Sound Walls

Sound wall foundation design consists of choosing standard designs from the current Standard Plans. Foundation types that support standard plan sound walls include pile foundations, trench footings, and spread footings.

Sound wall foundation types and sizes shown on the Standard Plan Sheets were designed using assumed soil strength parameters. The objective of a sound wall foundation investigation is to determine if the soil strength at the proposed wall location meets or exceeds the assumed soil strength used to design the sound wall.

Sound walls are not designed to retain soil. Standard Type 1, 5 and 7 retaining walls have been designed to accommodate sound walls and are available as Bridge Standard Details Sheets.

Typically, the most cost-effective sound wall foundation is cast-in-drilled-hole (CIDH) piles. This is different from most structures where the least expensive foundation is usually spread footings. Trench or spread footings may be considered where groundwater would require wet pile installation, but the trench or spread footing is dry.

Investigations

Refer to the *Geotechnical Investigations* module for general instructions on performing the planning-phase site investigation (e.g., literature review, site visit) and the design-phase site investigation (e.g., site visit, selection of investigative methods, locations, and depths).

Explorations for the design of standard plan sound wall foundations seek to identify and describe the subsurface material, determine its strength, locate the groundwater table (if within the influence depth of the anticipated sound wall foundations), and to identify relevant conditions that might affect the foundation construction (e.g., caving conditions, presence of cobbles and boulders, shallow rock).

Borings should be spaced no closer than 500 feet apart unless warranted by anticipated variations in geotechnical characteristics, constructability conditions, and/or foundation types.

Subsurface explorations for standard plan sound walls are typically required to extend no more than 10 feet deeper than the standard plan pile length or two times the footing width below the bottom of footing. However, if special design considerations are needed (e.g., liquefaction and lateral spreading), the depth of subsurface explorations should be extended to accommodate anticipated pile tip elevations.

Auger borings are preferred since they mimic the typical construction method for sound wall CIDH pile foundations, but the auger borings should be switched to mud rotary for

borehole stability once groundwater is encountered. Auger borings provide information on hole stability, groundwater table depth, and presence of cobbles, or shallow rock, which might render CIDH piles infeasible. Use CPTs to supplement auger borings where feasible.

Perform corrosion testing in accordance with Caltrans Corrosion Guidelines.

It is not necessary to conduct a drilling program for sound walls that will be founded entirely in engineered fill that has yet to be placed, such as elevated roadway embankments or sliver widenings, as fills are constructed to a minimum of 90% relative compaction.

CIDH Pile and Trench Footing (Cohesionless Soil)

As Standard Plan sound wall foundation design is based on constructability and three standard soil strength cases, laboratory testing is not required for the purposes of determining soil strength or soil classification in cohesionless soil. The Standard Penetration Test (SPT) is sufficient for correlating cohesionless soil strength. Presenting the soil identification as determined by the visual/manual method provides sufficient information for designing and constructing sound wall foundations.

CIDH Pile and Trench Footing (Cohesive Soil)

In non-saturated cohesive soil, sample and perform laboratory testing to determine the drained shear strength. Correlations based on index parameters and soil type should only be used for preliminary design.

Design Procedures: Sound Walls on CIDH Piles and Trench Footings

The design of sound walls supported on CIDH piles and trench footing foundations in cohesionless or non-saturated cohesive soil are based on two parameters:

1. Ground Line

Case 1: Level ground ± 10% on both sides of the wall
Case 2: Level ground ± 10% on the traffic side of the wall, sloping ground no steeper than 2:1 on the opposite side

2. Soil Drained Friction Angle (Phi, ϕ)

Phi of 25°
Phi of 30°
Phi of 35°

For cohesionless soil, determine the drained friction angle (ϕ) in accordance with field SPT measurements and the *Soil Correlations* module, then select the appropriate pile spacing and length (or trench footing depth) from the Standard Plan (based on wall

height). For non-saturated cohesive soil, determine the drained shear strength via laboratory testing, then select the appropriate pile spacing and length (or trench footing depth) from the Standard Plan (based on wall height).

Engineered fills compacted to 95% relative compaction (e.g., approach fills within 150 feet of a bridge abutments) should be assumed to satisfy the requirements for a friction angle of 35°. Engineered fills compacted to 90% relative compaction (most fills other than abutment approach fills) should be assumed to satisfy the requirements for a friction angle of 30°.

