TECHNICAL NOTE

Oppdragsnavn	**Skredsikring Sukkertoppen**
Prosjekt nr.	**1350029372**
Kunde	**NVE**
Notat nr.	**G-not-013**
Versjon	**0**
Til	**Stian Bue Kanstad**
Fra	**Johanne Garcia de Presno**
Utført av	**Johanne Garcia de Presno**
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ADHESION OF ROCK MASS IN VANNLEDNINGSDALEN

1 General

1st of March 2021

NVE is planning to establish protection against slush avalanche in Vannledningsdalen in Longyearbyen. The avalanche hazard and avalanche protection are evaluated and designed by Skred AS and HNIT. Geotechnical design, including anchoring, is performed by Rambøll.

Over a period of one month (November to December 2020), a total of 60 anchors were installed and pullout tests were conducted in Vannledningsdalen by DS Entreprenør. Procedure and results are presented in DS Entreprenør AS's reports (DS Entreprenør AS, n.d., 2021) (DS Entreprenør AS, 2021).

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2 Assessments of the adhesion between mortar and rock

2.1 Method

The characteristic initial adhesion between mortar and rock is calculated by the following equation:

$$\tau_{k,grout/rock} = \frac{F}{A_{grout/rock}}$$

were F is the pullout force.

Note that the initial adhesion is to be calculated for the tests that were pulled out. For the anchors that remained intact, a minimum adhesion can be calculated.

For a pullout test to be qualified for further evaluation, the grouted length must be in rock (soft/loose rock does not qualify). Anchors with irregularities during installation or pulling are not included in the assessment. A total of 24 tests do not fulfill these requirements and are thus removed from further evaluation.

For the following profiles, information about the geology in the drilling holes has been found by reading the handwritten drilling logs (DS Entreprenør AS, 2021): 690, 810, 920, 1030, 1150, 1290, 1250. Information about the geology for the rest of the drilling holes was found in drilling logs converted to an Excel-file.

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2.2 Results

Of the ten tests that were pulled out, three are deemed valid. For these tests, the initial adhesion is calculated to be 0.95, 1.19 and 1.39 MPa. For the test with an adhesion of 0.95 MPa, the drilling speed suggests that the anchor may have been grouted in rock of poorer quality. This test is still included.

Figure 1 shows the minimum adhesion plotted with the grouted length. All the anchors were pulled with appr. the same force. For the anchors that were not pulled to failure, smaller grouted length gives higher calculated adhesion (minimum). This indicate that these anchors were mobilized more than the anchors with higher grouted length. If each anchor was pulled out so that the actual adhesion could be calculated, the plot would likely not show the trend like in figure 1.

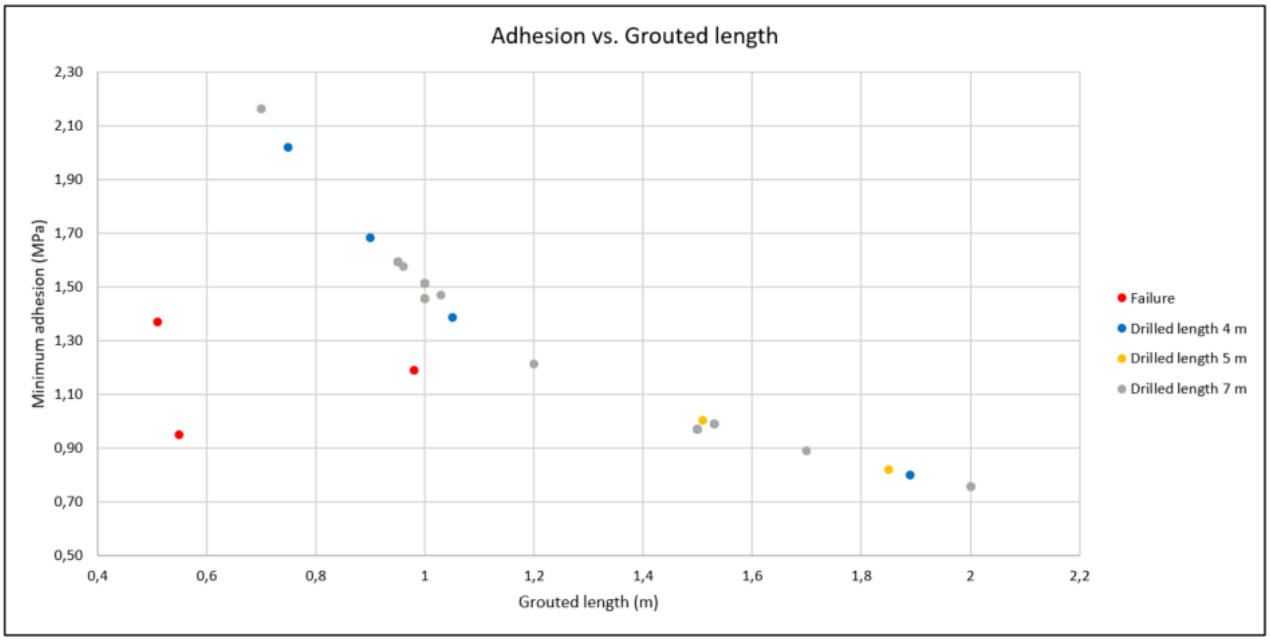

Figure 1. Adhesion plotted against grouted length.

2.3 Conclusion

Three of the ten anchors that were pulled out, qualified for further evaluation. These had an initial adhesion of 0.95, 1.19 and 1.37 MPa. The minimum adhesion for the tests that were not pulled out varied between 0.76 MPa and 2.16 MPa. About >85 % of these tests have a minimum adhesion of ca. 1 MPa or more.

At this stage in the project, **the initial adhesion is set to 1.0 MPa,** under the precondition that the grouted length is at least 1.0 m in competent rock.

Anchoring length in concrete constructions with 500 steel is normally 50*D. For D=40mm steel anchors this gives an anchoring length of min 2.0 m based on the parameter steel/concrete. Therefore, the minimum grouting length is 2.0 m. Due to the permafrost, the anchoring level starts 3.0 m below the terrain. This means that the length of the anchors must be minimum 5.0 m.

As more information is achieved and more assessments done in the future, this value may be adjusted. An evaluation of the necessary anchor lengths must be done when more information about the permanent anchors for the avalanche net is at hand, such as the location, orientation, type of anchor and the maximum forces on the net.

3 References

DS Entreprenør AS (2021). *Report for drilling, injecting and testing/pulling anchor in Vannledningsdalen, Longearbyen, October-December 2020.*

DS Entreprenør AS (n.d.). *Procedure Anktertesting with the Tiroler Tripod*.