Rockfalls in Eocene flysch rock mass: geomechanical aspects of remediation of abandoned quarries in Central Dalmatia

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Abstract

Flysch is a typical example of heterogeneous rock mass with layers of different mechanical properties. Even though they are formed by sedimentation and originally were horizontal, since flysch was suitable for tectonic shaping, layers that are often bent or inclined at various dip angles from 0 to 50 degrees can be encountered. While for homogeneous rock mass the process of weathering and erosion on outcrops is relatively predictable, and it can be well described by mathematical models of recession, for heterogeneous flysch, this task is significantly more complex and sometimes unpredictable.

In the presented study, the talus material restitutive characteristics were examined, because of its quasi-stable nature. It is known that when talus blocks jump over a barrier, the intensity of return impacts depends on the height of the barrier, mass, speed and size of the block, and the characteristic parameters of the barrier material. The most significant is the type of material used for construction of the barrier (e.g., concrete, rocks, etc.); the thickness of the layer is also important. An example of this is the determination of the minimal height of a barrier that would prevent rockfall debris from jumping over it.

The methodological approach included (1) the use of Terrestrial 3D Laser Scanning (TLS) for point cloud capture, (2) the mathematical modeling to analyze the stability of the landslide, and (3) the reconstruction of the slope. The first collection of data of a landslide at a quarry on the eastern side of the municipality of Kaštel Štafilić was captured in 2011. A point cloud of the same location was captured six months later.

The presented results are based on the analysis of the point clouds using the Vlastelica’s (2015) method. The calculation of the test sites is performed with the mathematical model that uses the characteristics of the rock mass (c, φ), the thickness of the sandstone layer, observed shape and geometry of the slope, and the expected maximum horizontal acceleration of 0.22 g. The obtained results are very close to the measurements taken during the field work. Also, the recommendation to use 50% of the measured talus mass for the construction of the barrier is significantly more cost-effective.

Results

<table>
<thead>
<tr>
<th>ΔT=10 years</th>
<th>ΔT=50 years</th>
<th>ΔT=100 years</th>
</tr>
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<tbody>
<tr>
<td>Parameter 1</td>
<td>Parameter 2</td>
<td>Parameter 3</td>
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<tr>
<td>Value 1</td>
<td>Value 2</td>
<td>Value 3</td>
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</tbody>
</table>

Conclusions

- Abandoned quarries in flysch rock mass in Dalmatian area provide a new public resource as they are state-owned land. However, funding for their remediation is usually very limited, so protection against rockfalls has to be dealt with conventional (expensive) geotechnical structures.
- Even though talus material restitutive parameters are favorable (it consists mainly of disintegrated material), because of its quasi-stable nature, talus is prone to sliding in case of extreme loading conditions.
- Because it cannot satisfy the minimal factors of safety when using EC7, and the additional build-up of newly eroded material changes the slope geometry, an additional maintenance of talus zone is necessary.

References and additional information: