Rock mass classification and geotechnical model for the foundation of a RCC gravity dam

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1) Description of project

- Roller Compacted Concrete:
  „RCC is concrete but it is placed by non-traditional methods.
  By the definition of ACI, RCC is concrete that has a consistency that allows it to be compacted with a vibratory roller.“ (Ernest Schrader)
1) Description of the project

<table>
<thead>
<tr>
<th>Project characteristics</th>
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</thead>
<tbody>
<tr>
<td>Dam type: RCC (Roller compacted concrete)</td>
</tr>
<tr>
<td>Dam height: 150m</td>
</tr>
<tr>
<td>Purpose: Hydropower</td>
</tr>
<tr>
<td>Power plant: 3 + 1 units power house</td>
</tr>
<tr>
<td>Status: Under construction</td>
</tr>
</tbody>
</table>
2) Project Geology
3) Geotechnical investigations

- **Phase I**
  During early design stages (feasibility – final design)
  - Core drillings
  - Laboratory tests
  - Pressuremeter tests

- **Phase II**
  In powerhouse excavation pit during execution – detail design
  - Geo seismic tests
  - Plate load tests
  - *Schmidt* hammer tests
3) Geotechnical investigations I
3) Geotechnical Investigations II
## 4) Design parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Basalt - massive</th>
<th>Basalt - jointed</th>
<th>Tuffite coarse</th>
<th>Tuffite fine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deformation modulus</td>
<td>[GPa]</td>
<td>17.3</td>
<td>5.6</td>
<td>5.8</td>
<td>1.2</td>
</tr>
<tr>
<td>Poisson ratio</td>
<td></td>
<td>0.22</td>
<td>0.25</td>
<td>0.30</td>
<td>0.35</td>
</tr>
<tr>
<td>Cohesion</td>
<td>[MPa]</td>
<td>2.0</td>
<td>1.3</td>
<td>1.1</td>
<td>0.6</td>
</tr>
<tr>
<td>Friction angle</td>
<td>[°]</td>
<td>57.0</td>
<td>51.0</td>
<td>45.0</td>
<td>31.0</td>
</tr>
<tr>
<td>UCS</td>
<td>[MPa]</td>
<td>11.7</td>
<td>3.1</td>
<td>3.8</td>
<td>1.0</td>
</tr>
<tr>
<td>Global strength</td>
<td>[MPa]</td>
<td>27.5</td>
<td>17.2</td>
<td>6.6</td>
<td>2.0</td>
</tr>
<tr>
<td>Unit weight</td>
<td>[kN/m³]</td>
<td>26.5</td>
<td>26.4</td>
<td>23.2</td>
<td>22.5</td>
</tr>
</tbody>
</table>
5) Effects of geotechnical model on structural behavior

- 2D plane strain models were used to
  - Perform stability calculations
  - Analyse deformations of the dam and powerhouse
  - => Models were not detailed enough to show „real“ behavior
5) Effects of geotechnical model on structural behavior

- 3D model of dam
6) Conclusions

- 3D modelling results in a significant reduction of displacements
  - Construction (Dead Load): Ratio 2D/3D = 1/0.6
  - Operation (Water, Silting): Ratio 2D/3D = 1/0.5

- Relative displacements
  - For dam concrete blocks ~ 1-1.5cm
  - For single powerhouse units ~ 1cm
6) Conclusions

- Moderate dam inclinations were chosen to reduce stresses in dam foundation.
- A thorough monitoring system was installed at the dam and powerhouse.
- For dam upstream surface a foil system was proposed.
- Shear boxes between power house machine hall units were applied.
- Local weak zones of sand layers under powerhouse were grouted.
Current construction progress

- Spillway
- Intake =>
- Main Dam
- Powerhouse
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