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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-VAR
EA: 12-0N890
Project ID: 1214000130
New Retaining Walls Along SB SR 133
Wall No. 37, 29, and 9071

Attention: MR. AMIT JOSHI

From: **MICHAEL YEE**
DIVISION OF ENGINEERING SERVICES
Geotechnical Services
Office of Geotechnical Design – South, Branch-C

SUBJECT: **STRUCTURE PRELIMINARY GEOTECHNICAL REPORT FOR THE PROPOSED RETAINING WALLS (NO. 37, 29, AND 9071)**

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 three new retaining walls that are part of 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 three retaining walls. The scope of work determined by OGDS as per the request of OSDS dated February 22, 2019 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 nearby bridge structures.
2. Evaluate preliminary seismic hazard at the site.
3. Prepare preliminary recommendation for the design and construction of the new retaining walls and,
4. Prepare this report

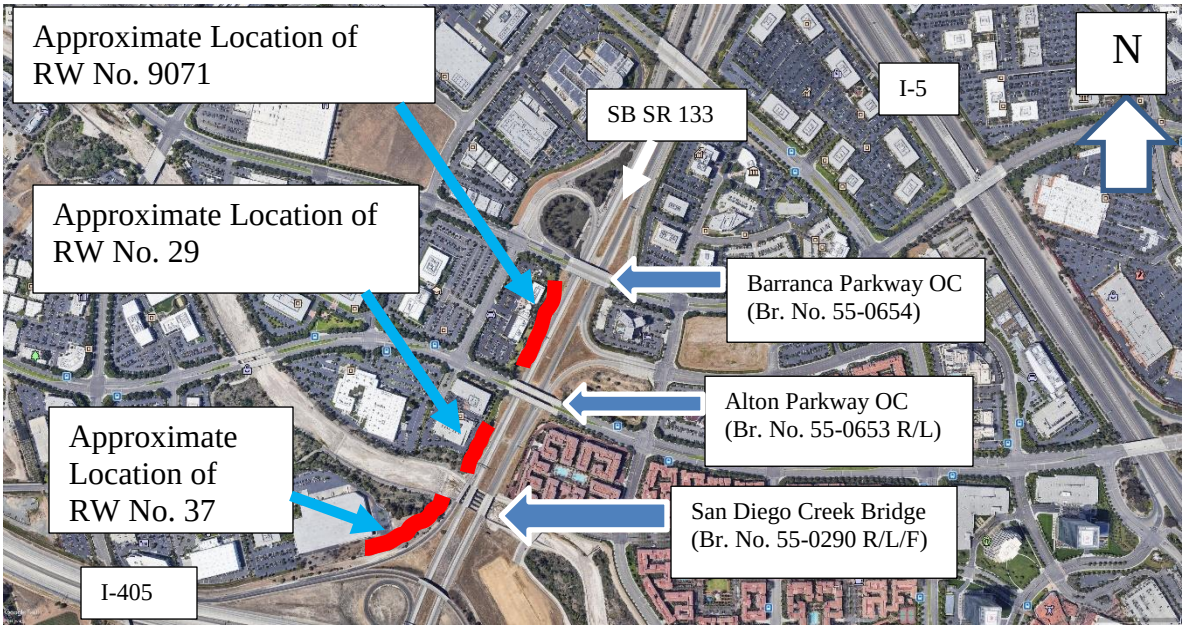
The information and recommendations presented in this report are based on reviewing of available As-built plans, Log of Test Borings (LOTB), and other relevant site information obtained from the resources such as and Bridge Inspection Records Information System (BIRIS), and Digital Archive of Geotechnical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

As per the Advanced Planning Study (APS), three retaining walls No. 37, 29, and 9071, with approximate length of 650, 200, and 500 feet, respectively, are proposed. The wall No. 37 is proposed to be located just south of San Diego Creek along the shoulder of SB SR 133 to NB I-405 connector. The wall No. 29 is proposed to be located just north of San Diego Creek at the beginning of the SB SR 133 to NB I-405 connector. The wall No. 9071 is proposed to be located along SB SR 133 between Barranca Parkway Overcrossing and Alton Parkway Overcrossing. Approximate locations of the proposed retaining walls are given in Figure 1.

