CALIFORNIA STATE TRANSPORTATION AGENCY

Analysis of Cost Differential Between Asphalt Containing Crumb Rubber and Conventional Asphalt for 2012 ("2012 Crumb Rubber Report")

Public Resources Code Section 42703

Prepared by

CALIFORNIA DEPARTMENT OF TRANSPORTATION

March 2014

This is to certify that this "Analysis of Cost Differential Between Asphalt Containing Crumb Rubber and Conventional Asphalt for 2012" (or "2012 Crumb Rubber Report") meets the requirements of Public Resources Code section 42703.

Approval recommended by:

MALCOLM DOUGHERTY, Director
California Department of Transportation

Date 4/1/2014

Approved by:

For BRIAN P. KELLY, Secretary
California State Transportation Agency

Date 4/22/2014

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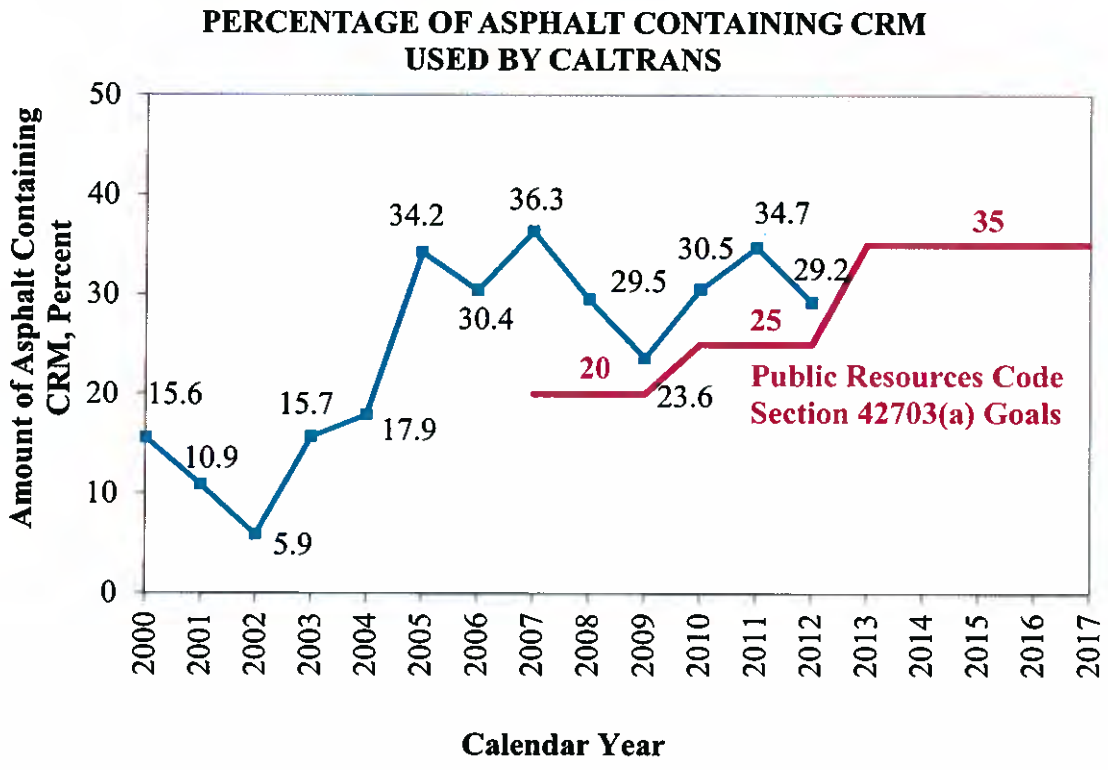
Executive Summary

Public Resources Code section 42703 requires the California Department of Transportation (Caltrans) to meet specified amounts of crumb rubber modifier (CRM) usage in asphalt and requires the Secretary of the California State Transportation Agency to prepare an annual analysis comparing the cost differential between asphalt containing crumb rubber and conventional asphalt paving material. This report addresses Public Resources Code sections 42703(a)(2), 42703(b)(2), 42703(c)(1)(A), (B), and (C), and 42703(c)(2). (See appendix for the full text of section 42703.)

