IS 11309 (1985): Method of conducting pull-out test on anchor bars and rock bolts [CED 48: Rock Mechanics]

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Indian Standard

METHOD FOR CONDUCTING PULL-OUT TEST ON ANCHOR BARS AND ROCK BOLTS

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Rock Mechanics Sectional Committee, BDC 73

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0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 29 June 1985, after the draft finalized by the Rock Mechanics Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 A number of Indian Standards covering methods of test to assess various properties of rocks are being formulated. This standard covers method for conducting pull-out test on anchor bars and rock bolts is a full-column-grouted rock bolt or bar with cement-sand grout or resin and rock bolt is ungrouted mechanically anchored bolt. The anchorage may be of any type that is lot wedge type, expansion shell type, etc.

0.3 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

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1. SCOPE

1.1 This standard lays down the method for conducting anchor pull-out test in rock and the evaluation of bond strength between reinforcement and grout concrete or grout concrete and rock.

NOTE — This method assumes that diameter of the bore in rock throughout the length of reinforcement is uniform and cement mortar density around the reinforcement and throughout the length of reinforcement is also uniform.

2. EQUIPMENT

2.1 Central Hole Jack — It is a special jack in which ram has a dentral hole throughout the height of the jack.

*Rules for rounding off numerical values (*revised*).

3. DESCRIPTION OF THE ANCHOR BAR PULL-OUT TEST

3.1 A hole is drilled in rock with the help of minicore drill machine keeping in view that the geology of the mass should not be disturbed around the desired diameter. The diameter of the bore-hole should be at least double the diameter of the anchor bar and the bore length should be equal to the length of anchor bar. Arrangement should be made to make base slab below the jack perpendicular to the bolt.

NOTE — It is necessary to test anchors under realistic field conditions. Therefore, care is necessary in selection of site for such test specially the rock mass shall be representative of the same at actual anchor location. The drill hole shall be inclined to the bedding planes at the same angle at which it will be placed during excavation.

3.2 The upper end of the bar under test should project up to the length of 50 cm, so that the double nuts may be fitted in it above the 40 cm high spring-return central-hold jack.

3.3 The rock surface around the reinforcement over a diameter of 60 cm should be made flat by hand chiselling and plastered by a rich cement-sand mortar. A mild steel plate of 25 mm thickness having a hole equal to the diameter of bore hole should be placed over it.

3.4 The cement-sand slurry should be filled in bore-hole all round the anchor bar with the help of grouting machine at suitable pressure.

3.5 Prior to starting the actual test it should be ensured that the curing period of grout mix filled in the bore-hole around the anchor is completed (*see* IS : 6066-1985*).

4. APPLICATION OF LOADING

4.1 Central-hole jack should be fitted in anchor bar. Two dial gauges, 0·01 mm least count and 50 mm travel, should be fitted on diagonally opposite sides of central-hole jack to record the movement of the anchor bar at the time of loading (Fig. 1).

4.2 Pressure should be applied, with the help of hydraulic pump connected with the central-hole jack of 50 tonne capacity having a central hole of 60 mm with uniform but slow rate of 250 kg/min as the pulling bar should not be subjected to any jerk till the bar starts coming out. During the application of pressure, the dial gauge observations should also be recorded at every load interval of 1 tonne. The plot of pull versus bolt extension should also be made as shown in Fig. 2 for better understanding of mode of failure.

*Recommendations for pressure grouting of rock foundations in river valley projects (*first revision*).

