Controlling water risks in tunnels

The Hydrogeological Excavation Code -
A value added methodology

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JASPERS - Roads Division
Mutual interferences between tunnels and surrounding hydrogeology

By nature, tunnels interfere with surface and underground water flows. As soon as excavation begins, it starts to modify the hydrogeological set up and to attract water from aquifers. The risks of encountering water inrushes, infiltrations or leaks at some point in a tunnel’s lifetime are high.

Water in tunnels may put safety at risk and cause irreversible damages to the environment. Both the construction phases and the long-term operation of a tunnel may be disrupted, resulting in losses of time and reputation. Cost overruns can also be sizeable.

Assessing the hydrogeological situation at a very early stage in the project cycle is crucial, as is the systematic monitoring of water levels throughout a tunnel’s lifetime. As an example, areas that appear impermeable during test drillings can behave quite differently when excavating a tunnel in full scale.

With this in mind, JASPERS has adapted a methodology called Hydrogeological Excavation Code (HEC), to help transport infrastructure authorities manage the hydrogeological risks in major underground projects.

Areas of risks and impacts

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<thead>
<tr>
<th>Environment</th>
<th>Tunnel</th>
<th>Society - Economy</th>
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<tbody>
<tr>
<td>Impact on the hydrogeology</td>
<td>Infringement with regulation</td>
<td>Accidents and fatalities</td>
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<td>Impact on the water table</td>
<td>Lack of environmental consent</td>
<td>Disruptions of traffic and delays</td>
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<td>Unwanted diversion of water courses</td>
<td>Delays in construction</td>
<td>Public resistance for various reasons</td>
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<td>Flooding</td>
<td>Cost and value for money issues</td>
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<td>Erosion and corrosion</td>
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<td>Collapsing</td>
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The Hydrogeological Excavation Code (HEC) is a 3-pillar protocol

The HEC, as originally defined by Coli and Tanzini (see Bibliography), has been used to assess water flows of various magnitudes (from a few litres to over a hundred litres per second), including in difficult circumstances such as Karst type geology. The HEC is compatible with FIDIC Red, Yellow and Silver Book contract types.
The HEC is a 3 pillar protocol to:

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<td>Analyse the tunnel’s expected interference with surface and underground water. Build a hydrogeological and hydrological model. Conduct a detailed hydrogeological risk assessment.</td>
<td>Design preventive and protective measures for the short and the long run, such as drainage, waterproofing and stabilisation systems. Achieve compliance with Article 4.7 of the Water Framework Directive (WFD).</td>
<td>Monitor water levels and their effects on ground water and water supply throughout the tunnel’s lifetime. Adapt preventive and protective measures accordingly.</td>
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**JASPERS experience**

JASPERS engineers have advised on numerous tunnel projects in Europe, in a variety of climates and hydrogeological situations. In recent years, they have supported the development of the Višňové twin Tunnel (7.5 km – Slovakia), the Cebrat twin Tunnel (4 km – Slovakia), the Divača Koper – Karst Excavation and Management Code - KEMC (20 km – Slovenia), and the Prešov twin Tunnel (3 km – Slovakia).

The estimated water inflows in these tunnels range from few litres to real underground rivers (more than 3000 l/s). In the last scenario, as an alternative to sealing the tunnel, a bypass (for instance an underground bridge) is considered to keep the hydrogeological and hydrological set up unchanged.

JASPERS experience

![Diagram](https://via.placeholder.com/150)

**Methodological process steps**

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<tr>
<td>Hydrogeological and hydrological model. Assessment of area of influence (rivers and spring waters monitoring, water supply management).</td>
<td>Definition of level of acceptance vs. value for money and value engineering (tunnel choice/technique).</td>
<td>Assessment of preventive and protective measures. Compliance with Article 4.7 WFD.</td>
<td>Monitoring effects on ground water level. Maintaining / validation of pre-grouting.</td>
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Bibliography


“JASPERS helped us address these issues in several road tunnel projects, allowing us to continue implementation with a better understanding of risks, thereby increasing public consent.”

J. Durisin. CEO, Slovak Motorways Company.

Contact us

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General questions:

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