

BACHELOR THESIS

Technical comparison of two advance safety methods in tunnel construction using the example of pedestrian tunnels in the Middle East

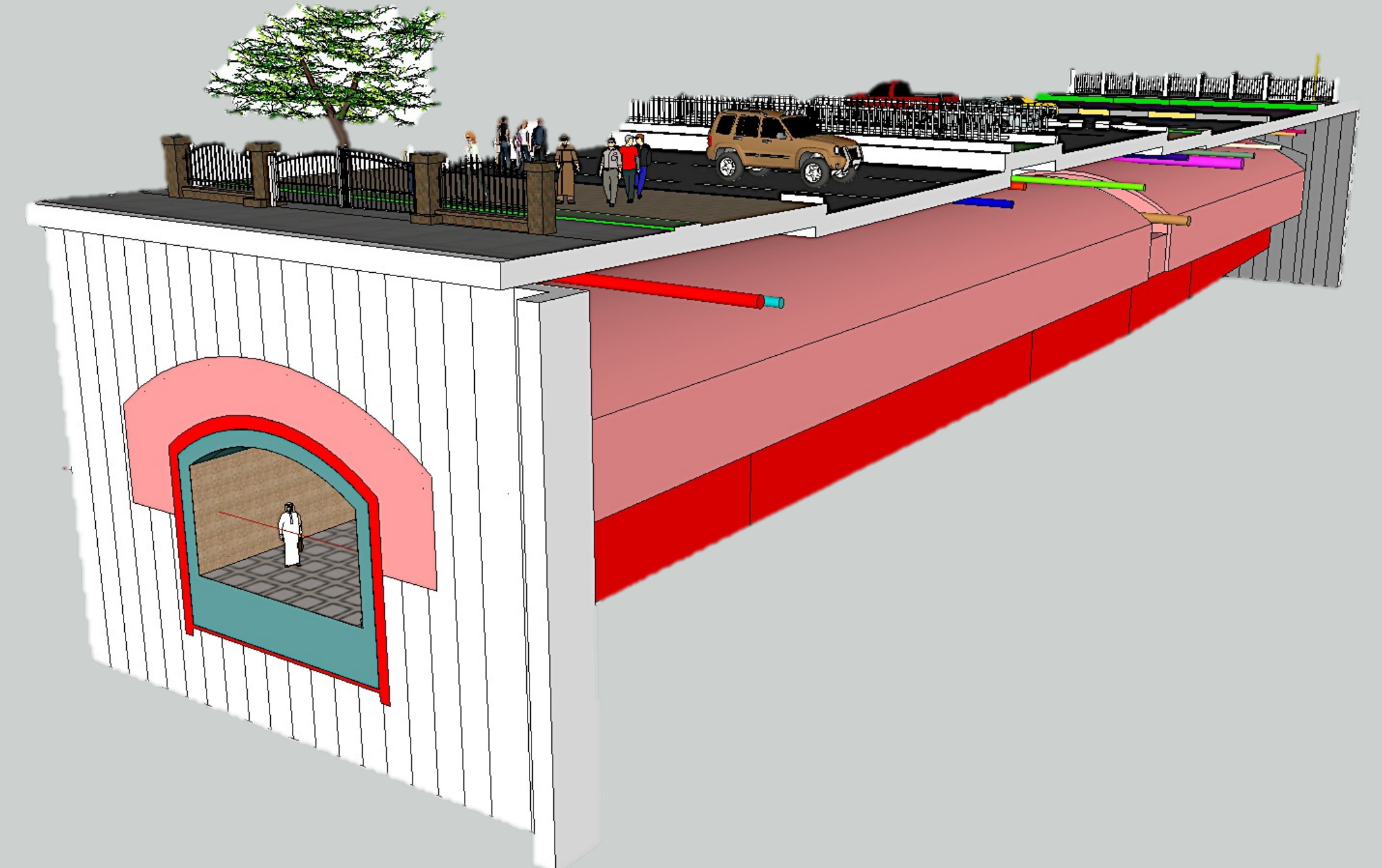
Content:

- Explanation of the theoretical basics of tunnel construction
- Introduction to anticipatory safety methods for closed tunnel construction
 - Pipe arch and umbrella injection in general
- Completed pedestrian tunnel projects and their boundary conditions in Abu Dhabi and Doha
- Technical comparison of pipe arch and umbrella injection

Objective:

- Technical explanation of how to perform both backup methods
- Comparison of the areas of application, suitability tests, drilling methods, measuring systems and problems that arise
- Advantages and disadvantages of a pipe arch and umbrella injection including calculation of material costs
- Conclusion and outlook on future pedestrian tunnels in the Middle East

3D tunnel model with umbrella injection
Nation Towers pedestrian tunnel Abu Dhabi
Quelle: BAUER



Construction method:

Tunnel construction:

- Open construction
- Closed construction
- Special Construction

Tunneling methods:

