



Editorial - Remarkable Role of Rock Engineering in Infrastructure Development

Humans have used natural rock caverns for shelter since time immemorial. The Rishyamukha mountain is an important location in the great epic of Ramayana during Treta Era, where the exiled Sugreeva took shelter to protect himself from his elder brother Vali (also known as Baali), the ruler of the Kingdom Kishkindha, who had unfortunately turned against him. This ancient area of Kishkindha, safely located in Dandak Forest (also known as Dandakaranya) is famous for its dramatic, rock landscape and historical ruins featuring numerous caves and believed to be located near Ajandari Hills (the birth place of lord Hanuman) - a UNESCO world heritage site in Hampi, Karnataka. The entire region is considered spiritually vibrant, where Sugreeva first met Lord Ram and Hanuman (his trusted counsellor) - a pivotal moment in the epic, and is often identified with a mountain near the Tungabhadra River in modern-day Hampi, Karnataka, in South India

Archaeological findings reveal that a 1.036 km long Eupalinian Aqueduct or tunnel of Eupalinos in 1.8 m x 1.8 m size was built in Samos, Greece around 550 BC to carry water from springs to the city of Samos, 1.6 km away. The entire aqueduct system, including channels, exceeded 2.5 km. During the People's Movement in China in 1960s/1970s, Mao Zedong deployed a large labour force to construct several hundred kilometres of tunnels, which now accommodate the famous underground markets and malls. In Sweden, the Stockholm sewage treatment plant is located entirely underground, including the tertiary treatment facilities. These are few examples of ancient cave or underground space use.

Rock Mechanics and Underground Space Technology contribute to environmentally friendly infrastructure by providing the expertise to build resilient, low-impact facilities that conserve space and support green energy solutions. Placing infrastructure underground (transport, utilities, storage, power plants, etc.) reduces surface land use and soil scarring, enabling the preservation or creation of green spaces, natural habitats, and agricultural land. Underground spaces also maintain stable ambient temperatures, providing natural insulation and significantly reducing energy consumption for heating and cooling—thereby lowering life-cycle costs and carbon footprints.

Rock Engineering plays an important role in green energy and waste management. In addition, it has proven essential for developing safe deep geological disposal facilities for nuclear waste and enabling the use of sub-surface space for renewable energy applications such as geothermal systems, compressed-air storage, and carbon capture and sequestration.

Understanding rock properties allows for the safe and efficient management of water resources (e.g., flood control basins, water channels, etc.) and supports the reuse of excavated rock as aggregate in construction materials, reducing dependence on new raw materials. Underground infrastructure is less susceptible to extreme weather events (storms, floods, avalanches, etc.) and natural hazards such as earthquakes, ensuring continuity of critical services and enhancing urban resilience to climate change impacts. Underground construction techniques also minimise disruption to existing urban fabric and ecosystems during construction, compared to surface-level development.

Recently several projects highlight latest advancements in Rock Engineering and Tunnelling, which include India's Chenab rail bridge (taller than the Eiffel Tower)- the world 's highest railway arch bridge addressing immense geological challenges of the Himalayas to provide all-weather rail connectivity to the Kashmir Valley. In addition to the above mentioned rock engineering marvel, several other projects draw our attention, which include Shinku La Tunnel (the world 's highest tunnel beneath the Shinku La pass to provide year round access to Laddakh, a region often cut-off in winter due to heavy snow from the rest of India), Large Hardon Collider tunnel in Switzerland (a 17 mile circumference tunnel), Atal Tunnel (approx. 9 km long highway tunnel, the world 's longest at an altitude of over 10000 feet in Kashmir Valley, India) etc. Latest developments in rock engineering for sustainable and trouble-free construction of tunnels and underground space essentially focus on the integration of artificial intelligence (AI), advanced monitoring systems, innovative ground support technologies, and the use of eco-friendly materials. AI and Machine Learning (ML) models are increasingly used for a variety of critical tasks, including geological condition prediction, optimising construction methodology, Automated monitoring, Digital twin technology, Automation and robotics etc.

In this context ISRMTT continues to play a key role in disseminating experience and knowledge through conferences, workshops, seminars, and, last but not least, the publication of the bi-annual journal JRMTT for over 32 years. Today, Rock Engineers feel more confident about the reliability of their planning and design work, followed by successful construction in challenging geological formations such as the Himalayas.

Prof. Bhawani Singh, the founding Chairman of the Editorial Board of JRMTT, once mentioned in a lecture at the erstwhile University of Roorkee (now IIT Roorkee) - I quote
"A field of knowledge may become popular if its socio-economic relevance is proved repeatedly. Global commercial relevance is better. The word repetition is important. There is immense power in repetition, as the public memory is short. This is one of the roles of conferences."

The 10th Indian Rock Conference of ISRMTT (popularly known as Indorock), the flagship event of the Society, was successfully organised recently in New Delhi in association with CSMRS, New Delhi, and Norwegian Geotechnical Institute (NGI), Norway. Continuous support and efforts from Dr. Rajinder Kumar Bhasin, President, ISMRTT and Regional Manager Asia, NGI in mobilizing the NGI and other countries scientists has helped in the activities of ISRMTT and IndoRock-2025, which provided a strong forum for exchanging ideas, experiences, and interactions among experts from different countries. There was an excellent and truly committed response to the invitation to submit papers for presentation and discussion at the conference held on November 5-7, 2025. Although I was not present in person at the venue of the IndoRock, I was very much there in spirit.

The present edition of the journal (the 63rd Issue of JRMTT, Vol. 32, No. 1) includes 3 updated / revised papers presented in the 10th Indorock including an insightful keynote paper titled "Strength and Weakness with NMT and NATM, and Due Care with Numerical Modelling" by the doyen of rock engineering, Dr. Nick Barton.

I express particular thanks to the authors - without their efforts there would be neither journal or conference nor issues or volumes. Thanks, are also due to the colleagues of the IndoRock Organising Committee, the reviewers of the manuscripts, and the entire editorial team. Their endeavours are greatly appreciated.

-Dr. Subhash Mitra
Chief Editor, JRMTT