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MATERIALS INFORMATION

Geotech Report

State of California
DEPARTMENT OF TRANSPORTATION

Business, Transportation and Housing Agency

Memorandum

Flex your power!
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To: MR. LANCE BROWN
Senior Transportation Engineer

Date: January 12, 2012

File: 02-TRI-3-26.15
Crib Wall

Attn: Mr. Kurt Schneider

From: **DEPARTMENT OF TRANSPORTATION**
Division of Engineering Services
Geotechnical Services

Subject: Crib Wall – Assessment and Recommendations

On Thursday, January 5, 2012 Mr. Scott Lewis of the Office of Geotechnical Design North (OGDN) visited TRI 3 PM 26.15 with Mr. Kurt Schneider and Mr. Joseph McNeely of the Office of Maintenance Engineering to assess the problems at the site, which were first reported by field maintenance personnel under the supervision of Mr. McNeely. The site involves a deteriorating wooden crib wall that runs approximately 90 feet along the north side of the highway and has a maximum height of about 14 feet roughly in the middle of its length. The wall is surcharged above by a soil slope with an approximate slope ratio of 2:1 that ascends to the roadway grade where it levels out and creates a 3- to 4- foot unpaved shoulder. The edge of travelled way is inches away from the edge of pavement as the fog line lies along the pavement edge. A sketched cross-section is shown in Plate 1.

According to Mr. McNeely cracks began to develop at least three years ago in the level shoulder that parallels the edge of pavement. Maintenance personnel regraded the shoulders during these years. The cracks observed during the recent site visit, while still in the shoulder and paralleling the direction travel, have now also moved into the paved section about 1 foot from the outer edge of the fog line. The cracks in the unpaved shoulder demonstrated horizontal extensions of up to 2 inches at the time of the site visit. These cracks did not extend to the eastern termination of the wall where a large (about 90 ft tall) cottonwood stands behind the wall face in the unpaved shoulder bordering the highway. Cracks did extend, however, to the western end of the wall where they terminated. Observations of the crib wall show that the wooden timbers are moderately decomposed and softened, though very little distinct failure was observed. The individual cribs are wrapped around their faces and restrained back into the wall by 2-inch steel straps that appear to be in good metallurgic condition. The quality of the wood they wrap around inside the wall is likely dubious, based on the condition of the timbers at the crib wall face. The wall batter is slightly variable, which is likely indicative of some internal shifting/settlement. The area below the road in front of and neighboring the crib wall is moderately to highly vegetated predominantly with hydrophilic plant species of the Rubus genus, which is indicative of the presence of water throughout the year. Based on aerial photos from Caltrans DHIPP (Digital Highway Inventory Photography Program), the topography below the wall, the slopes neighboring the ends of the wall, and the presence of an old abandoned concrete structure at the

base of the middle (length-wise) of the wall (where the wall is highest and deepest), it appears that this wall was built to hold back fill placed to bridge a small surficial waterway that likely transported surface and shallow ground water. Some or all of the surface water from this water path, which was probably not of large volume, was likely diverted somewhere south of the road on private property prior to the construction of the wall. Some or most of the original groundwater likely still travels the original course.

It is highly likely that the cause of the cracks in the shoulder and pavement are the result of the deterioration of the wall timbers, consequent internal settlement of cobbles and soil retained by the cribs, and a resultant pulling away (from the roadway) of the crib wall and its retained material. In the area of the large cottonwood tree the material behind the wall is most likely being retained by the deep and expansive roots of the cottonwood, which explains why the cracks do not extend to the eastern termination of the wall. The movement of the wall appears to be accelerating, based on the reoccurrence of repaired cracks and the expansion of their presence into the pavement. It is likely that this acceleration will continue, though data is inadequate to determine exactly what the acceleration is or when total failure of the crib wall might occur. The quantity of movement will likely evolve exponentially from year to year, a development that already appears to be happening, as evidenced by the migration of the cracks into the roadway. At the present moment the roadway is not imminently threatened. Crack repair is highly recommended soon to keep winter rains out of the cracks, water from which would only exacerbate and speed up the movement. It is very possible that cracks will migrate into the middle of the westbound lane within a couple years, the exact timing dependent mostly upon the severity and amount of yearly precipitation. It does not bode well that the movement has migrated into the pavement this year when so little precipitation has occurred so far this season. If and when cracks migrate into the middle of the westbound lane, the travelled way will be jeopardized and require more than maintenance forces can provide to keep the westbound lane viable. When cracks have migrated into the center of the westbound lane, the wall will be at risk of imminent failure.

