Technical Note

A Practical Problem with Threaded Rebar Bolts in Reinforcing Largely Deformed Rock Masses

By

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1. Introduction

Rebar bolt is probably the most commonly used rock reinforcement element in both mining and civil engineering applications. The most commonly seen rebar bolt is an end-threaded steel bar that is fully grouted in borehole with cement or resin, Fig. 1. A fully-grouted rebar bolt is characterised by its high bond between the bolt and the grout because of the ribs on the cylindrical surface of the bar. Rebar bolts are installed without pretension. The load a rebar provides to the rock is developed afterwards when it is subjected to rock deformation. After excavation, the country rock moves towards the opening with the largest deformation at the free surface of the opening. Thus, it is at the surface of the opening where the bolt is most loaded. On the other hand, the weakest part of a rebar bolt is its thread which is located exactly at the surface of the opening. It is often seen in the field that rebar bolts fail at the thread in case of occurrence of large rock deformation, for instance in a weak rock mass subjected to high ground pressure. In this technical note, failure of rebar bolts observed in the field is presented first. Then, the loading condition of the bolt is examined for the purpose of showing how much the thread reduces the loading capacity of the bolt. The aim is to point out the weakness of rebar bolts so that one is aware of the direction to enhance the load-bearing capacity of rebar bolts when needed.

2. Observations of Bolt Failure

A metallic mine in Sweden is currently conducting its mining activities at a depth of about 1000 m under the surface of the ground. The ground pressure at that depth is
quite high and the rock is chlorite-rich and weak. Therefore, rock deformation in mine stopes is large. The wall-to-wall convergence in a 7 m wide stope often reaches more than ten centimetres in a short period after excavation. The mine uses threaded rebar bolts for rock reinforcement. The bolts are fully grouted in boreholes with cement mortar. It was observed in the stopes that a number of bolts failed at the thread and lost their support capacity. Figure 2 shows two of the rebar bolts installed in a mine stope. These two photographs show how a bolt reacts to ground pressure. The rock moves towards the opening under the ground pressure. The face plate of the bolt tends to prevent the rock movement, resulting in a load on the face plate, as seen in Fig. 2a. The load on the face plate is then transferred to the bolt through the nut and the thread. If the bolt is properly grouted, the load in the bolt would become smaller towards the far-end of the bolt because of the bond between the bolt and the grout (Li and

Fig. 1. A sketch illustrating a threaded rebar bolt cement-grouted in a borehole

Fig. 2. Rebar bolts in situ. a A heavily loaded rebar bolt. b A rebar bolt failed at the thread and sunk into the rock