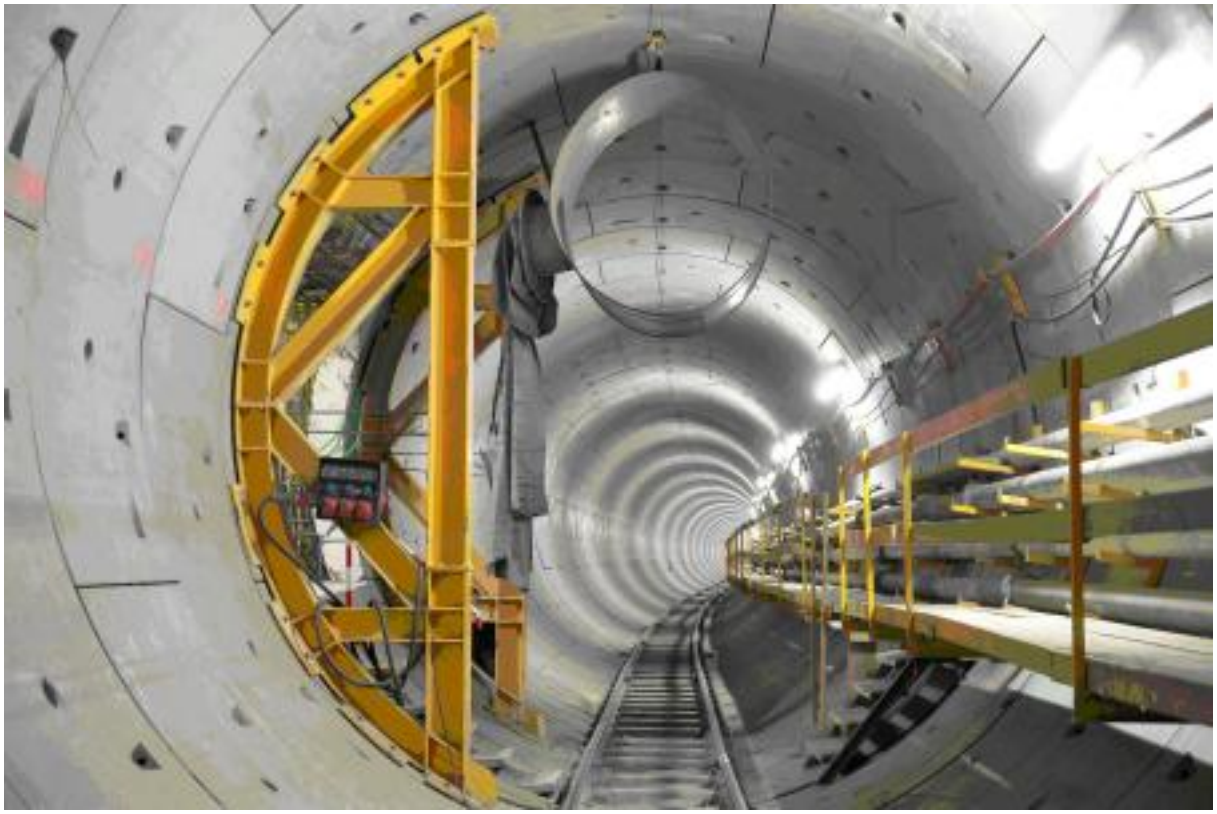
Sustainable tunnelling: reduce cement content, recycle excavated material

About this project



RTTS

Sustainable tunnelling: reduce cement content, recycle excavated material

Markets:

Material: Steel, Others (Concrete)

This project is funded by the Technology Transfer Programme Leichtbau (TTP LB) of the Federal Ministry of Economics and Climate Action.

Technology Transfer Program Leichtbau

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Context

Tunnelling requires enormous quantities of reinforced concrete. In particular, the production of the segments - the prefabricated concrete elements from which the tunnel tube is assembled - is resource-intensive. The main components are cement, steel and natural aggregates such as gravel and sand. These materials cause high CO2 emissions and require large quantities of primary raw materials.

At the same time, machine tunnelling produces large quantities of excavated material in the form of rock and soil. This is often dumped instead of being recycled. A sustainable approach to tunnelling must therefore combine two aspects: CO2-reduced concrete technology and efficient recycling of the excavated material.

Purpose

In the RTTS research project, the project team is developing an innovative segment production technology that optimally combines material savings, recycling and load-bearing capacity. The researchers are reducing the cement content in the concrete by using alternative binders, such as lime-rich active substances, granulated blast furnace slag and pozzolanic substances, in order to achieve a comparable strength and durability of the material.

In addition, they integrate recycled aggregates into the concrete to reduce the use of primary raw materials. In order to optimise the CO2 consumption of the entire tunnel support system, the team will also investigate the influence of the annular gap on the load-bearing behaviour. On the one hand, the contact behaviour of the segmental rock mass will be mapped and, on the other hand, the pre-relaxation and the support pressure on the soil stresses before backfilling and hardening of the annular gap mass will be taken into account.

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Procedure

The project team first carries out extensive material analyses. The researchers test different mixtures of alternative binders and recycled aggregates in the laboratory for strength, durability and workability. In addition, digital models simulate the load-bearing behaviour of the optimised segments under real load conditions. Various load scenarios are analysed, including axial pressure, bending and shear forces that occur in tunnel construction.

The most promising concrete compositions are then used in full-scale tests: In a pilot project, the team is producing segments with reduced amounts of cement and steel, which will be subjected to mechanical and climatic stresses in a realistic test facility. The researchers want to develop a practical construction method that makes tunnel concrete more sustainable without sacrificing functionality.

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Funding duration:

Funding sign:	03LB3113	**Funding amount:**	EUR 1.7 million

Further websites foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=view&fkz=03LB3113A - RTTS in the federal funding catalogue

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Project coordination

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Lightweighting classification

	Realisation
Offer	
Products Parts and components, Software & databases, Materials	✓
Services & consulting Consulting, Simulation	✓
Field of technology	
Design & layout Lightweight manufacturing	✓
Functional integration	
Measuring and testing technology	
Modelling and simulation Loads & stress, Optimisation, Structural mechanics, Materials	✓
Plant construction & automation Automation technology	✓
Recycling technologies Recycling	✓
Manufacturing process	
Additive manufacturing	
Coating (surface engineering)	
Fibre composite technology Casting (concrete), Spraying (concrete)	✓
Forming	
Joining	
Material property alteration	
Primary forming	
Processing and separating	
Textile technology	

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Lightweighting classification

	Realisation
Material	
Biogenic materials	
Cellular materials (foam materials)	
Composites Others (Concrete)	✓
Fibres	
Functional materials	
Metals Steel	✓
Plastics	
Structural ceramics	
(Technical) textiles	