Figure 1: Aerial View of the Project Site with Approximate Locations of the Proposed Retaining Walls # 37, 29, and 9071



This report presents the information of the site soil condition as per the existing LOTBs, and preliminary geotechnical recommendations for the proposed retaining walls. 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 structure. 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 along the southern edge of the project site. The streambed for the San Diego Creek within the project area is a trapezoidal channel with natural channel bottom 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 north of I-405. The surrounding terrain is relatively flat lying and mostly commercially developed.

Subsurface Conditions

There are no existing Log of Test Borings specifically prepared for the proposed retaining wall locations, as there are no existing structures at the proposed locations. The project area, however, consists of a few nearby bridge structures such as Barranca Pkwy OC, Alton Pkwy OC, and San Diego Creek Bridge, and other connector bridges. LOTBs that are located near the proposed locations are utilized for compiling this SPGR. Additional test borings will need be done in the project site areas for more accurate soil data as recommended later under the section ADDITIONAL FIELD WORK AND LABORATORY TESTING.

Subsurface Conditions for Proposed Retaining Wall No. 37

For the Retaining Wall No. 37, existing Log of Test Borings from both San Diego Creek bridge/Ramp #14 to NB I-405, and NB SR133 to NB I-405 Connector Separation are utilized to get information on existing subsurface soil conditions. Based on those LOTBs, the proposed site is underlain predominantly by sandy soil with some silt and clay. From the LOTB for San Diego

Creek bridge, the top thirty feet of soil was slightly compact to very dense sand with some silt to an elevation of about 135 feet and becomes very dense to the maximum drilling depth of the borings up to an elevation of about 125 feet. From the LOTB for the NB SR-133 to NB I-405 connector Separation, the soil has been reported as compact to very dense sand to the maximum drilling elevation of about 164 feet. At this boring location which is about 300 feet from proposed retaining wall, very dense sandstone (bedrock) is reported within about eight feet depth. Additional information for the above discussed borings is shown in Table 1.

Table 1 – Summary of Existing Subsurface Exploration (Retaining Wall No. 37)

LOTB Site	Borehole ID	Date Drilled	Total Depth (ft)	Surface Elevation (ft)	Station	Offset (ft) from C/L of SR 133
San Diego Creek (Ramp #14)	B-1	09/26/1965	41	167	Sta 439+80	Lt. 48
San Diego Creek (Ramp #14)	B-12	09/27/1965	32	163	Sta 439+50	Lt. 120 (about 5 ft from C/L of Ramp #14
NB 133 to NB 405 Connector	B-1	09/01/1965	20	184	Sta 33+49	On C/L of SR 133

Subsurface Conditions for Proposed Retaining Wall No. 29

For the Retaining Wall No. 29, existing LOTBs from both Alton Parkway OC and San Diego Creek Bridge site are utilized to get information on existing subsurface soil conditions. Based on the LOTBs, the proposed site is underlain by predominantly silt and sand, with some clay. From the LOTB for Alton Parkway OC (which is relatively nearer to the northern end of the proposed retaining wall), the top thirty feet of soil is semi-compact to compact to an elevation of about 150 feet and becomes compact to dense to the maximum drilling depth of borings at an elevation of about 110 feet. From the LOTB for San Diego Creek bridge, the top thirty feet of soil by the southern end of the proposed retaining wall is loose to compact sand with some silt to an elevation of about 135 feet and becomes dense to very dense to the maximum drilling depth of the borings at an elevation of about 120 feet. Detailed information for the borings is shown in Table 2.