OGDN proposes several mitigation options for consideration by the Office of Maintenance Engineering and the District:

1) Continue filling shoulder cracks and patching up pavement cracks with maintenance forces. This will suffice for maybe two years, but may result in exposing the highway to a condition of imminent failure risk if no other mitigation is undertaken beyond approximately two years, and if the cracks continue to increase in severity as they have over the past 3 years.
2) Buttress the crib wall with RSP at a slope of 1.5:1 or slightly steeper (no steeper than 1.3:1) as shown in Plate 2. The area of the sloping shoulder above the wall and buttress should be rebuilt, with fabric placed at the level of the top of the wall to prevent the migration of fines down into the large inter-cobble voids present within the cribs. Construction of this buttress would not require traffic control or temporary movement of the roadway. There may be a small amount of post-construction settlement in the shoulder area over several years due to

internal shifting and deformation of the rotting timbers and material within the cribs. This settlement would be relatively small and require only a minor effort by maintenance forces to repair. This option is shown in Plate 2.

3) Construct a soil nail wall over the crib wall face. If done internally (within Caltrans) a subsurface investigation would be required to determine design parameters. This could also be a candidate for drilled soil nails as part of a design-build project by a company such as Landslide Solutions. The same post-construction settlement as cited in number 2 above would likely occur. Work could likely be done all from below the roadway, thereby avoiding the incurrence of traffic control issues and costs. This option is shown in Plate 3.
4) Replace the wall with a new wall. Possible wall types include most gravity walls, such as type 1 walls, a crib wall, or a gabion wall. The wall design chosen must have sufficient drainage capacity. This option is shown in Plate 4.

Our office recommends starting with option 1 and continuing with it through next year (winter-spring of 2013), while vigilantly watching the signs of strain as demonstrated by cracks in the shoulder and pavement and deformation of the wall face. It is possible that the acceleration of deformation may slow over that time, though such a slowing is considered unlikely. The district should be prepared to make a decision between options 2, 3, and 4 by the end of the winter-spring of 2013, if not sooner, should the ongoing deformation continue accelerating.

If you have any questions or comments, please call me at (530) 225-3516.

