

Memorandum

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To: MR. TOM OSTROM, CHIEF
OFFICE OF EARTHQUAKE ENGINEERING

Date: January 28, 2013

File: 07-LA-14, PM 24.3
0000001016 6SSCN
Sierra Highway OC
Bridge No. 53-1013

Attention: Mr. Mark Yashinsky

From: DEPARTMENT OF TRANSPORTATION
DIVISION OF ENGINEERING SERVICES
Materials Engineering and Testing Services and Geotechnical Services
Office of Geotechnical Support – Geotechnical Instrumentation

Subject: Evaluation of Fault Rupture Potential, Sierra Highway Overcrossing, Los Angeles County

SUMMARY

Sierra Highway Overcrossing (OC), Bridge No. 53-1013, is located about 230 feet north of the nearest potentially active fault which is either a secondary trace of the Santa Susana fault (located one mile south of the structure) or a landslide scarp. Since the fault could not be definitively located in the field during this evaluation, a probabilistic fault rupture analysis was performed and a design value of 4 inches determined for the OC. **No further work is recommended at this time.**

INTRODUCTION

This evaluation was prepared as part of the statewide evaluation of fault rupture potential at Caltrans bridges. Caltrans' policies regarding fault rupture at bridges are described in Memo to Designers (MTD) 20-10. Caltrans requires a fault rupture evaluation if a bridge is located within an Alquist Priolo Earthquake Fault Zone (EFZ) or within 1,000 feet of an un-zoned fault 15,000 years or younger in age. Sierra Highway OC is situated within the EFZ established in 1976 for the Sierra Madre fault zone (Santa Susana fault) in the Oat Mountain 7-1/2' Quadrangle; therefore a fault evaluation was required.

An initial estimate of potential offset was based on an analysis developed by Division of Research and Innovation in collaboration with Geotechnical Services, using methods presented in Abrahamson (2008), Moss and Ross (2011), and Petersen, et al (2011). Both a deterministic fault displacement analysis (DFDHA) and a probabilistic fault displacement analysis (PFDHA) were performed using magnitude, slip rate (for PFDHA), mapping and base map errors, and likelihood of secondary fault traces. If the main trace of the Santa Susana fault crossed beneath the OC, the

expected displacement at the OC would be about 3-1/2 feet deterministically or 5-1/4 feet probabilistically. Mark Yashinsky and Fadel Alameddine reviewed the bridge plans and determined the OC could not withstand these displacements without modification. Therefore additional work, documented herein, was performed to better define the fault location.

Sierra Highway OC was built in 1955 and is a single span bridge 124 feet long and 28 feet wide supported on spread footings. The OC is situated beneath Sierra Highway Separation (Br. No. 53-0848; addressed separately), and crosses over an abandoned ramp of Route 14 (Figure 1).

FAULT RUPTURE EVALUATION

The evaluation consisted of:

- Review of existing data
- Aerial photography interpretation
- Field reconnaissance

The evaluation reached the following conclusions:

- The mapped fault nearest to Sierra Hwy OC is either a secondary trace of the Santa Susana fault or a preferential landslide slip surface
- It is unlikely that the fault trace crosses beneath the OC.

REVIEW OF EXISTING DATA

The Santa Susana fault (Figure 2) is part of the Sierra Madre fault zone and is historically active with the most recent rupture occurring in 1971. The Sierra Madre fault zone extends from the hills north of Simi Valley to north of San Dimas, and consists of several different faults distinguished by differences in orientation and age. The expected maximum magnitude earthquake for the Santa Susana fault is M6.8 (USGS, 2008) and slip rate is 6 mm/yr (Dawson and Weldon, 2012). The fault is reverse dipping about 55 degrees to the north, and sinuous in nature.

The February 9, 1971 M6.7 San Fernando (or Sylmar) earthquake damaged or destroyed many of the structures in that region. Figures 2 - 4 and literature reports (e.g., Sharp, in Oakshott, 1975) indicate that the majority of displacement during the earthquake occurred on primary traces of the Santa Susana and San Fernando faults. Although damage to the 5/14 Interchange was severe, as can be seen from Figure 3 these structures were on the hanging wall of the main fault and therefore subject to magnified shaking. Sierra Highway OC sustained no damage during the earthquake, whereas the bridge situated over the OC, Sierra Hwy UC (53-848L/R) had both

structures shift off their respective bearing seats, with resulting extensive damage to pedestals and shear keys as a result of shaking (Caltrans, 1971a).