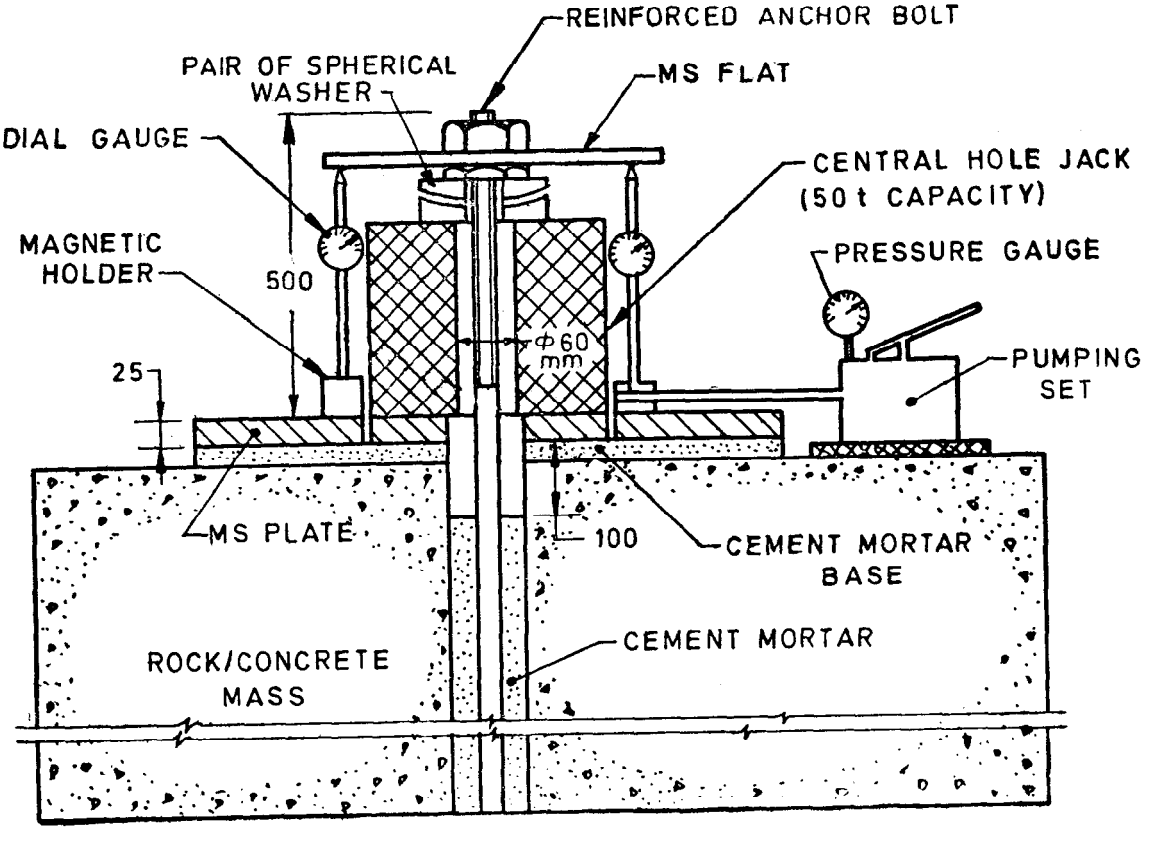

FIG. 1 SET-UP FOR PULL-OUT TEST

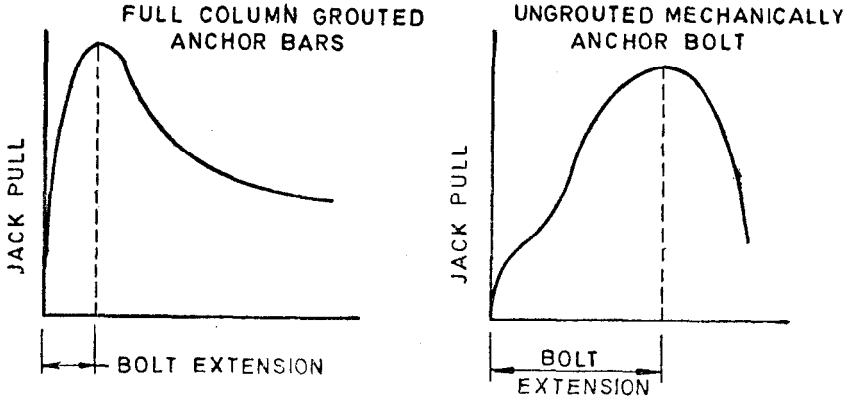

FIG. 2 VARIATION BETWEEN JACK PULL AND BOLT EXTENSION

4.3 An initial arbitrary load not greater than 5 kN shall be applied to take up slack in the equipment.

4.4 The anchor/rock belt shall be tested by increasing the load in increments until total extension greater than 40 mm reached or bolt yields or fractures whichever is early.

4.5 Readings for each increment shall be taken only after both load and extension are stabilized.

4.6 The ram of the jack must have low friction seals for reproducible calibration.

4.7 A pair of spherical washers shall be provided between nut and the jack to avoid eccentric loading on the jack.

4.8 At least 3 tests shall be conducted in one rock formation.

4.9 The bolts that form part of the actual rock support system shall not be tested beyond 10 percent more than the design load.

5. DETERMINATION OF BOND STRENGTH BETWEEN GROUT AND ROCK (τ_r)

5.1 Load versus movement of bar observations should be recorded and plotted on arithmetic scale.

5.2 The bond strength is worked out by the following formula in case bolt is below up to failure between grout and rock.

$$\text{Bond strength } \tau_r = \frac{W \times 1\,000}{2\pi R \times L} \text{ kgf/cm}^2 \quad \ldots\ldots\ldots (1)$$

where

W = Load taken by the bar in tonnes,

R = Radius of grouted hole in cm, and

L = Length of embedded bar in cm.

6. BOND STRENGTH BETWEEN STEEL AND GROUT (τ_g)

6.1 If failure is between bar and grout, equation (1) will be used to determine bond strength considering 'R' equal to radius of bar.

7. DETERMINATION OF ANCHORAGE CAPACITY OF MECHANICAL ANCHORAGES OF ROCK BOLTS (P)

7.1 The actual anchorage capacity of a mechanical anchorage of a rock bolt is the maximum pull exerted by the ram in tonnes.

8. REPORTING OF TEST RESULTS

8.1 The report shall include the following informations:

a) Lithological description of rock;

b) Details of grout mix and curing period along with date of grouting and date of testing;

c) Type of bolt or anchor bar;

d) Dimensions of anchor bar or bolt — length and diameter;

e) Dimensions of hole — length and diameter;

f) Bond strength and mode of failure observed, if the bar fails in tension, it should also be mentioned; and

g) Number of tests.