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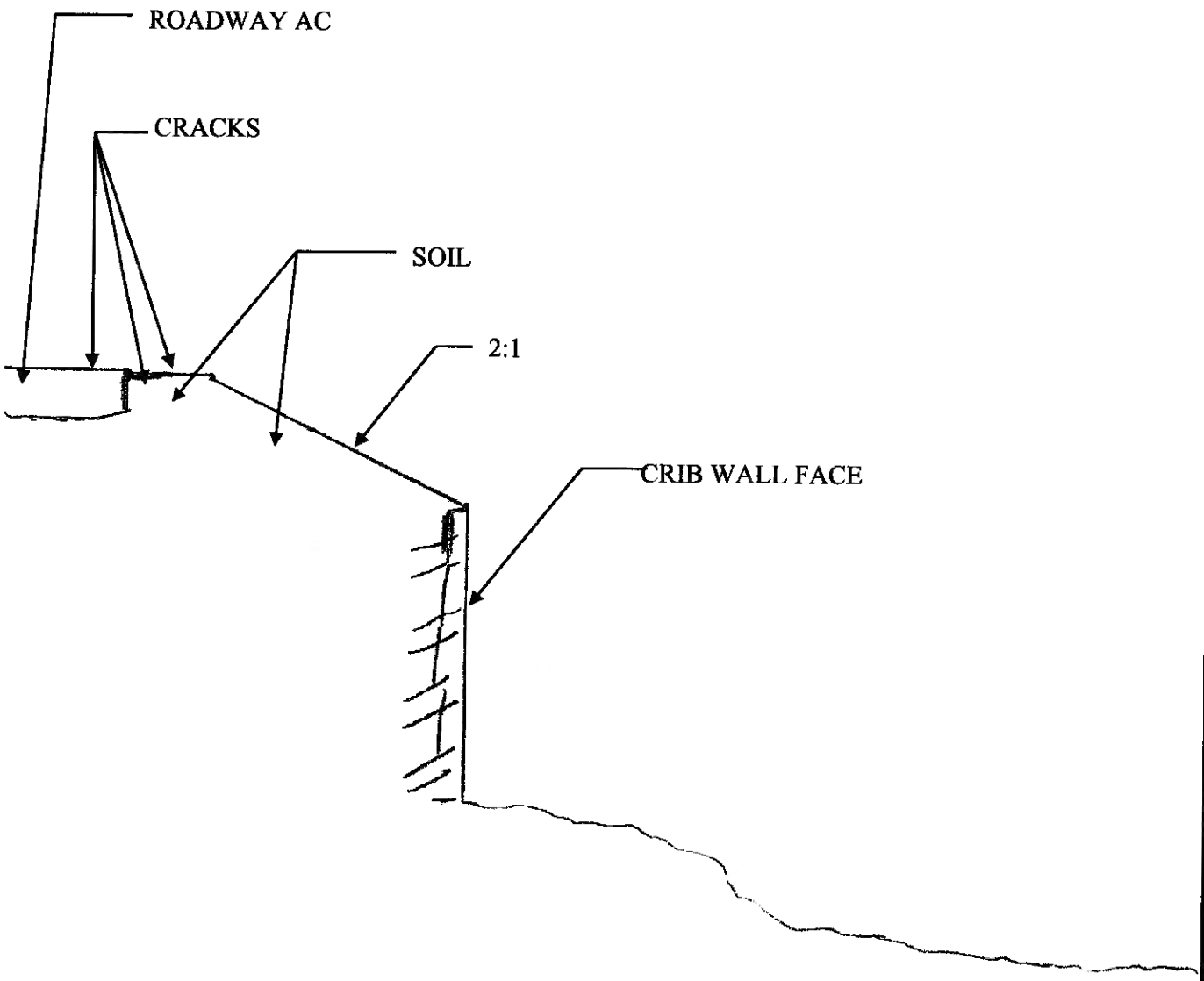
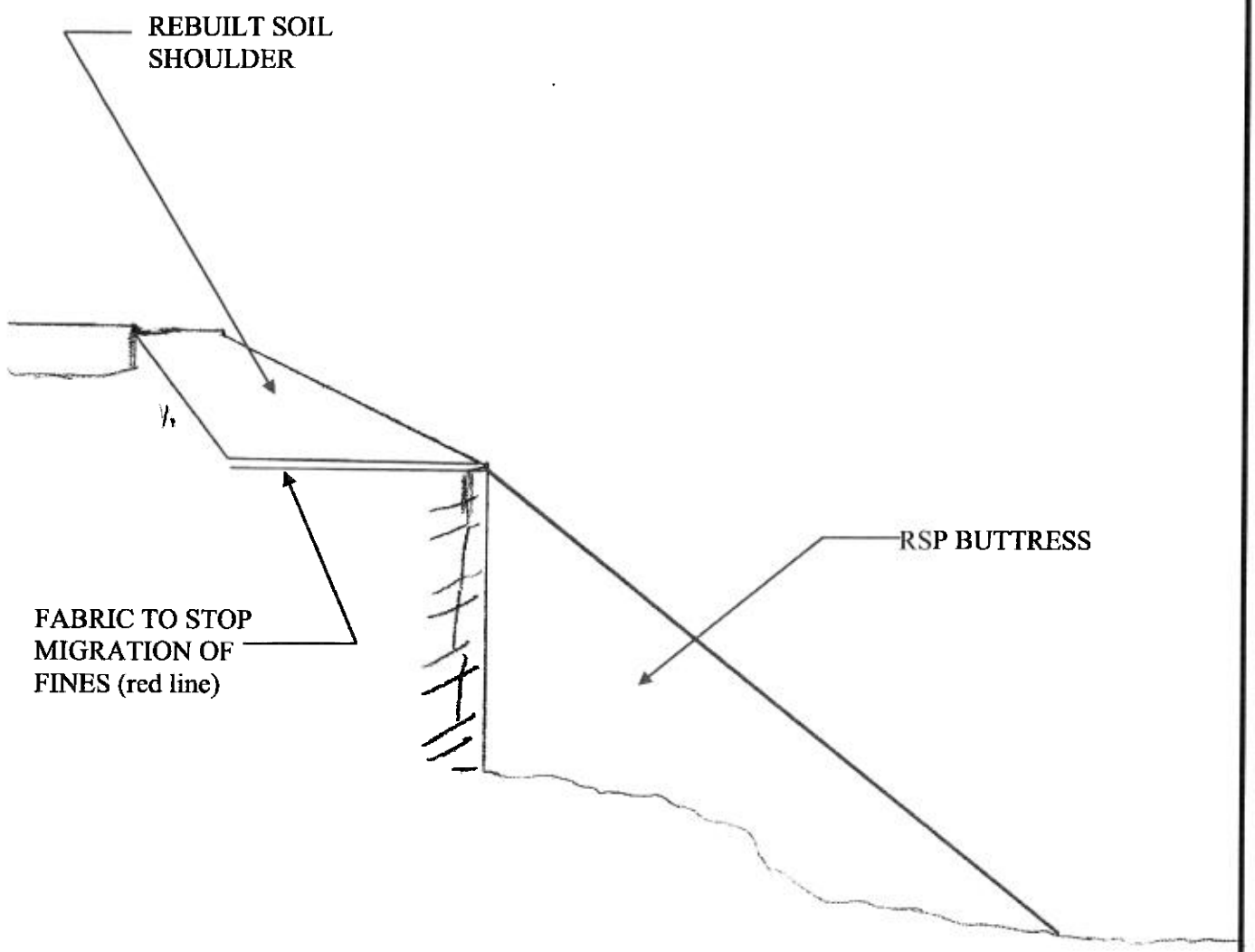
Attachments:

