

Quieter Bridge Deck Construction

Quiet pavement strategies produce traffic noise reduction benefits over time without compromising safety, ride quality, and durability of pavement surfaces. The noise emitted from the highway system has become a subject of complaint and environmental impact to residents, specifically to those in urban areas. The primary traffic sources of generated noise are classified into three categories: propulsion, aerodynamics, and tire/pavement interface. At highway speed the dominant noise is generated at the tire/pavement interface. Engineers throughout the world have been researching methods to reduce the noise impacts of highway systems beyond building sound barriers. These methods include improvement of the roadway pavement types and textures to reduce tire/pavement interface noise.

The previous standard bridge deck texturing method used by California Contractors was transverse texturing which proved to be significantly louder than longitudinally tined Portland Concrete Cement (PCC) pavement measured by the On-Board Sound Intensity (OBSI) method. Experience has shown that Contractors aggressively texture the bridge deck to ensure meeting the specified minimum coefficient of friction value. Aggressive texturing often results in a uniformly unbalanced or uneven surface known as *shingling* which further increases the vehicle tire noise.

Quiet Pavement Research (QPR) has shown that traffic noise can be minimized by incorporating quiet pavement strategies in construction practices at little or no additional cost. QPR has found that for rigid pavement including bridge decks *longitudinal grinding and grooving*, or *longitudinal tining* are two textures that can be used to reduce tire noise. Research has found that these two methods produce less tire/pavement interface noise than the transverse texturing method previously used on most California bridge decks. The texturing is almost identical to that used on PCC pavement highways. Tire noise measured by the OBSI method on California bridge decks that are transversely textured range from 105 decibels (dB) to 112 dB. For comparison, tire noise measurements for *longitudinal tining* range from 103 dB to 105 dB, for *longitudinal grinding and grooving* range from 100 dB to 103 dB, and for *flexible pavement* range from 95 dB to 105 dB. An increase in 10 dB is perceived as double the noise to the human ear. Grinding has reduced the tire noise on bridge decks by as much as 10 dB and has been used as an interim measure to remedy noisy transversely textured bridge decks.

Longitudinal grinding and grooving of PCC roadways and bridge decks produce adequate coefficient of friction results for bridge decks. Grinding is typically used to remedy surfaces that do not meet friction requirements. The primary purpose of the longitudinal grooving applied to the ground surface is to increase water channeling below the tire.

The [Contract Specifications](#), Section 40-1.03H(3), *Concrete Pavement – General – Construction – Finishing – Final Finishing*, requires an initial texture created with a burlap drag or broom device which produces striations parallel to the centerline. The purpose of the initial texture is to slightly roughen the surface to achieve the required friction. This is also necessary to achieve the required friction on longitudinally tined bridge decks. Similar to grooving, the primary purpose of *longitudinal tining* is to increase water channeling below the tire.

There are many polyester concrete bridge decks in service on the state highways today that have been tined longitudinally. The longitudinally tined polyester concrete bridge deck surfaces have resulted in lower than expected tire noise compared to a transversely tined bridge deck and have easily exceeded the minimum friction requirement. Figure No. 1 is an example of a longitudinally tined polyester concrete bridge deck surface.

For more information on quieter pavement technology see report [Bridge Deck Tire Noise Research](#).

New Practice

All new bridge deck projects advertised after January 1, 2011, include the Standard Special Provision (SSP), *Bridge Deck Surface Texture*. This specification provides the following two options for bridge deck texturing:

1. Longitudinal grinding and grooving
2. Longitudinal tining

The requirements for bridge decks which address smoothness, friction and crack intensity remain unchanged.

A longitudinal tined texture can easily be accomplished on a bridge deck. Longitudinal tining machines are commercially available but are not mandatory. The longitudinal tining machine will accommodate a bridge deck with a variable cross slope, a crown, or superelevation. The Contractor may propose another technique or device to achieve the requirements of the specification.

Following are construction aspects that should be ensured when using the *longitudinal grinding and grooving* option and the *longitudinal tining* option:

Longitudinal Grinding and Grooving Option

- The bridge deck thickness will be increased 1/4 inch.

- The concrete mix design must meet the specification requirements for cementitious material and quality aggregates to ensure the deck surface durability.
- The bridge deck drains, and other permanent fixtures should be set to the final grade per the contract plans.
- All recessed areas that will not be accessible by the grinding blades such as the area adjacent to bridge deck drains should be hand textured longitudinally to match adjacent concrete, while the concrete is wet.
- The 18 inches of bridge deck surface adjacent to the barrier rail will be inaccessible by the grinding blades. This area should be hand textured longitudinally to match adjacent concrete, while the concrete is wet.
- Figure No. 2 is an example of a bridge deck surface using the *longitudinal grinding and grooving* option.

