Trenchless Tunnel Construction of Bukit Panjang Underpass

Ed Züblin AG - Singapore Branch
Member of the STRABAG Group
Singapore
Located in the western region of Singapore, the Land Transport Authority (LTA) Contract 9057 Bukit Panjang Underpass Project was awarded to Ed Züblin AG – Singapore Branch in 2014. The scope of works included the Architectural works, the design, construction and completion of an additional underground Entrance and a linkway tunnel connecting the new Entrance to the existing Entrance of the Bukit Panjang Mass Rapid Transit (MRT) Station.
• **Project Owner:**

Name : Mr. Chiang Chee Cheong  
Company : LTA (Land Transport Authority of Singapore)  
Position : Senior Project Manager (SPM)  
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• **Project Owner’s Consultant:**

Name : Mr. Ngan Ping Leung  
Company : PB (Parsons Brinckerhoff)  
Position : Deputy General Manager  
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• **Structural Designer**:
  Name: Dr. Oskar SIGL
  Company: Geoconsult Asia Singapore Pte Ltd
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• **Architectural Designer**:
  Name: Lim Choon Keang
  Company: CKLI:ET Architects
  Position: Managing Principal
  Email: ck@cklietarchitects.com

• **M&E Designer**:
  Name: Edward Woo Ewe Wee
  Company: Gims & Associates Pte Ltd.
  Position: Professional Engineer
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**Jet Grouting:**
Name: Benny Oh  
Company: Sonic Foundation  
Position: Director  
Email: sonicfoundation@yahoo.com.sg/benny.oh@sonicfoundation

**Structural Steel Works:**
Name: Soe Tin  
Company: Asia Metal  
Position: Director  
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**Reinforced Concrete Works:**
Name: Liu Jiang  
Company: China Railway 11  
Position: Executive Manager  
Email: LiuJiang@chinarailway11.com.sg
**Operational**

<table>
<thead>
<tr>
<th>Major Brands</th>
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<tr>
<td><img src="image" alt="Züblin" /></td>
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<table>
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<tr>
<th>Central Staff Units</th>
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<tr>
<td>AUDIT</td>
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<table>
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<tr>
<th>Central Service Companies</th>
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<tbody>
<tr>
<td>BRYF</td>
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</table>

- Ed. Züblin AG was founded in 1898 by Eduard Züblin
- It has 14,000 Employees and 3.8 billion Euro turnover (2017)
- Is Part of the STRABAG Group
- Is operating in Singapore for the past 21 years
STRABAG SE: Development of Turnover

<table>
<thead>
<tr>
<th>Year</th>
<th>Turnover (Mio. €)</th>
<th>Number of Employees</th>
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<tbody>
<tr>
<td>2011</td>
<td>13,713</td>
<td>76,866</td>
</tr>
<tr>
<td>2012</td>
<td>12,983</td>
<td>74,010</td>
</tr>
<tr>
<td>2013</td>
<td>12,394</td>
<td>73,100</td>
</tr>
<tr>
<td>2014</td>
<td>12,475</td>
<td>72,906</td>
</tr>
<tr>
<td>2015</td>
<td>13,123</td>
<td>73,315</td>
</tr>
<tr>
<td>2016</td>
<td>12,399</td>
<td>71,839</td>
</tr>
<tr>
<td>2017</td>
<td>13,508</td>
<td>72,904</td>
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</table>
TUNNELING AND PIPE JACKING EXPERIENCES

<table>
<thead>
<tr>
<th>Experience Type</th>
<th>Distance</th>
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<tbody>
<tr>
<td>Tunneling Experiences</td>
<td>1,174.0 km</td>
</tr>
<tr>
<td>Pipe Jacking Experiences</td>
<td>417.0 km</td>
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</tbody>
</table>
BPU:
Length: 120.0 m
Width: 8.5 m
Height: 6.0 m
Depth: 12.0 m
PIPE JACKING FROM SHAFT 2 TO SHAFT 3
CONNECTION SHAFT
GEOTECHNICAL PROFILE

SHAFT 3

SHAFT 2

Pipe Jacking
ADVANTAGED OF LARGE DIAMETER PIPES

Reduce number of pipe jacking drives

Ground improvement carried out from inside of the tunnel pipes
-Applying the JET GROUTING technique, the support beam’s spacing can be increased.

-Using a retrievable TBM the pipe roof system can be constructed timely independent from the construction of Access Shafts.
PIPE JACKING MACHINE

AVN 1500TB – Herrenknecht M-1896M

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Max. Torque</td>
<td>454 kNm</td>
</tr>
<tr>
<td>Max. Drive Length</td>
<td>500m</td>
</tr>
<tr>
<td>Rotation Type</td>
<td>Bi-directional</td>
</tr>
<tr>
<td>Excavation Mode</td>
<td>Slurry Mode</td>
</tr>
<tr>
<td>Steering</td>
<td>900/550 Kn</td>
</tr>
<tr>
<td>Guidance System</td>
<td>Laser &amp; Target System</td>
</tr>
<tr>
<td>PJM OD</td>
<td>1810/2056mm</td>
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<tr>
<td>Cutting Head Type</td>
<td>Rock Cutting Head</td>
</tr>
</tbody>
</table>

Chuzhou-Nanjing 7th November 2018

Christian Isfort, General Manager; Ed Züblin -AG
PIPE TO PIPE JOINING METHOD

Welding to be carried out after completing the entire drive
INSTALLATION OF JET GROUTING PILES AT EVERY EXCAVATION SPAN

Chuzhou-Nanjing 7th November 2018
Christian Isfort, General Manager; Ed Züblin -AG
CASTING PERMANENT BASE SLAB UPON EXCAVATION

Chuzhou-Nanjing 7th November 2018

Christian Isfort, General Manager; Ed Züblin -AG
Project Summary:

Using an innovative and flexible Engineering Concept, the following Achievements have been realized:

- A robust and safe pipe roofing system has been created.
- The productivity of tunnel excavation has been increased.
- Ground treatment of cohesive soils within the tunnel area could be performed from inside of the pipe roofing system.
- By using a retractable Tunnel Boring Machine works could be performed in parallel so that the overall construction time could be shortened.
- The Tunnel Boring Machine could cope with the mixed soil conditions.
- Ground settlements during shaft and tunnel construction was maintained within the designed limits.
- Environmental Aspects have been addressed and appreciated.
- Safety (see next slides)
From the commencement of the project in 2014 until completion in February 2018, Zueblin had achieved a total of approximately 1.4 million-man hours, all of which was lost time injury (LTI) free.

The project achieved a zero in Accident Frequency Rate (AFR) and Accident Severity Rate (ASR) for the past four years, an effort and achievement which was subsequently recognized by the Singapore Ministry of Manpower (MOM) and Workplace Safety and Health Council (WSHC) in 2016 and 2017.

The Zueblin Team has been awarded the Safety and Health Award Recognition for Projects (SHARP) for 2018.
THANK YOU.