For calendar year 2012, Caltrans used an average of 9.27 pounds of CRM per metric ton of asphalt paving material, exceeded the 8.27 pounds of CRM required by Public Resources Code section 42703(a)(2). Caltrans projects using CRM in asphalt paving diverted more than 4.5 million waste tires from landfills and tire stockpiles.

Caltrans used more than 5.7 million metric tons of total paving asphalt in calendar year 2012; with the 1.7 million metric tons of asphalt containing crumb rubber (see table 1 on page 3), Caltrans' usage of asphalt containing crumb rubber was 29.2 percent of the total paving asphalt, exceeded the 2012 goal of 25 percent. The 2013 targeted goal is 35 percent (see chart below).



Public Resources Code section 42703(b)(2) mandates that on and after January 1, 2007, and before January 1, 2015, not less than 50 percent of the asphalt pavement used to comply with the requirements of section 42703(a)(2) shall be rubberized asphalt concrete. (That is, half of the goals shown in the chart must be rubberized asphalt concrete.) Caltrans used 92.2 percent rubberized asphalt concrete to comply with requirements of Public Resources Code section 42703(b)(2).

Because of the limitations of existing maintenance and pavement management systems, the material life span or maintenance costs for asphalt materials cannot be analyzed as required by Public Resources Code sections 42703(c)(1)(A) and 42703(c)(1)(B). However, Caltrans is implementing an improved pavement management system, which will be used to determine the the lifespan and duration of the asphalt materials, as required by section 42073(c)(1)(A), after seven to ten collection cycles of pavement distress data.

The material life span and maintenance cost for both asphalt containing crumb rubber and conventional asphalt were assumed equal in order to perform the analysis required by Public Resources Code section 42703(c)(1)(C). The cost comparison analysis was performed on pavement preservation (maintenance), rehabilitation, Capital Preventive Maintenance (CAPM), and other construction projects. The analysis showed the cost of asphalt containing crumb rubber ranged from 1.4 percent more for pavement preservation (maintenance) to 37.4 percent more for other construction projects than the cost of conventional asphalt, depending on the project category.

The Secretary of the California State Transportation Agency finds usage of CRM cost-effective for reflective cracking. Caltrans must continue to use sound engineering judgment to determine when and where CRM should be used.

Background

Assembly Bill 338, relating to recycling, was chaptered in 2005, and added section 42703 to the Public Resources Code. The intent of this legislation was to require Caltrans to use more asphalt containing crumb rubber when it is cost-effective compared with conventional asphalt. The ultimate goal of this legislation is to increase the recycling of the more than 40 million reusable and waste tires generated each year in California and thereby reduce the amount of tires placed in landfills and scrap tire piles.

Public Resources Code section 42703 requires Caltrans to meet increasing specified amounts of CRM usage on and after January 1 of 2007, 2010, and 2013. The Secretary of the California State Transportation Agency must prepare an annual cost differential analysis based on the Public Resources Code section 42703 requirements. This report addresses Public Resources Code sections 42073(a)(2), 42073(b)(2), 42703(c)(1)(A), (B), and (C), and 42073(c)(2). (See appendix for the full text of section 42703.)

Crumb Rubber Usage Analysis and Results

Public Resource Code section 42703(a)(2) requires on or after January 1, 2010, Caltrans shall use, on an annual average, not less than 8.27 pounds of CRM per metric ton of total asphalt paving materials used.

