State of California

Business, Transportation and Housing Agency

Memorandum

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Design Office 59-232

Attention: Mr. Gary Blakesley

Date: June 26, 2000

File: 11-SD-5-KP 48.28
11-0301U1

S5/S805 Truck Connector
Bridge No. 57-1069F

From: **DEPARTMENT OF TRANSPORTATION**
ENGINEERING SERVICE CENTER
Division of Structural Foundations - MS 5
Office of Structure Foundations

Subject: Foundation Recommendations

Introduction

The proposed S5/S805 Truck Connector (Br. No. 57-1069F) is part of planned Route 5/805 Freeway improvements for the San Diego area. A Request for Final Foundation Recommendations (dated October 22, 1998) for the subject bridge was submitted to the Office of Structure Foundations (OSF) by Mr. Ramin Rashedi. Site specific ARS, liquefaction potential, and methods of liquefaction mitigation were requested in the above memorandum. A list of preliminary column/pile loads and shaft diameters were provided to OSF by Mr. Rashedi (dated December 18, 1998). As the 5/805 and 5/56 project has progressed, further revisions of the above pile load and shaft diameter list was sent to OSF including Revision 1 (dated February 24, 1999), Revision 2 (dated April 9, 1999), and Revision 3 (dated May 11 and 26, 1999). Abutment pile diameters and axial service loads were provided by Mr. Rashedi (February 1, 2000) who also requested P-Y curves or COM624 soil profile information at the abutments and final P-Y curves for the bents. Mr. Gary Blakesley provided bottom of footing/pile cutoff elevations for the proposed bridge (Caltrans facsimile copies, dated February 18 and March 24, 2000). Finish grades at support locations were also provided by District 11 Design and sent by Mr. Blakesley to OSF (June 13, 2000, Caltrans E-mail). Mr. Blakesley also mentioned (June 14, 2000) that isolation casings would be used at Bents 19 and 20 and that Bent 15 would be a two column bent with different finish grades at the left and right supports. P-Y curves were also requested by Mr. Earl Seaberg (Division of Structure Design) on February 24, 1999. In the same memorandum it was mentioned that in order to mitigate the effects of potential liquefaction, large diameter cast-in-drilled-hole piles (CIDH) would be used for structures at the 5/805 Interchange (Seaberg, February 24, 1999). In preliminary evaluations of the As Built Log of Test Borings (LOTBs) from an adjacent structure (Sorrento Valley Blvd Undercrossing, Br. No. 57-0786R/L) performed by the Office of Geotechnical Earthquake Engineering (Perez-Cobo and Abghari, February 10 and April 7, 1999), potentially liquefiable soils are estimated as approximately 7.6 to 9.1 m (25 to 30 ft) thick. Final liquefaction analysis (including bent specific elevations of potentially liquefiable layers), p-y, and t-z curves were provided by Mr. Reza Mahallati and Mr. Abbas Abghari (May 18, 2000) of the Office of Geotechnical Earthquake Engineering (OGEE).

Subsurface information was obtained by OSF drilling 20 - 94 mm, 1 - 82 mm, and 1 – 79 mm diameter mud rotary borings which also involved extensive coring. Results from the field studies will be shown on the LOTBs. In addition to the recent field work, the As Built LOTBs for the adjacent Sorrento Valley Blvd. Undercrossing (Contract No. 11-045894, dated April 14, 1972) and the Los Penasquitos Creek Bridge (Br. No. 57-0511, Contract No. 11-022454, dated July 1964) contained additional site and subsurface information and will be included within the new contract plans.

Site Description

During OSF's recent foundation investigation, sediments at the site consist of preexisting embankment fill, from adjacent southbound Rte. 805 and both northbound and southbound Rte. 5, which is fairly thick in the area of proposed Abutment 1, Bents 2, 10, 11, 12, 14, 18, and 19. Embankment fill material, along the proposed bridge footprint, ranges between approximately 0.61 to 15.70 m (2 to 51.5 ft) thick and is especially thick where the proposed truck connector either joins Rte 805 and Rte. 5 or crosses over Rte. 5 as noted above. Underlying alluvium (Holocene and possible older Quaternary alluvium, undifferentiated) ranges from approximately 2.44 to 22.40 m (8 to 73.5 ft) thick and generally thins to the southeast, northwest, and beneath proposed Bent 12. The undulatory top surface of the underlying Eocene Ardath Shale or interfingering Torrey Sandstone was encountered from elevations ranging from +10.97 to –13.99 m (+36.0 to –45.9 ft).

