AT - Pipe Umbrella System
Introduction

The AT - Pipe Umbrella System is a pre-support measure used in weak ground conditions in conventional as well as mechanized Tunneling. Pipe umbrella pipes increase the stability in the working area by transferring loads in the longitudinal direction and decrease excavation induced deformations. The system increases safety in the working area.

Beside this standard usage, the system is often applied to increase stability in portal sections and for the re-excavation of collapsed sections in underground construction. Another application area is ground improvement and waterproofing in combination with all tunnel construction methods.
Fields of Application

- Advances in weak ground and ground conditions prone to subsidence
- Advances in alpine fault zones
- Advances in sediments or talus
- Portal sections
- Advances in frequently changing ground conditions
- Re-excavation of collapsed drifts or tunnels
- Urban Tunneling

Main Advantages

- Installation with conventional drill jumbos
- Execution of pipe umbrella drilling with on-site personnel
- Simple and robust system components
- Fast self-drilling installation
- Smallest possible stress relaxation due to an immediate support of the borehole wall during installation
- Accurate installation due to a minimized annular gap
- Length of pipe umbrella pipes can be adapted to constricted space
- Different pipe coupling types available to suit different project requirements
System Description

The AT - Pipe Umbrella System is installed
- Using the overburden drilling method
- Piecewise
- With conventional drill booms
- By hydraulic, rotary-percussive drilling

Cooling, flushing, and back-flow of the cutting takes place inside the casing pipes using water.

System Components

- AT - Starter Unit with Drill Bit
- AT - Extension Tube
- Valves in injection holes
- Various AT - Adapters
- Drill Rods
- AT - Grouting Plug (End Plug)
## Specifications

<table>
<thead>
<tr>
<th>System</th>
<th>Steel grade</th>
<th>Modulus of elasticity</th>
<th>Yield strength</th>
<th>Outer diameter</th>
<th>Wall thickness</th>
<th>Weight</th>
<th>Standard tube length</th>
<th>Moment of inertia</th>
<th>Section modulus</th>
<th>Maximum moment (elastic)</th>
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</tbody>
</table>

1) Deviating structural properties are available on request
2) According to EN 10296-1
Technical Features

- Quick length adjustment of the AT - Pipe Umbrella System facilitated by piecewise installation
- Simple connection of extension tubes even in restricted space
- High drilling accuracy of pipe umbrella drills
- Special pipe coupling types for different static requirements
- The use of the AT - Pipe Umbrella Automation Unit increases the drilling progress, minimizes over-excavation (saw tooth profile), and increases personnel safety
- Application of preventers possible
- Recording and control of the grouting process using a flow-pressure meter

AT - Drilling System

The drilling energy is transferred via drill rods and an inside adapter onto the single-use drill bit of the AT - Starter Unit. The cooling and flushing medium is immediately transported from the drill bit front backward inside the umbrella pipes. After completion of the installation, the single-use drill bit remains at the toe of the borehole; adapter and drill rods are removed and re-used for consecutive pipe installations.

- Loss or blocking of a drill bit is impossible because it is fixed within the starter unit
- A single-use drill bit ensures the same high quality for each drilling process
- Application of a single-use drill bit provides optimum pre-conditions to achieve the total drilling depth every time
- The drill bit type can be adapted to given geological conditions
- Stable drilling direction due to stable drill bit orientation
- Disconnecting and reconnecting of drill rods is possible at any time
- Small overcutting ensures the lowest possible stress relaxation
- Special pipe coupling types for different static requirements
- The use of the AT - Pipe Umbrella Automation Unit increases the drilling progress, minimizes over-excavation (saw tooth profile), and increases personnel safety
- Application of preventers possible
- Recording and control of the grouting process using a flow-pressure meter
AT - Pipe Couplings

The AT - Pipe Umbrella System is installed with conventional drilling machines. Single pipes are installed piecewise at a length that fits the drill boom length.

Type and quality of the pipe coupling are decisive factors for the maximum achievable load-bearing capacity of the support system.

For this reason, three different types of couplings are available for the AT - Pipe Umbrella System.

Standard Thread Connection

When using a standard thread connection, an outside and inside thread is cut into the ends of the pipe umbrella pipes. This type of coupling reduces the cross-section of the pipe at the area of the thread connection. Thereby, the section modulus is decreased as well. Besides the geometrical conditions of the thread, the overall quality of the pipes is a major concern for the maximum load-bearing capacity. In general, calibrated tubes reach a higher resistance against bending than non-calibrated ones.

