Geological and geotechnical databases and developments in the Netherlands

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What is Geodata?

All location dependent data from:

- Surface, and
- Subsurface

Surface data:

- Climate
- Vegetation
- Land use
- Erosion models
- Etc.

Subsurface data

- Properties of materials
- Material boundaries
- Subsurface processes

Geodata

In short all data that describe the surface and the subsurface of the earth and all processes that have been or are still active to form the materials of the earth.

Geodata in the past

Past:

No design other than the design of the construction based on expertise of the master builder

Past:

- Construction by trial and error
- No idea about fundamentals ground behaviour
- Only the effect on the construction could be seen

Past:

Influence of client (nobility, clergy, powerful landlords, etc.) on location and type of building was very large and in most cases overruling possible technical considerations

Past:

Underground excavations in an urban environment

The catacombs and burial sites in an urban environment: catacombs of Rome (built by trial and error)

Popes-Catacomb in Rome (photo David MacDonald, http://www.davidmacd.com/images/pope_catacomb.jpg)

Past:

Most underground excavations for mining

normally not in an urban environment

Past:

However, mining often provided the chance to gain experience and expertise in

- Ground behaviour, and
- Interaction structure - ground

Past:

During the industrial revolution and thereafter the expertise of miners is a keystone for the development of underground excavations for civil engineering

Also today, I would advice every engineering geologist and geotechnical engineer to work for some time in a mining environment to obtain a decent knowledge on the behaviour of soil and rock masses

Because it is the only place where structures are built with a safety factor of just 1, and which are also intended and allowed to fail over a short time span

Past:

Surface structures

Tower of Pisa

(trial and error….)

Tower of Pisa (photo Pisa, 2006)

Oude Kerk, Delft, The Netherlands

(trial and error….)

Oude Kerk, Delft, The Netherlands (photo Oude Kerk (Delft), 2006)

For both towers was already during construction found that the subsurface gave excessive differential settlement and the building was adjusted, result:

Pisa a leaning curved tower, Delft a leaning bended tower

Tower of Pisa (photo Pisa, 2006)

Oude Kerk, Delft, The Netherlands (photo Oude Kerk (Delft), 2006)

Past:

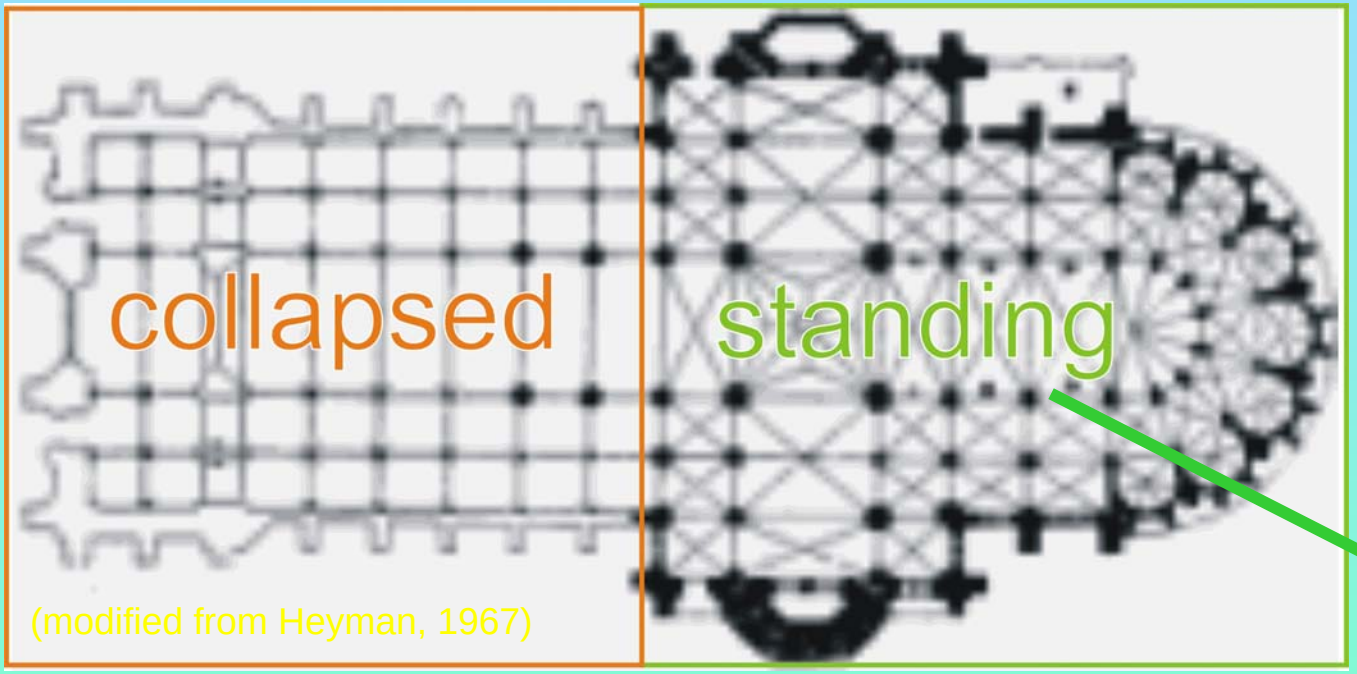
When the “error” was larger then in the forgoing examples mostly the structure collapsed

