Business, Transportation and Housing Agency

Analysis of Cost Differential Between Asphalt Containing Crumb Rubber and Conventional Asphalt for 2010 ("2010 Crumb Rubber Report")

Public Resources Code Section 42703

Prepared by

CALIFORNIA DEPARTMENT OF TRANSPORTATION

October 2011

This is to certify that this "Analysis of Cost Differential Between Asphalt Containing Crumb Rubber and Conventional Asphalt for 2010" (or "2010 Crumb Rubber Report") meets the requirements of Public Resources Code section 42703.

Approval recommended by:

MALCOLM DOUGHERTY, Acting Director
California Department of Transportation

Date 10/11/2011

Approved by:

TRACI STEVENS, Acting Secretary
Business, Transportation and Housing Agency

Date 10/13/11

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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 Business, Transportation and Housing 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) and 42703(c)(1)(A), (B), and (C). (See appendix for the full text of section 42703.)

For calendar year 2010, Caltrans' CRM usage averaged 10.26 pounds of CRM per metric ton of asphalt paving material, exceeding the 8.27 pounds of CRM required by Public Resources Code section 42703(a)(2).

Because of the limitations of the existing pavement management system, 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 developing the technical specifications for an improved pavement management system that will provide the needed analysis, which should be in place by 2013.

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 new construction, rehabilitation, capital preventative maintenance (CAPM), and pavement preservation (maintenance) projects. The analysis showed the cost of asphalt containing crumb rubber ranged from 27.3 percent less for preventative maintenance to 56.6 percent more for rehabilitation than the cost of conventional asphalt, depending on the project category.

The Secretary of the Business, Transportation and Housing Agency finds usage of CRM is cost-effective in most cases. Pursuant to Public Resources Code section 42703(a)(2), Caltrans 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. 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 was to increase the recycling of the 44,000,000 scrap 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 Business, Transportation and Housing 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) and 42703(c)(1)(A), (B), and (C) stated below. (See appendix for the full text of section 42703.)

Excerpts, 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:
  (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.

(c) (1) The Secretary of Business, Transportation and Housing shall, on or before January 1, 2009, and on or before January 1 annually thereafter, 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 lifespan [*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.

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 2010 from Caltrans' Division of Construction 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

2010 DATA ANALYSIS RESULTS
CRUMB RUBBER USAGE*

Quantity of Asphalt Placed (*Metric Tons*)			**Percentage of Asphalt Containing Crumb Rubber to All Paving Material**	**Pounds of Crumb Rubber Placed**	**Pounds of CRM per Metric Ton of Total Asphalt Placed**
Total Asphalt	**Conventional Asphalt**	**Asphalt Containing Crumb Rubber**	**Percentage**	**Average**	**Calculated**
3,502,355	2,430,436	1,071,919	30.6	35,919,690	10.26

*Data compiled for this analysis was based on 409 projects in construction paving in 2010.

For calendar year 2010, Caltrans used an average of 10.26 pounds of CRM per metric ton of asphalt paving material, exceeding the 8.27 pounds of CRM required by Public Resources Code section 42703(a)(2).

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. Caltrans used almost 100 percent rubberized asphalt concrete to meet the requirements of section 42703(a)(2). Caltrans used just over 3.5 million metric tons of total paving asphalt in calendar year 2010; with the 1.1 million metric tons of asphalt containing crumb rubber (see Table 1), Caltrans' usage of asphalt containing crumb rubber was 30.6 percent of the total paving asphalt.

Cost Comparison Analysis and Results

Public Resources Code section 42703(c)(1) requires the Secretary of the Business, Transportation and Housing 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: new construction (such as lane additions or new road alignments), rehabilitation, CAPM, and pavement preservation (maintenance). For new construction projects, there was insufficient data to establish a cost comparison because asphalt containing crumb rubber is primarily used in thin overlays and is rarely used in new pavement designs.