If the field investigation reveals that standard plan CIDH piles would extend below the groundwater surface, then CIDH piles should be abandoned as the preferred foundation type in favor of a trench or spread footing. If neither the trench nor spread footing alternatives are feasible, then CIDH piles should be recommended, provided they are at least 24-inches in diameter to satisfy the requirement for non-destructive testing (gamma-gamma logging) of the piles. Recommending 24-inch CIDH piles for support of a sound wall will require a special design, so this alternative should be used only after the three standard foundation types are proven infeasible. Refer to the *CIDH Pile* module to determine required information to collect during the site investigation. Work with the Structure Designer to determine what data needs to be provided by Geotechnical Services (GS) and/or with Structures and Engineering Services (SES) to complete the design.

Standard Plan Design Procedures: Sound Walls on Spread Footings

The design of standard plan sound walls supported on spread footing foundations is based on Working Stress Design. The Standard Plans show two ground line cases as follows:

Case 1: Level ground ± 10% on both sides of the wall
Case 2: Level ground ± 10% on the traffic side of the wall, sloping ground no steeper than 2:1 on the opposite side

When recommending a sound wall to be supported on a spread footing, verify that the geotechnical bearing capacity at the wall location, considering an effective footing width, B', meets or exceeds the factored bearing pressure demand listed in the Standard Plans.

Design Procedures: Sound Walls on Retaining Walls on Spread Footings

For sound walls supported on retaining walls with spread footing foundations, refer to the appropriate Bridge Standard Details "XS" sheets for the LRFD design requirements and to the Conventional Retaining Walls module for investigative and design procedures, respectively.

Design Considerations: Sound Walls with Liquefaction and Lateral Spreading

Design of Standard Plan sound walls considering liquefaction and lateral spreading conditions is based on two primary conditions:

- Depth to the groundwater table
- Liquefaction potential of the foundation supporting zone.

Since the standard plan sound walls are pre-designed for non-saturated soil conditions within foundation supporting depth, liquefaction and lateral spreading within the soil depth supporting foundations must be prevented. This depth, referred to as *influence depth of the foundation,* is defined as a depth of one and a half times footing width (or pile diameter) below bottom of footing or pile tip.

Figure 1 shows a flowchart outlining the sound wall design process for addressing liquefaction and lateral spreading.

Comply with the following requirements and Figure 1:

- Standard plan sound walls may be used when liquefaction (and its associated seismic hazards) occur below the influence depth of the foundation.
- Sound walls on a Bridge or a Retaining Wall must be designed in accordance with all required design requirements and procedures addressed in the *Foundation Reports for Bridges* and *Foundation Reports for Earth Retaining Systems* guidelines, respectively.
- Liquefiable conditions within the influence depth of soundwall foundations require a special design. In this case, liquefaction within the influence depth of the foundation and associated seismic hazards (including lateral spreading), need to be considered in the design. Refer the client to Bridge Design for further guidance, or Structures Engineering Services if necessary.
- Overall slope stability for seismic conditions and/or lateral spreading due to liquefaction of soils located below the influence zone of foundation for standard plan sound walls do not need be addressed.