Embankment fill material consists of soft to hard/very loose to very dense, sandy lean clay, clay, elastic silt, and clayey sand interlayered with silty sand and sandy silt with intermittent scattered gravel, cobbles [up to 205 mm (8 in) diameter], and very rare boulders [up to 600 mm (24 in) diameter]. Coarse rock fragments are composed of soft mudstone, sandstone, claystone and hard subrounded metavolcanic fragments (generally gravel and cobble size). Native material [mapped as Holocene alluvium and slope wash undifferentiated according to Kennedy (1975) and probably including some older alluvium and possible Pleistocene Bay Point Formation at depth], can be divided into two units with the upper sediments [from 0 to 17.22 m (0 to 56.5 ft) thick] consisting of dominantly very loose to medium dense/very soft to very stiff, silty sand, sand, silt, and gravel with clay or elastic silt matrix with intermittent scattered gravel and rare cobbles [up to 155 mm (6 in) diameter] interbedded with sandy lean clay, clay, clayey sand, and rare elastic silt. Calcite nodules and veinlets, scattered shell fragments, and rootlets were observed within these upper alluvial sediments. The underlying native alluvial unit [from 0 to 7.62 m (0 to 25 ft) thick] found below elevations ranging from +16.09 to –9.27 m (+52.8 to –30.4 ft) consists of dense to very dense/firm to hard, gravel/cobble lenses with sand, silty sand, clayey sand, and clay matrix interbedded with fine to medium sand with gravel, silty sand, sandy silt to elastic silt, clay, and clayey sand with gravel. Generally the extremely hard, subrounded to subangular gravel/cobbles [up to 300 mm (12 in) diameter] composed of metavolcanic, quartzite, siliceous siltstone, and chert rock fragments directly overlie bedrock. Rare boulders up to 600 mm (24 in) maximum length can be found but were composed of soft mudstone and sandstone only. Much of the loose and soft native material is considered potentially liquefiable and has been investigated by the OGEE (Mahallati and Abghari, May 18, 2000) which will also provide potential mitigation measures or will review adequacy of proposed mitigation measures. Within the above Caltrans Memorandum by OGEE, final P-Y (lateral resistance) and t-z (axial resistance) curves have been developed for use at proposed bridge support locations. The underlying Eocene Ardath Shale generally consists of interbedded very soft to moderately hard, mudstone, claystone, and siltstone. The formation is generally slightly weathered, slightly fractured, often thinly bedded, and contains occasional concentrations of pelecypod debris. The typical Ardath Shale in this area is partially underlain and interfingers with the Eocene Torrey Sandstone at Los Penasquitos Creek and north of the Creek. The Torrey Sandstone also directly underlies alluvium at the Bent 17 area (Boring 99-10). The intertongueing sandstones representative of the Torrey Sandstone are dominantly composed of formational sand (uncemented to weakly cemented, soil-like, very dense sand) and minor moderately hard to hard calcite-cemented fine to medium sandstone. Also included within the Torrey Sandstone are minor soft mudstone/claystone/siltstone interbeds and cobble/gravel conglomerate lenses [up to 0.61 m (2 ft) thick] and scattered gravel and cobbles up to 205 mm (8 in) diameter. The very soft to moderately soft upper formational mudstones/siltstones of the Ardath Shale [0 to 3.0 m (0 to 9.9 ft) thick], were considered to possess weak rock unconfined compressive strengths ranging from 1275 to 765 kPa (185 to 111 psi). Below this upper zone, generally soft to hard mudstone/claystone/siltstone/and cemented sandstone (fairly strong rock) show unconfined compressive strengths ranging from 1517 to 2068 kPa (220 to 300 psi) and higher. Intertongueing

