Extended Abstract : Caldecott Tunnel Construction 4th Bore / NATM Tunnel in San Francisco SH 24 California
After three tunnel constructions and investigation programs – are there no surprises anymore?

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INTRODUCTION

The 4th Bore is a highway tunnel on California State Route 24 currently under construction. The 4th Bore was undertaken by the California State Department of Transportation (CALTRANS) and the Contra Costa County Transportation Commission (CCTC) to alleviate traffic congestion on SR24 connecting the cities of Oakland and Orinda in the San Francisco East Bay Area. The cost for the 4th Bore is estimated at $390.8 Mill. The 3,249 ft long Bore tunnel will have excavated dimensions of approximately 40 ft height and 49 ft width. A total of 7 cross passages will run between the 3rd and the new 4th bore.

Caldecott bores numbers 1, 2 and 3 run parallel to the 4th bore, are offset approximately 100m (328ft) to 32m (105ft). The construction of the 1st and 2nd bore began in 1934 and was completed in 1937. The 3rd bore was excavated from 1961 to 1964.

With a detailed interpretation of all geological and geotechnical data this paper provides a description of the project which discusses important elements such as ground class, ground conditions, behaviors, groundwater and construction considerations. Thereby challenges during the excavation of Bore #4 in comparison to the existing Bores 1-3 and the prognosis under analogy of historical events are discussed.

Geology and Hydrogeology

The project is located in the Oakland Berkeley Hills of the SF Bay Area. The Caldecott Tunnels lie within the easterly assemblage of the Hayward fault zone province which consists of a sequence of sedimentary and volcanic rocks that accumulated in the interval between about 16 and 8.4 Ma (Miocene). The basal rocks of these Tertiary deposits consist of deep marine basin sediments of the Monterey Group. These rocks are overlain uncomfortably by an interbedded sequence of terrestrial sediments (Orinda Formation) and volcanic rocks (Moraga Formation). The Tertiary rocks have been folded into large amplitude, NW trending folds that are cut by N trending strike and slip faults. The SF Bay Region, which is crossed by 4 major faults (San Gregorio, San Andreas, Hayward, and Calaveras), is considered one of the more seismically active regions of the world. The active Hayward fault lies 0.9mi to the west of the Caldecott Tunnels and is the closest major fault to the project area. The tunnel is at the moment under top heading construction: West Portal (360ft) and East Portal (1,968.5ft).

CONCLUSIONS

In the presence and near of fault zones (0 – 50 m) the water inflow is significantly lower than expected and in absence of fault zones higher water inflow rates than expected were measured in porous rock materials (Sandstone, Conglomerate, shale). This talk discusses the observed and the measured water inflow influence of fault zones during top heading excavation of the 4th Caldecott Tunnel and in comparison to Bores 1 - 3. The hydraulic conductivity decreased in fractured rock masses adjacent to faults and shear zones – as predicted in the GBR (similar to Bore No. 3, 2 and 1) but during our construction work it became clear, that the most important and most significant for the hydraulic conductivity and water inflows were rock properties and lithology. From the lithology standpoint, the Second Sandstone would be one of the most competent units found. Borings recovered during the investigation phase produced high quality rock and this is reflected in the design. It would appear that there is some along strike variability within the unit. In Page's 1950 article, he anticipated this variability and notes that local igneous and sandstone dikes produce differing geologic conditions from one tunnel heading to the next. This would certainly apply to underground versus surface exposure, as well.

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Dr. Gerhard Neuhuber has over twenty years of experience in Geology, Hydrogeology, and Engineering Geology, and as one part of his work also in the design, construction, and construction management of tunnels and underground tunneling. His expertise encompasses soft-ground, mixed-face, and rock-tunneling for transit structures in urban settings utilizing TBM, NATM, and cut-and-cover techniques; employing ground improvement measures to facilitate tunneling by means of grout injections specialty fore-poling systems. He is the Geotechnical Tunnel Engineer associated with the Caldecott Fourth Bore, and the NATM Tunnel in San Francisco. A citizen of Austria, he holds a Magister Rerum Naturalium degree and a Doctor Rerum Naturalium degree, from the Paris Lodron University, in Salzburg, Austria (received 1990 and 1996, respectively). He holds Civil Engineer Qualifications and a Registration as a Civil Engineer in Geology and Mineralogy (Earth Science) from the Republic of Austria and the European Union. He has extensive experience in the following areas: Engineering Geology, Soil Mechanics, Site Supervision; Geotechnical Tunnel Engineer; Geological Geotechnical Documentation, Reporting, Expertises; Geological – Geotechnical Prediction, Evaluation of Tunnel Projects and Excavation Works; Tunnelling (NATM, Method of Drill + Blast, by Excavator, TBM Tunnelling); Geological Exploration, Soil-Investigations, Geological Mapping, Drilling Campaigns; Geological Mapping (tunnels, surface, etc.), Rock Classification, Consulting in Rock Support; Tunneling (highways, hydro power plants, caverns, etc.) Micro tunneling; Geotechnical Site Supervision; Geotechnical Risk Assessment Studies, Slope Engineering, Hazard Evaluation in rock/ soil; Monitoring Engineering and Project Management of Underground Projects; Hydrogeological Consultancy on sewage and water search projects; Hydrogeological Expert in search and evaluation of drink water reservoir and water supply projects, thermo pumps, supervision of drilling campaigns related to mineral water search; Geotechnical Expert in Dump Assessment and Evaluation of waste/ dump locations.