Geomechanical evaluation of an abandoned chalk mine using in-situ measurements

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The Malogne site is an abandoned underground phosphatic chalk quarry located in the Mons Basin (Belgium) mined out at shallow depth by the room-and-pillar method. With its 67 ha total area the site is situated very close to important surface infrastructure and residential houses. During and after its exploitation several significant ground collapses were registered. The last one from 2015, with an area of 1.2 ha and a maximum amplitude of 3 m, occurred close to the railway Brussels-Paris affecting agricultural land.

To characterize the geomechanical conditions of the underground openings in the central part of the quarry the Geological Strength Index (GSI) (Hoek et al., 1995; Marinos et al., 2005) and Rock Mass Rating (RMR_{89}) (Bieniawski, 1989) classification systems were applied. The discontinuities characterization is based on a structural survey (293 measurements). The geomechanical evaluation of the massif is realized by a set of parameters as the Joint Roughness Coefficient (in 39 profiles), the Rock Quality Designation (in 8 locations) and the Intact Rock Strength (in 356 points).

Due to the seasonal groundwater level fluctuation in the studied area three zones are differentiated - dry, transitional and water-saturated which is not accessable for observations. As a result, of the annual variations some of the pillars are exposed to cycles of water saturation and drying.

Considering the most unfavorable rock mass conditions three geomechanical zones were identified in the studied area (Figure 1). Those connected with Good to Fair rock mass (classes II and III) are typical for the dry parts of the quarry while the Poor one (class IV) is mainly related to the transitional zone. An exception of that is a narrow elongated area of rock mass class IV in the western part of the site that follows the faulted zone. The rock mass next to the collapsed sector was also classified as Poor.

Table 1. Rating for computing RMR_{89} values for dry and transitional zones in the central part of the Malogne quarry

Parameter	Dry zone			Transitional zone		
	min.	avg.	max.	min.	avg.	max.
Strength of the intact rock mass	1	2	2	1	1	1
RQD	17	20	20	17	17	20
Spacing of discontinuities	6	10	15	5	8	10
Conditions of discontinuities	5	15	20	0	10	15
Groundwater	10	13	15	0	4	7
RMR_{89}	39	60	72	23	40	53
Rock mass classes	IV Poor	III Fair	II Good	IV Poor	IV Poor	III Good

Based on the GSI estimation, two geomechanical zones were distinguished - such with GSI values in the range of 55-60 that mostly corresponds to the dry part of the site, and another one with lower levels (GSI=45-50) that is more related to the transitional zone but also identified in the Very Blocky dry zone. Regarding the RMR89 assessment (Tab. 1) three different zones were defined: (1) with higher values of RMR89 corresponding to Good and Fair rock mass quality, associated to the dry zone, and (2) with Good and Poor rock mass quality

that are mainly related to the transitional zone.

The in situ observations confirmed the obtained results for the geomechanical conditions in the studied part of the site. The presented data could be used as indicative for the possible geomechanical risk that could be expected in the Malogne quarry as well as for conducting preventive monitoring if necessary.

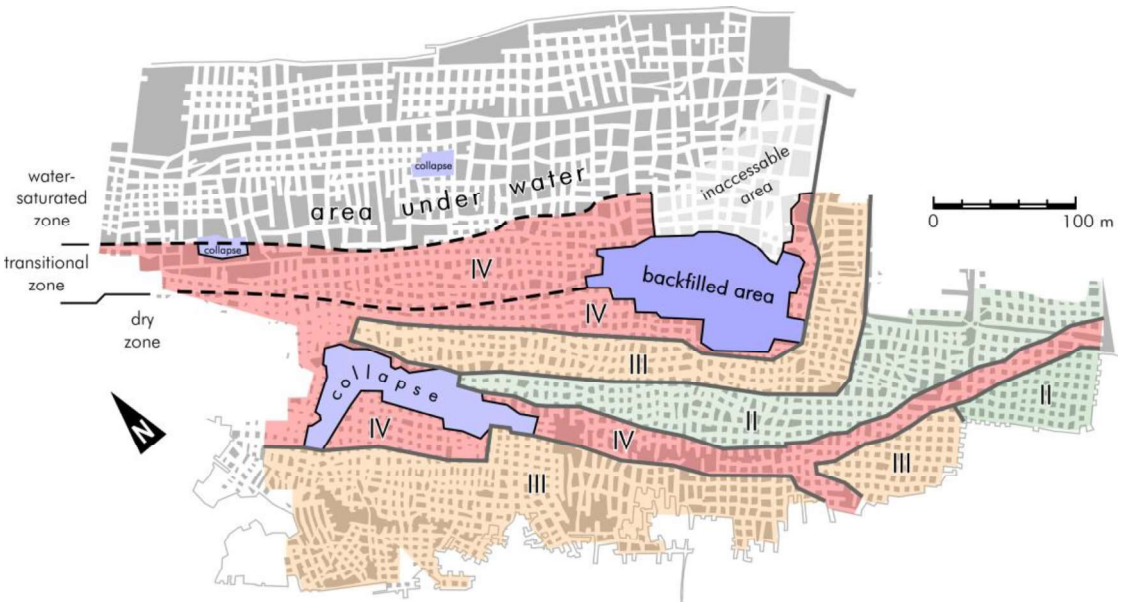

Figure 1. Geomechanical zonation of the central part of the Malogne quarry indicating the level of the possible geomechanical risk.

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