Table 2 – Summary of Existing Subsurface Exploration (Retaining Wall No. 29)

LOTB Site	Borehole ID	Date Drilled	Total Depth (ft)	Surface Elevation (ft)	Station	Offset (ft) from C/L of Rte 133
Alton Parkway OC	B-5	05/29/1985	72	183	Sta 49+94	Rt. 53
Alton Parkway OC	B-6	05/28/1985	32	182	Sta 48+48	Lt. 42
San Diego Creek (Ramp #14)	B-3	09/22/1965	46	164	Sta 440+40	Lt. 120
San Diego Creek	B-7	09/22/1965	40	164	Sta 440+40	Lt. 63

Proposed Retaining Wall No. 9071

For the Retaining Wall No. 9071, existing Log of Test Borings from both Alton Parkway OC and Barranca Parkway OC are used to get information on existing subsurface conditions. Based on those LOTBs, the proposed site is underlain by predominantly silt and sand, with some clay. From the LOTBs for Barranca Parkway OC (which is relatively nearer to the northern end of the proposed retaining wall), the top thirty-five feet of soil is semi-compact to dense to an elevation of about 150 feet, and becomes dense to very dense to the maximum drilling depth of borings at an elevation of about 110 feet. From the LOTB for Alton Parkway OC (which is relatively nearer to the southern end of the proposed retaining wall), the top thirty feet of soil is semi-compact to compact to an elevation of about 150 feet. Detailed information for the borings is shown in Table 3.

Table 3 – Summary of Existing Subsurface Exploration (Retaining Wall No. 9071)

LOTB Site	Borehole ID	Date Drilled	Total Depth (ft)	Surface Elevation (ft)	Station	Offset (ft)
Barranca Parkway OC	B-1	05/28/1985	46	184	Sta 95+59	Rt. 5
Barranca Parkway OC	B-2	05/29/1985	72	184	Sta 96+94	Rt. 36
Alton Parkway OC	B-6	05/28/1985	32	182	Sta 48+48	Lt. 42

GROUNDWATER

According to the As-built Log of Test Borings from Barranca Parkway Overcrossing, Alton Parkway Overcrossing, groundwater was encountered from 30 to 35 feet deep. From the LOTBs near the location of Retaining Wall No. 37, groundwater was not encountered in general except for borings within the San Diego Creek influential zones.

Table 4 – Summary of Groundwater Conditions from Nearby LOTBs

LOTB Site	Borehole ID	Date Drilled	Groundwater Elevation (ft)	Groundwater Depth (ft)	Station	Offset from C/L of Rte 133 (ft)
Barranca Parkway OC	B-2	05/29/1985	149	35	Sta 96+94	Rt. 36
Alton Parkway OC	B-5	05/29/1985	148	35	Sta 49+94	Rt. 53
Alton Parkway OC	B-6	05/28/1985	149.5	32.5	Sta 48+48	Lt. 42
Alton Parkway OC	B-4	05/30/1985	154	30	Sta 51+93	Rt. 3

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. (Elev. 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

Since the proposed retaining walls does not cross over any body of water, there is no scour potential applicable.

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 should 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 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 nearest contributing fault to the site is the San Joaquin Hills fault. The fault parameters for the Retaining Wall No. 37, 29, and 9071 are listed below in Table 5, 6, and 7, respectively.

Table 5 – Fault Information for Retaining Wall No. 37

Fault Name	Fault ID	Type	M_{max}	Dip direction (Dip angle)	R_X (km)	R_{JB} (km)	R_{RUP} (km)	PGA
San Joaquin Hills	376	Rev	7.0	W (23°)	0.415 (0.26 mi)	0.0	2.043 (1.27 mi)	0.684g

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

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 340 m/sec (1115 ft./sec) based on correlations with soil types and SPT blow counts obtained from nearby LOTBs. The soil is classified as marginal according to the Caltrans Seismic Design Criteria.

The design Peak Ground Acceleration (PGA) has been evaluated as 0.684g 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 1.27 miles.

Table 6 – Fault Information for Retaining Wall No. 29

Fault Name	Fault ID	Type	M_{max}	Dip direction (Dip angle)	R_X (km)	R_{JB} (km)	R_{RUP} (km)	PGA
San Joaquin Hills	376	Rev	7.0	W (23°)	0.256 (0.16 mi)	0.0	2.016 (1.25 mi)	0.669g

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

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 320 m/sec (1050 ft./sec) based on correlations with soil types and SPT blow counts obtained from nearby LOTBs. The soil is classified as marginal according to the Caltrans Seismic Design Criteria.