The data collection process for this analysis captured the available project quantities for asphalt containing crumb rubber and conventional asphalt placed during calendar year 2012 from Caltrans' Division of Construction's Contract Administration System progress payment database. The method used to determine the amount of CRM per metric ton of asphalt placed required the following assumptions:

1. CRM asphalt binder contains between 18 percent and 20 percent CRM; calculations were based on a value of 19 percent.

2. Asphalt containing crumb rubber has the following CRM asphalt binder content ranges:

   - Gap-graded contains between 7 to 9 percent CRM asphalt binder, based on average field mix designs; a value of 8 percent was used for calculations.

   - Open-graded contains between 7 to 10 percent CRM asphalt binder, based on average field mix designs; a value of 8 percent was used for calculations.

The results of the crumb rubber usage analysis are shown in table 1 below.

Table 1

2012 DATA ANALYSIS RESULTS
CRUMB RUBBER USAGE*

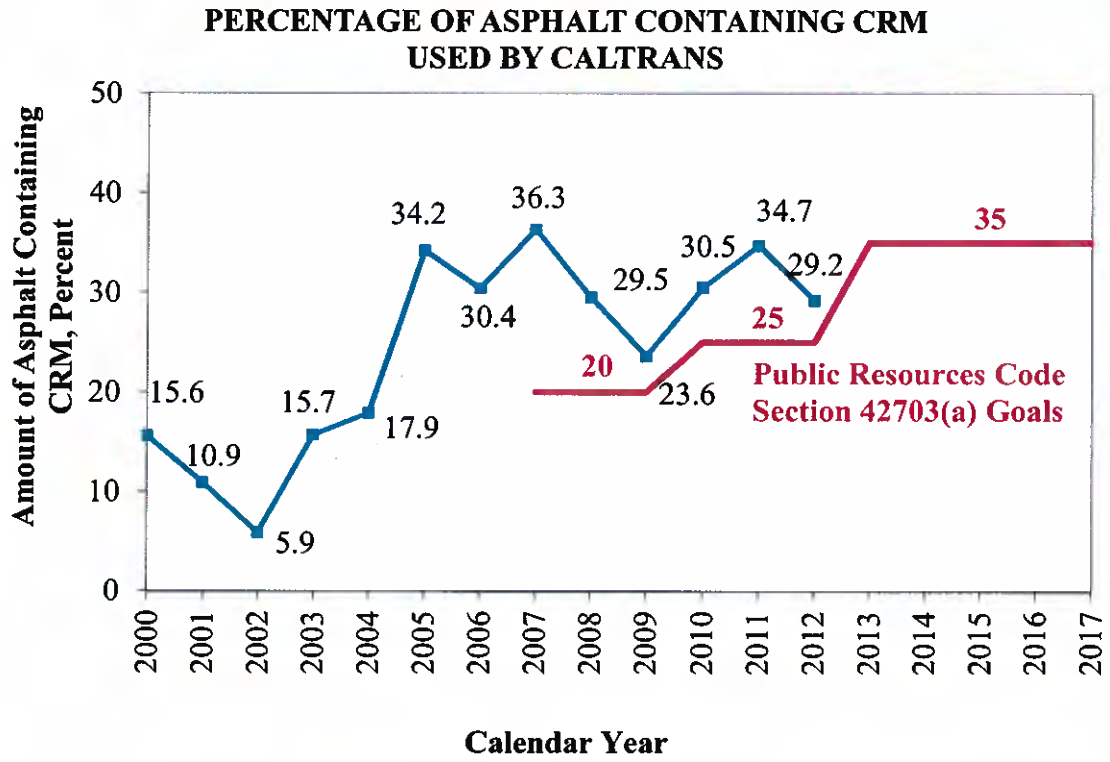
Quantity of Asphalt Placed (*Metric Tons*)			Asphalt Containing Crumb Rubber to Total Asphalt Paving (*Percentage*)	Crumb Rubber Placed (*Average Pounds*)	Pounds of CRM per Metric Ton of Total Asphalt Placed (*Calculated*)
Total Asphalt	**Conventional Asphalt**	**Asphalt Containing Crumb Rubber**			
5,745,875	4,069,425	1,676,450	29.2	53,286,289	9.27

*Data compiled for this analysis was based on 425 projects in construction paving in 2012.

