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To: MR. FRANK WEI
Bridge Design Branch 19
Office of Bridge Design South
Structural Design
Division of Engineering Services

Date: April 19, 2019

File: 12-ORA-133-PM 8.59
EA: 12-0N890
Project ID: 1214000130
BR.# 55-0290 L/F (widen)

Attention: MR. AMIT JOSHI

From: **BALA K. BALAKRISHNAIYER**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design – South, Branch-C

SUBJECT: **STRUCTURE PRELIMINARY GEOTECHNICAL REPORT FOR THE PROPOSED WIDENING OF SAN DIEGO CREEK BRIDGE (BR. No. 55-0290 L/F)**

In response to the request dated February 22, 2019 by the Division of Engineering Services, Bridge Design Branch 19 of the Office of Structure Design South (OSDS), the Office of Geotechnical Design South (OGDS) has prepared this Structure Preliminary Geotechnical Report (SPGR) for the proposed operational improvements along State Route (SR) 133 in the city of Irvine, California.

SCOPE OF WORK

This SPGR presents information of the existing site soil characteristics and preliminary geotechnical recommendations for the proposed bridge widenings. The scope of work determined by OGDS is as follows:

1. Review of the available geotechnical information for the subject site and pertinent reports, plans, and As-built Log of Test Borings (LOTB) of the existing bridge structure.
2. Evaluate preliminary seismic hazard at the site.
3. Prepare preliminary recommendation for the design and construction of the proposed widening of the bridges and,
4. Prepare this report

The information and recommendations presented in this report are based on reviewing of available As-built plans, Log of Test Borings (LOTB), and other relevant site information obtained from the resources such as and Bridge Inspection Records Information System (BIRIS), and Digital Archive of Geotechnical Data (GeoDOG).

PROJECT DESCRIPTION

This project proposes to construct a new auxiliary lane on SB SR 133 between SB I-5 connector to NB I-405 connector and proposes to extend the number three lane on SB SR 133 approximately 300 feet south of San Diego Creek to match the existing roadway pavement. The purpose of this project is to improve traffic flow on SB SR 133 by reducing congestion and operational deficiencies between the SB I-5 connector and the NB I-405 connector. The project will also provide additional vehicular storage, shorten the queue length of vehicles, enhance operations, and improve safety for the drivers during peak periods.

Figure 1: Aerial View of the Project Site with Approximate Locations of the San Diego Creek Bridge Site (Br. No. 55-0290 L&F)

As per the Advanced Planning Study (APS), Bridges 55-0290 L and 55-0290 F are going to be widened under the proposed improvement. The bridge structures are a continuous 5-span reinforced concrete (RC) slab bridge mounted on solid continuous RC pier walls and closed end strutted abutments. The pier walls and abutments are all supported on driven RC piles.

Unless otherwise noted specifically, all elevations referenced in this report are based on the National Geodetic Vertical Datum of 1929 (NGVD29).

EXCEPTIONS TO POLICIES AND PROCEDURES

As per the available information and the scope of work, no exceptions to policies and procedures are identified for this project.

FIELD INVESTIGATION AND TESTING PROGRAM FOR THIS REPORT

No field investigation or laboratory testing programs were conducted for preparing this SPGR. All the information and recommendations provided in this report are based on the As-built LOTB data and other relevant information regarding the existing bridge structure.

However, OGDS recommends conducting additional geotechnical field exploration and a laboratory testing program for this project. Those recommendations are described more in detail later in this report under the section "ADDITIONAL FIELD WORK AND LABORATORY TESTING".

SITE GEOLOGY AND SUBSURFACE CONDITIONS

Regional Geology

The site is located within the Peninsular Ranges geomorphic province north of the base of the San Joaquin Hills. The San Diego Creek flows under the subject bridge. The streambed for the San Diego Creek within the project area is a trapezoidal channel with natural channel bottom with rip-rap for erosion protection and concrete lined side slopes.

Site Geology and Topography

The project area is mapped as mostly Quaternary Alluvial Fan deposits, but there is an outcrop of the Eocene to Miocene aged Vaqueros Sandstone on State Route 133 just at and north of the intersection I-405. The surrounding terrain is relatively flat lying and mostly commercially developed.

Subsurface Conditions

Based on As-built Log of Test Borings, alluvial deposits such as sands and silts with some clay, and sandstone/shale underlie the project. The alluvial deposits consist of medium dense to very dense clayey sands, gravelly sands, and silty sands with scattered clay and silt beds. Very dense sandstone formations have been documented at depths about 18 feet (elev. 145) to 34 feet depth (elev. 130).

