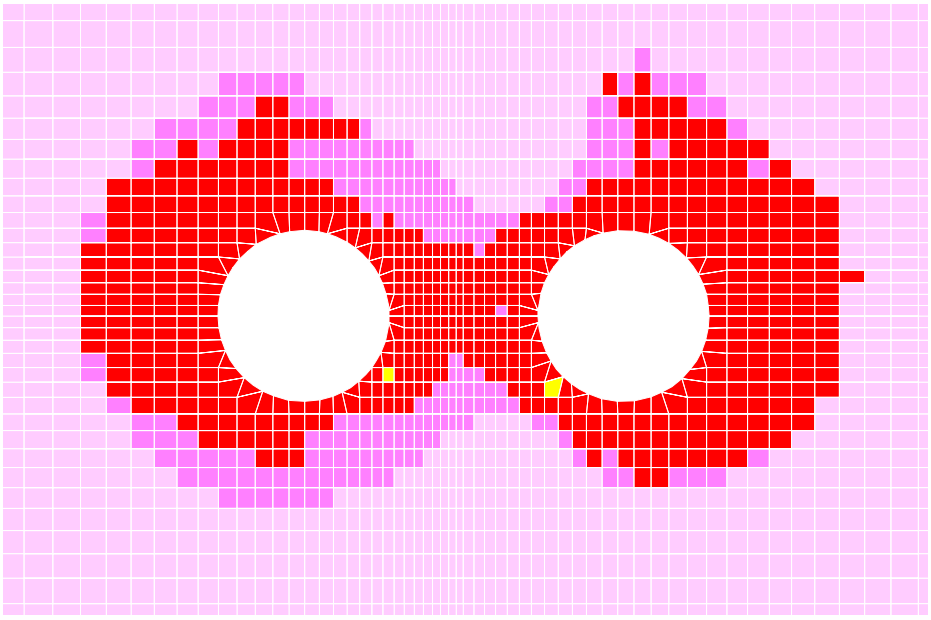
Los Angeles Metro Red Line—Geotechnical Analysis

CNA Consulting Engineers conducted a geotechnical evaluation of squeezing ground conditions in the Upper Topanga Shales during TBM construction of the Red Line tunnels for the Los Angeles Metro system. The problem arose during a holiday shutdown, and trapped one TBM for several months. Within two weeks of the first sign of a problem, the ground had squeezed in about one inch around the cutter head, one inch to five inches on the roof shield, and up to eight inches behind the TBM.



CNA developed a rational, mechanics–based model that explained the observations and was used to predict future ground behavior. From these predictions and experience, CNA developed opinions on future tunneling conditions. The approach consisted of five parts: i) collect and understand the observations, ii) use the observed behavior to infer the mechanical properties of the ground, iii) develop several possible ground behavior mechanisms that explain ground behavior, iv) develop and calibrate a numerical model to predict observations, and v) to project future behavior.

The ground was tightly folded and highly irregular with closely spaced, near–vertical beds and numerous shear zones at various dips. A significant fault was nearby, but the exact location and influence was unknown. Few planes of weakness (bedding planes and shears zones) were at adverse orientation to the face, which was stable. However, the combined bedding planes and shears were adversely oriented to the unstable tunnel walls, crown and invert and strongly influenced their stability.

The FLAC model was used to estimate ground reaction curves, the amount of tunnel squeezing and the support pressure necessary to maintain elastic behavior. The ground reaction curves showed that the tunnel displacement was sensitive to the material strength, with displacements varying by about a factor of four. The support pressure necessary to prevent rock yield varied from about 14,000 psf for the weakest rocks to 3,000 psf for the strongest rocks.

Owner — Metropolitan Transit Authority, Los Angeles, CA

Client — Construction Managers including Hatch Mott MacDonald

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