To comply with Public Resources Code section 42703(a), subparagraphs (1) through (3), target percentages were calculated as follows, based on Caltrans' use of CRM per metric ton of the total amount of asphalt paving materials used:

(1) For 2007 through 2009, the annual average mandate of 6.62 pounds is 20 percent.
(2) For 2010 through 2012, the annual average mandate of 8.27 pounds is 25 percent.
(3) For 2013 and beyond, the annual average mandate of 11.58 pounds is 35 percent.

For calendar year 2012, Caltrans used an average of 9.27 pounds of CRM per metric ton of asphalt paving material, exceeded the 8.27 pounds of CRM required by Public Resources Code section 42703(a)(2). Caltrans used an average of 53.3 million pounds of CRM in rubberized asphalt concrete diverting more than 4.5 million waste tires from landfills and tire stockpiles. Caltrans used more than 5.7 million metric tons of total paving asphalt in calendar year 2012; with the 1.7 million metric tons of asphalt containing crumb rubber (see table 1 on page 3), Caltrans' usage of asphalt containing crumb rubber was 29.2 percent of the total paving asphalt, exceeded the 2012 goal of 25 percent (see chart below).



Public Resources Code section 42703(b)(2) mandates that on and after January 1, 2007, and before January 1, 2015, not less than 50 percent of the asphalt pavement used to comply with the requirements of section 42703(a)(2) shall be rubberized asphalt concrete. (That is, half of the goals shown in the chart must be rubberized asphalt concrete.) Caltrans used 92.2 percent rubberized asphalt concrete to comply with requirements of Public Resources Code section 42703(b)(2).

Cost Comparison Analysis and Results

Public Resources Code section 42703(c)(1) requires the Secretary of the California State Transportation Agency to prepare annually by January 1, an analysis comparing the cost differential between asphalt containing crumb rubber and conventional asphalt. The cost comparison analysis was segregated by the four major pavement project categories: pavement preservation (maintenance), rehabilitation, CAPM, and other construction projects (such as lane additions, new road alignments, and safety and landscape projects).

Caltrans' Division of Construction's Contract Administration System progress payment database was used to obtain the costs of various pavement projects and total tonnage of materials.

Four major assumptions were necessary before any cost comparisons could be made.

1. Cost per ton for asphalt material was calculated based on the tonnage and bid item cost of the asphalt material.

2. Cost comparisons were completed for the following categories of projects:

   - Pavement Preservation (Maintenance). Overlay strategies, compared and placed at the same one-inch minimum thickness under the maintenance preservation program.

   - Rehabilitation. Pavement rehabilitation projects funded in the State Highway Operation and Protection Program (SHOPP).

   - CAPM. CAPM strategies are thinner than rehabilitation strategies and are usually double the thickness of pavement preservation (maintenance) treatments funded from the SHOPP.

   - Other Construction. All other program projects not listed in the above categories (safety, landscape, State Transportation Improvement Program, protective betterment, etc.).

   These assumptions were necessary because Caltrans has many different types of projects, such as roadway rehabilitation, roadside, safety, and drainage, that contain small amounts of asphalt that would make a cost per ton analysis meaningless. Similar types of strategies need to be compared for an accurate cost comparison between asphalt containing crumb rubber and conventional asphalt.

3. Rehabilitation strategies with asphalt containing crumb rubber and conventional asphalt life spans were considered the same.

   This assumption was necessary because Caltrans, at this time, does not have a pavement management system that contains pavement life span data or that can be used to predict pavement life cycles. For this report, expected life spans were assumed the same for asphalt containing crumb rubber and conventional asphalt. The asphalt life span was assumed to be three to five years for pavement preservation (maintenance) projects, ten years for rehabilitation projects, five to seven years for CAPM projects, and twenty years for new construction projects.

