COTTON, SHIRES & ASSOCIATES, INC.
CONSULTING ENGINEERS AND GEOLOGISTS

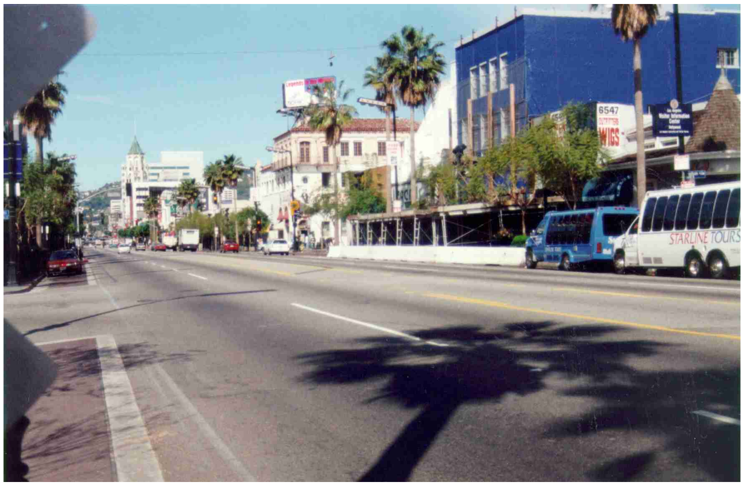
LOS GATOS
CARLSBAD
SAN ANDREAS

TUNNEL DISTRESS INVESTIGATION

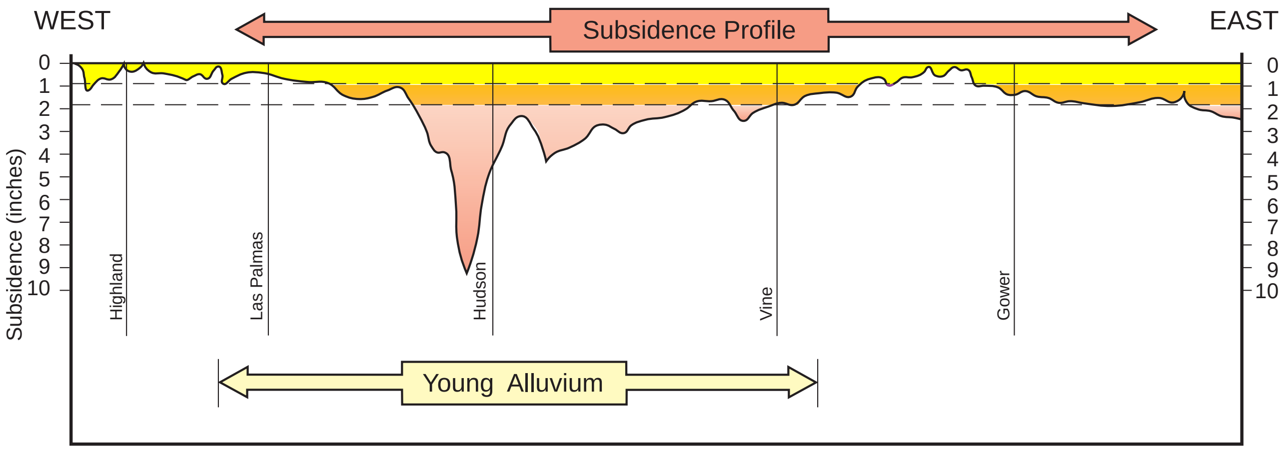
METROPOLITAN TRANSIT AUTHORITY
HOLLYWOOD, CALIFORNIA

PROJECT DESCRIPTION

In the wake of twin-bore, soft ground subway tunneling in 1994, the ground surface settled up to 10.5 inches at a geologically unique site along the historic Walk of Fame corridor in Hollywood, California. This portion of Hollywood Boulevard hosts a large number of unreinforced masonry buildings, and Cotton, Shires and Associates (CSA) was retained by legal counsel for the County of Los Angeles to investigate several million dollars in distress claims brought by building owners. The alleged tunnel-related distress was complicated by the fact that the 1994 Northridge earthquake had caused significant distress to buildings in the area shortly before tunneling. Many building owners perceived the earthquake damage to be tunneling-related damage.



CSA's scope of work included research of geotechnical and construction records, floor-level surveying and distress mapping, subsurface exploration including 30-inch-diameter bucket-auger (downhole logged) and small-diameter boreholes, sophisticated laboratory testing of samples, installation and monitoring of extensometers, inclinometers and piezometers, technical analyses including finite-element modeling of subsidence, ground water movement and seismic shaking, and formulation of conclusions and recommendations regarding the cause and extent of subsidence and possible mitigation alternatives. In order to distinguish between earthquake distress and possible tunneling-related distress, CSA overlaid floor-level plots and detailed crack maps of floors and walls with building sections and ground monument survey data to arrive at the most likely zone of tunnel influence. This proved a successful methodology for comparing pre-tunnel distress with post-tunnel distress.