Torrey formational sands (dominantly uncemented to weakly cemented) were treated as very dense soil for pile/soil skin friction calculations. The bottom of the two deepest borings for the bridge, Boring 99-9 (near proposed Bent 12) and 99-11 (near proposed Bent 15), were 54.62 to 56.39 m (179.2 to 185.0 ft) below the surface [elevations -41.54 to -44.17 m (-136.3 and -144.9 ft)], respectively. Downhole P-S logging (compression and shear wave) showed that the upper formational mudstones/siltstones/claystones had shear wave velocities ranging from 365 to 496 meters per second (1200 to 1628 fps) which appeared to correlate with unconfined compressive strengths of 1241 kPa (180 psi) and higher. Shear wave velocities ranging from approximately 457 to 719 meters per second (1500 to 2361 fps) in pseudo-rock-like material correlated with unconfined compressive strengths of at least 1517 to 2757 kPa (220 to 400 psi in the Ardath Shale and interbedded mudstones within the Torrey Sandstone) below approximate elevations ranging from -0.46 to -22.56 m (-1.5 to -74.0 ft). The competent upper mudstone/siltstone/claystone unit of the Ardath Shale is shown to be at least 2.59 to 24.54 m (8.5 to 80.5 ft) thick beneath all supports except proposed Bent 17 where the mudstone unit appears to lense out and is replaced depositionally by the Torrey formational sands. Approximately beneath proposed Bents 10 (Boring 99-12) through Abutment 21 (Boring 99-13, the upper mudstone tongue often thins and interfingers with the Torrey formational sands (uncemented to weakly cemented, very dense sands) and cemented sandstones. Beneath proposed Bents 13 and 14, the mudstones appear to thicken. The LOTBs should be reviewed for more specific details.

Surface Water and Scour

Surface water was often stagnant within Los Penasquitos Creek with only minor flow observed during the field investigation. Following a wet period on March 2, 2000, the author observed more substantial surface flow, however, flows were not enough to cause apparent substantial scour.

The proposed bridge will span Los Penasquitos Creek with Bent 13 to be located within the stream channel. Remaining nearby supports are behind embankment levees with rock slope protection and won't be affected. Only minor erosion or scour was found near the east side of existing pier 2 for the nearby Los Penasquitos Creek Bridge, Br. No. 57-0511, during OSF's field investigation and brief survey of the stream bottom in the area. The As Built Borings B-2 and B-5 (Br. No. 57-0511) show up to approximately 6.1 m (20 ft) of loose, silty sand with some clay binder intergrading with clayey sand and sandy silt below the channel surface. The cohesive interbeds are less likely to be affected by stream scour. According to the Preliminary Report (Wang, February 19, 1999) for the Los Penasquitos Creek Bridge (Br. No. 57-0511), total pier scour in this area is estimated at up to 2.5 m (8.2 ft).

The large diameter piles proposed to support the S5/S805 Truck Connector will be affected very little by scour due to their extreme length and anchorage within unscourable rock material. Axial support is gained within unscourable rock material. However, potential scour should be considered with regards to erosion and possible loss of lateral support within shallow soils at the proposed in-channel bent. Due to the length of the piles, OSF feels that potential loss of significant lateral support is unlikely.

For further information, refer to Preliminary Investigations and Hydraulics reports in this area.

Ground Water

Static ground water was measured recently at three locations for the truck connector and nearby bridges and is estimated from recent borings drilled near Los Penasquitos Creek and north. A table below summarizes proposed support location, date ground water last measured, and measured and estimated static ground water levels.

Support Location	Last Date Measured	GWS m (ft)
Bent 4	1-11-2000	+9.48 (+31.1)
Bent 7	1-11-2000	+8.93 (+29.3)
Bent 10	3-2-2000	+8.84 (+29.0)
Bent 12	estimated	+8.53 (+28.0)
Bent 14	estimated	+8.53 (+28.0)
Bent 15	estimated	+8.53 (+28.0)
Bent 18	estimated	+9.30 (+30.5)
Bent 20	estimated	+10.36 (+34.0)

Notes:

At proposed Bent 7 - static water measured within Boring 99-6 from nearby Br. No. 57-1070G. At proposed Bent 10 - static water measured within Boring 99-5 from nearby Br. No. 57-0512. Static ground water at all other locations are estimated from borings within the region, water encountered during recent drilling and soil sampling, and estimated from the bottom of stream survey and bedrock topography.

