



RAMBOLL

FAST, COST-EFFECTIVE AND VERSATILE LAND STEAMER SEISMIC INVESTIGATIONS

In the field of land based seismic Ramboll's geophysical group provides a comprehensive suite of unique and innovative solutions

The land steamer seismic was pioneered by Ramboll in the late 90's. We have since improved the working methodology and have today performed more than 1500 km. This is due to a unique capability of acquiring data with a cost-effective, fast and versatile system without compromising data quality. With a 10-meter shot interval the average daily production is about 3-4 km and this is done with field crews of only 3 persons. As the surveys are performed on roads there is no need for permits from landowners. This allows for fast process between the planning phase to acquiring data in the field. This setup has shown to be a remarkable tool when mapping for near surface seismic from 20 m to more than 1000 m depth.

Method of Choice

Ramboll uses a well-proven configuration for land steamer seismic surveys. The IVI Minivib T7000 seismic vibrator, employed as energy source, is mounted on a trailer pulled by a small truck. The vibrator can be

configured both vertically and horizontally. This assures maximum flexibility and fast mobilization for any type of survey. The land steamer, consisting of geophones mounted on steel sledges, provides excellent contact to the ground and can be pulled either directly by the vibrator truck or by a separate vehicle for full flexibility of shot location planning e.g. in urban areas or large road crossings. It is possible to choose from a selection of several streamers with different geophone types and spacings. The streamer selection is based on providing the optimal spread to the target area for the given project.

From idea to execution

As the surveys are performed on roads there is no need to contact landowners or worry about permits. This allows for fast process between the planning phase to acquiring data in the field. With a 10-meter shot interval the average daily production is about 3-4 km and this is done with field crews of

only 3 persons. And at the end of the day a brute stack of the days production is produced. The fast, permit free deployment and high production rate, which is possible on roads, makes the method ideal e.g. for feasibility studies prior to expensive large scale seismic surveys.

Solution Based Planning

Even though Ramboll's land steamer method was initially developed for mapping within the field of groundwater

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SELECTED LAND STREAMER REFERENCES

Nature Agency Denmark

- Groundwater research in Denmark. Several project app. 1000 km

Fehmarn Belt - Denmark/Germany

- Geological and geotechnical investigations

Shell Sweden

- Gas Exploration

SKB Sweden

- Deep Nuclear Waste Deposit

Metro in Copenhagen Denmark

- Geological and geotechnical investigations

DONG Energy

- Oil Exploration Denmark

Lund University Sweden

- Geothermal investigations

Helsingborg City Sweden

- Geotechnical investigations

research it has successfully been used for various projects: From gas exploration to mapping very shallow sand deposits in geotechnical investigations. All data acquisition is exclusively performed by Ramboll personnel and using Ramboll's own equipment. The primary setup for data acquisition is the P-wave reflection seismic as this still represent the vast majority of projects performed by Ramboll. However, recent years demand on achieving near surface profiling at higher resolution have given way for acquiring additional data such as S-wave reflection seismic and surface wave seismic (MASW). All of these data types can be acquired using the land streamer method and customized for a specific project. Also processing and interpretation is designed based on the requirements of the given project. The processing tools include full range of state of the art reflection seismic-, refraction- and surface wave processing as well as visualization tools. In the following some standard survey setups are listed:

P-wave Reflection Seismic

With more than 1500 km P-wave reflection seismic surveys performed this setup has proven to be a remarkable tool when mapping for e.g. groundwater. The final product is a 2D seismic profile showing reflectors with a vertical resolution of about 5 m from about 20-40 m below ground level to a depth of more than 1000 meters.

S-wave Reflection Seismic

By performing an S-wave reflection seismic survey we are able to map very near surface and small geological structures, such as sand deposits and boulders. The final product is a 2D seismic profile showing reflectors with a vertical resolution of about 1 meter from few meters below ground level to a depth of more than 100 meters.

Refraction Seismic

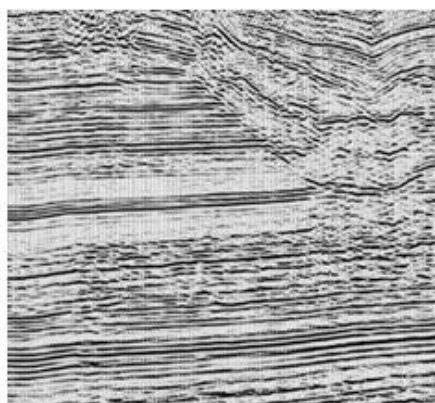
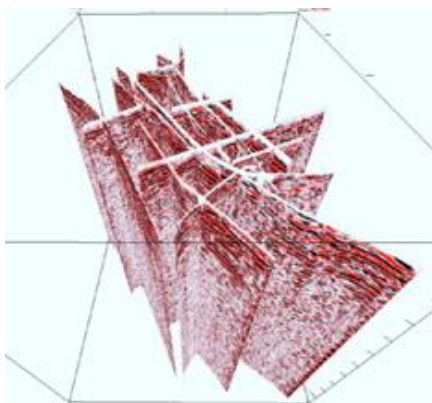
A refraction seismic analysis can be performed on the reflection seismic data. The method provides a gradual velocity variation, both horizontally and vertically. Refraction surveys are typically used to map the top of bedrock.

MASW

The surface wave seismic survey will provide a pseudo-2D section of S-wave velocity against depth. The end product will help form a picture of how the subsurface geology is structured from the ground level to a depth of around 30 meters. Shear wave velocity from MASW or S-wave refraction surveys is a useful parameter in geotechnical investigations since it is directly linked to e.g. small strain G-modulus.

Interdisciplinary Planning

All seismic investigations can be supplemented by various geophysical or other types of services. As Ramboll has a broad range of expertise not only in geophysics but within many service areas, it allows us to provide optimized local or large scale solutions. Ramboll's geophysical group is continuously working on integrating and coordinating our planning and technical solutions throughout the organization, so we can provide broadly based services to municipalities as well as public and private companies.



LEFT
3D visualization of the acquired seismic data in the city of Helsingborg

RIGHT
2D seismic segment showing a buried valley in southern Denmark