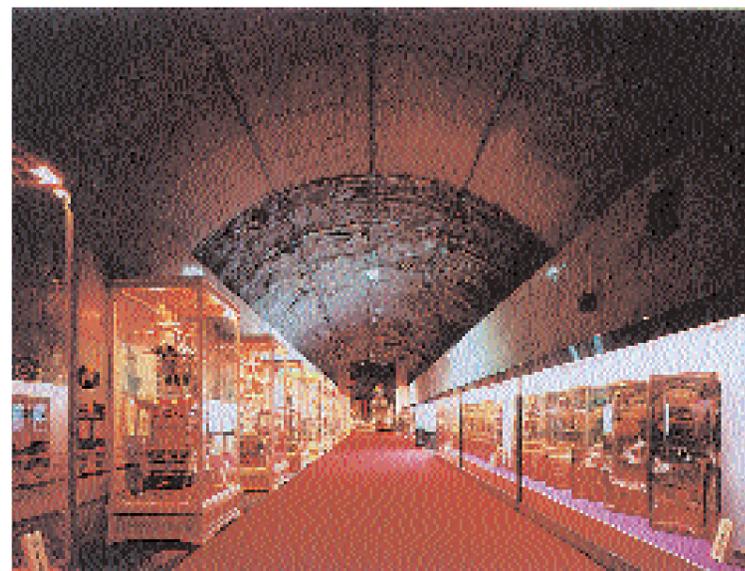




The first full-scale underground art museum utilizing a rock cavern in Japan with earthquake-resistant design in addition to static structural design for the rock cavern with shallow overburden in an active seismic area involving a construction control method for large-scale rock cavern within jointed rock mass

Le premier musée entièrement construit en souterrain au Japon
Conception résistante aux tremblements de terre, conception statique et structurelle du souterrain avec une couverture superficielle dans les zones à activité sismique
Méthode de contrôle de l'excavation souterraine dans les masses rocheuses fracturées

Longueur totale: 220 m (tunnel d'exposition 70 m, hall d'exposition 40,5 m, tunnel-abri 110 m)
Diamètre: 40,5 m
Section excavée: 644 m²
Coût du gros œuvre: 1 milliard de Yens (pour le génie civil)
Durée des travaux: mai 1996 – avril 1998
Date de mise en service: 27 avril 1998



The Takayama Festival Art Museum in the Hida district of Gifu Prefecture is the first major rock cavern for public use in Japan. Inaugurated in April 1998, the museum received 800,000 visitors during its first year.

At the museum are administrative facilities on the surface. The museum itself is a 70 m long tunnel with exhibition halls attached and a dome of exhibition with a diameter of 40.5 m, all excavated under a surface cover of 30 m.

Geological formations surrounding the excavation consist of topsoil, clayish colluvium and pyroclastic welded tuff belonging to the upper Cretaceous to Paleogene Nohi-Rhyolite. The tuff in which the excavation was made is hard and fractured. Faults of category 1 (the Adera and Atotsugawa faults) pass about 25 km north-northeast of the site according to a north-south orientation. De facto, the design of the museum underground, beyond static and structural questions, had to take into account the possibility of an earthquake for the purpose of ensuring a high level of safety.

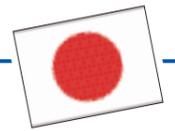
The excavation works began in July 1996 with the excavation of the exhibition dome from the tunnel. The dome had previously been excavated to survey and evaluate the ground conditions for the planning and design. Rock anchors (7 steel wire strands with a length of 8.5 to 11.5 m) of the arch were installed to reinforce and stabilize it, and were temporarily tensioned before excavating the exhibition tunnel. Subsequently, the exhibition dome was excavated by the long bench cut method from the portal concurrently with the anchoring works and connected with the arch of the exhibition dome by a glory hole. Then, the bench and the peripheral refuge tunnels were excavated. Excavation was completed at the end of March 1997, and re-

tioning of rock anchors, installing of inner lining, final shotcreting, placing of base concrete and civil works were completed in July 1997. The results of field measurements and in-situ surveys after excavation works showed that little loosening had occurred around the cavern. This was because the directions and mechanical properties of joints within the rock mass made it difficult for slippage or collapse of rock blocks to occur due to excavation. Further, the use of smooth blasting, finishing excavation by hydraulic breaker and an effective support system appeared to have caused little damage within the ground surrounding the rock cavern.