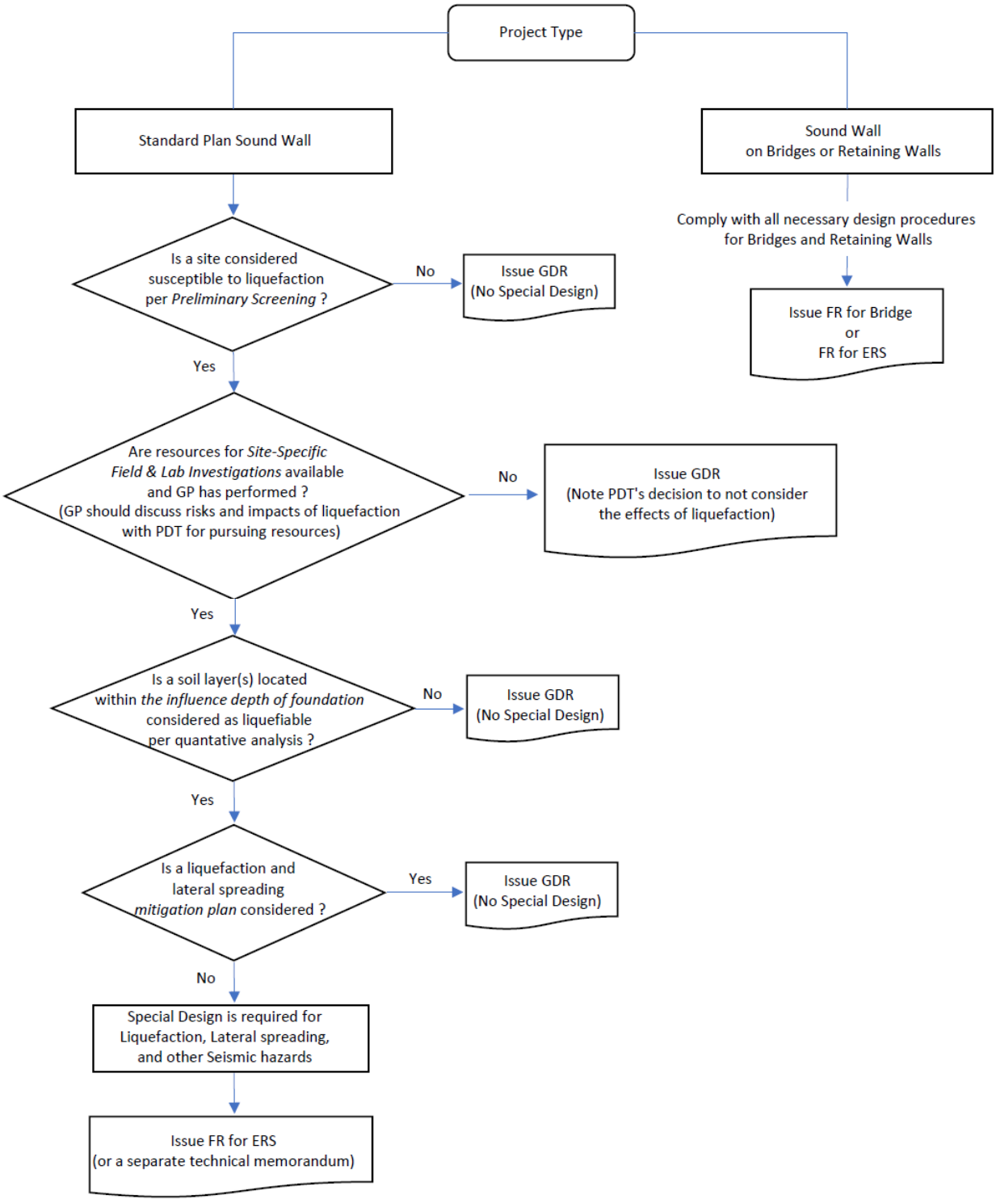

Figure 1. Sound Wall Design Flowchart for Liquefaction and Lateral Spreading

Helpful Hints

- The standard sound wall pile is 16 inches in diameter. The maximum particle size for feasible construction of a 16-inch CIDH pile is approximately 5 inches. Soils with cobbles larger than 5 inches may not be suitable for CIDH pile foundations.
- The minimum required ultimate bearing capacity of a standard plan sound wall spread footing is 3.75 ksf considering a factor of safety of 3.0.
- The standard trench footing width for sound wall foundations is 12 inches (Case 1) or 15 inches (Case 2). The maximum particle size for construction of trench footings is about 6 inches.
- Trench footings are not a suitable foundation type in caving soils or below the groundwater table.

Reporting

Present Standard Plan sound wall recommendations in accordance with the *Geotechnical Design Report* module.

Include the following in the *Analyses and Design* section of the Preliminary Geotechnical Design Report or Geotechnical Design Report:

1. The ground water surface elevation used for design.
2. The load case(s) per Standard Plans (e.g., Case 1, Case 2)

Include the following in the *Recommendations* section of the Preliminary Geotechnical Design Report or Geotechnical Design Report:

1. Statement verifying that the geotechnical conditions at the site meet all Standard Plan sound wall requirements.
2. *Sound Wall Foundation Recommendations* table
3. Foundation improvements required to meet geotechnical design objectives, such as sub-excavation.
4. If in a corrosive environment, provide a statement to address corrosion.

Boring Records must be incorporated into the GDR, along with the design recommendations when borings and/or CPTs are performed. If requested by the District, include a Log of Test Borings (LOTB) sheet in the GDR (and omit the boring records). Produce an LOTB sheet when a Foundation Report for a special design sound wall is required. A note should be added to the report directing the designer to include the LOTB in the contract plans, along with a list of LOTB sheet titles.

Table X: Sound Wall Foundation Recommendations

Station Limits	Foundation Type	Minimum Recommended Drained Friction Angle (degrees)
Sta 08+59 SW LOL to Sta 11+47 SW LOL	CIDH Piles	35
Sta 11+47 SW LOL to Sta 12+89 SW LOL	CIDH Piles	30
Sta 15+17 SW LOL to Sta 16+27 SW LOL	CIDH Piles	35
Sta 16+27 SW LOL to Sta 20+37 SW LOL	CIDH Piles	30