Quantification of rock slope terrain properties

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Rockfall trajectory simulation codes need information on the terrain properties to formulate appropriate rebound models. Usually, the manuals of rockfall simulation codes give sketches or photographs of terrain samples [1,2]. Based on these the user can select suitable terrains for the simulation area. We now would like to start a discussion whether it is possible to numerically quantify the terrain properties which would make the ground assignment more objective.

Different ground properties play a role for the interaction between a falling rock and the ground:
- Elastic deformation
- Plastic deformation
- Energy absorption
- Friction
- Hardness
- Roughness
- Surface vs. underground
- Particle size distribution
- Particle distribution
- Soil cover
- Water content

The question is now whether it is possible to quantify above parameters and to finally provide tables that contain appropriate simulation parameters. In a first attempt we suggest different methods or parameters that might be evaluated in situ:
- Small scale drop tests
- Light weight deflectometer (LWD)
- Particle sizes
- Sliding angle
- Soil cover
- Water content

Of course, above measurements will never perfectly fit to different mountain slopes. However, if a number of measurements has been made their spreading will give an idea on the natural variability of the ground properties. As an example, the following table gives an idea on how the $M_E$ and $E_{vd}$ values vary for different soils.

<table>
<thead>
<tr>
<th>Ground type</th>
<th>Soil layer</th>
<th>Soil humidity</th>
<th>$E_{vd}$ (median)</th>
<th>$\sigma$ (median)</th>
<th>$E_{vd}$ (average)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humus-carb.</td>
<td>&lt; 10 cm</td>
<td>dry</td>
<td>17.4</td>
<td>6.8</td>
<td>15.6</td>
</tr>
<tr>
<td>Regosol</td>
<td>10 – 30 cm</td>
<td>dry</td>
<td>8.6</td>
<td>3.9</td>
<td>9.4</td>
</tr>
<tr>
<td>Brownish</td>
<td>30 – 50 cm</td>
<td>dry</td>
<td>12.1</td>
<td>3.2</td>
<td>11.7</td>
</tr>
<tr>
<td>Calcaric</td>
<td>30 – 50 cm</td>
<td>dry</td>
<td>7.5</td>
<td>3.3</td>
<td>7.0</td>
</tr>
<tr>
<td>Acid brownish</td>
<td>70 – 100 cm</td>
<td>dry</td>
<td>7.8</td>
<td>2.1</td>
<td>7.7</td>
</tr>
<tr>
<td>Fahlgley</td>
<td>10 – 30 cm</td>
<td>dry</td>
<td>9.2</td>
<td>4.0</td>
<td>7.7</td>
</tr>
</tbody>
</table>

References