Longitudinal Tining Option

- The Contractor must drag burlap or a light broom longitudinally in advance of the tining operation to ensure that the surface friction is adequate. Attention should be paid to the texture operation to ensure the burlap or other tools used to roughen the surface in front of the tining operation are evenly weighted and produces a flat roughened surface.
- The concrete mix design must meet the specification requirements for cementitious material and quality aggregates to ensure the deck surface durability.
- The concrete mix design water content and corresponding slump is important to ensure the specified tining texture can be achieved and is consistent.
- Ensure that the concrete will be delivered timely per the specifications. It is desirable to place as much deck as possible for each longitudinal tining pass to minimize starts and stops in the tining pattern.
- Close attention must be paid to the concrete consistency to ensure the finish tines or intrusions are consistent with the requirements of the specifications.
- Ensure the finishing tools (tine, burlap, broom, etc.) are properly adjusted and kept clean.
- Each tine should be a rectangular shape and the width should be between 3/32" and 1/8".
- The tining should produce a negative intrusion into the surface and not produce any positive texture.
- Ensure the tining spaces are evenly spaced at 3/4".

- Ensure the depth of the tining is between 3/16" and 1/8". Note: The distance from the edge of a quarter to the top of President Washington's head is about 1/8".
- Figure No. 3 is an example of a PCC bridge deck using the *longitudinal tining* option.
- Figure No. 4 is an example of a tining tool used for the *longitudinal tining* option.
- Grinding for smoothness, when necessary per *Contract Specification*, Section 51-1.03F(5)(a), *Concrete Structures – General – Construction – Finishing Concrete – Finishing Roadway Surfaces-General*, is still required.

Attention to all the details associated with placing the bridge deck concrete will result in a higher quality bridge deck that is quieter.

Special Situations

A bridge may be in a noise sensitive area if it is adjacent to a residential area, hospital, school, park, or hotel. For projects within a noise sensitive area, defined by the Division of Pavement Management, Pavement Policy Bulletin ([PPB 09-02](#), *Quieter Pavement Strategies for Noise Sensitive Areas*, and identified in *Standard Special Provisions (SSP)*, Section 51-1.03F (5)(b)(i), *Concrete Structures- General – Construction – Finishing Concrete – Finishing Roadway Surfaces – Bridge Deck Surface Texture – General*, the district may request that only the *longitudinal grinding and grooving* option be specified. If a bridge project is in a noise sensitive area and the SSP is not in place, or to address any other quiet bridge deck questions or concerns, contact SC HQ Office Associate for assistance.

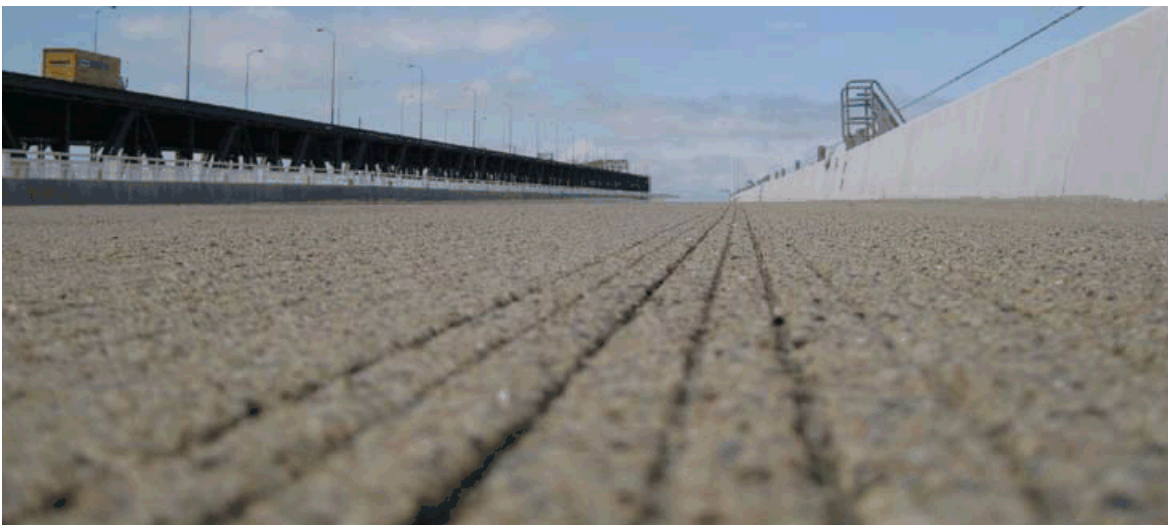


Figure No. 1: Example of Longitudinally Tined Polyester Concrete Bridge Deck Surface.



Figure No. 2: Example of a PCC Bridge Deck Using the *Longitudinal Grinding and Grooving* Option.



Figure No. 3: Example of a PCC Bridge Deck Using the *Longitudinal Tining* Option.



Figure No. 4: Example of the Tining Tool used for the *Longitudinal Tining*.