The design Peak Ground Acceleration (PGA) has been evaluated as 0.669g 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 1.25 miles.

Table 7 – Fault Information for Retaining Wall No. 9071

Fault Name	Fault ID	Type	M_{max}	Dip direction (Dip angle)	R_X (km)	R_{JB} (km)	R_{RUP} (km)	PGA
San Joaquin Hills	376	Rev	7.0	W (23°)	0.077 (0.05 mi)	0.077	2.001 (1.24 mi)	0.627g

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

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 280 m/sec (919 ft./sec) based on correlations with soil types and SPT blow counts obtained from nearby LOTBs. The soil is classified as marginal according to the Caltrans Seismic Design Criteria.

The design Peak Ground Acceleration (PGA) has been evaluated as 0.627g 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 1.24 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 project site includes San Diego Creek area and the proposed retaining walls are to be located on either side of the creek. The San Diego Creek Channel area is the only region within the project boundary that is mapped by the California Geological Survey as prone to liquefaction. The design spectral PGA for the subject site is 0.627g to 0.684g. Due to the possibility of shallow groundwater conditions and the presence of moderately loose sandy and gravelly soil layers in the subsurface profile, there is a possibility of liquefaction affecting these structures due to a seismic event that can trigger strong enough shaking lasting for relatively longer duration.

A site-specific liquefaction evaluation will be performed during the design phase.

AS-BUILT FOUNDATION DATA

For the locations of the proposed retaining walls along SB SR 133, there is no existing as built foundation data.

PRELIMINARY FOUNDATION RECOMMENDATIONS

The retaining wall heights are not known at the time of this report. It is anticipated to be less than about 10 feet high walls. Since the PGA at site is evaluated to be from 0.627g to 0.684g (more than 0.6g), modified Type 1 or Type 5 walls with special design consideration can be used. Based on the site space restrictions, right-of-way, and other practical considerations, either a spread footing or pile foundations can be utilized to support these retaining walls. If pile foundations are considered, they can be CIDH reinforced concrete piles or Pre-cast reinforced concrete driven piles. Since the site corrosion characteristics are not known at this time, the applicability of steel "H" piles can be determined at design phase with the availability of the site soil corrosiveness testing data. The apparent earth pressure distributions for retaining walls can be found in Section 3.11.5.7.1 – Cohesionless Soils of AASHTO LRFD Bridge Design Specifications (6^{th} edition, 2012).

Based on as-built LOTBs, layers of sand and silt underlie the site. Due to the layers being predominantly sandy soil, caving potential is anticipated during excavation at the proposed retaining wall sites. In the vicinity of the San Diego Creek area, which is in general the southern segment of the project, relatively shallow bedrock conditions can be possible as per the existing LOTBs for nearby structures.

The above are preliminary 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 the purpose of cost estimates and preliminary planning.

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 four borings for these retaining wall sites. Out of the four borings, two are for Wall No. 37, one for Wall No. 29, and one for Wall No. 9071. 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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DES Project Liaisons Engineer – Angela Ezekiel
OGDS Branch Chief – Tim Lam (Electronic File)
GS Archive (Electronic File)