- Simplest connection type
- Installed tubes show a constant inner diameter
- The stiffness of the connection is considerably lower than the stiffness of the standard pipes
- The rupture load of the connections is comparable to the design load of standard pipes; it is clearly lower for non-calibrated tubes
- Further decrease of the load-bearing capacity if mistakes occur during screwing or grouting of the pipes
- A lower load-bearing capacity can only be compensated by a higher number of pipes
- Dislocation of the coupling positions in the longitudinal direction does not increase the load-bearing capacity
- Installation can be accomplished with or without an AT - Pipe Umbrella Automation Unit

Squeezed Connection

A squeezed connection consists of a reduced pipe end which is force-fitted with its counter piece. In the coupling area, the cross section stays constant and the section modulus is decreased.

- The ultimate load of this connection is higher than the elastic design load of a normal pipe (> 1.5)
- Transition from elastic to plastic material behavior begins at approximately ¾ of the elastic design load (standard pipe)
- Reduction of the inner diameter in the connection area
- Reduction of the stiffness against bending in the connection area
- Installation can only be accomplished with an AT - Pipe Umbrella Automation Unit incorporating a squeezing unit

Usage of this connection type can be recommended for all advances where a pipe umbrella is installed because of its static load-bearing capacity.
Nipple couplings are an additional steel nipple where a thread connection is pressed and welded into both ends of the extension tubes. This ensures that the section modulus at the coupling is never lower than the section modulus of the standard pipe.

- The elastic design load is equal to the one of a standard pipe
- Stiffness in the elastic range is comparable to the one of a standard pipe
- Reduction of the inner cross-section
- Installation can be accomplished with or without an AT - Pipe Umbrella Automation Unit

Usage of this connection type can be recommended for advances where the static load-bearing capacity is required to achieve stable conditions and settlement limitations are part of the design.
Installation Procedure

1. For drilling, the AT - Starter Unit with drill bit is assembled together with the first AT - Extension Tube, the AT - Adapter, and the drill rod onto the drill boom.

2. Installation of the first AT - Extension Tube.

3. The next drill rod with AT - Extension Tube is connected to the previously installed pipe and the drilling process is continued afterwards.

4. The last step shall be repeated until the designed length of the AT - Pipe Umbrella has been installed.
The AT - Pipe Umbrella Automation Unit allows automated feeding, screwing, and installation of extension tubes plus drill rods.

**Main Advantages**

- Shorter manipulation times due to exact and automated feeding
- Faster construction of a pipe umbrella support system
- Higher occupational safety
- No handling besides moving parts of the drilling machine
- Simple re-charging of extension tubes via a loading basket
- Remote-controlled feeding of tubes
- Less manpower required
- Optimum utilization of the working space
- Smaller saw-tooth shaped profile and thereby less excavation volume
Assembly groups

Specifications

<table>
<thead>
<tr>
<th>Characteristics / Assembly group</th>
<th>Dimensions (L x B x H) [mm]</th>
<th>Weight [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe deposition</td>
<td>1,040 x 230 x 350</td>
<td>28</td>
</tr>
<tr>
<td>Screwing unit and centering/clamping device</td>
<td>1,165 x 360 x 745</td>
<td>160</td>
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<tr>
<td>Loading device and pipe feeding system</td>
<td>3,485 x 350 x 565</td>
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<td>Central guiding device</td>
<td>155 x 190 x 220</td>
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<tr>
<td>Hydraulic control box</td>
<td>550 x 275 x 345</td>
<td>60</td>
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<tr>
<td>Electric switch case</td>
<td>380 x 600 x 350</td>
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<tr>
<td>Remote control</td>
<td>250 x 140 x 180</td>
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<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Unit</th>
<th>Value</th>
<th>Remark</th>
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<tbody>
<tr>
<td>Total weight (gross)</td>
<td>[kg]</td>
<td>460 - 490</td>
<td>Deviations possible, depending on the type</td>
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<td>Electric supply</td>
<td>[V]</td>
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<td>Hydraulic supply</td>
<td>[L/min]</td>
<td>20</td>
<td>At approx. 170 [bar]</td>
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</table>
Assembly groups

- Screwing unit and centering/clamping device
- AT - Starter Unit with drill bit
- Foundation ground
- Central guiding device
- Hydraulic rock drill
- Drill boom
- Hydraulic control box
- Pipe deposition with AT - Extension Tube and drill rod
- Loading device and pipe feeding system with AT - Extension Tube and drill rod
Accessories

- Flow-Pressure meter
- Injection packer
- Mortar-Mixing pump
- DYWI® Inject Systems
- Fishing tab
- Drill rod wrench
- Chain pipe wrench
- Rock drilling equipment: shank adapter, coupling, and coupling adapter

Further References

- AT - Pipe Umbrella Geometry Calculator
- Installation Manual for the AT - Pipe Umbrella System
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