Rock Grouting Technology for Reducing Groundwater Inflow in Deep Underground

Masakuni TSUJI ► Manager, Civil Engineering Planning division, Shimizu Corporation, tsujimas@shimz.co.jp;
Koki IKEDA ► General Manager, Geoscience Facility Construction Section, Tono Geoscience Center, Japan Atomic Energy Agency;
Shin-ichiro MIKAKE ► Manager, Geoscience Facility Construction Section, Tono Geoscience Center, Japan Atomic Energy Agency;
Hiroya MATSUI ► Principal Engineer, Crystalline Environment Research Group, Tono Geoscience Center, Japan Atomic Energy Agency.

1. Mizunami Underground Research Laboratory

JAEA is operating the Mizunami Underground Research Laboratory (MIU) project in order to establish a firm scientific basis for safe geological disposal of high-level radioactive waste. The geology below 170m depth consists of Cretaceous granite. It has been essential to develop rock grouting technology in the conductive zones as a countermeasure to minimize water inflow into a tunnel in the view of grological disposal in JAPAN. We have applied various materials such as ordinary cement, superfine cement, and a liquid type durable grout, colloidal silica grout (CSG) to seal fine rock fractures. The CSG is composed of activated silica colloid with gelling property and its penetrability is much higher than that of cement due to a particle size of a nanometer.

2. Grouting experiences in 500m depth

We have recently conducted pre- and post-grouting works at a gallery in 500m depth of MIU. The groundwater pressure was around 3.5–4.0MPa and a maximum grouting pressure was set to 5.5MPa. As a result, water inflow was reduced to a one-hundredth of an assumed amount with no grouting were performed, which is reduction from approx. 6,000L/min/100m to 60L/min/100m. Moreover, after a later post-grouting work repeated in the most wet section of the relevant gallery, all dripping spots turned out to be lower than 1 L/min, which is assumed to be a criteria for post-grouting of point leakage in disposal tunnels in Sweden.
Especially for the post-grouting technologies, three new concepts were demonstrated and found to be effective; which is the CSG for a new material, complex dynamic grouting method (Fig.1) for a new injection method, and sealing outer area of pre-grouted zones (Fig.2) for a new grouting area as design concepts.

3. Conclusion

It can be concluded that this technology is applicable to general tunnels in hard rock with abundant fractures and a severe inflow requirement, and to construct the future disposal tunnels in deep underground, accordingly decreasing maintenance costs such as longtime water discharge in disposal projects.

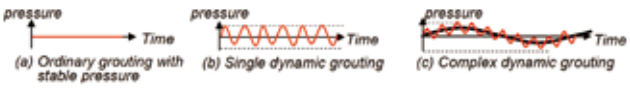

Fig.1 Concepts of different injection systems regarding grouting pressure with time.

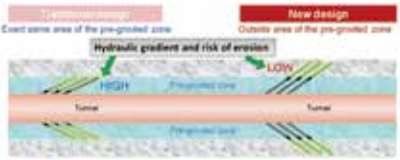

Fig.2
A schematic view of the new design in post-grouting zone, which is outside of the pre-grouted zone in the right compared with a view of the traditional design in the left.