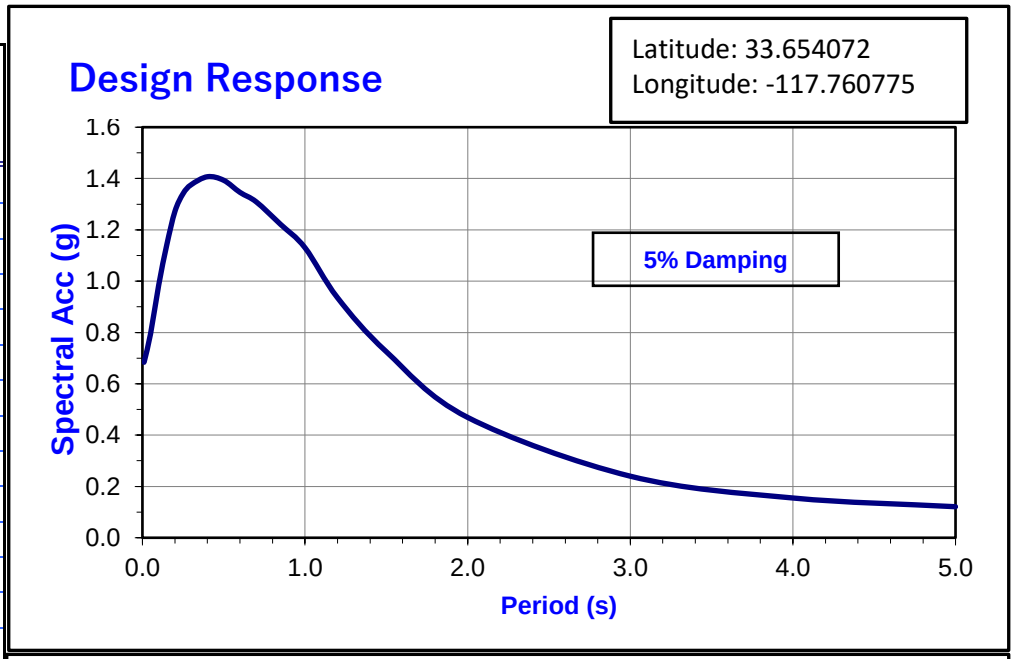
Appendix I: Preliminary Seismic Design Data Sheets

APPENDIX -I

(Preliminary Seismic Design Data Sheets)

Preliminary Seismic Design Data Sheet for the Retaining Wall No. 37

Period (s)	Spectral Acceleration, Sa(g)
0.010	0.684
0.050	0.795
0.100	0.984
0.150	1.142
0.200	1.272
0.250	1.341
0.300	1.376
0.400	1.407
0.500	1.393
0.600	1.346
0.700	1.309
0.850	1.221
1.000	1.130
1.200	0.935
1.500	0.725
2.000	0.469
3.000	0.240
4.000	0.155
5.000	0.121



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.

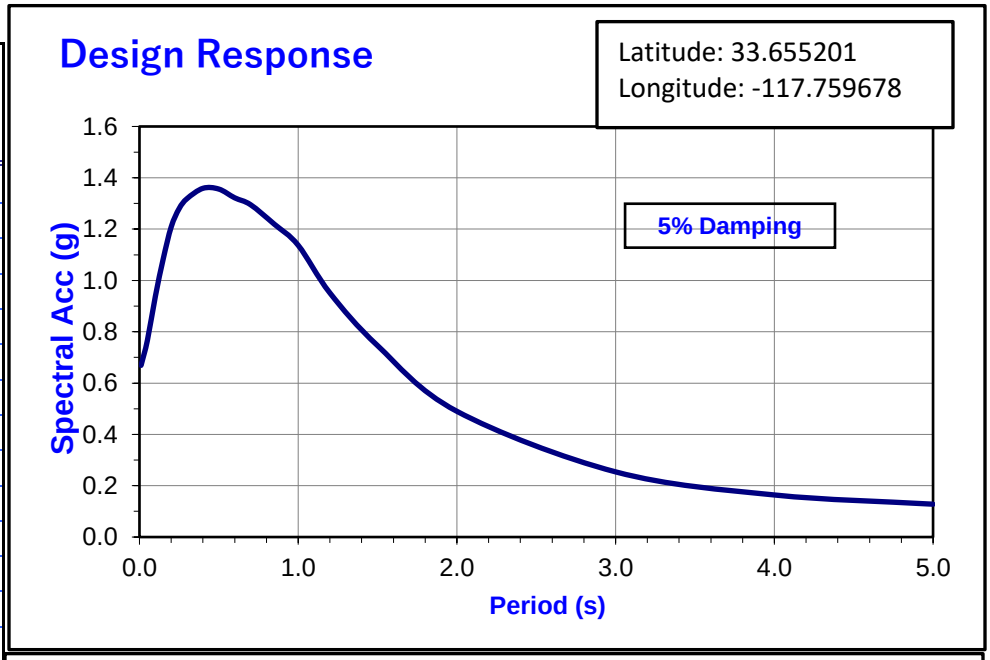
Seismic Loading Table (per MTD 1-47)