A fault evaluation was carried out by Caltrans geologist Tim Beck and others (1994) for the entire 5/14 Interchange. Detailed mapping led to the conclusion that the features south of the interchange that were mapped as faults were actually landslide scarps, with the gouge zone (Figure 5) representing a preferential slip plane. Caltrans noted this conclusion in a cover letter for the report to Earl Hart, CGS geologist in charge of the Alquist-Priolo (AP) Special Studies program. CGS geologist R. Saul (in Oakshott, 1975; cited in T. Smith, 1977) similarly indicated that the apparent faults were likely expressions of landslide scarps. Mr. Hart indicated that more work would be needed to eliminate the zone. A trench excavated for the Caltrans study failed to reach natural ground and no faulting was observed. No further work has been undertaken near the 5/14 Interchange.

No damage in this interchange was attributed to surface rupture, as noted below:

“Primary tectonic movement was not noted at bridge sites at these locations [Rte 5 north of 5/210 IC, the 5/14 IC, and Rte 14]. Secondary movement in natural ground was minor. Most of the surface cracking and movement was confined to embankments and this was principally in the Route 5 area between the 5/210 and 5/14 interchanges.” (Caltrans, 1971a).

Prysock and Egan (1981) in their geologic report on the 1971 earthquake pointed out only the landslide located southeast of the OC and no fault rupture in the area, although they report surface rupture elsewhere. They indicated that surface rupture occurred only at locations, “...sufficiently removed from separation structures [so] that no damage to bridges resulted.”

Review of aerial photos/Lidar data

Aerial photos taken “before” and “after” the 1971 San Fernando earthquake were reviewed (Caltrans, 1970; 1971). No evidence of faulting was observed in any of the photos. Readily apparent in the “after” photos however is slope failure associated with the earthquake that occurred near the mapped fault trace both southeast and southwest of the OC in artificial fill.

No Lidar data are available for this area at this time.

Field Reconnaissance

A field reconnaissance of the OC site vicinity was conducted on 1/10/2013 by Douglas Cook, CEG from the office of Geotechnical Design South - Branch 2 and Martha Merriam. Road construction, vegetation, and natural erosion have concealed or removed any evidence of surface faulting in this area. The visit confirmed the OC location.

POTENTIAL FOR FAULT RUPTURE

Based on the above observations, the potential fault mapped 230 feet south of the OC is at most a secondary trace of the Santa Susan fault and actually may not be a fault at all. Because the fault could not be definitively located, a probabilistic evaluation of fault rupture was performed per Moss and Ross, 2011 (Figure 6). Based on that evaluation, potential fault rupture at the OC is estimated at 0.1 m or 4 inches.

RECOMMENDATIONS FOR ADDITIONAL INVESTIGATIONS

No additional work is recommended at this time.

If you have any questions, please contact Martha Merriam at (916) 227-7135.

Prepared by:

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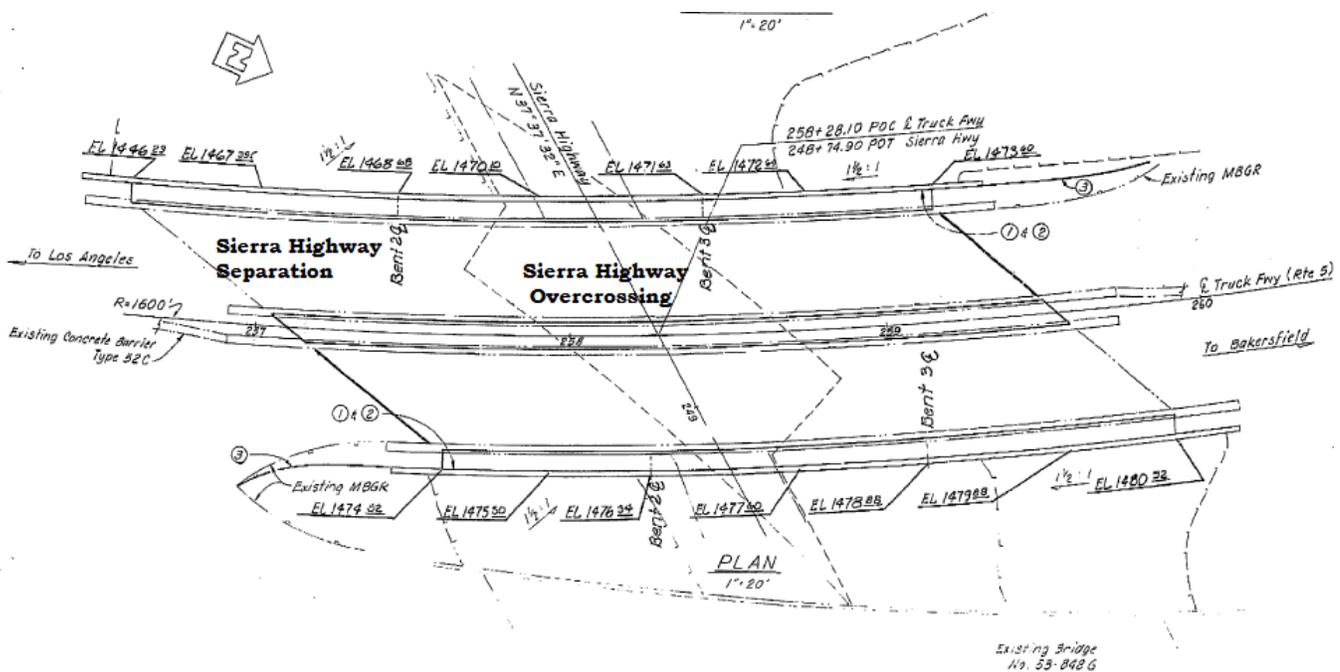


