ABSTRACT: The tunneling industry in the Netherlands has a long history concerning immerse tunnels as well as cut & cover tunnels. In the last 20 years the shield driven tunneling technology (TBM) has been successfully introduced in the Netherlands where the soil condition is very poor. Some of challenging projects were successfully finished such as: high speed line tunnel Green Heart, till 2006 the biggest in the world, metro Amsterdam, 3 TBM tunnels at Betuweroute, Rotterdam to German border etc. The experience gained with the tunneling projects in the past has created the possibilities for the new projects in the Netherlands. This paper deals with the upcoming mayor tunneling highway projects in the Netherlands in the period 2013-2020 such as: Rotterdamse baan at the Hague, Rijnlandroute at the Voorschoten, Leiden and East-gate tunnel to Brainpark at Laarbeek. All these tunnels have similarities concerning their function, construction method and efficiency to their environment. Engineering company Movares showed that these tunnels are technically and financially feasible. The estimated limited higher cost of the bored tunnels makes them a attractive alternative on regular tunneltypes.

1 Introduction
New infrastructure requires appropriate adjustment to its environment. Both in urban and in rural areas is often considerable public resistance present against the new highways. People really do not want to hear, see and smell the traffic which lead to creation of pressure on the planning and processes. They are also not amused to have disturbances from the construction sites for couple of years but the highways have to be build. Shield driven tunnels are increasingly seen as alternative because the technique is optimized and costs are lower than some years ago. With current experience and knowledge of bored tunnels in the Netherlands the 'wheel reinvention' is unnecessary. One of the successful examples of the highway tunnels is Hubertus tunnel in The Hague (L=1,6 Km, D= 10,5 m, see Figure 1).

The future mayor project Rotterdamse baan at the Hague (ROBA), Rijnlandroute at the Voorschoten / Leiden (RLR) and Brabant city-Brain Gate East at Laarbeek (BP) (see Figure 2) are comparable with the Hubertus tunnel concerning tunnel diameter, soil conditions, construction method etc. This similarity between the tunnels lead to repetition of the solutions: A previously selected design is repeated with saving on engineering and could provide a potential benefit to the tender. Shield driven tunneling method consists of repetition of construction process with unified elements and relatively fixed number of details. This reflects to the lover costs of unforeseen risks and the design costs.
2 Rijnland route bored tunnel (RLR)

Rijnlandroute – Part of de Rijnlandroute connects two highway’s: A44 and A4. In June 2012 a trace without bored tunnel was already approved by the Province of South Holland. A new 2x2 lane motorway between A4 and A44 in municipalities Leiden and Voorschoten was planned in different tunnel segments: part open, part cut&cover, part sunk passing de river Rijn. This new compound is of great importance for the region Holland Rijnland, especially around Leiden and Katwijk. The Rijnlandroute is necessary for the economic potential of the whole region and development of new housing projects at adjacent municipalities as Wassenaar and Leidschendam-Voorburg. Movares was commissioned by the Province of South Holland and the municipalities Voorschoten and Leiden to perform a feasibility study for the realization of this route as a bored tunnel (section between A44 and A4, see Figure 3). Two variants have been examined, a short bored tunnel located between A4 and just passing the railway (west side) and a 500 m.longer bored tunnel. The results of the variant study showed that the short tunnel variant is a better option concerning logistic and financial aspects. Further optimization in later planning stages is off course possible.
The total length of the double tube tunnel is 2.6 km comprising a 324 m western incline, a 374 m eastern incline and 1,906 km of the shield driven tunnel. Tunnel diameter is 10.5 m (see Figure 4.) and the thickness of the precast concrete segments is 0.4 m. Escape cross passages between the tubes are located at every 250 m. The western and eastern inclines are broken down in three sections: open cutting of (169 m and 251 m); cut and cover tunnel of (195 m and 93 m) and start respectively exit shafts of 30 m.

Figure 4. Cross section

The inclines are built inside the containment made of steel sheet piles where the underwater concrete has been anchored by driven piles. Soil characteristics of the tunnel location are poor but not challenging. There are multiple soil layers consisting of salty and brackish water with water table up to the ground surface. The Holocene Westland geological formation, with 10 m to 15 m thick pit and marine clay layer settled on the lose sand, gives a proper picture of difficult soil conditions for any construction works. Under this formation are fine sand layers with density of 10 % to 60 %. Furthermore, any construction works under these soil conditions should be carefully considered, taking into account the influence of a soil disturbance on the structures.