Beauvais Cathedral of Saint Pierre, France -

collapsed (in part) 3 times

Cathedral of Saint Pierre, Beauvais (photo Allen et al., 2003)

Beauvais Cathedral, France



Beauvais Cathedral, France

Remaining part also today under threat of collapse due to differential settlement in the subsurface and structural weaknesses in the construction


(photo Allen et al., 2003)

In the past:

- Expertise of the master
- Trial and error
- No idea about fundamentals of ground behaviour
- Only the effect of the ground behaviour on the construction could be observed
- Transfer of knowledge on ground behaviour and geodata by system of “master and apprentices”
- Strong influence of the client

At present (1):

Past: Expertise of the master

Present: Although not called a master the chief engineer is still important

Past: Trial and error

Present: “normally” avoided by using modelling and testing

At present (2):

Past: No idea about fundamentals of ground behaviour

Present: Since the last ½ century large development of knowledge

Past: Only the effect of the ground behaviour on the construction could be observed

Present: Plenty of monitoring options of the ground itself

At present (3):

Past: Transfer of knowledge on ground behaviour and geodata by system of “master and apprentices”

Present: the same but also universities and schools, written and printed documents, and recently internet

Past: Strong influence of the client

Present: the same, but more “hard” technical documentation available to convince client if his wishes may not be “logical” …….

Future:

Is geodata going to be required?

Is more geodata going to be required?

Is other geodata required than at present?

Can the ease of use of geodata be improved?

Can geodata be made more credible?

Use of the subsurface

- More emphasis on environmentally more sound forms of infrastructure (hence underground)
- Shortage of space will require more use of the underground
- Power stations (for example, nuclear power stations) underground
- Storage of energy
- Storage of waste
- Geoenergy

More and more structures and infrastructure underground

which will increase the demand for geodata

- More structures and infrastructure underground means more competing uses of the underground
- More complex relations and influences between different uses of the underground

  (for example, it is not nice if your neighbor installs a geoenergy storage installation just besides your wine cellar)

more use will also require:

- Protection of sites (for example, archeological etc.)
- Geological special sites (for example, type sections)

More use of the underground is without doubt going to lead to

- more subsurface related disasters, and
- destroying of valuable underground features

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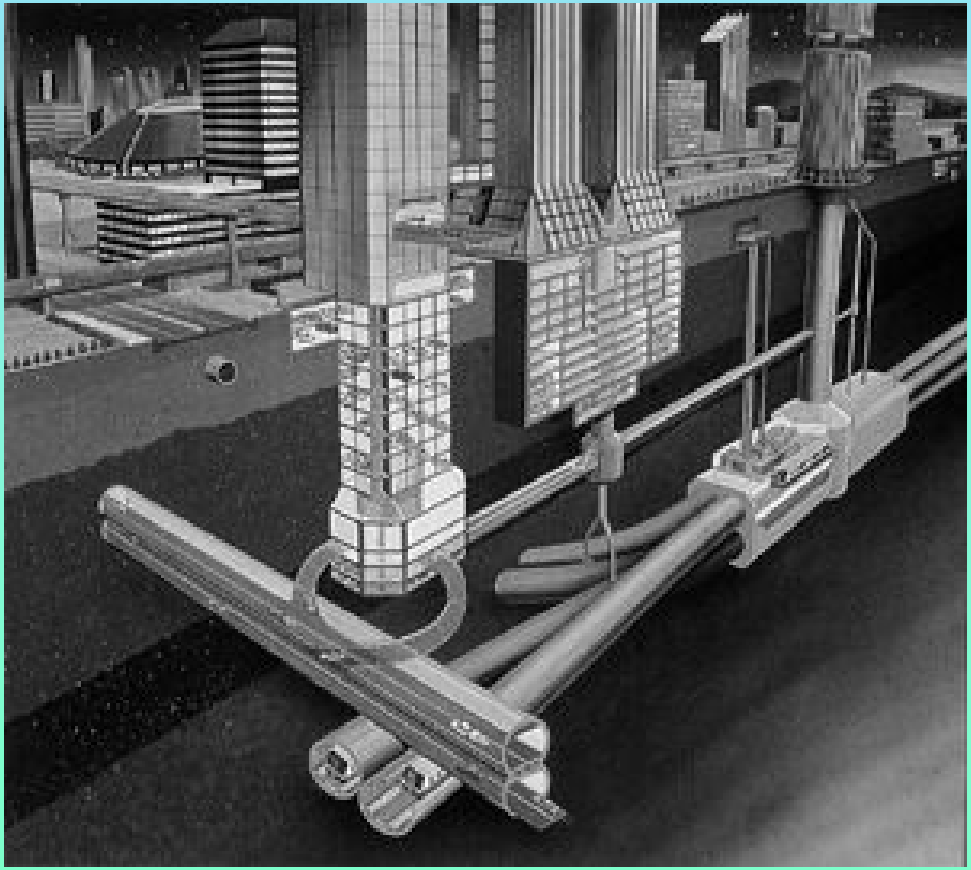
Are other types of geodata required?

