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Prediction of Overbreak in Underground Tunnel Blasting – A Case Study

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Abstract:

Tunnels are required to be constructed for meeting different human needs such as power generation, transportation, underground storage, sewages etc. Irrespective of the purpose for which the tunnels are driven, all are plagued by overbreak problems. Tunnels driven for water conveyance, in hydroelectric projects, in particular, need to be excavated with minimum overbreak so that the cost of permanent concrete lining is kept to minimum.

Predicting overbreak assumes significant importance to design site-specific blasts for minimizing the same. This paper presents a brief review of existing peak particle velocity (PPV) based overbreak estimation models and discusses the influence of PPV on overbreak in a lake tap horizontal tunnel of Koyna Hydro-electric Project, India. Koyna Lake Tap Tunnel is a water feeder tunnel for a fully underground hydroelectric power project. The tunnel had to be driven through hard compact basalt under a shallow cover of 15m beneath a fully charged water body. The rock parting is also compact basalt. Water injection and subsequently grout injection tests confirmed that the rock is intact and there is no evidence of major joints or cavities.

Blasting was completed in two rounds: First the lower part (up to spring level) and then the upper part (arch shape) in a controlled manner i.e., by limiting the maximum charge per delay. Vibration studies were conducted for both the rounds using Minimate Plus) 077 Seismographs, placed on the sidewall. The threshold limits of PPV for different degrees of rock damage are proposed from extrapolated vibration predictor equation. The actual overbreak in the tunnel was measured from the tunnel profiles using a Planimeter. It was found that the percentage overbreak varied from 2.45 to 16.07. The predicted overbreak from extrapolated PPV measurements is compared against the measured overbreak to validate the proposed blast-induced rock damage (BIRD) assessment model. The PPV threshold level, for incipient crack growth was found to vary from 1300 to 2000 mm/s; for crack widening from 2000 to 2800 mm/s and for overbreak from 2800 to 5200 mm/s.

Keywords: overbreak assessment; blast design and vibration monitoring; determination of max charge/delay; near-field PPV; overbreak; overbreak/blast damage assessment; change in strata; seepage.