RTH 309-80

SUGGESTED METHOD FOR MONITORING ROCK BOLT TENSION USING LOAD CELLS

1. Scope

1.1 This method is for monitoring changes in tension that occur in a rock bolt over an extended period of time following installation (Note 1).

NOTE 1—Tension may fall below that applied at the time of rock bolt installation due to loosening and slip either of the anchor or of the faceplate assembly, for example as a result of rock creep, anchor corrosion, fretting of rock from beneath the faceplate, or blasting vibration. Tension may also either rise or fall as a result of bulk rock dilation or contraction associated with the progress of nearby excavation.

2. Apparatus

2.1 Rock bolt load cells should be used to monitor tension in approximately one bolt in ten of the support system to be studied (special considerations may require the instrumentation of a greater or lesser percentage of bolts). The load cells may, for example, be of mechanical, photoelastic, hydraulic, or electric type, depending on requirements of cost and accuracy. The cells should have reversible and preferably linear calibrations (see paragraph 3) and should incorporate a spherical seating or other provision to ensure that load transfer and measurement are reproducible. They should be capable of withstanding the effects of nearby blasting, water, and dust over long periods of time.

3. Procedure

3.1 Calibration of load cells should be accomplished as follows:

(a) Calibration is required when selecting a suitable type of load cell, and each load cell to be installed should be individually calibrated before use.

(b) Short-term calibration of each cell is performed in a testing laboratory by increasing the load in increments, taking readings of 'observed' and 'true' load values (Note 2). Tension is released and incremental readings are taken during unloading. A further cycle of loading and unloading is made, and a graph plotted showing data points and curves fitted to these points (Fig. 1).

NOTE 2--Details of the calibrating devices and their precision should be included in the report.

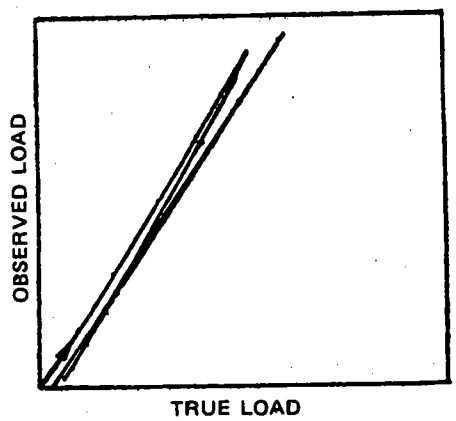

Fig. 1. Load cell calibration

(c) A check should also be made on the stability of readings over extended periods of time. Tension is increased to a value approximately equal to that to be measured on site, and is maintained at this value for as long a time as is practical. Any 'drift' in reading is noted. The effect of water on the cell should be observed, also the effect of coupling and uncoupling any electrical connections.

3.2 Installation and monitoring shall be as follows:

(a) Load cells are installed on selected rock bolts at the time of installation of the support system. Care should be taken to ensure that spherical seatings are correctly positioned and lubricated. Bolts that have been instrumented should be clearly and permanently numbered,

and may be painted for ease of recognition. Bolt length, diameter, and type of anchor should also be noted.

(b) Tension readings should be taken immediately following installation and again a few hours later. Further readings may be taken at intervals depending on the rate at which readings are changing. In the vicinity of an advancing face, for example, intervals between readings should be of the order of hours, whereas if steady values are recorded for bolts in inactive areas the intervals between readings may be increased to days or weeks. Each reading should be accompanied by a record of bolt number, location, and the date and time of observation.

4. Calculations

4.1 Bolt tension readings are corrected using the calibration charts. Graphs of bolt tension versus time are plotted for each bolt (Fig. 2). For comparison, the loss or gain of tension may be reduced to a percentage of the initial installed value.

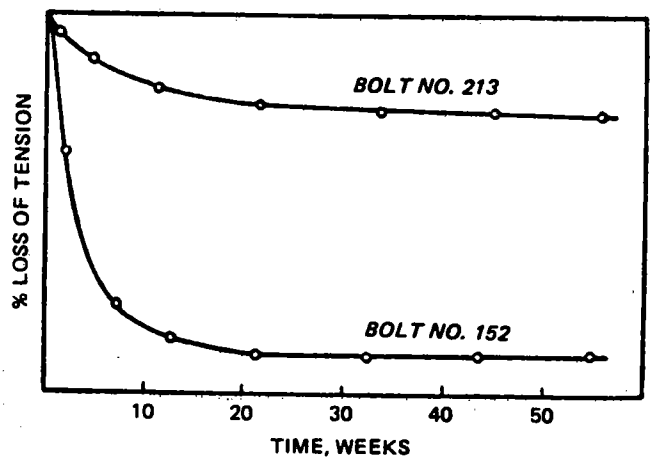

Fig. 2. Graph of bolt tension loss.

5. Reporting of Results

5.1 The report should include:

(a) Details of the load cells used, calibration methods, and results.

(b) Locations of the rock bolts monitored.

(c) Details of rock characteristics, bolt and anchor types and dimensions, and dates and methods of installation and grouting.

(d) Monitoring results in the form of tabulated values and a graph of bolt tension versus time for each bolt monitored.