Soil Profile (V_{S30}): 1115 ft/s (340 m/s)

Magnitude: **M** = 7.0; PGA: 0.684g

Preliminary Seismic Design Data Sheet for the Retaining Wall No. 29

Period (s)	Spectral Acceleration, Sa(g)
0.010	0.669
0.050	0.767
0.100	0.938
0.150	1.085
0.200	1.209
0.250	1.280
0.300	1.319
0.400	1.359
0.500	1.356
0.600	1.322
0.700	1.295
0.850	1.219
1.000	1.137
1.200	0.951
1.500	0.746
2.000	0.490
3.000	0.254
4.000	0.164
5.000	0.128



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.

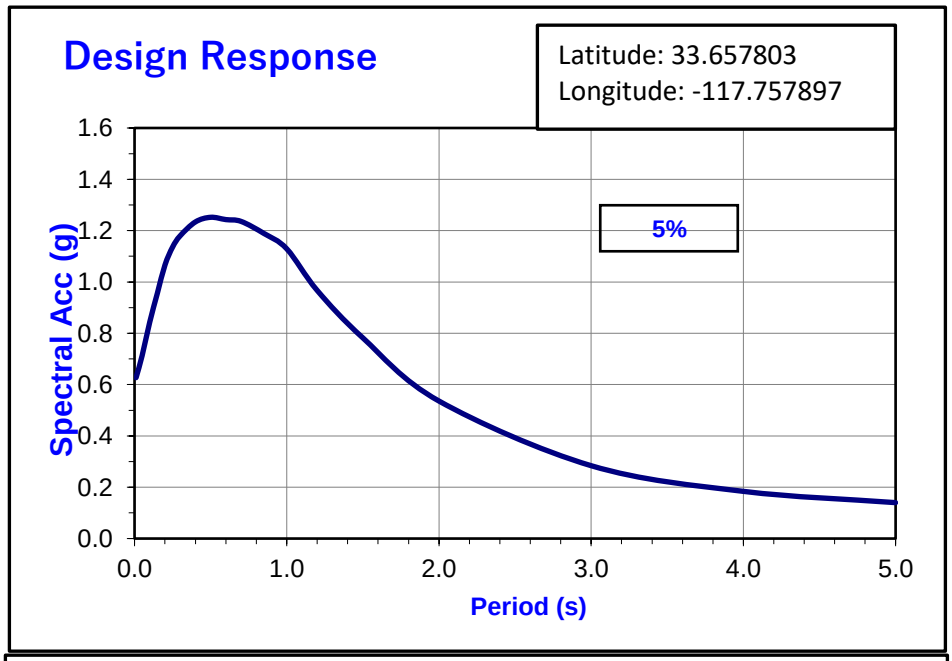
Seismic Loading Table (per MTD 1-47)

Soil Profile (V_{S30}): 1050 ft/s (320 m/s)

Magnitude: **M** = 7.0; PGA: 0.669g

Preliminary Seismic Design Data Sheet for the Retaining Wall No. 9071

Period (s)	Spectral Acceleration, Sa(g)
0.010	0.627
0.050	0.713
0.100	0.844
0.150	0.956
0.200	1.066
0.250	1.136
0.300	1.180
0.400	1.234
0.500	1.252
0.600	1.243
0.700	1.236
0.850	1.189
1.000	1.129
1.200	0.967
1.500	0.782
2.000	0.536
3.000	0.284
4.000	0.184
5.000	0.140



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}): 919 ft/s (280 m/s)

Magnitude: **M** = 7.0; PGA: 0.627g