GROUNDWATER

According to the As-built Log of Test Borings from San Diego Creek Bridge (Br. No. 55-0290 L/F) site, groundwater was encountered at some of the boring locations. Ground water data from Log of Test Borings No. 2 (sheet 16 of 16 of 1965 data) is summarized in Table 1.

Table 1 – Groundwater Conditions from As-built LOTB for San Diego Creek Bridge
(Br. No. 55-0290 L/F and Ramp No. 14; LOTB No. 2 of 2 dated September 1965)

Borehole ID	Date Groundwater Documented	Groundwater Elevation (ft)	Surface Elevation (ft)	Groundwater Depth (ft)
B-5	09/22/1965	144.8	164.8	20.0
B-6	09/22/1965	145.0	165.1	20.1
B-11	09/22/1965	142.8	165.3	22.5

According to the As-built Log of Test Borings from San Diego Creek Bridge site (Br. No. 55-0290 R), groundwater was encountered in some of the borings. Ground water data from Log of Test Borings dated September 1965, and November 1955 are summarized in Table 2.

Table 2 – Groundwater Conditions from As-built LOTB for San Diego Creek Bridge
(Br. No. 55-0290 R and Ramp No. 7; LOTB No. 1 of 2 dated September 1965, and Br. No. 55-0290; LOTB dated November 1955)

Borehole ID	Date Groundwater Documented	Groundwater Elevation (ft)	Surface Elevation (ft)	Groundwater Depth (ft)
B-1	09/30/1965	157.7	168.2	10.5
B-4	09/27/1965	145.0	172.0	27.0
B-2	11/10/1955	142.6	169.6	27.0
B-3	11/09/1955	144.5	166.3	21.8

The nearest well listed on the California Department of Water Resources Water Data Library website is located about 0.5 miles northwest of the northern end of the project site. Groundwater was measured at a depth of 53.53 ft. (el. 130.1 ft. NGVD29) in 1990.

The State Water Resources Control Board Geotracker website does not list any groundwater records near the project site.

A site-specific groundwater investigation is required during the design phase of the project to determine the depth to groundwater in the subject area.

SCOUR EVALUATION

This project site has a history of scour issues in the past. At different times, attempts have been made for score mitigation related remedial repairs such as rip-rap rock placement, and check-dam installation. There have been few reports on the past scour evaluation and mitigation work at this bridge site.

The latest report from Structure Hydraulics and Hydrology (dated 04/04/2019), indicated the presence of scour and hence exposure of pile caps and piles at the bridge foundation level and remedial measures have been recommended.

At the design phase, a structure hydraulics report should be developed and forwarded to our office when completed, so that scour depth can be addressed in the geotechnical design of the foundations.

CORROSION EVALUATION

The Department considers a site to be corrosive if one or more of the following conditions exist for the representative soil and/or water samples taken at the site: Chloride concentration greater than or equal to 500 ppm, sulfate concentration greater than or equal to 1500 ppm, or the pH is 5.5 or less.

No information of the corrosivity of site soils was found in the As-built records for the subject project site. Other generally available authoritative resources such as soil survey data and corrosivity mapping from the Department of Agriculture's web-based system, indicate low corrosion potential for concrete elements, and high corrosion potential for steel components at the subject bridge site.

Site specific soil sampling and corrosion evaluation will be done during the design phase.

PRELIMINARY SEISMIC DESIGN INFORMATION AND RECOMMENDATIONS

Faulting and Seismicity

The design Acceleration Response Spectrum (ARS) curve was developed for the seismic design of this bridge using the Caltrans ARS Online (v2.3.09) website and the Caltrans Fault Database V2.

The nearest contributing fault to the site is the San Joaquin Hills fault. The fault parameters are listed below in Table 3.

An average shear wave velocity (V_{s30}) for the upper 30 meters (100 feet) of subsurface soils at the site was estimated to be about 324 m/sec (1063 ft./sec) based on correlations with soil types and SPT blow counts.

From the subsurface soil profiles obtained from the existing LOTBs, the soil is classified as "Marginal" according to the Caltrans Seismic Design Criteria.