4. Maintenance costs for asphalt containing crumb rubber and conventional asphalt were considered the same and did not affect the cost comparison.

   This assumption was necessary because Caltrans' Integrated Maintenance Management System does not segregate pavement maintenance costs for asphalt containing crumb rubber and conventional asphalt material from other pavement work. Caltrans' ability to segregate and calculate maintenance costs for asphalt containing crumb rubber or conventional asphalt locations is difficult to quantify accurately. Consequently, maintenance costs were not included in the analysis and were assumed the same for asphalt containing crumb rubber and conventional asphalt.

Using the four listed assumptions and the progress payment data from the Division of Construction's Contract Administration System, the results of the cost comparison analysis are shown in table 2 below. The results are segregated by the four major pavement project categories: pavement preservation (maintenance), rehabilitation, CAPM, and other construction.

Table 2

2012 DATA ANALYSIS RESULTS
INITIAL COST COMPARISON PER TON BY PAVEMENT PROJECT TYPE FOR ASPHALT CONTAINING CRUMB RUBBER VERSUS CONVENTIONAL ASPHALT

	Pavement Preservation (Maintenance)	Rehabilitation	CAPM	Other Construction
Asphalt containing crumb rubber	$102.59	$93.05	$88.99	$98.52
Conventional Asphalt	$101.20	$70.76	$77.98	$71.73

For pavement preservation (maintenance) projects, the initial cost of asphalt containing crumb rubber was 1.4 percent more than conventional asphalt. For rehabilitation projects, the initial cost of asphalt containing crumb rubber was 31.5 percent more than conventional asphalt. For CAPM projects, the initial cost of asphalt containing crumb rubber was 14.1 percent more than conventional asphalt. For other construction projects, the initial cost of asphalt containing crumb rubber was 37.4 percent more than conventional asphalt.

Asphalt pavement containing crumb rubber does initially cost more per ton than conventional asphalt pavement. Caltrans' research has shown that asphalt pavement containing crumb rubber provides a better performance to resist reflective cracking of the existing pavements. Caltrans should continue to use sound engineering judgment to determine when and where asphalt containing crumb rubber shall be placed.

Findings and Recommendations

The Secretary of the California State Transportation Agency finds that:

1. Caltrans used an average of 9.27 pounds of CRM per metric ton of total asphalt paving materials. This exceeds the Public Resources Code section 42703(a)(2) requirement of 8.27 pounds of CRM per metric ton of total asphalt paving material used. Caltrans' usage of asphalt containing crumb rubber is 29.2 percent of the total paving asphalt.

2. Caltrans used 92.2 percent rubberized asphalt concrete to comply with requirements of Public Resources Code section 42703(b)(2). This exceeds the Public Resources Code section 42703(b)(2) requirement that on and after January 1, 2007, and before January 1, 2015, not less than 50 percent of the asphalt pavement used to comply with the requirements of section 42703(a)(2) shall be rubberized asphalt concrete.

3. The initial cost per ton of asphalt containing crumb rubber varies between 1.4 percent more for pavement preservation (maintenance) projects to 37.4 percent more for other construction projects than the cost of conventional asphalt, depending on the project category. Caltrans' research has shown that asphalt pavement containing crumb rubber overlays are cost-effective when used to resist reflective cracking. Caltrans should continue to use sound engineering judgment to determine when and where asphalt containing crumb rubber shall be placed.

4. Caltrans projects using CRM in asphalt paving diverted more than 4.5 million waste tires from landfills and tire stockpiles during the 2012 calendar year. Information about additional waste tire applications used by Caltrans is available on the Internet at <http://www.dot.ca.gov/hq/oppd/rescons/sb876.htm>.

Appendix: Public Resources Code Section 42703

(a) Except as provided in subdivision (d), the Department of Transportation shall require the use of crumb rubber in lieu of other materials at the following levels for state highway construction or repair projects that use asphalt as a construction material:

(1) On and after January 1, 2007, the Department of Transportation shall use, on an annual average, not less than 6.62 pounds of CRM per metric ton of the total amount of asphalt paving materials used.