In the area of Boring 99-1 (near Bent 8, left side – left bridge widen) for the nearby Sorrento Viaduct (Br. No. 57-513L), static ground water was measured at elevation +7.77 m (+25.5 ft) on January 11, 2000. Boring 99-1 is south of the proposed Bent 13 for the subject bridge on the east side of Sorrento Valley Road. The bottom of Los Penasquitos Creek in the area ranges from an estimated (elevations based on one survey point and estimates) +7.01 to +7.62 m (+23 to +25 ft) elevations and can be flooded. The ground water level fluctuated approximately from 0.03 to 0.3 m (0.1 to 1 ft) during OSF's recent investigation.

The As Built LOTB for the adjacent Sorrento Valley Blvd. Undercrossing Shows ground water was encountered from approximate elevations +8.29 to +7.74 m (+27.2 to +25.4 ft) based on NGVD29 elevations, which requires a +0.588 m (+1.93 ft) add (Schuh, Caltrans Memorandum, March 7, 2000) to adjust to the current metric elevations (NAVD 88) upon which the recent plans and boring program are based. The adjusted to metric As Built elevations would then show ground water was encountered at elevations +8.88 to +8.33 m (+29.1 to +27.3 ft) for the earlier foundation investigation, with measurements taken during May 1969. The As Built LOTB for the adjacent Bridge Across Los Penasquitos Channel (Br. No. 57-0511) shows ground water was encountered from approximate elevations +3.26 to +4.33 m (+10.7 to +14.2 ft) based on the City of San Diego datum, which requires a +2.45 m (+8.05 ft) add (Schuh, Caltrans Memorandum, March 7, 2000 and facsimile copy, February 14, 2000) to adjust to the current metric elevations (NAVD 88). The adjusted to metric As Built elevations would then show ground water was encountered at elevations +5.71 to +6.78 m (+18.7 to +22.2 ft) for the earlier foundation investigation, with measurements taken during April 1962. The As Built LOTB for the slightly upstream (Rte. 805) Los Penasquitos Creek Bridge (Br. No. 57-0779) reveals ground water was encountered from elevations ranging from +6.58 to +6.40 m (21.6 to 21.0 ft). Again correcting English to metric (NAVD88) elevations would show ground water encountered from elevations +7.17 to +6.99 m (+23.5 to +22.9 ft) using an add of +0.588 m (1.93 ft).

The above measurements indicate that ground water level fluctuates between different locations, years, and seasons.

Seismicity

See the memorandum (dated February 10, 1999) concerning Preliminary Seismic Design Recommendations sent to Mr. Earl Seaberg from Mr. Angel Perez-Cobo and Dr. Abbas Abghari.

Final Seismic Design Recommendations and lateral and axial resistance, P-Y and t-z curves have been submitted by the OGEE (Mahallati and Abghari, May 18, 2000).

As mentioned above (Perez-Cobo and Abghari, February 10, 1999) the proposed "structures are located approximately 5 km from the Newport-Inglewood-Rose Canyon fault which has a maximum credible earthquake moment magnitude of M=7.0 and based on the Caltrans California Seismic Hazard Map (Mualchin, 1995), these structures are within the peak horizontal bedrock acceleration zone of 0.5 g."

As mentioned above pseudo-rock-like material [Vs ranging from 457 to 719 meters per second (1500 to 2361 fps)] occurs below approx. elevations ranging from -0.46 to -22.56 m (-1.5 to -74 ft).

Liquefaction

Liquefaction potential is considered moderate to high within the upper alluvial unit. Holocene and older Quaternary alluvium (undifferentiated) at the site is dominantly composed of very loose to medium dense/very soft to very stiff, silty sand, sand, silt, and gravel with clay or elastic silt matrix with intermittent scattered gravel and rare cobbles [up to 155 mm (6 in) diameter] interbedded with sandy lean clay, clay, clayey sand, and rare elastic silt. Ground water is also fairly shallow and was measured within the recent investigation at 1.34 m (4.4 ft) below the surface at Bent 4 (within the valley) and estimated at 8.23 m (27 ft) below the surface at Bent 20 (on the hillside). Preliminary analysis (Perez-Cobo and Abghari, February 10, 1999) estimates that the top 7.6 to 9.1 m (25 to 30 ft) of soils are considered potentially liquefiable. As mentioned above, final liquefaction analysis has been provided by the OGEE (Mahallati and Abghari, May 18, 2000). Potentially liquefiable soil thicknesses at support locations range from 0 to 10.36 m (0 to 34 ft) thick as provided within the above report.