(1) Plate 1. Cross Section of Wall and Roadway
(2) Plate 2. Cross Section of Buttress Repair
(3) Plate 3. Cross Section of Soil Nail Wall
(4) Plate 4. Cross Section of New Type 1 Wall

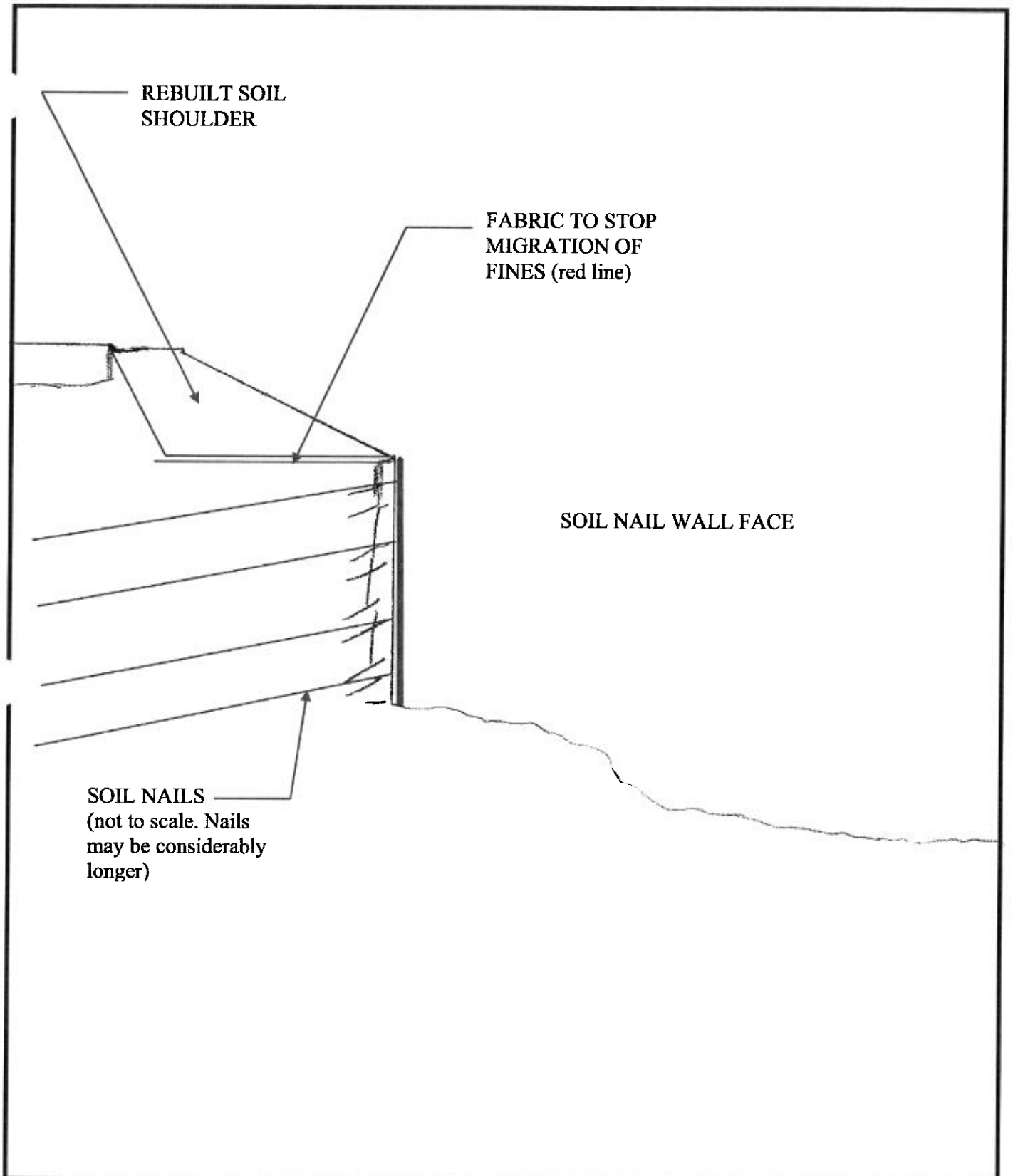
ec: Roy Bibbens
Mark Hagy



CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-930321 Date: January 2012	**CROSS-SECTION OF WALL & ROADWAY**
	02-TRI-3 PM 26.15 GEOTECHNICAL ASSESSMENT and RECOMMENDATIONS	Plate No. 1

