AN APPRAISAL OF THE TEST GROUTING DATA FOR THE TEHRI DAM, INDIA

ESTIMATION DES INJECTIONS NÉCESSAIRES POUR LE BARRAGE DE TEHRI, INDE

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Abstract

Test grouting has been carried out in the three different rock units (phyllites grade I, II & III) exposed around Tehri Dam Project to evaluate the groutability of these rocks and to evolve optimum spacing of grout holes to be adopted for the grout curtain. Since it has been observed that permeability of the rock mass is essentially secondary and is mainly joint and fissure controlled, the structural discontinuities observed in the rock types have been analysed for finding out the direction of grout holes that can intersect the maximum numbers of discontinuities and hence seal the rock mass properly. The grouting has been carried out through grout holes and its effectiveness has been observed through inspection holes drilled in between and depending upon the effectiveness, secondary and tertiary holes were drilled in between to reduce the spacing of holes from inspection holes. Finally, when the permeability values of inspection holes were reduced to 1 lugeon or less after grouting through tertiary holes, it has been considered to have achieved optimum grouting efficiency. The effective grout travel distance in the phyllites has been proved to be 0.75 m. It has been inferred that adoption of high grout pressures while emplacing the grout curtain might change the spacing to around 1.5 m apart.

Résumé

Des essais d'injection ont été réalisés dans trois types différents de roches (phyllites I, II et III) sur le site du projet de barrage de Tehri, afin d'évaluer les capacités d'absorption de ces roches et pour calculer l'espacement optimal des forages d'injection pour la réalisation du rideau d'étanchéité. On a observé que la perméabilité du massif rocheux est essentiellement secondaire et dépend surtout des joints et fissures. Les discontinuités de structure ont donc été analysées pour trouver les meilleures orientations possibles pour les forages d'injection, de façon à recouper le plus grand nombre possible de ces discontinuités et ainsi sceller au mieux le massif. L'injection a été réalisée dans des forages d'injection et son efficacité a été observée à l'aide de forages d'inspection intercalaires et dans certains cas des forages supplémentaires ont été rajoutés, en fonction des résultats observés. Finalement, on a considéré que lorsque la valeur de la perméabilité a été réduite à moins de 1 lugeon après injection dans les forages supplémentaires, l'efficacité optimale était atteinte. L'écartement optimal des forages d'injection dans les phyllites s'est avéré être de 0.75 m. On en a déduit que l'adoption de pressions d'injection élevées lors de la mise en place du rideau pourrait permettre d'adopter un espacement de 1,5 mètre.

Introduction

Tehri Dam Project envisages construction of a 260.5 m high rock-fill dam across river Bhagirathi at a location about 1.5 km downstream of Tehri town in Himalayan terrain. In the initial stages of project planning, the exploratory holes drilled in the project area have indicated that the equivalent permeability of rock mass varies from $0.17 \times 10^{-5}$ cm/sec to $7.2 \times 10^{-4}$ cm/sec (Pant, Narula and Shome 1969) and on this observation test grouting was suggested to decide the parameters of the grout curtain. Three platforms about 14 m x 14 m in size (Fig. 1) were therefore selected in the three different rock units exposed around project area and the test grouting was carried out through inclined holes going down to different depths to find out the groutability of the rock and to evolve optimum spacing of grout holes.

2. General geology of the Area

The Chandpur phyllites (Ordovician-Silurian, Auden 1939) exposed around the project area have been classified into three broad categories (Shome and Kumar, 1979) on the basis of lithological characteristics, engineering properties and tectonic deformation suffered by these units. Among these phyllites, grade I (phyllitic quartzite) is the best type of rock so far as engineering competency is concerned, predominantly arenaceous in composition, massive in nature and distinctly jointed. Lithologically, phyllite grade-II is quartzitic phyllite in composition, banded in appearance and in physical competence intermediate between grade-I and grade-III phyllites. Phyllite grade-III (schistose phyllite) is composed mostly of argillaceous materials, schistose in nature, with foliation planes, cleavages and joints very closely spaced and generally involved in minor folds and puckers. These three rock units show pinching and swelling characteristics and merge with one another along their strike extent (in lateral distances of about 20-30 m).
The foliation of phyllite generally varies in strike from N55°W-S55°E to N80°W-S80°E with dip varying from 35°-60° in south-westerly direction. These rocks in the dam site area occur on one limb of a major anticline plunging south-east.

3. Structural discontinuities and its analysis with respect to the grout holes

The physical assessment of the three rock units, indicates that the rock as such has got negligible granular (primary) permeability and the water loss indicated in the drill holes are mainly due to the fracture permeability of the rock mass (secondary). Hence, in order to assess the equivalent permeability vis-a-vis structural discontinuities, a detailed analysis of these discontinuities pattern have been carried out and following trend has been observed in order of prominence.

i) Discontinuities parallel to foliation: Several shear zones with their strike and dip parallel to those of foliation have been observed. The thickness of gouge or brecciated rock of individual shear zones vary from a fraction of centimetre to as high as 50 mm. One set of joint has been observed parallel to the foliation and generally these are very tight.

ii) Discontinuities across foliation: The next important set of discontinuities trend parallel to foliation but dip in north-easterly direction at an angle varying from 35° to 65°. One such major shear zone has been exposed on the abutment and encountered in drifts and tunnels and found to vary in thickness from 1.5 m to 3.0 m. Less prominent shear zones of this type have been observed varying in thickness from a few centimeters to even 10 cm. Joint sets having this trend have been found and these are generally tight in nature.

iii) Discontinuities oblique to foliation: Less prominent discontinuities have been found to be dipping steeply and trending almost parallel to the foliation. One of such shear zones have been found to strike in N60°E-S60°W direction dipping vertically and the other one has been found to strike N30°E-S30°W direction and cut across the foliation vertically. Joint sets parallel to these have also been observed and have been found to be tight in nature.