More intensive underground use will require more data on:

- Time effects
- Heat flow/isolation capacity



Time effects:

- “Walking” pipelines and tunnels
- Degradation of material under influence of vibrations or pressure

Heat flow/isolation capacity of ground:

- How well does the ground isolate fires?
- How are the ground properties influenced by a fire?

Heat flow/isolation capacity of ground:

- How do ground properties change or degrade under influence of repeating cycles of temperature changes (geoenergy storage)
- How well does the ground isolate? (your wine cellar neighbouring a geothermal energy storage!)
- Etc.

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Ease of use and credibility:

- Invisibility of the subsurface
- High “hocus-pocus” level and the vagueness of many geological or geotechnical advices caused by:
  - The complexity of underground data
  - The complex relations and processes in the subsurface

  In addition:
  - The often high degree of uncertainty
  - The impossibility to quantify the uncertainty

Invisibility

Visibility improves day-by-day:

- 3 and 4 dimensional GIS
- High-level of 3 and 4 dimensional visualization of the subsurface

Is not (yet) perfect but rapidly improving in quality

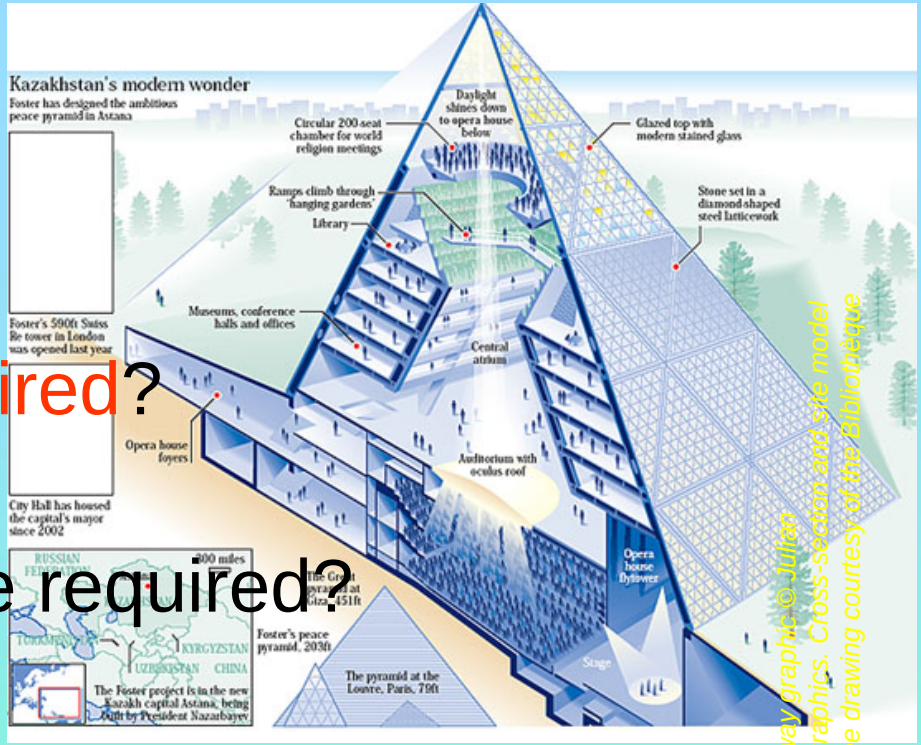
Allows also non-experts to get a better idea on the geodata of the subsurface