Foundation Recommendations

The following recommendations are based on the S5/S805 Truck Connector, Br. No. 57-1069F, General Plan (revised May 29, 1999), Foundation Plans (6 sheets, checked October 1, 1998 by Sinclair Wang), the above mentioned memorandums and personal communications from Mr. Rashedi (Caltrans facsimile copy dated May 26, 1999 and a memorandum supplying abutment pile diameters and service loads, February 1, 2000), and Mr. Blakesley (Caltrans facsimile copy with final bottom of footing/cutoff elevations, dated February 18 and March 24, 2000, and Caltrans E-mail with finish grades at support locations, sent June 13, 2000). Mr. Blakesley also mentioned (June 14, 2000) that isolation casings would be used at Bents 19 and 20 and that Bent 15 would be a two column bent with different finish grades at the left and right supports.

Fills can be placed in accordance with Section 19-6 of the Standard Specifications. End dumping is not permitted. At the Abutment 1 area, additional fill is estimated at 7.92 m (26 ft) maximum height. Existing Rte. 805 embankment has been in place since 1972 so settlement may be reduced somewhat from the calculated maximum settlement of 254 mm (10 in). The settlement period is estimated at approximately 120 days, however the actual settlement period will be determined by the project engineer on the basis of settlement data in the field.

At the Abutment 21 area, additional fill is estimated at 3.66 m (12 ft) maximum height. Existing Rte. 5 embankment has been in place since 1964 so settlement should be reduced from the calculated maximum settlement of 51 mm (2 in). Again, all fills can be placed in accordance with Section 19-6 of the Standard Specifications. OSF recommends a fill settlement period of up to 60 days in this area; however, the actual settlement period will be determined by the project engineer on the basis of settlement data in the field.

OSF assumes that structure approach slabs will be incorporated within the new bridge, but approach slabs were not denoted on available plans.

Plumb, 1.2m (4 ft) diameter, Cast-in-Drilled-Hole (CIDH) piles can be used to support the bridge abutments. Plumb, 2.4, 3.0 and 3.6 m (8, 10, and 12 ft) diameter drilled shafts will be used at the bent supports as shown below. CIDH pile capacities were calculated using the Federal Highway Administration's Drilled Shaft Manual (Pub. No. FHWA-HI-88-042) published July 1988. Permanent casing is recommended to be placed into bedrock to facilitate construction of the drilled shafts, prevent caving of loose soils and gravel/cobble lenses into the shaft borings, and in many cases seal off ground water from entering the shaft borings. OSF feels that permanent steel casing can be emplaced at least near specified tip elevation using a vibratory hammer. In discussions between Mr. Ron Jones (OGEE) and the author (for nearby Sorrento Viaduct, Br. No. 57-0513R/L, March and April, 2000) the practice of drilling ahead of the casing before dropping the casing into place is considered undesirable as caving of loose soils and gravel/cobble lenses would create voids between the casing and surrounding soil, thus compromising the lateral capacity of the pile. However, drilling slightly ahead of casing in the basal gravel/cobble lenses and within bedrock will probably be necessary. <u>OSF assumes no additional axial geotechnical capacity for permanent steel casing</u> that will be installed to aid in construction of CIDH piles shown below.