Figure 1. Sierra Highway Overcrossing lies beneath Sierra Highway Separation (53-848) and crosses an abandoned ramp of Route 14.



Figure 2. Area fault map.

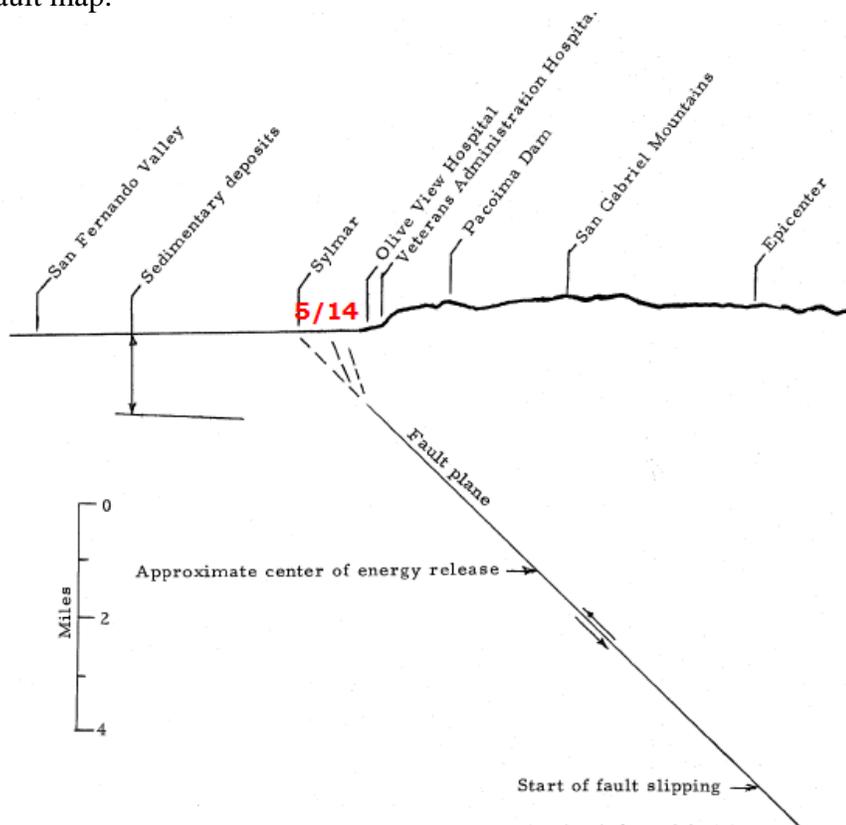


Figure 3 Schematic N-S cross-section showing inferred faulting.