Table 3 – Fault Information at the San Diego creek Bridge Site (Bridge No. 55-0290 R/L/F)

Fault Name	Fault ID	Type	M_{max}	Dip direction (Dip angle)	R_X	R_{JB}	R_{RUP}	PGA
San Joaquin Hills	376	Rev	7.0	W (23°)	0.295 km (0.18 mi)	0.0	2.022 km (1.26 mi)	0.672

Notes: R_X = Horizontal distance to the fault trace
R_{JB} = Shortest horizontal distance to the surface projection of the rupture area
R_{RUP} = Closest distance to the fault rupture plane

The design ARS curve is an envelope of both deterministic and probabilistic acceleration response spectrum curves. The probabilistic ARS curve was developed with a ground motion return period of 975 years, which corresponds to a 5% probability of exceedance in 50 years.

The design Peak Ground Acceleration (PGA) has been evaluated as 0.672 g from the design ARS curve and is controlled by the deterministic spectrum. The site to fault distance is also controlled by the deterministic spectrum at 1.0 seconds and is 1.26 miles.

Surface Fault Rupture Hazard Evaluations

The project site is located neither within an Alquist-Priolo Earthquake Fault Zone (EFZ) as defined by the California Geologic Survey, nor within 1000 feet of an un-zoned fault that is Holocene (11,000 years) or younger in age. Therefore, there is no risk of surface fault rupture hazard for this location.

Liquefaction Potential

The San Diego Creek Channel area is mapped by the California Geological Survey as prone to liquefaction.

The design spectral PGA for the subject site is 0.672g. Due to the possibility of shallow groundwater conditions and the presence of moderately loose granular soil layers in the subsurface soil profile, there is a possibility of liquefaction affecting the bridge site due to a seismic event that can trigger strong enough shaking lasting for relatively longer duration.

A site-specific liquefaction analysis and other seismic hazards will be performed during the design phase of the project.

AS-BUILT FOUNDATION DATA

The San Diego Creek Left and Connector Ramp Bridges (Br. No. 55-0290 L/F) were constructed in 1967. According to the available As-built foundation plans, reports, and other details, the bridges are supported on Class I and Class II driven concrete piles. A summary of the pile foundation information is provided in Table 4.

Table 4 – Summary of Foundation Information for San Diego Creek (Br. No. 55-0290 L/F)

Bridge Support Location	Foundation Type	Design Pile Capacity (Ton)	Bottom of Footing Elevation (ft)		Specified and (Average) Pile Tip Elevations (ft)	
			L	F (QL)	L	F (QL)
Abut. 1	Concrete Driven Piles (Class I)	45	163.0	159.0	140.0 (142.7)	140.0 (142.7)
Bent 2	Concrete Driven Piles (Class II)	45	159.0	159.0	140.0 (142.3)	140.0 (142.3)
Bent 3	Concrete Driven Piles (Class II)	45	158.0	158.0	140.0 (139.3)	140.0 (139.3)
Bent 4	Concrete Driven Piles (Class II)	45	158.0	158.0	140.0 (137.3)	140.0 (137.3)
Bent 5	Concrete Driven Piles (Class II)	45	155.0	155.0	135.0 (131.5)	135.0 (131.5)
Abut. 6	Concrete Driven Piles (Class I)	45	156.0	156.0	135.0 (133.7)	135.0 (133.7)

PRELIMINARY FOUNDATION RECOMMENDATIONS

As-Built plans and after construction reports indicate that the abutments and piers at San Diego Creek Bridge are supported on 45-ton pre-cast concrete driven piles (Class I for abutments, and Class II for piers).

OGDS recommends that the proposed widening can be supported on concrete driven piles similar to the existing ones. Alternatively, the proposed widening could also be supported on Cast in Steel Shell (CISS) concrete piles or steel H piles as well. The piles can be driven as battered piles and can be advanced into the underlying bedrock. When using steel piles, it may need additional sacrificial steel if the site soil found to be corrosive. Site specific corrosion data is not available to comment on the applicability of the steel piles at this time.

Cast in Drilled Hole (CIDH) piles are not recommended because the soil profile at this bridge site consists of predominantly sands in relatively loose condition at shallower depths with relatively high groundwater level, and hence caving potential is anticipated during excavation. CIDH piles would need to be 24-inch diameter or larger in size and would require temporary casing and slurry to construct. CIDH piles cannot be battered piles.

Spread footing foundations are not recommended due to the presence of near surface loose granular soil conditions with relatively shallow ground water level, and hence the existence of liquefaction potential.