S5/S805 Truck Connector, Br. No. 57-1069F:

Support Location/ Type & Diameter	Design Loading			Nominal Resistance		Intended Length of Rock/Formational Socket m (ft)	Bottom of Pile Footing/Cutoff Elevation m (ft)	Permanent Casing Specified Tip Elevation m (ft)	Design Pile Tip Elevation m (ft)	Specified Pile Tip Elevation m (ft)
	Compression kN (tons)	Tension kN (tons)	Lateral kN (tons)	Compression kN (tons)	Tension kN (tons)					
Abut 1/CIDH 1.2 m (4 ft)	N/A			**2000 (220)**	0	3.05 (10.0)	+17.00 (+55.8)	Right +0.61 (+2.0) Left -2.44 (-8.0)	Right -2.44 (-8.0) Left -5.49(1) (-18.0)(1)	Right -2.44 (-8.0) Left -5.49 (-18.0)
Bent 2/CIDH 2.4 m (8 ft)				**28,050 (3150)**	**0**	13.72 (45.0)	+7.65 (+25.1)	-3.66 (-12.0)	-17.38(1) (-57.0)(1)	-17.38 (-57.0)
Bent 3/CIDH 2.4 m (8 ft)				**28,050 (3150)**	**0**	12.80 (42.0)	+8.45 (+27.7)	-6.71 (-22.0)	-19.51(1) (-64.0)(1)	-19.51 (-64.0)
Bent 4/CIDH 3.0 m (10 ft)				**28,050 (3150)**	**0**	10.67 (35.0)	+6.13 (+20.1)	-6.10 (-20.0)	-16.77(1) (-55.0)(1)	-16.77 (-55.0)
Bent 5/CIDH 3.0 m (10 ft)				**28,050 (3150)**	**0**	10.97 (36.0)	+6.95 (+22.8)	-7.01 (-23.0)	-17.98(1) (-59.0)(1)	-17.98 (-59.0)
Bent 6/CIDH 3.0 m (10 ft)				**28,050 (3150)**	**0**	10.97 (36.0)	+8.19 (+26.9)	-7.32 (-24.0)	-18.29(1) (-60.0)(1)	-18.29 (-60.0)
Bent 7/CIDH 3.0 m (10 ft)				**28,050 (3150)**	**0**	11.28 (37.0)	+8.39 (+27.5)	-8.84 (-29.0)	-20.12(1) (-66.0)(1)	-20.12 (-66.0)
Bent 8/CIDH 3.0 m (10 ft)				**28,050 (3150)**	**0**	10.97 (36.0)	+9.39 (+30.8)	-9.75 (-32.0)	-20.72(1) (-68.0)(1)	-20.72 (-68.0)
Bent 9/CIDH 3.6 m (12 ft)				**28,050 (3150)**	**0**	9.75 (32.0)	+9.39 (+30.8)	-10.36 (-34.0)	-20.11(1) (-66.0)(1)	-20.11 (-66.0)
Bent 10/CIDH 3.0 m (10 ft)				**28,050 (3150)**	**0**	12.50 (41.0)	+14.18 (+46.5)	-9.14 (-30.0)	-21.64(1) (-71.0)(1)	-21.64 (-71.0)
Bent 11/CIDH 3.0 m (10 ft)				**28,050 (3150)**	**0**	17.07 (56.0)	+16.40 (+53.8)	-9.45 (-31.0)	-26.52(1) (-87.0)(1)	-26.52 (-87.0)

Notes: Design tip elevation is controlled by the following demands: (1) Compression; (2) Tension; (3) Lateral Loads

S5/S805 Truck Connector, Br. No. 57-1069F (continued):