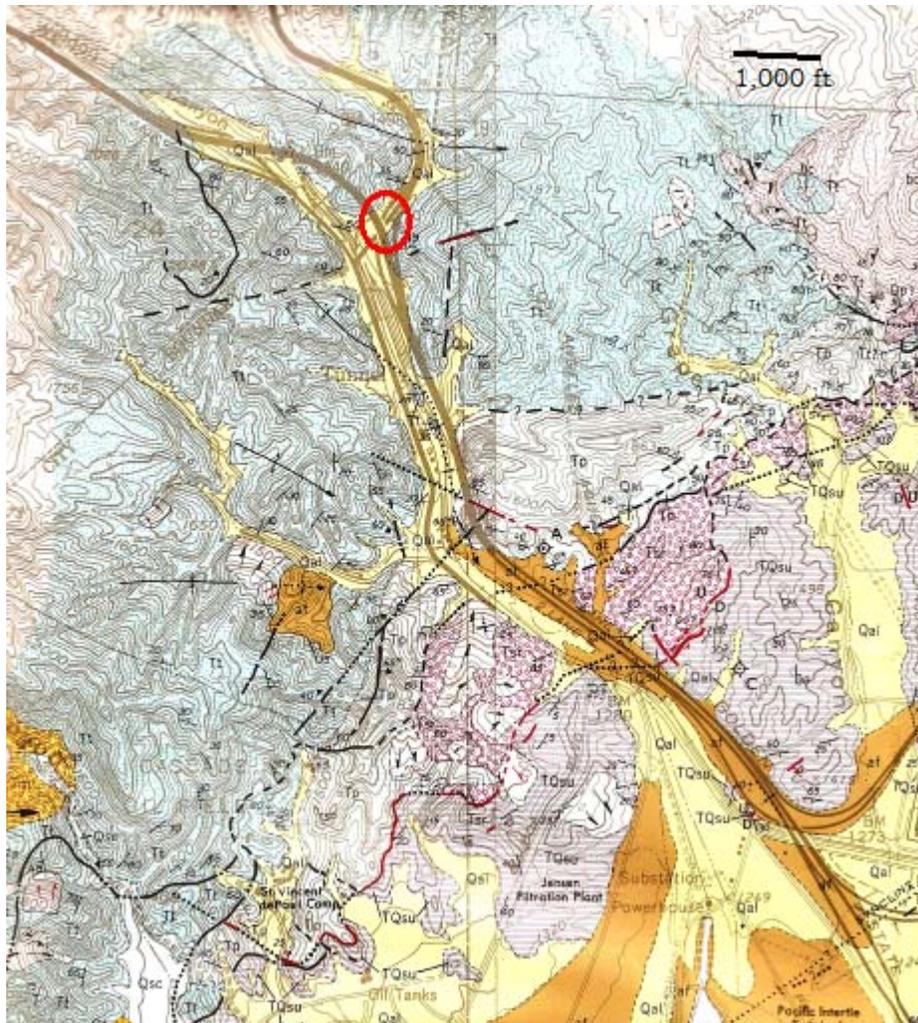


Figure 4. Mapping completed in 1971 by Barrows et al (Oakshott, 1975). 5/14 Interchange is circled in red. Small portion of eastern trace near the I/C is red indicating 1971 rupture or ground crack. Main traces of Santa Susana fault are shown south of the OC.