Since the San Diego Creek flows under the bridge, dry season would be preferable for relatively easier construction purposes. Dewatering devices and tremie seals, and/or temporary diversion of water flow away from construction area may be necessary during periods of surface flow. Due to the presence of relatively hard soils and shallow bedrock at site, predrilling maybe needed to assist at some of the pile locations.

The above are preliminary foundation recommendations and may be revised and/or updated when a site-specific field investigation is completed. The above discussions are intended to provide preliminary interpretation of the site conditions for cost estimations and preliminary planning and are not final recommendations.

ADDITIONAL FIELD WORK AND LABORATORY TESTING

OGDS recommends conducting a geotechnical field exploration and a laboratory testing program. The field exploration should include at least two borings, drilled at the site. Lane closures and permits may be required to complete the field exploration. Based on the existing information, OGDS anticipates the depth of boring(s) to be on the order of 70 feet.

Laboratory testing will be performed and may include moisture content and density, soil classification, corrosion, and direct shear tests. Other laboratory tests may be required depending upon the nature of the soils encountered during the investigation.

If you have any questions or comments, please call Bala Krish at (657) 328-6546, or Kris Barker at (909) 806-4701.

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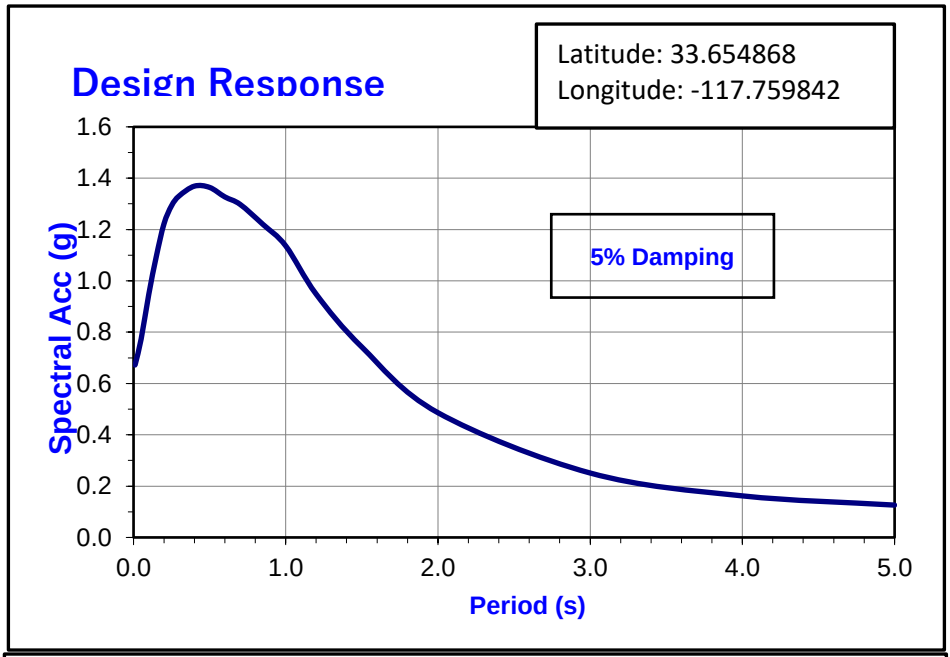
Appendix I: Preliminary Seismic Design Data Sheet

APPENDIX -I

(Preliminary Seismic Design Data Sheet)

Preliminary Seismic Design Data Sheet (Br. No. 55-0290 L/F)

Period (s)	Spectral Acceleration, Sa (g)
0.010	0.672
0.050	0.773
0.100	0.947
0.150	1.096
0.200	1.222
0.250	1.293
0.300	1.331
0.400	1.369
0.500	1.364
0.600	1.327
0.700	1.298
0.850	1.220
1.000	1.136
1.200	0.948
1.500	0.742
2.000	0.486
3.000	0.251
4.000	0.162
5.000	0.126



The Design Response Spectrum is the upper envelope of the deterministic and probabilistic response spectrum, but not less than the Minimum Deterministic Spectrum for California. The deterministic spectrum is obtained by using the average using the 2008 Campbell-Bozorgnia and the 2008 Chiou-Youngs ground motion prediction equations. Probabilistic response spectrum is obtained for 5 percent probability of exceedance in 50 years from the 2008 USGS Interactive Deaggregation web tool.

Seismic Loading Table (per MTD 1-47)

Soil Profile (V_{S30}): 1063 ft/s (324 m/s)

Magnitude: **Mmax** = 7.0; PGA: 0.672g