- conventional tunnel drive
 - Blast
 - Excavator
- by machine tunnel drive
 - Roadheader TSM
 - Tunnel boring machine TVM

Cross Section Division:

- Full breakout
- Partial breakout

Backup methods:

- Wandering hedge
- Permanent hedge
- Ahead moving hedge

Pre-fuse Backup:

- Groundwater management
- Freezing method
- Pipe arch
- Umbrella injection
- HDI-Process

Permanent Backup:

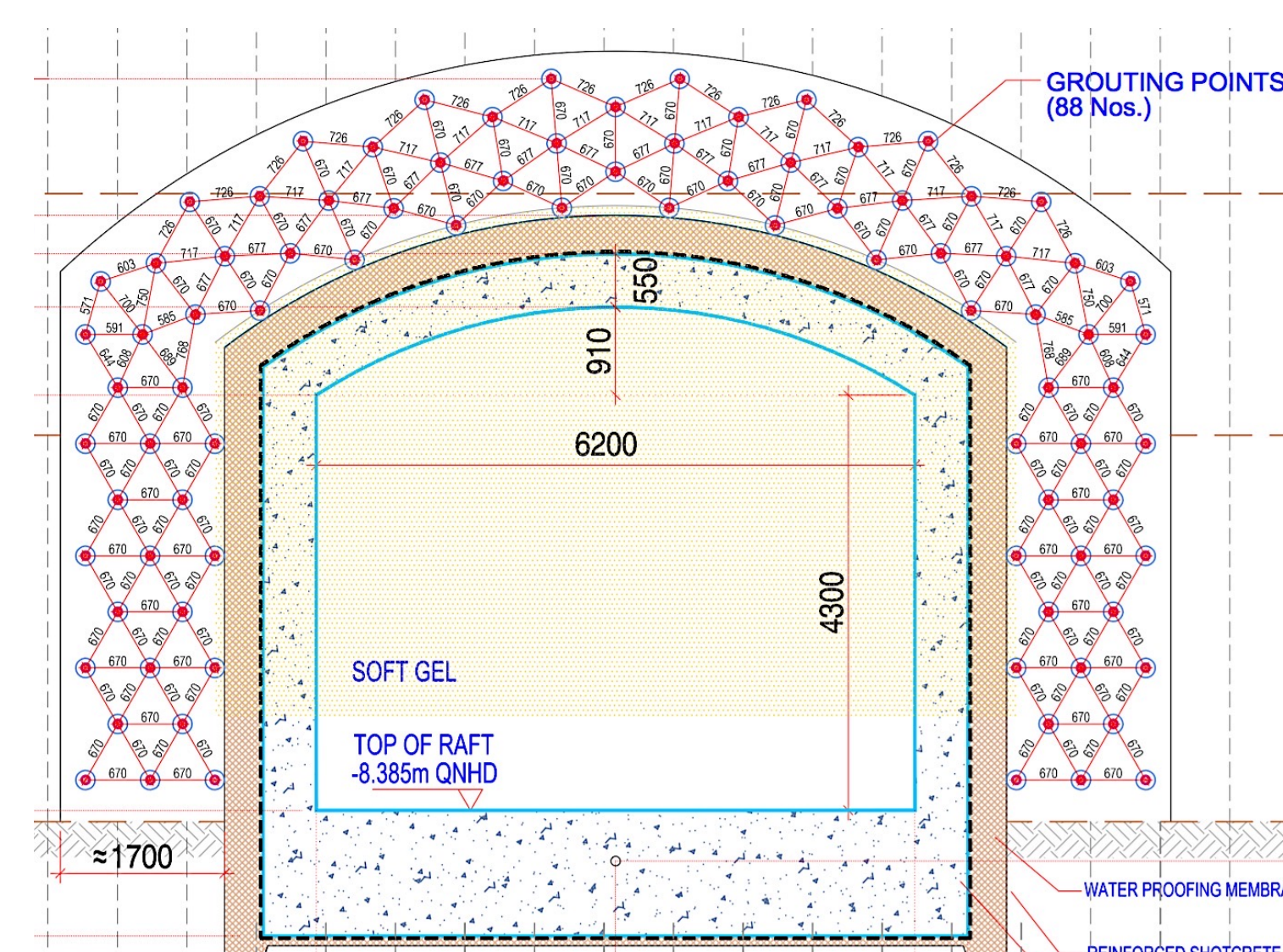
- Concrete
 - Shotcrete
 - Formwork concrete
 - Precast concrete
- Steel
 - Anchor
 - Bows
 - Skewers
 - Welded wire mesh

Manufacturing process of pedestrian tunnels:

- Closed construction with conventional tunneling using an excavator in full excavation under shotcrete support and advance umbrella injection or steel pipe arch.

