

N O T E

To: Whom it may concern

From: Femern Bælt A/S

**Geotechnical Investigations
Activities Overview**

1. General

The overall purpose of the geotechnical investigations is that Femern Bælt A/S at any time during the project development can supply the necessary information about the ground conditions to authorities, consultants and contractors involved in the project.

Preliminary geotechnical investigations for the Fehmarnbelt Fixed Link were performed as part of the feasibility study in 1995/96, for the German and Danish ministries of transport.

The project geotechnical investigations are performed over the years 2008-2011 by Femern Bælt A/S, the state owned Danish organization responsible for the preparatory work for the link.

Following the EU procurement procedure, Femern Bælt A/S has appointed Rambøll Arup Joint Venture as geotechnical consultant. The investigations are performed by this organization and investigation contractors, selected according to the EU procurement procedures.

These investigations are designed to meet the design and construction requirements of a fixed link, covering both a bridge solution and a tunnel solution within a 2 km wide corridor east of the existing ferry route between Rødby and Puttgarden.

The main elements of the project investigations are:

- Organizing the existing and new information in a state-of-the-art geo information system
- Establishing a project specific positioning system

- Geophysical surveys
- Geotechnical boring campaign
- Advanced laboratory testing
- Large scale on site testing

Eventually, during construction, the contractors are anticipated to perform detailed control investigations for all parts of the selected project and thus verifying the basis established during the project investigations.

2. Geo Information System

All geo-related information has been installed in the Geo Information System, comprising Geo Database and Geo Archive. This new system includes modern facilities for web-access and searching.

The system is installed on servers at Femern Bælt A/S and access will be given to relevant stake holders according to their role in the project.

3. Positioning System

Modern GPS is available to anyone and high accuracies may be achieved by including signals from existing reference stations, correcting local errors. Such systems are named Differential Global Positioning System (DGPS).

In order to limit the necessary number of radio frequencies and for improved reliability and accuracy, Femern Bælt A/S will establish a project specific DGPS with a number of reference stations around the project area. These stations will transmit coordinated corrections to surveyors working in the project area.

This facility will comprise:

- *The Positioning Reference System*, i.e. the theoretical geodetic basis, established in cooperation with Kort og Matrikelstyrelsen (KMS) in Denmark and Bundesamt für Kartographie und Geodäsie (BKG) in Germany.
- *The Positioning Reference Frame*, i.e. the physical establishment in the form of benchmarks, say at 2-3 locations in Denmark and 2-3 in Germany, preferably located close to the shore. Furthermore, the reference frame includes the instruments necessary to determine the positions, namely reference station, rover stations etc.

4. Geophysical Surveys

General

The purpose of the geophysical surveys is to improve the geological understanding by identifying the various soil layers and the nature of the seabed and any objects hereon.

Furthermore, these surveys contribute to archaeological and environmental knowledge.

These surveys have been performed by the consultant.

Offshore

Vessels surveyed a 2 km wide corridor with an anticipated alignment as centreline. The survey lines across the belt have a spacing of 25 m. The duration of the marine survey was approximately 1 month.

The survey comprised multi beam echo sounder, side scan sonar, different reflection seismic, and magnetometer. Receiving hydrophones were towed in a streamer behind the vessel.

Onshore

These surveys were carried out during the summer and autumn 2008, following the completion of the harvesting season.

On Fehmarn, the survey area extended from the shore and 2 km inland and 1 km on either side of the road/railway connection to the ferry harbour and to the west of Marienleuchte.

On Lolland, a similar corridor with centreline approximately 1 km to the east of the ferry harbour was investigated, likewise extending 2 km inland and 2 km wide.

The surveys comprised:

Reflection seismic profiling performed by a medium size off road vehicle, towing a vibration trailer and a 250 m long cable streamer with geophones mounted on small sledges. This profiling preferably takes place on existing roads.

MEP (Multi Electrode Potential). Light transport vehicles (i.e. 4 wheel motor bike) and light hand carried measuring equipment. Preferably on virgin land.

5. Boring Campaign

General

The purpose of the boring work is to obtain information on all soil layers to a depth of 50-100m below the seabed.

Borings Type A will be carried out by continuous coring, aiming at obtaining full sample coverage of the entire depth penetrated.

In addition to sampling, the borings will enable measuring of soil properties, geophysical bore hole logging and laboratory classification testing.

Borings Type B will be carried out next to some of the borings Type A. These borings Type B are meant for in situ strength measurements.

All borings will be properly grouted after completion.

The boring work will be performed by the specialized boring contractor Fugro Engineers BV, Holland.

Offshore

One or two jack-up platforms will perform geotechnical borings in the project corridor. In total say 30 borings.

The platforms will be assisted by tug-boats and guard ships will assist in smooth cooperation with other ships.

A drill ship will perform strength measurements from the seabed and until a depth of 25 metres.

Onshore

Truck mounted drill rigs will perform the geotechnical borings. In total say 5 borings in Germany and 5 borings in Denmark.

Stand pipes for continuous groundwater monitoring will be established in wells under protected covers as agreed with relevant authorities.

6. Advanced Laboratory testing

On selected samples from the boring campaign, advanced laboratory testing will be performed for determining the soils deformation and strength characteristics.

This testing will be carried out under a contract with a specialized laboratory.

7. Large Scale Testing

The purposes of large scale testing in the project area are to measure ground properties and construction element's performance in a scale comparable to real life structures. Likewise time effect may be studied over several years.

The nature and extend of the large scale in situ testing has not been defined in any details yet.

However, it is likely that temporary onshore and/or nearshore test fields will be established for investigating such important issues as settlements, pile bearing capacity, sliding capacity and etc.

8. Time Schedule

The activities described above will timewise be organized as a top down process, starting with overall understanding and finishing with all necessary facts.

ACTIVITY	YEAR 2008	YEAR 2009	YEAR 2010	YEAR 2011
Geo Information System	■			
Positioning System		■		
Geophysical Surveys	■			
Boring Campaign		■	■	
Advanced Laboratory			■	■
Large Scale Testing		■	■	■