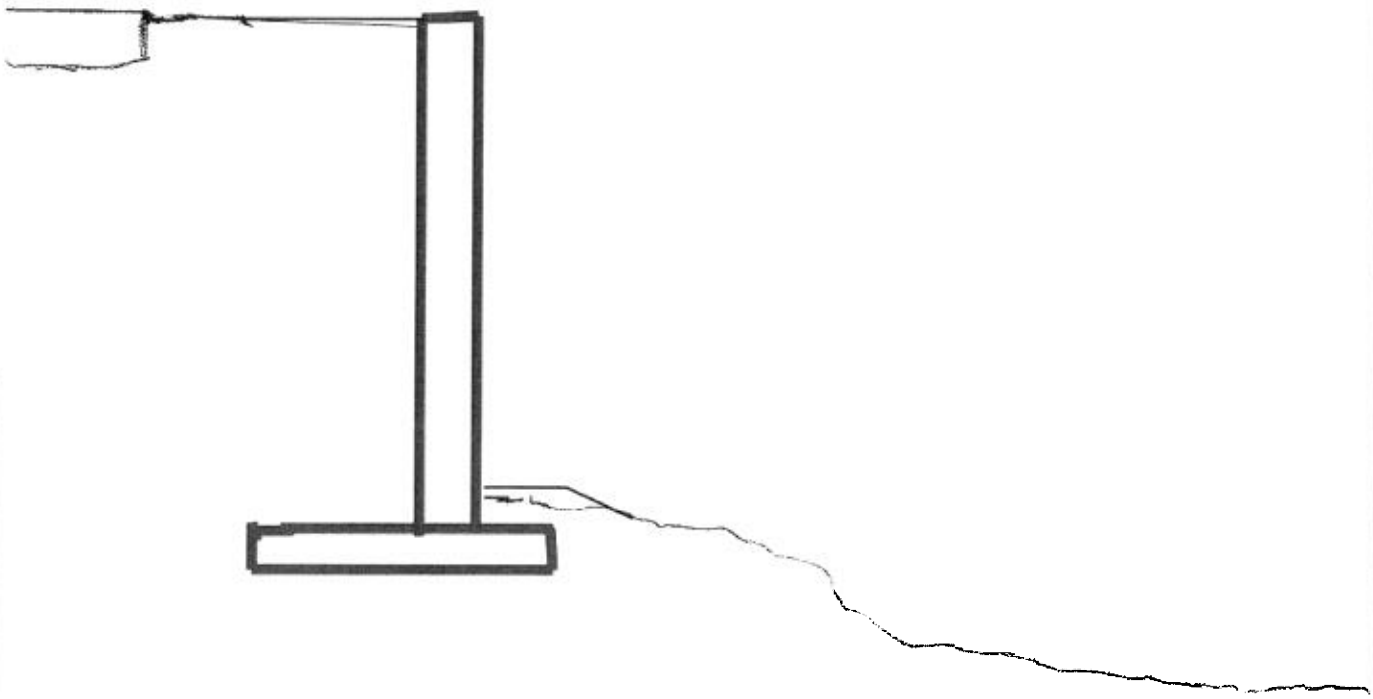


CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-930321 Date: January 2012	**CROSS SECTION of BUTTRESS REPAIR**
	02-TRI-3 PM 26.15 **GEOTECHNICAL ASSESSMENT and RECOMMENDATIONS**	Plate No. 2



CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-930321 Date: January 2012	**CROSS SECTION of SOIL NAIL WALL REPAIR**
	02-TRI-3 PM 26.15 **GEOTECHNICAL ASSESSMENT and RECOMMENDATIONS**	Plate No. 3

WALL REPLACED WITH NEW WALL. In this case a Type 1 Wall. It may be other types of gravity walls, such as a gabion wall or crib wall.



CALTRANS Division of Engineering Services Geotechnical Services Office of Geotechnical Design-North	EA: 02-930321 Date: January 2012	**CROSS SECTION of NEW WALL REPAIR**
	02-TRI-3 PM 26.15 **GEOTECHNICAL ASSESSMENT and RECOMMENDATIONS**	Plate No. 4