Curiosity of this project could be find in the process development of the politic consensus between the province, municipalities and the citizens. Enormous social and administrative pressure and criteria of the council executive and advisory board ware an input for decision of Province of South Holland to investigate a the alternative of a bored tunnel. Results of the feasibility study of a bored tunnel showed that this solution is technically and financially feasible (short version). This means also a minimal impact on population health at Voorschoten. Homes and companies on the route do not have to move and the facilities in Voorschoten remain: sports fields, allotments, golf course, existing connections remain intact, surface remains mostly untouched. The goodwill of all participants to find the optimal solution was the key element. But the momentum was definitely influenced by public pressure on alternative solutions and the recent experience on the cost of bored tunnels.

The repetition as a tool for more efficiency can be also implemented in this project. The municipality of The Hague (ROBA) and the Province of South Holland (RLR) decided to collaborate in the construction of the two similar tunnels. Both bored tunnels have a similar function, technical issues (tunnel diameter, segment thickness, etc.) and are developed simultaneously. Cooperation during the design phase and possibly also in the construction phase leads to benefits such as increased efficiency in the implementation, lower costs and reduced risks The Hague will have in the future three tunnels under their own management (Hubertus, ROBA and RLR) and their expertise in this area will be shared with the Province of South Holland.

Preliminary design and integration plan have to be ready at the end of 2013 and the start of construction is planned at the end of 2014 with expected completion in 2019.

3 Brabant City - Brain Gate – East West corridor at Laarbeek

The project Northeast Corridor (NOC) part of Brain Gate project will increase the accessibility of the province North Brabant (PNB) on the east side of the Eindhoven region. Goal is to improve the Veghel Helmond
connection while providing opportunities for the spatial development of the entire area. The NOC is a part of the field development of the region between Eindhoven and Helmond above and below the Wilhelmina channel. This includes the area of Dommel and Aa; an investment in nature and water in the middle area between Eindhoven and Helmond to enlarge viability of the inhabitants of the metropolitan region and recreation within the region. The Northeast Corridor is about upgrading the N279 between Veghel and Asten in conjunction with the construction of a new east-west connection with which the ‘Ring’ around Eindhoven - Helmond is completed.

The adjustments with the infrastructure should lead to: improving the accessibility of the eastern part of the Eindhoven – Helmond, linking economic clusters in Brain Gate, Improved quality of life, reduced fluctuation of traffic through urban areas, increase the robustness of the road network. Northeast Corridor project - N279 – consist of upgrade from 2x1 to 2x2 lanes. The east-west connection between Eindhoven and Helmond – consist of new highway with 2x2 lanes without drilling the new tunnels (see Figure 5).

At the junction Nr. 2 at Laarbeek passage Dierdonk and south of Willemsvaart and Dommeldal Nr. 5 the Cut & Cover tunnels have been considered. Movares was commissioned by the municipality of Laarbeek to help them with our knowledge and experience concerning technical and financial feasibility of the alternative solution with a bored tunnel. The results of the variant study showed that the bored tunnel variant is a better option than cut & cover tunnel because of the following reasons: financial aspects, a minimal impact on population health in the vicinity. Homes and companies on the route do not have to move and the facilities in the region remain: sports fields, allotments, existing connections remain intact and surface remains partly untouched.

The total length of the double tube tunnel is 3,7 Km comprising a 350 m western incline, a 350 m eastern incline and 3,0 km of the shield driven tunnel. Tunnel diameter is 10,5 m (see Figure 4.) and the thickness of the precast concrete segments is 0,4 m. Escape cross passages between the tubes are located at every 250 m. The western and eastern inclines are broken down in three sections: open cutting, cut and cover tunnel and start respectively exit shafts of 30 m. The inclines are built inside the containment made of steel sheet piles where the underwater concrete has been anchored by driven piles.

The repetition as a tool for more efficiency can be also implemented in this project. This tunnel has a similar function, tunnel diameter, segment thickness, cross passages etc with the Hubertus, ROBA and RLR tunnels and it can possibly take advantage of a simultaneous development with the other projects. Construction will commence in 2015 after finishing the necessary activities around project preparation such as preliminary design, integration issues etc.
4 Considerations and conclusions

Hubertustunnel, Rotterdamse Baan, Rijnlandroute and the Laarbeek-tunnel have these common issues: Construction method with TBM, same diameter, segment thickness, cross passages, access ramps and shafts, Tunnel Technical Installations and equipment, tunnel management and maintenance. Project organizations ROBA & RLR are organizing a partnership between them. Brain Gate project will probably try to follow the example of ROBA & RLR project. This will increase the chance of lower costs for related organizations, design, implementation, management and maintenance with lower risk profile.

The recent studies tell us that lower cost of bored tunnels at the moment en even further cost-optimization in the future trough technical stadardisation will increase the posibilities of considering this type of tunnel. Even in situations where, considering the Dutch conditions, it was held for impossible because of the immense costs.

Standardized solutions for the highway with 2x2 lanes through the shield driven tunnels results in: savings in costs, less public resistance, lower risk margin in early planning phase and satisfaction. Also for the durable society this is a evident gain.

5 References