fully completed only if it has a practical impact on practices applied in the infrastructure sector.

MSC CIV.ENG. MIKKO SAUNI
WELADO OY &
TAMPEREEN YLIOPISTO

I am currently working as a post-graduate researcher and construction consultant. The content of my studies has come up almost entirely in some way already at this early stage of my career – I should not have taken any fewer courses than I did. The range of working tasks is very wide and it is very difficult to say what a normal working day involves.

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Research Centre

TERRA Geo Road Rail

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