(2) On and after January 1, 2010, the Department of Transportation shall use, on an annual average, not less than 8.27 pounds of CRM per metric ton of the total amount of asphalt paving materials used.

(3) On and after January 1, 2013, the Department of Transportation shall use, on an annual average, not less than 11.58 pounds of CRM per metric ton of the total amount of asphalt paving materials used.

(b) (1) The annual average use of crumb rubber required in subdivision (a) shall be achieved on a statewide basis and shall not require the use of asphalt containing crumb rubber in each individual project or in a place where it is not feasible to use that material.

(2) On and after January 1, 2007, and before January 1, 2015, not less than 50 percent of the asphalt pavement used to comply with the requirements of subdivision (a) shall be rubberized asphalt concrete.

(3) On and after January 1, 2015, the Department of Transportation may use any material meeting the definition of asphalt containing crumb rubber, with respect to product type or specification, to comply with the requirements of subdivision (a).

(c) (1) The Secretary of Transportation shall, on or before January 1 of each year, prepare an analysis comparing the cost differential between asphalt containing crumb rubber and conventional asphalt. The analysis shall include the cost of the quantity of asphalt product needed per lane mile paved and, at a minimum, shall include all of the following:

(A) The life span [sic] and duration of the asphalt materials.

(B) The maintenance cost of the asphalt materials and other potential cost savings to the department, including, but not limited to, reduced soundwall construction costs resulting from noise reduction qualities of rubberized asphalt concrete.

(C) The difference between each type or specification of asphalt containing crumb rubber, considering the cost-effectiveness of each type or specification separately in comparison to the cost-effectiveness of conventional asphalt paving materials.

(2) Notwithstanding subdivision (a), if, after completing the analysis required by paragraph (1), the secretary determines that the cost of asphalt containing crumb rubber exceeds the cost of conventional asphalt, the Department of Transportation shall continue to meet the requirement specified in paragraph (1) of subdivision (a), and shall not implement the requirement specified in paragraph (2) of subdivision (a).

If the secretary determines, pursuant to an analysis prepared pursuant to paragraph (1), that the cost of asphalt containing crumb rubber does not exceed the cost of conventional asphalt, the Department of Transportation shall implement paragraph (2) of subdivision (a) within one year of that determination, but not before January 1, 2010.

(3) Notwithstanding subdivision (a), if the Department of Transportation delays the implementation of paragraph (2) of subdivision (a), the Department of Transportation shall not implement the requirement of paragraph (3) of subdivision (a) until three years after the date the department implements paragraph (2) of subdivision (a).

(d) For the purposes of complying with the requirements of subdivision (a), only crumb rubber manufactured in the United States that is derived from waste tires taken from vehicles owned and operated in the United States may be used.

(e) The Department of Transportation and the board shall develop procedures for using crumb rubber and other derived tire products in other projects.

(f) The Department of Transportation shall notify and confer with the East Bay Municipal Utility District before using asphalt containing crumb rubber on a state highway construction or repair project that overlays district infrastructure.

(g) For purposes of this section the following definitions shall apply:

(1) "Asphalt containing crumb rubber" means any asphalt pavement construction, rehabilitation, or maintenance material that contains reclaimed tire rubber and that is specified for use by the Department of Transportation.

(2) "Crumb rubber" or "CRM" has the same meaning as defined in section 42801.7.

(3) "Rubberized asphalt concrete" or "RAC" means a paving material that uses an asphalt rubber binder containing an amount of reclaimed tire rubber that is 15 percent or more by weight of the total blend, and that meets other specifications for both the physical properties of asphalt rubber and the application of asphalt rubber, as defined in the American Society for Testing and Materials (ASTM) Standard Specification for Asphalt-Rubber Binder.