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The survey and drilling on the site were completed after the completion of the excavation works. The survey revealed a slight loosening around the cavern. The reason is that the falls of blocks and slides during excavation were not facilitated by the orientation and the mechanical properties of the rock mass. In addition, the fine cutting method, the use of the hydraulic cutter, the finishing of the excavation by the hydraulic cutter, the effective support system etc. have allowed the minimization of the degradation of the rock mass around the excavation.

The Takayama Festival Art Museum in the Hida district of Gifu Prefecture is the first major rock cavern for public use in Japan and was opened at the end of April 1998, attracting 800,000 persons in the first year. The museum consists of administrative facilities above ground, an exhibition tunnel with a length of 70 m, escape tunnels, and an exhibition dome with a diameter of 40.5 m excavated under a shallow overburden with a



Name of Project/Nom du projet
Takayama Festival Art Museum

Location/Région
Takayama, Gifu, Japan

Tunnel Use/Destination du tunnel
Underground Museum

Client/Maitre d'ouvrage
Hida Teiseki Corporation

Consulting Engineer/Planification et direction des travaux
Tobishima Corporation

Contractor/Exécution
Tobishima Corporation

Total Length: 220 m (Exhibition tunnel: 70 m, Exhibition hall: 40.5 m, Escape tunnel: 110 m)

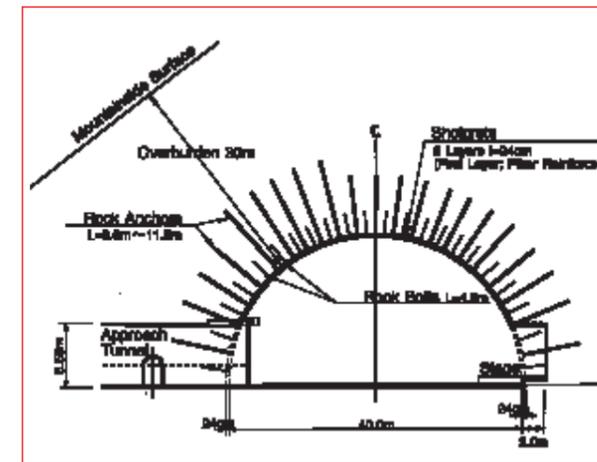
Diameter: 40.5 m

Cross-Section: 644 m²

Roughwork Costs: 1000 million Yen (for civil works)

Construction Time: May, 1996 to April, 1998

Opened: April 27, 1998



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The museum consists of administrative facilities above ground, an exhibition tunnel with a length of 70 m, escape tunnels, and an exhibition dome with a diameter of 40.5 m excavated under a shallow overburden with a

minimum thickness of 30 m.

The geological formations around the cavern, in descending order, are the topsoil, clayish colluvium and pyroclastic welded tuff belonging to the upper Cretaceous to Paleogene Nohi-Rhyolite. The tuff where the exhibition dome was excavated is hard and jointed. Class 1 faults, the Atotsugawa and Adera, lie about 25 km to the north of the site running north-east to south-west, and about 40 km to the south running north-

west to south-east, respectively. Therefore, in the structural design stage of the underground museum, earthquake-resistant designs in addition to static ones were carried out to ensure high standards of safety.

Excavation of the rock cavern began in July 1996 by enlarging the arch of the exhibition dome by using the existing survey tunnel, which had previously been excavated to survey and evaluate the ground conditions for the planning and design. Rock anchors (7 steel wire strands with a length of 8.5 to 11.5 m) of the arch were installed to reinforce and stabilize it, and were temporarily tensioned before excavating the exhibition tunnel. Subsequently, the exhibition dome was excavated by the long bench cut method from the portal concurrently with the anchoring works and connected with the arch of the exhibition dome by a glory hole. Then, the bench and the peripheral refuge tunnels were excavated. Excavation was completed at the end of March 1997, and re-

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