Technical comparison:

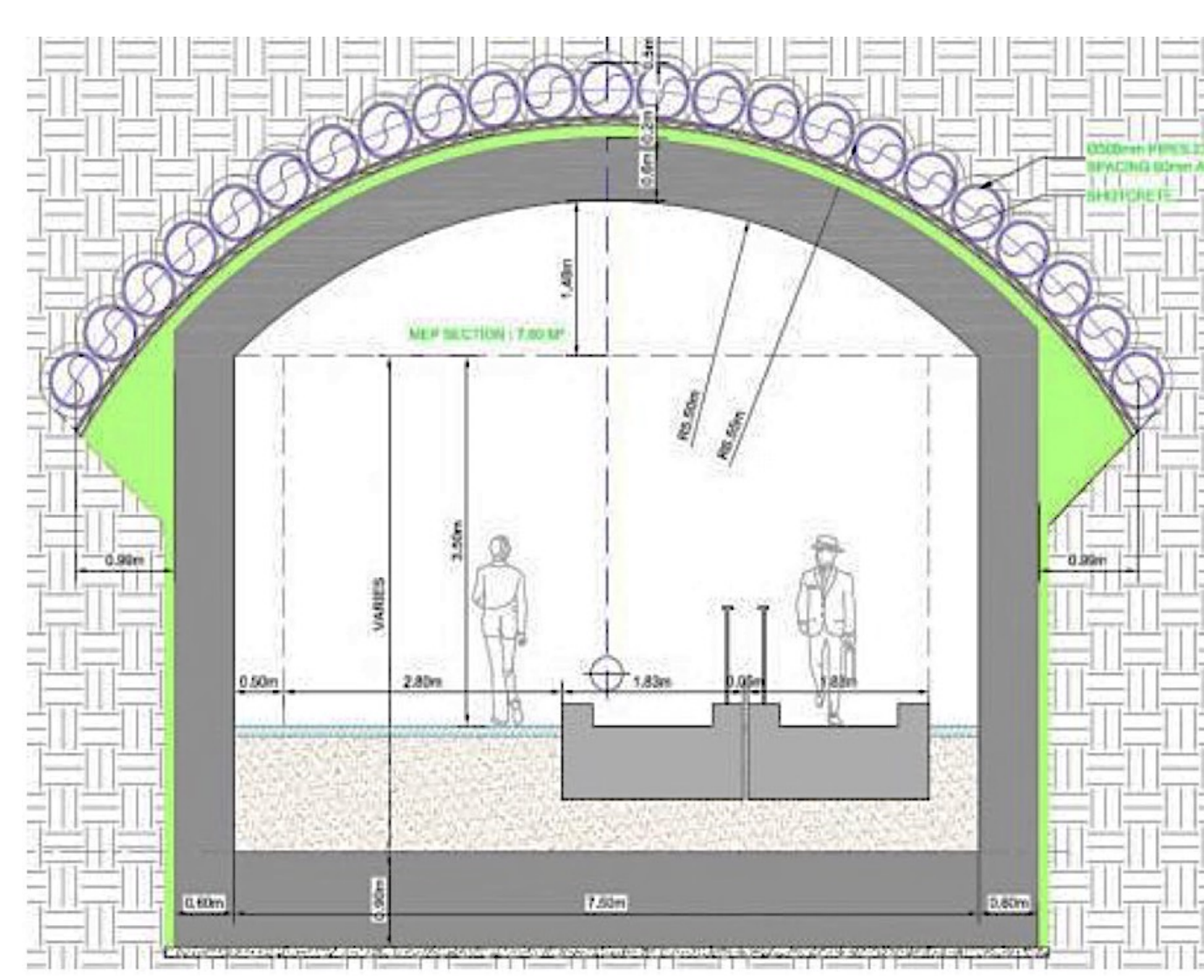
Umbrella Injection:



Quelle: BAUER

- Elaborate preliminary investigations into injection materials and soil conditions
- Field tests are necessary
- executable in almost every geology
- Executable in groundwater
- Construction requires relatively little space
- Drilling process relatively uncomplicated
- Ground obstacles can be included
- surveying requires a lot of experience
- Elaborate injection process
- Expensive

Steel pipe arch:



Quelle: QDVC

- Preliminary investigations mainly by finite element method
- Field tests are not necessary
- Mainly suitable for firmer geology
- Only suitable to a limited extent in narrowly graded sands
- Not executable in groundwater
- drilling rig requires more effective space
- Drilling process expensive to manufacture
- Obstacles in the subsoil cannot be included
- Surveying technology very user-friendly
- Economical

Conclusion:

- Both methods allow the tunnel construction in closed construction under difficult boundary conditions.
- A detailed soil investigation remains unavoidable
- Costs can be saved by using a steel pipe arch if it can be implemented
- An injection umbrella can be implemented almost anywhere, but is more expensive
- If the production of a steel pipe arch is feasible, this is recommended
- Ultimately, the given boundary conditions decide on the backup method

Outlook:

- The required tasks are becoming more and more complex these days and require solutions like these. The implementation of pedestrian tunnels under difficult boundary conditions without impairing road traffic remains a challenge for future projects. In order to get a solution that is as economical as possible, a combination of both processes can also be considered..