Monitoring of cutting tools in TBM’S

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A. INTRODUCTION

Monitoring of Softground and Hard rock tools / cutter heads is different

Softground TBM: EPB TBM / MIX SHIELD TBM

Softground:
- Wear
- Rotation
A. INTRODUCTION

HARD ROCK TBM:

Hard rock:

• Damages indicated by indirect sensors
• Cutter load to limit risk
A. INTRODUCTION

Cutting tools:

Overview of tolls at different cutting wheels:
### C. Monitoring

**What does monitoring mean?**

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<th>Wear detection</th>
<th>Cutter disc conditions</th>
<th>Online load measuring</th>
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<td>Load measuring of disc cutters</td>
<td>Softground</td>
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<td>Softground</td>
<td>Direct</td>
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<td>Looking for load limits, Geotechnical indications</td>
<td>Avoid compressed air interventions</td>
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D. MONITORING SYSTEMS

Soft ground tool monitoring

Indication for high wear or damaged tools / cutter head
D. MONITORING SYSTEMS

Disc Cutter Rotation Monitoring (DCRM):

- System structure:
  - Hard rock TBMs
  - Hydroshield TBM with accessible cutting wheel
D. MONITORING SYSTEMS

Disc Cutter Rotation Monitoring (DCRM):

- Signal transmission on hard rock machines:
  - Emission of radio signals.
  - Signal transmission to the operator cabin.
  - Power supply through rotary coupling.
F. CHANGE

Accessible cutter heads:

- Individual tools are equipped with pressure locks for atmospheric change
D. MONITORING SYSTEMS

Disc Cutter Load Monitoring (DCLM):

System structure:

Sensor plates (piezo–resistive)

Cutting force

Thrust force
D. MONITORING SYSTEMS

Disc Cutter Wear Monitoring (DCWM):

- System structure for Hydroshield TBM with accessible cutterheads:

Ultrasonic sensors

Test rig with bentonite
D. MONITORING SYSTEMS

Disc Cutter Wear Monitoring (DCWM):

Test system measurement results:

![Graph showing wear monitoring results]
E. INSPECTION

Assisted tool inspection:

- System structure:
  - Extendible inspection robot in tube garage
  - Assembly of the garage between pressure wall and submerged wall
  - Opening towards the excavation chamber
E. INSPECTION

Assisted tool inspection:

- Application on Hydroshield TBM:

  - Pressure wall
  - Submerged wall
  - Water jet, light & camera
  - Endoscope
F. CHANGE

Assisted & automated cutting tool change:

Support structure & manipulator:
### G. SUMMARY

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<th>Hardrock TBM</th>
<th>Hydroshield TBM EPB TBM</th>
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<td>Existing systems</td>
<td>Existing systems</td>
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<td>Cutter conditions</td>
<td>DCRM – Hard rock</td>
<td>DCRM – FSP, DCRM – SG under development</td>
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30.09.2013 T. Edelmann (Herrenknecht AG) | Tunnelbauforschung in Leoben, Schwanau und Bochum
Thank you for your attention!