(and to understand why it is important)

Expectations from research

- Developments of standards for exchange of geodata (and thus also models)
- Uncertainty quantification

Future:



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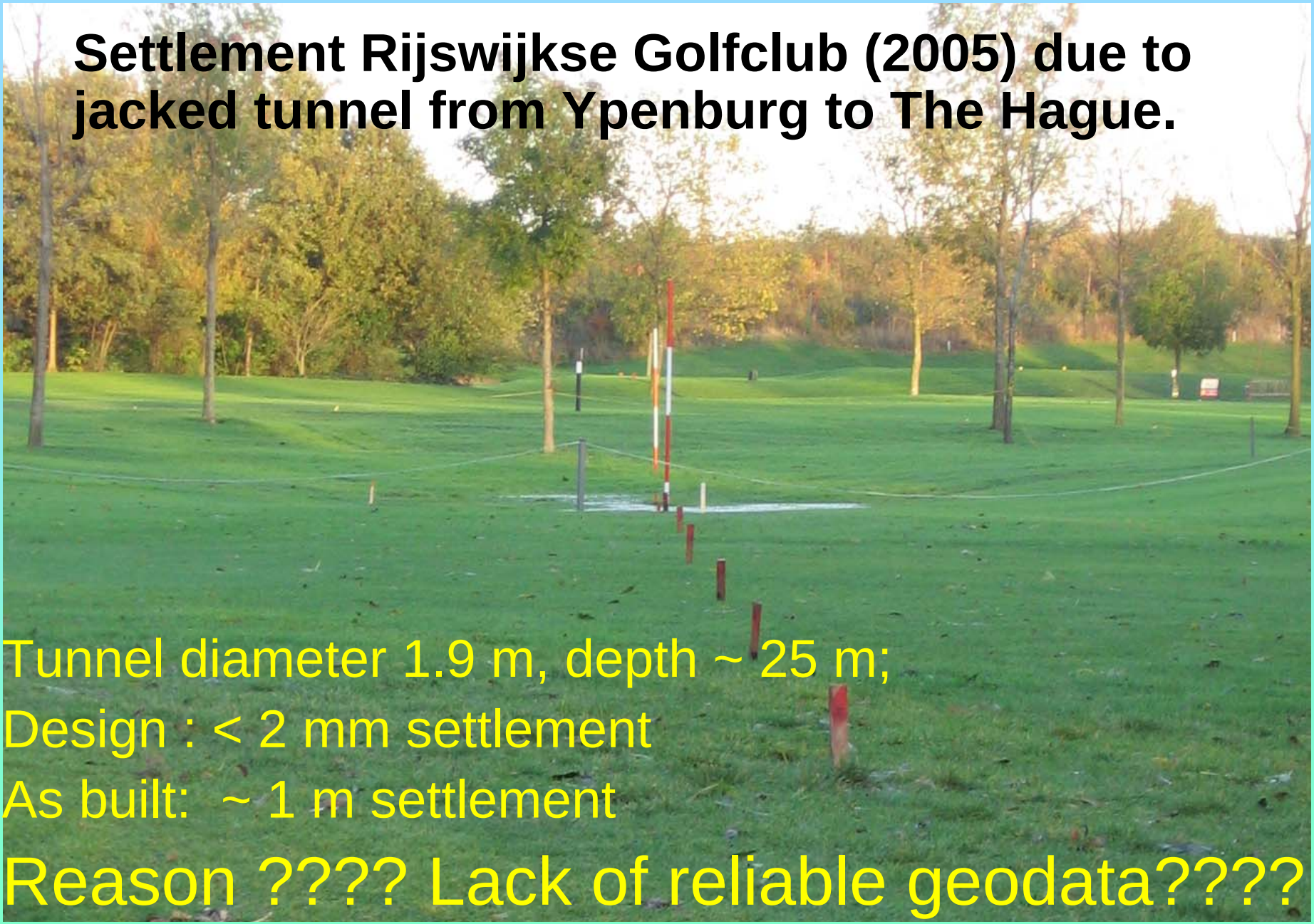
Settlement Rijswijkse Golfclub (2005) due to jacked tunnel from Ypenburg to The Hague.



Tunnel diameter 1.9 m, depth ~ 25 m;

Design : < 2 mm settlement

As built: ~ 1 m settlement

Reason ???? Lack of reliable geodata????

Is there really that much improved ?

Probably not yet …..