Design of the Underground Research Tunnel in KAERI

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1. Introduction

In order to dispose high-level radioactive waste(HLW) safely in geological formations, it is necessary to assess the feasibility, safety, appropriateness, and stability of the disposal concept at an underground research laboratory(URL) constructed in the same geological formation as the host rock. Many countries considering geological disposal of radioactive waste, therefore, constructed underground research laboratories and carried different in situ experiments.

In Korea, a small scale URL was planned and a conceptual design of the URL with an access tunnel and research modules was developed in 2003. To confirm the validity of the conceptual design for constructing the URL at KAERI, geophysical survey, borehole drilling, and in situ and laboratory tests had been carried out[1]. The mechanical stability of the URL was investigated with a consideration of the surface topology, tunnel geometry, tunnel slope, sequential excavation, and rock property variation along the tunnel using the three-dimensional code, FLAC3D. From the study, it was possible to conclude that the small scale URL constructed in KAERI will satisfy the minimum requirements[2].

In this study, the final design of the small scale URL was developed based on the geological survey and stability analysis.

2. Basic concept of the small scale URL

The URL at KAERI will be utilized for various in situ experiments including rock mechanics, hydrology, engineered barrier, and migration of ion and colloid. The research modules,at which major researches will be performed, should be located at the same rock type as the host rock at depth more than 100m. Also good rock conditions are required for maintaining the underground tunnel for a long time with a limited rock supports mainly consisted of rock bolts and wire mesh. With the consideration of the requirements, basic concept of the URL could be made.

In order to achieve the minimum depth efficiently with a shorter access tunnel, an area with a mountain was selected as the site. By placing the research modules below the 208m high mountain, the required depth can be easily achieved with a short access tunnel. Based on the local topography and borderline of KAERI domain, tunnel direction of N56°W was chosen. Tunnel size of 6mx6m was recommended to allow utilizing jumbo drill and other equipments typically used for tunnel construction. The access tunnel is considered to have downward slope to place the research modules as deep as possible with a limited length of access tunnel. It is also necessary to consider the transportation during the construction and operation for selecting the tunnel slope. With a consideration of workability and efficiency of achieving required depth, -10% access tunnel was suggested. However, the final tunnel geometry, direction, and slope should be determined with the consideration of other factors including the geological, environmental, hydraulic conditions, and mechanical stability.

3. URL design

In the URL design, the following items could be finally suggested with a consideration of the geological, hydrological, and environmental conditions, rock properties, in situ stress conditions, mechanical and hydrological modelings:

- Tunnel shape, size, length, direction, depth, and location
- Excavation method and rock support system
- Ventilation, illumination, ground water pumping, water supply, power supply, communication system
- Location of turning shelter and sumper
- Shape of portal and slope reinforcement system
- In situ stress and deformation measurement system
- Construction equipments and dumping of muck
- Other auxiliary facilities including a temporary building.

Figure 1 shows the overall layout of the URL. Figure 2 shows the expected portal area after slope reinforcement. Figure 3 and Figure 4 shows the ventilation system and blasting/support system, respectively. URL will be located at KAERI, Yuseong, Daejeon. The access tunnel dimensions are 235m long, 6m wide and 6m high. There will be two 8m long turning shelters for easy movement of vehicles. The research modules are 25m long, 6m wide, and 6m high.It will be located at about 120m deep hard rock. The total tunnel area is 1,869 m^2. The tunnel portal area will be 2,261 m^2.

The construction of the URL will be done with two stages: (a) Construction stage 1: 2004 ~ 2005 (10months); and (b) Construction stage 2: 2005 ~ 2006 (5months). The operation of the small scale URL will be started in 2006. The total required budget will be 3.2billion won including 0.4billion won for the site investigation and design and 2.8 billion for the construction.

3. Conclusion

The design of the small scale URL at KAERI was made based on the literature review, geological survey, in situ and laboratory tests, and computer simulation. The 50m long research modules and 230m long access tunnel will be excavated in good quality granite rock mass. The construction will be carried out by drill and blasting during 2004-2006. After construction, various tests such as rock mechanics, groundwater flow, migration, and disposal system validation for developing Korean reference HLW disposal concept will be able to be carried out. The total budget for the construction of 280m long tunnel and portal area as well as 300m long access road will be about 3.2 billion won.

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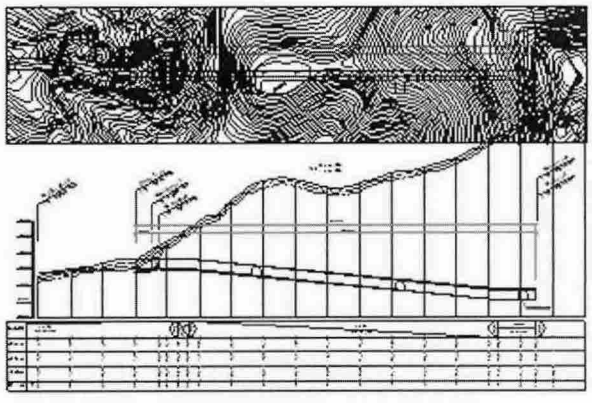

Fig.1 Overall layout

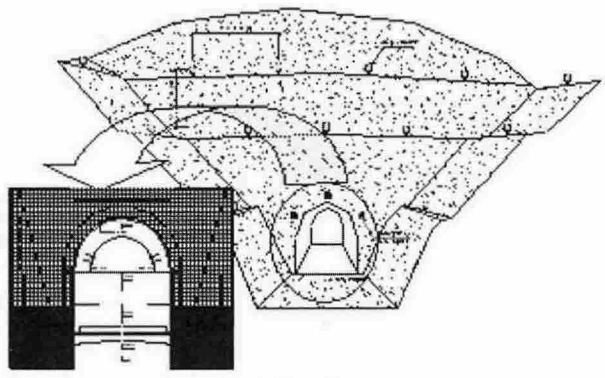

Fig.2 Portal area

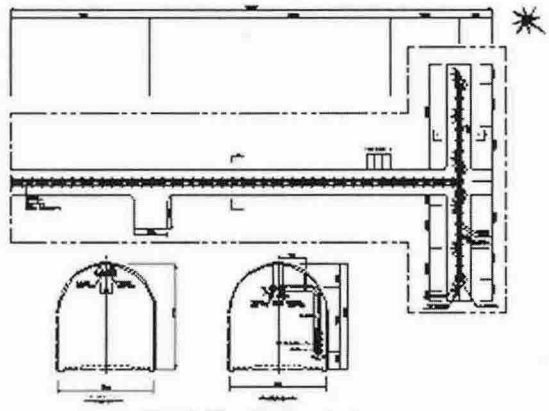

Fig.3 Ventilation design

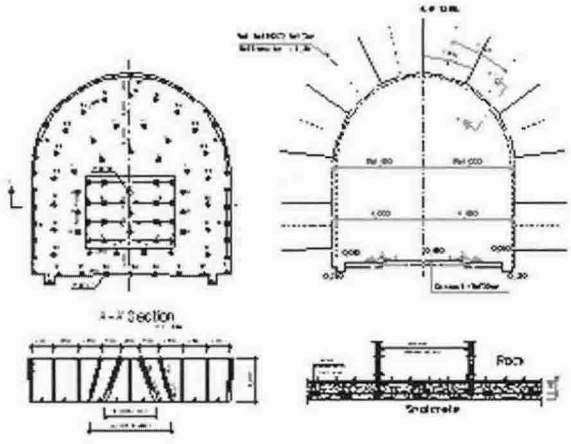

Fig.4 Blasting design and tunnel support