Summary of NCAT Survey on RAP Management Practices and RAP Variability

Randy C. West
July, 2008

Introduction

From September 2007 until June 2008, NCAT posted an on-line survey to gather information from contractors on how they currently manage and process RAP materials and to gather quality control statistics on their RAP stockpiles. This paper summarizes the results of that survey. The survey was set up to gather specific information about individual plant operations. Responses were accumulated from eighty-one operations in 26 states.

General Plant Operations

The survey began with general questions about the plants. Three fourths of the asphalt plants from responders were continuous mix plants; one fourth were batch plants. This is probably a fair representation of the proportion of plants across the U.S. Of the continuous mix plants, the point of RAP entry was 38% in the outer drum (i.e. Astec Double Barrel), 32% behind the burner (inferred as counter-flow driers), 24% as mid-drum (inferred parallel-flow drier), and 6% in a second mixing drum. When running recycled mixes, it is generally believed that emission problems are more likely to occur with mid-drum entry in parallel-flow driers. For the batch plant responses, the point of entry for the RAP was 62% at the pugmill with the RAP weighed separately for each batch, 31% in the weigh hopper, and 7% at the bottom of the hot elevator. Sixty-one percent of all plants in the survey had only one RAP bin; 36% had two RAP bins, and 3% had three RAP bins.

When asked about the supply of RAP on hand, 51% responded that the supply was stable, 24% indicated a declining supply, and 25% indicated an increasing supply. A histogram of the quantity of RAP stockpiled at the plants is shown in Figure 1. It can be seen that the amount of stockpiled material is a highly skewed distribution, with a large number of responders having stockpiles less than 80,000 tons. The median quantity of total RAP stockpiled was 25,000 tons. A few responders had much larger RAP stockpiles.

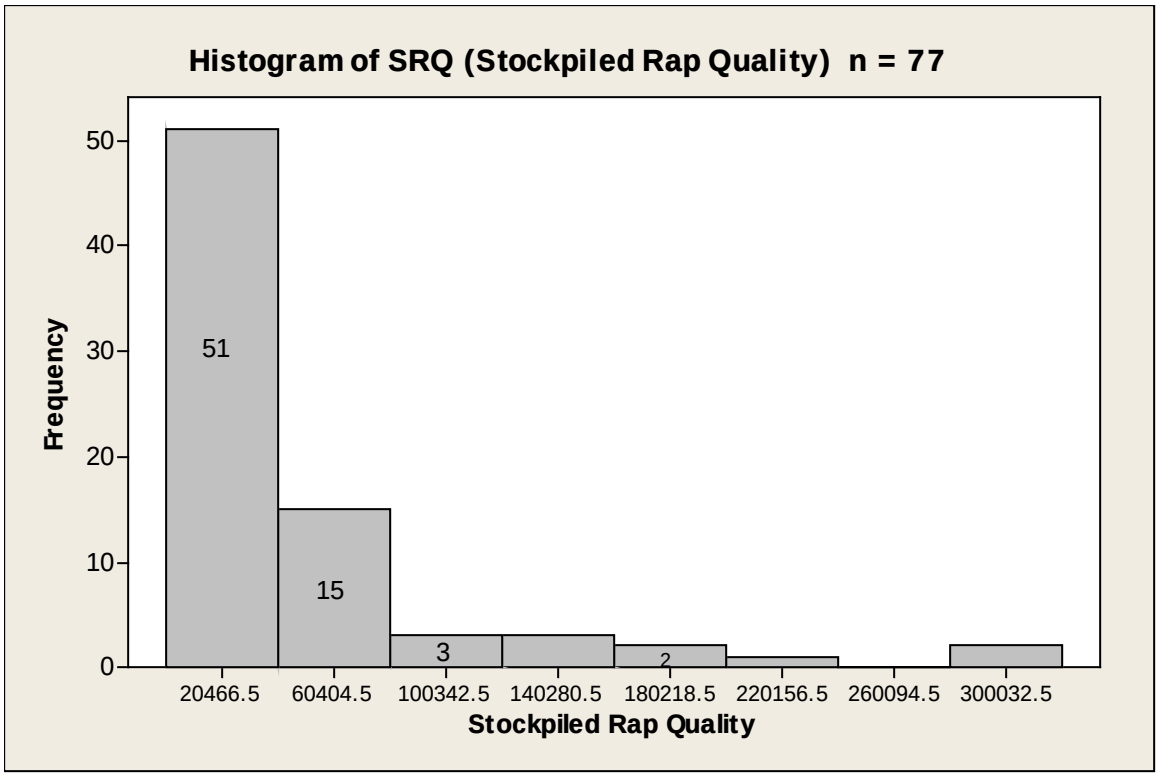

Figure 1. Histogram of the Quantity of Stockpiled RAP

RAP Management

The survey also gathered information on RAP management practices. Half of the responders indicated that they combined all RAP sources into a single pile for processing, whereas the other half maintained separate stockpiles for different sources of RAP. Reasons for this included (1) agency specifications allowed only DOT RAP in mixes for DOT projects, (2) to keep millings separate from other multiple source RAP material, and (3) to improve the consistency within the RAP stockpiles.

