

## Recommendation of ICUST-2011

The International Conference on Underground Space Technology was held in Bangalore, India during January 17-19, 2011. Based on presentation and discussion at various technical sessions of this conference, the following recommendations are made. They cover only aspects over and above present practice:

### **General**

1. To meet the future challenges of underground space there is a need for qualified, trained and skilled manpower. The academia, industrial houses and research agencies should make a concerted effort in this direction. In addition to the government and public enterprises, private companies should come forward to support R&D initiatives.
2. We should not lose sight of the fundamental geological investigation techniques: geomorphic mapping, field mapping, investigation drilling, in-situ and laboratory testing to provide proper inputs for modeling and design
3. Numerical modelling coupled with instrumentation should be compulsorily adopted for all mining excavations and large caverns requiring more than 10,000 cubic meters of excavation. Modelling should be updated progressively with the latest geological and instrumentation data. Due emphasis should be given to the quality of instruments and their calibration.
4. A core library should be maintained at all project sites. Core photographs and core logs should be made available to contractors as well as other investigating authorities in case of any future problem or requirement for design modification.
5. A comprehensive instrumentation programme is to be planned for calibration of the numerical model and for monitoring the health of the excavation prior to, during and post construction to give a better understanding of the rockmass response. This will help in refining and optimizing design parameters, mitigation of unplanned effects and planning of future projects.
6. To enhance the predictive capability of numerical modeling for geomechanics applications, it is necessary to develop realistic constitutive models for materials (soil, rock and coal as well as associated discontinuities including joints).

7. There should be a statutory authority to oversee safety aspects and to ensure quality of investigations in all construction projects (similar to DGMS in the Indian Mining industry). The authority should periodically visit and inspect project sites, and maintain a proper record of their inspections.
8. A minimum of 2% of the overall project cost, as per CWC guidelines, should be spent on engineering geological, geotechnical and geophysical investigations for site characterization.
9. While preparing core logs, care should be taken to standardise ROD by taking into account the drilling method/ capability (good/bad drilling technique) and core diameter, rock quality and recovered core sizes.

### **Mining**

1. With coal mining going deeper, it is essential that more inter-organisation collaborative R&D programmes be planned and executed to address the associated upcoming problems such as complex stress conditions, adverse geomining environment due to increase in gas content and rise in temperature. Research and academic institutions in India (CIMFR, NIRM, ISM, IIT etc.) have to join hands with the stakeholders to provide a comprehensive solution to the mining industry.

### **Tunnels and Caverns**

1. The models for prediction of water inflow, being used in excavation of longwall panels can be used in other underground excavations so as to avoid construction stage blues due to unsuspected heavy inrushes of water.
2. Adequate engineering geological investigation should be done to generate reliable and bankable data for design and construction. Geological and geotechnical data should identify adverse geological conditions so as to limit incidences of geological uncertainties during the construction stage. Emphasis should be on estimation of stand-up time, in-situ stress and hydrogeological conditions.
3. Research and development efforts are required to optimize the design, construction and operation of gas, crude oil and other hydrocarbon storage in rock caverns. They should be properly documented so as to evolve proper guidelines for planning, design and construction of future excavations of a similar nature.
4. The selection of excavation method by TBM or DBM should be based on assessment of geological conditions and geotechnical data, length of the tunnel and economic evaluation.

**Geophysical/ seismotectonic investigations:**

1. Standard geophysical investigations should be considered for site characterization. Resistivity survey should be considered where ground water/artesian problems are suspected.
2. The seismotectonic evaluation of the area of interest should be done carefully to identify active faults and likelihood of any stress related movements. Where such activity is suspected, or recorded or experienced, long-term monitoring of the area by a dedicated seismic network and analysis of the data should be carried out.