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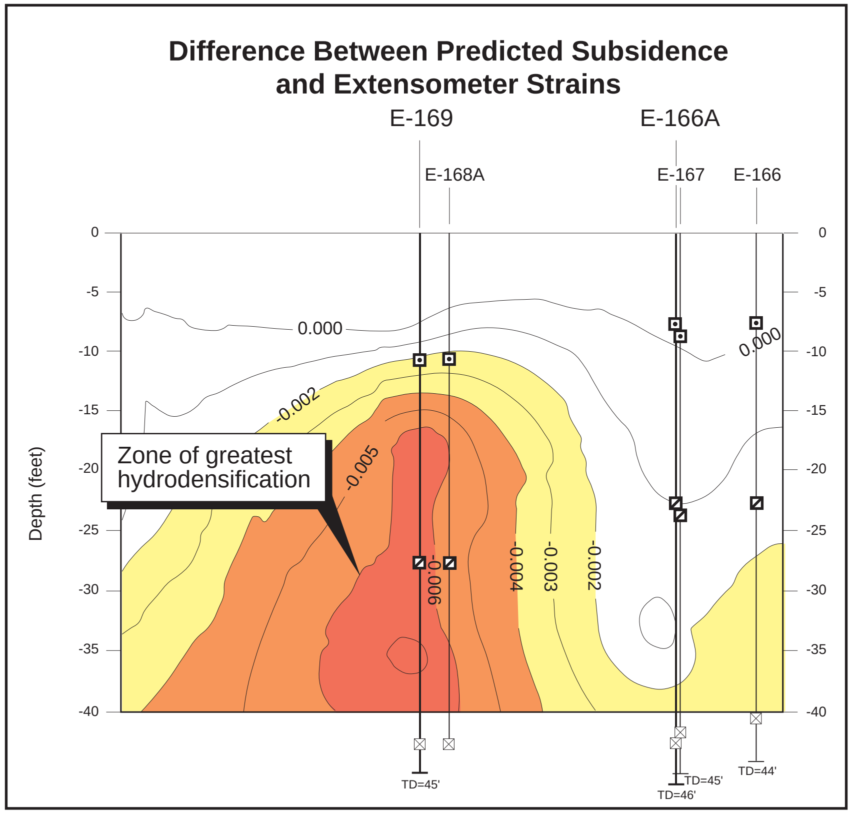
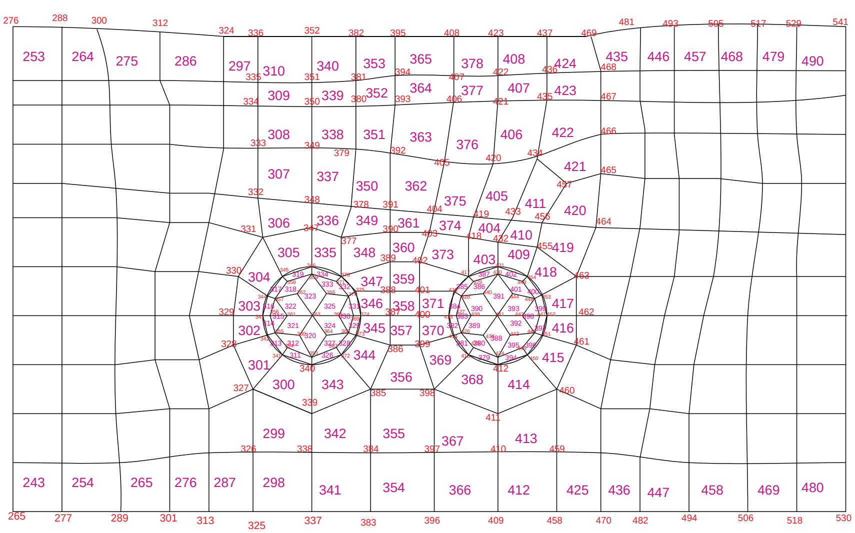
The settlement along the Walk of Fame was unusual in that analyses of extensometers indicated that subsidence over the tunnels was not related to overmining or running ground conditions, but was in large part due to consolidation of the soil structure in the shallow sediments well above the tunnel crowns. Two alternative theories were explored as likely triggering mechanisms for the observed soil densification: (1) vibration of the ground by tunneling machinery / operations, and (2) stresses induced in the ground above the tunnels by reaction of the ground to the tunnel bores. Our analyses suggest that the primary subsidence mechanism was consolidation of hydrodensifiable soils as stresses induced above the tunnel openings passed through the area. Other factors influencing subsidence included normal ground deformation due to tunneling, the presence of water in the soil and crushing of temporary wood wedges installed between the tunnel wall and liner.



Defining the zone of tunneling-related distress and establishing the mechanism of subsidence assisted our client, Wasserman, Comden, Casselman & Pearson, LLP in Tarzana, in successfully negotiating out-of-court settlements for the affected buildings. Throughout this project, CSA worked closely with Englekirk and Sabol Structural Engineers of Los Angeles, and Adamson Claims Management cost estimators of San Francisco. CSA is providing continued monitoring of surface and subsurface instrumentation, as well as providing mitigation recommendations for selected buildings.

FINITE ELEMENT ANALYSIS



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