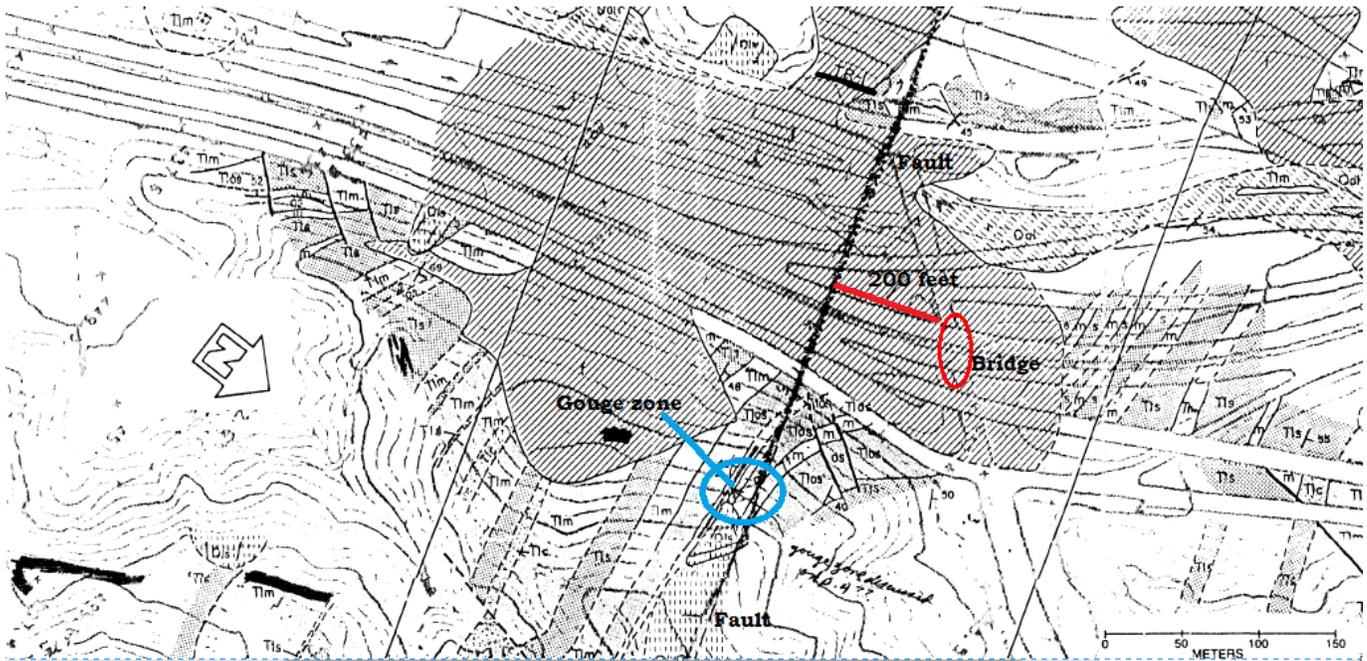


Figure 5. Overcrossing is within red circle, north is to right. Stippling denotes fill; alternating solid light grey and white denotes continuous or slightly offset sandstone and shale beds. Short thick black lines denote ground cracks from 1994 Northridge earthquake. Long thick black line trending east-west denotes EFZ fault trace, located about 230 feet south of OC. EFZs are lines parallel to fault and on either side. Evidence of faulting found in Caltrans mapping is south of the mapped fault within the blue circle (Beck, 1994).

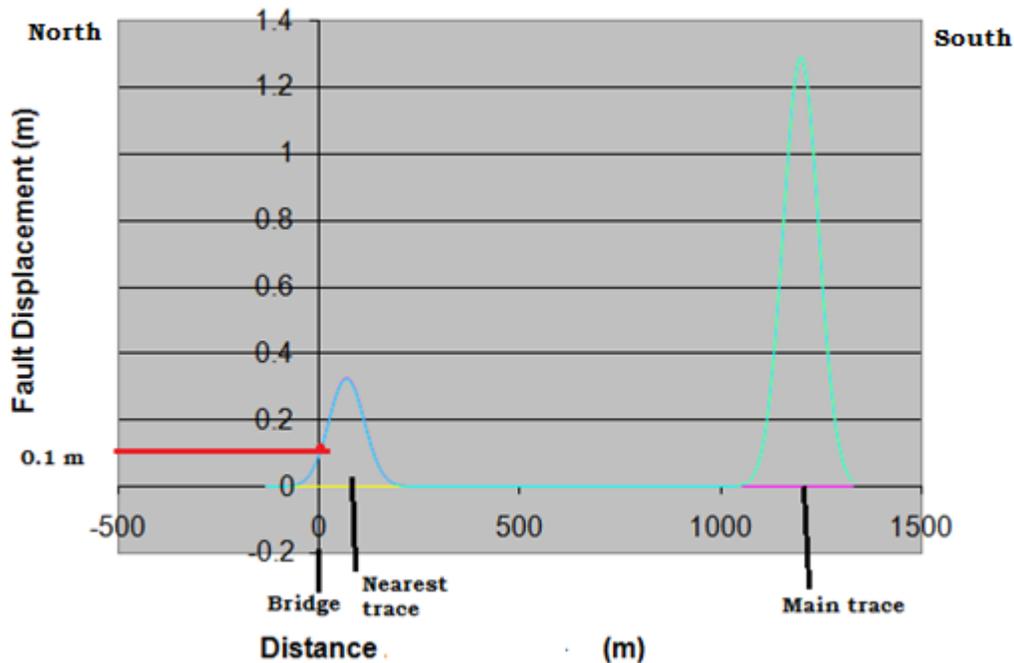


Figure 6. Four inches of displacement at OC (assumed 80% on main trace; 20% on nearest trace).