

How do we ensure that our infrastructure lasts a hundred years?

A geomechanical approach to sustainable design of infrastructure and construction.

Large investments with a long-term perspective

Infrastructure and construction projects are long-term investments that will add value to the society for more than a hundred years. It is important to make robust and sustainable constructions considering that the loads or the needs change over time. It is simple to secure the constructions against failure as the loadings are set on the safe side and assume reasonably low strengths of the materials. However, it is more difficult to ensure long-term functionality of the constructions as it is difficult to predict size and development of subsidence. Climate changes may also cause significant alterations in the impacts from wind, waves, currents and ice during the lifetime of the construction.

The project

The donation from COWIfonden supports a commercial Ph.D. project "*Efficient performance of large infrastructure: a geomechanical approach towards sustainable design*". It is a cooperation project between DTU Construction and COWI A/S. The project focuses on how foundations based on Paleogene clay can be made more robust. Paleo clay is more than 65 mio. years old and can be found under Fehmarn belt, Little Belt and Aarhus where there are large projects which require knowledge about understanding of paleo clay: construction of tunnel under Fehmarn Belt, securing the old Little Belt Bridge and construction of high-rise buildings in Aarhus Harbour.

Paleogene clay has a high plasticity and is very sensitive to decreasing. First, this means that the strength of the clay and its stiffness very much depend on the water content of the material. Secondly, the period and size of the loading influences how fast and how large the subsidence become.

The project uses laboratory tests and numerical and analytical models to investigate how paleo clay behave under different loadings in order to improve the predictions of subsidence and the impact of this on infrastructure or buildings.

The core of the project is a material model, which embrace loading history, durability and size of different constructions. With this model, you can optimize the design of subsidence sensitive constructions such as lowered tunnels and high-rise buildings and still meet the requirements of a 100-year lifetime.

The starting point of the project are Danish occurrences of paleo clay, but the models can be transferred to occurrences of clay with high plasticity and shrink sensitive at other places where COWI has projects, such as London Clay in the UK, soft clay in Gothenburg and light preconsolidated clay in South East Asia.

New knowledge is important for the sector

Infrastructure projects should contribute to expand technical knowledge among Danish engineers. The Great Belt project gave new knowledge about quaternary morainic deposits, whereas the Metro work in Copenhagen gave invaluable knowledge about chalk. Now focus will be on tertiary deposits of paleo clay. With this project, COWI once more contributes to broaden the knowledge level in the Danish geotechnical sector.