

## Shotcrete for Underground Support IX

Kyoto, Japan, November 17-20, 2002

by Dudley R. Morgan, Conference Co-Chair

The Japan Tunnelling Association (JTA) and International Tunnelling Association (ITA) sponsored the Shotcrete for Underground Support IX Conference held in Kyoto, Japan, from November 17-20, 2002. It is a cooperative conference with the United Engineering Foundation, New York, which sponsored the previous eight conferences, the first of which was held 30 years ago. A total of 35 papers were presented at the conference, 34 of which are published in a proceedings available from the JTA. The conference was chaired by Koichi Ono, Professor, Kyoto University, Japan, and co-chaired by D. R. (Rusty) Morgan, Chief Materials Engineer, AMEC Earth & Environmental Limited, Vancouver, British Columbia, Canada.

The conference was a resounding success. It was attended by over 70 delegates, with papers from Japan, South Korea, Vietnam, India, Canada, Brazil, France, Finland, Norway, and Switzerland. Keynote addresses were given by Koichi Ono from Japan on “Shotcrete Use in Tunnelling Works in Japan (over 2 million m<sup>3</sup> per annum); Minema Ikoma from the Japan Railway Construction

Public Corporation (JRCPC) on “Development of Shotcrete Technology in the JRCPC”; and Knut Garshol from Norway on “Admixtures and Other Factors Influencing the Durability of Sprayed Concrete” and “Sprayed Concrete: A Modern Holistic Approach.” In addition, Harvey Parker, from Seattle, Washington, a member of the ITA Executive Committee, gave an overview of ITA activities.

The conference was subdivided into six sessions. The first session was on “Shotcrete Materials,” with five papers on new alkali-free accelerators, two on slurry type accelerators, and one on a new dust-control agent. The impetus for much of this work is the new Japan Ministry of Health *Guidelines for Dust Reduction in Tunnel Construction*, which has set a dust concentration limit of 3 mg/m<sup>3</sup> at 50 m from the face during tunnel construction (including shotcreting operations). Most of the new shotcreting technologies were able to satisfy these new limits.

Nine papers were presented in the second session on Properties and Durability. Five of these papers dealt with the effects of accelerators on early- and later-age strength and/or durability of shotcretes. One paper looked at the effects of shotcreting velocity on various properties of shotcrete and there was an interesting paper from Brazil on the use of electrical gradient to increase early-age compressive strength in shotcrete in tunnels. Two papers were presented in the third session on Support Mechanisms. One paper focused on adhesion between shotcrete and the rock mass and the other looked at the failure mechanism of bonded shotcrete installations.

The fourth session had the theme of New Shotcrete Systems. Six papers were presented in this session. Four of these papers dealt with various aspects of a new airless shotcrete system that uses an impeller in a centrifugal sprayed system to apply shotcrete. This system generates very low dust emissions. Two of the papers in this session looked at mechanized shotcrete reinforcing erection systems and/or dust collection systems.

A variety of different papers were presented in the fifth session on Shotcrete Application. Papers



From left to right: Rusty Morgan, Co-Chairman; Koichi Ono, Chairman; Knut Garshol, Keynote Speaker; and Tarcisio Celestino, United Engineering Foundation Representative.

# Shotcrete Corner

ranged from shotcreting in conjunction with shield tunnelling methods to the use of fly ash in shotcrete tunnel linings to experiences with shotcrete support in underground openings in India. In addition, there was a very interesting paper on a new-sprayed type waterproof membrane for single-shell lining. In the final session, four papers were presented dealing with various aspects of fiber reinforcement in shotcrete linings. Papers dealt with both steel fiber reinforcement and new types of synthetic fiber reinforcement.

To summarize, having this conference in Japan, in English, provided the opportunity for Japan and its neighbors to showcase their state-of-the-art shotcrete for underground support technology. It is apparent that with over 1500 tunnels, with a total length of nearly 1700 km being constructed in Japan in 2001 alone, there is a great incentive to develop optimized tunnel lining systems. The Japanese have made great strides in developing mechanized shotcrete lining systems, and this conference provided an excellent

opportunity for technology transfer to the tunnelling community around the world.

Finally, delegates were treated to the spectacular fall colors in Kyoto and surrounding areas and an opportunity to visit Buddhist and Shinto Temples designated as United Nations World Heritage sites—a truly memorable experience!



*Fall colors at the Golden Temple, Kyoto.*