Support Location/ Type & Diameter	Design Loading Compression kN (tons)	Design Loading Tension kN (tons)	Design Loading Lateral kN (tons)	Nominal Resistance Compression kN (tons)	Nominal Resistance Tension kN (tons)	Intended Length of Rock/Formational Socket m (ft)	Bottom of Pile Footing/Cutoff Elevation m (ft)	Permanent Casing Specified Tip Elevation m (ft)	Design Pile Tip Elevation m (ft)	Specified Pile Tip Elevation m (ft)
Bent 12/CIDH 3.6 m (12 ft)				**28,050 (3150)**	0	17.37 (57.0)	+11.39 (+37.4)	-8.53 (-28.0)	-25.90(1) (-85.0)(1)	-25.90 (-85.0)
Bent 13/CIDH 3.6 m (12 ft)				**40,950 (4600)**	0	22.25 (73.0)	+6.55 (+21.5)	-11.58 (-38.0)	-33.83(1) (-111.0)(1)	-33.83 (-111.0)
Bent 14/CIDH 3.6 m (12 ft)				**40,950 (4600)**	0	21.34 (70.0)	+11.93 (+39.1)	-13.11 (-43.0)	-34.45(1) (-113.0)(1)	-34.45 (-113.0)
Bent 15-**Left**/CIDH 3.0 m (10 ft)				**28,050 (3150)**	0	21.64 (71.0)	+10.44 (+34.3)	-14.33 (-47.0)	-35.97(1) (-118.0)(1)	-35.97 (-118.0)
Bent 15-**Right**/CIDH 3.0 m (10 ft)				**28,050 (3150)**	0	21.34 (70.0)	+10.44 (+34.3)	-14.02 (-46.0)	-35.36(1) (-116.0)(1)	-35.36 (-116.0)
Bent 16/CIDH 3.0 m (10 ft)				**28,050 (3150)**	0	28.35 (93.0)	+12.14 (+39.8)	-14.02 (-46.0)	-42.37(1) (-139.0)(1)	-42.37 (-139.0)
Bent 17/CIDH 3.0 m (10 ft)				**28,050 (3150)**	0	30.78 (101.0)	+9.39 (+30.8)	-13.72 (-45.0)	-44.50(1) (-146.0)(1)	-44.50 (-146.0)
Bent 18/CIDH 3.0 m (10 ft)				**28,050 (3150)**	0	31.39 (103.0)	+10.93 (+35.9)	+4.57 (+15.0)	-26.82(1) (-88.0)(1)	-26.82 (-88.0)
Bent 19/CIDH 4 m (8 ft)				**28,050 (3150)**	0	35.66 (117.0)	+11.66 (+38.3)	+9.75 (+32.0)	-25.91(1) (-85.0)(1)	-25.91 (-85.0)
Bent 20/CIDH 2.4 m (8 ft)				**28,050 (3150)**	0	33.53 (110.0)	+11.38 (+37.3)	+9.14 (+30.0)	-24.39(1) (-80.0)(1)	-24.39 (-80.0)
Abut 21/CIDH 1.2 m (4 ft)	N/A			**2100 (235)**	0	3.35 (11.0)	+21.50 (+70.5)	+8.53 (+28.0)	+5.18(1) (+17.0)(1)	+5.18 (+17.0)

Notes: Design tip elevation is controlled by the following demands: (1) Compression; (2) Tension; (3) Lateral Loads
Isolation casing will be used at Bents 19 and 20.

If pile tip elevation is controlled by lateral demands, the designer is responsible to present correct foundation data, governed by lateral control, on the foundation plans.

Axial compression and tension values noted in the tables above are based on skin friction only within the rock and formational sands. End bearing was not considered due to working below the water table and the possibility that cleaning out the bottom of pile borings effectively may be rather difficult at depth and may make it difficult to realize substantial end bearing using Caltrans standard pile vertical deflection criteria of 13 mm (0.5 in).

Bedrock topography (top of rock) is often quite variable across short lateral distances. Due to this fact, the pile data table above includes intended length of the rock/formational socket at each support. The intended length of the rock/formational socket should not be altered and should be measured from the bottom of the constructed permanent casing down to the constructed pile tip elevation. OSF feels that permanent casing should be seated into rock approximately 0.61 m (2 ft). If the bedrock slope is steeper than expected, the permanent casing may need to be seated slightly deeper to seal out water (in most cases) and potential caving soils and constructed pile tip elevation would be lowered accordingly (keeping intended length of the rock/formational socket unchanged).