The Division of Construction 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. Per lane-mile cost for asphalt material was calculated based on the total cost of the pavement divided by the total lane miles of constructed pavement.

   This assumption was necessary because Caltrans does not have a database that can subtract the cost and quantity of asphalt material used for shoulders, medians, and turn lanes in order to calculate accurately the exact cost per lane mile.

2. Only cost comparisons for the following projects would be accurate:

   - New construction: new roads and lane additions.
   - Rehabilitation: mill-and-replace strategies only.
   - CAPM: overlay strategies only. CAPM strategies are thinner than rehabilitation strategies and are usually double the thickness of pavement preservation (maintenance) treatments.
   - Pavement preservation (maintenance): overlay strategies, compared and placed at the same one-inch minimum thickness.

   This assumption was 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 lane mile 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 when using a reduced thickness for asphalt containing crumb rubber as compared with the full thickness for conventional asphalt.

   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. As authorized by a 2008–2009 budget change proposal, a pavement management system, PaveM, is in development over the next two years to develop pavement life cycles. For this report, expected life spans were assumed the same for asphalt containing crumb rubber and conventional asphalt. New construction's life span was assumed to be twenty years. Rehabilitation's life span was assumed to be ten years. CAPM's life span was assumed to be five to seven years and pavement preservation's (maintenance) was assumed to be five years.

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 Contract Administration System, the results of the cost comparison analysis are shown in Table 2. The results are segregated by the four major pavement project categories: new construction, rehabilitation, CAPM, and pavement preservation (maintenance).

Table 2

2010 DATA ANALYSIS RESULTS
INITIAL COST COMPARISON BY PAVEMENT PROJECT TYPE PER LANE MILE FOR ASPHALT CONTAINING CRUMB RUBBER VERSUS CONVENTIONAL ASPHALT

	New Construction	**Rehabilitation**	**CAPM**	**Pavement Preservation (Maintenance)**
Asphalt Containing Crumb Rubber	NA	$561,363*	$241,747	$77,401
Conventional Asphalt	NA	$358,422	$276,417	$106,447

*Only two pavement rehabilitation projects used asphalt containing crumb rubber; additional analysis is required.

For new construction projects, the amount of data for asphalt containing crumb rubber was insufficient to establish a cost comparison. For rehabilitation projects, the initial cost of asphalt containing crumb rubber was 56.6 percent more than conventional asphalt.[1] For the CAPM projects, the initial cost of asphalt containing crumb rubber was 12.5 percent less than conventional asphalt. For pavement preservation (maintenance) projects, the initial cost of asphalt containing crumb rubber was 27.3 percent less than conventional asphalt.

[1]Only two pavement rehabilitation projects used asphalt containing crumb rubber; additional analysis is required.

Findings and Recommendations

The Secretary of the Business, Transportation and Housing Agency finds that:

1. Caltrans used an average of 10.26 pounds of CRM per metric ton of total asphalt paving materials. This exceeds Public Resources Code section 42703(a)(2) requirement of 8.27 pounds of CRM per metric ton of total asphalt paving material used.

2. The initial cost of asphalt containing crumb rubber varies between 27.3 percent less for pavement preservation (maintenance) to 56.6 percent more for rehabilitation than the cost of conventional asphalt, depending on the project category.

3. Caltrans should continue to develop good engineering applications of CRM usage to meet project delivery needs on CAPM and preservation (maintenance) projects.

4. Caltrans' usage of asphalt containing crumb rubber is 30.6 percent of the total paving asphalt and is on track to meet 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.

5. Pursuant to Public Resources Code section 42703(c)(2), Caltrans shall continue to use, on an average, not less than 8.27 pounds of CRM per metric ton of the total amount of asphalt paving materials used on and after January 1, 2010.

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 Business, Transportation and Housing shall, on or before January 1, 2009, and on or before January 1 annually thereafter, 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 lifespan [*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.