Retrospective Analysis of Tunnel Squeezing – A Case Study of Tunnel No. 10 along Sivok – Rangpo Railway Project (SRRP), Darjeeling, West Bengal, India

Saradindu Mukherjee
M.Tech. (Tunnel Engineering) Student, Dr. Vishwanath Karad MIT World Peace University, Pune, Maharashtra, India

Sanket Tirpude
M.Tech. (Tunnel Engineering) Professor, Dr. Vishwanath Karad MIT World Peace University, Pune, Maharashtra, India

Somnath Mishra
Geologist, Cemindia Projects Limited (formerly ITD Cementation India Ltd), T Nagar, Chennai, India

Abstract:
The Government of India has undertaken the construction of "Sivok – Rangpo Railway Project (SRRP)" to establish rail route connectivity between Sivok (in West Bengal) and Rangpo (in Sikkim). The railway line consists of total 14 tunnels of variable lengths with connecting bridges. The Tunnel No. 10, being the longest tunnel with 5300 m length, underpasses maximum height of overburden i.e. approximately 800m. As an integral part of the geologically complex Himalayan Orogenic Belt, the tunnelling ground poses various threats towards safe and economic construction of the Tunnel. During construction phase, the tunnel has experienced squeezing and rock burst that basically represent high in-situ stress induced tunnel instability. Below about 725m overburden, the tunnel suffered from very severe to extreme tunnel squeezing and had to undergo re-excavation. To figure out the root cause of tunnel squeezing, an attempt to estimate the ratio of average horizontal stress to vertical stress (Earth Pressure Co-efficient or 'k') has been made from measured tunnel strain data. Considering the vertical rock pressure as minimum principal stress direction, complete in-situ stress tensor has been estimated. Retrospective analysis for tunnelling ground behavior has been exercised based on laboratory tested rock strength parameters and 50% reduced rock strength parameters (due to time dependent deformation or creep deformation) under the influence of 'Back-analyzed' in-situ rock stress magnitudes. Empirical, Semi-Empirical, Analytical (Convergence Confinement Method) as well as Numerical (Finite Element Method) analyses confirm the apprehension of very severe to extreme tunnel deformation that appears with concordance to the reality.

Keywords:
convergence confinement method, finite element method, ground – support equilibrium, long term ground response curve, yielding tunnel support system.