Constructability

As mentioned above, OSF recommends installation of permanent casing to be placed into bedrock to prevent caving of loose soils and gravel/cobble lenses into shaft borings and help seal out ground water (in most cases) from entering the excavations once casing is seated into low permeability mudstones/siltstones/claystones. OSF and OGEE feel that using a vibratory hammer to place steel casing down to a level close to casing specified tip elevation would facilitate pile construction and effectively reduce creation of voids along the pile length by undesireable caving of loose soils and subbrounded cobble/gravel material. Drilling ahead of the casing, especially within the upper loose/soft soil zones should be avoided to reduce caving and creation of voids, thus compromising lateral pile capacity. OSF anticipates center relief drilling to facilitate casing advancement. Hard slow drilling [through hard metavolcanic cobble zones (cobbles up to 300 mm diameter), cobble-size mudstone rock fragments, and bedrock] is anticipated during installation of permanent casing, possible temporary casing, and CIDH piles (rock sockets). Drilling ahead of casing may be required, in order to advance casing within the lower gravel/cobble lenses and within bedrock. Once casing is seated into bedrock, drilling for the rock/formational sockets can be completed. Optional full length temporary casing, may be considered by the contractor, to be placed inside permanent casing [seated 0.61 m (2 ft) into mudstone/formational sands] to facilitate drilled shaft construction due to the interfingering uncemented formational sands that exhibit aquifer characteristics at Bents 11 through 20. CIDH piles installed at Bents 11 through 20 will penetrate the upper mudstones/siltstones/claystones (exception is Bent 17 which will penetrate formational sand mostly) and will likely tip out within underlying uncemented formational sands of the Torrey Sandstone. Lab tests show that moisture content commonly increases threefold within the formational uncemented sands of the Torrey Sandstone when compared to overlying mudstones of the Ardath Shale.

The Caliper log within Boring 99-4 (proposed Bent 4) which was an uncased hole, shows that some caving [in the upper 13.7 m (45 ft)] happens readily within shallow loose/soft often saturated alluvial sands and clayey sands. Also, the Caliper log within Boring 99-11 (Bent 15) shows substantial caving in alluvial sediments between elevations +7.44 to +2.83 m (+24.4 to +9.3 ft) and in the cobble zone above bedrock [-9.14 to -12.19 m (-30 to -40 ft)]. The uncemented formational sand within Boring 99-11 does not show much caving, however, drilling mud is circulated within the borehole just before measurement to prevent caving and loss of downhole geophysical tools.

Ground water should be anticipated at relatively shallow depths as mentioned above. The bottom of all excavations should be cleaned of loose debris before placing concrete.

Clay mineralogy within formational mudstones/siltstones/claystones appears sensitive to the introduction of fresh water, which could cause swelling of clays and slicking of borehole walls, resulting in reduced pile/soil skin friction capacity. OSF feels that a mud/polymer expert should be consulted and be available to the contractor to advise on proper drilling fluid/slurry chemistry in order to prevent clay swelling. OSF feels that seating permanent casing into the formational mudstones/claystones/siltstones should help seal off introduced water from reacting with the formational clays.

Corrosiveness

Laboratory tests of soil samples taken within Boring 99-2 (proposed Bent 4) indicate that alluvial material is slightly corrosive based on minimum resistivity. Corrosion tests show a pH of 7.4 to 7.9, minimum resistivity of 725 to 1300 ohm-cm, sulfate and chloride content were measured at 45 to 200 ppm and less than 25 ppm, respectively. Fill was also sampled within

Boring 00-19 (proposed Bent 2) and tested as noncorrosive with sulfate content of 740 ppm and chloride content of less than 25 ppm.

Laboratory tests of composite soil samples taken within Boring 99-1 for the adjacent Retaining Wall No. 524 (near the vicinity of Bents 9, 10, and 11 for the truck connector) indicate that fill and native material are corrosive. Corrosion tests on embankment fill show a pH of 7.48, minimum resistivity of 475 ohm-cm, sulfate and chloride content were measured at 5730 and 760 ppm, respectively. Corrosion tests on alluvial material show pH ranges from 7.48 to 7.98, minimum resistivity ranges from 475 to 746 ohm-cm, sulfate and chloride content were measured at 6000 to 360 ppm and 230 to 150 ppm, respectively. Lab tests also show that alluvium sampled within Boring 99-22 (near proposed Bent 13) has a pH of 8.27. OSF feels that the Corrosion Technology Branchy should be consulted regarding test results and possible recommendations.

If you have any questions, please call Joe Pratt at (213) 620-2001 or Richard Fox at (916) 227-7085.

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c: R.E. Pending File
DBarlow - Specs & Estimates
OAlcantara - Proj Mgmt
Dist. 11 (2)
ELeivas - OSF
RFox - OSF
AAbghari - OGEE
DParks – CTB
LA File

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