With regard to crushing and processing of RAP materials, the pie chart in Figure 2 shows how the respondents indicated RAP is crushed. The chart shows that the vast majority of the operations crush all of their RAP stockpiles to a single size. The survey indicates that only a small percentage of operations are fractionating RAP into different sizes at this point in time. Also, a small percentage of respondents do not process RAP stockpiles further before using the material in a new mix. This is only feasible when millings from different sources are stockpiled separately.

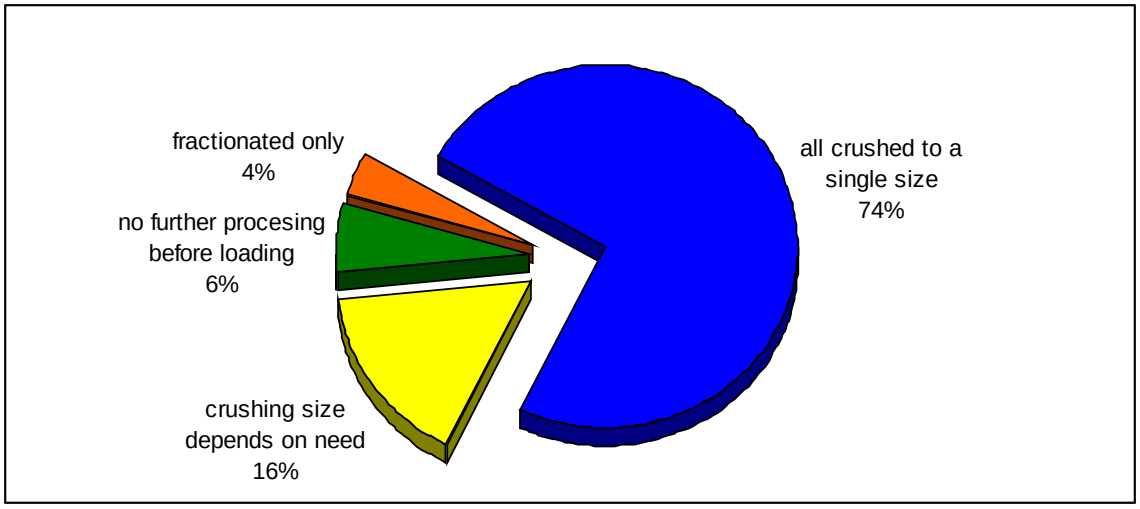

Figure 2. Summary of How RAP is Crushed

Table 1 shows the screen size (i.e. maximum particle size) to which responders indicated they crush their RAP stockpiles. A popular size is 1/2 inch.

Table 1. Screen Sizes Used in RAP Crushing

Screen Size	% of Responses
< 1/2 inch	6%
1/2 inch	52%
5/8 inch	16%
3/4 inch	11%
1 inch	5%
> 1 inch	11%

Figure 4 shows a summary of the responses regarding RAP stockpiling practices. Most of the responders indicated that they treat RAP stockpiles in the same way as other aggregate materials. This indicates that, in general, some improvements in RAP stockpiling can be made. Each of the bottom three practices can benefit the plant operation by reducing RAP moisture contents. This would allow for higher production rates, lower superheating temperatures for virgin aggregates, better transfer of heat from virgin materials to the RAP, and less fuel usage per ton of mix.

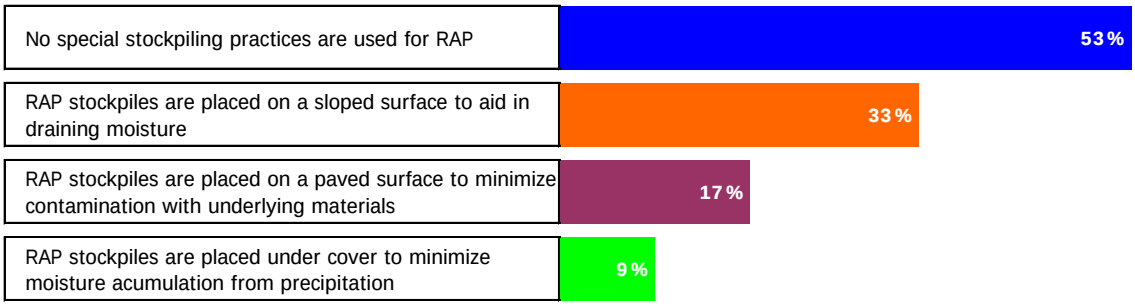

Figure 4. Summary of RAP Stockpiling Practices

Utilization of RAP

Figures 5 and 6 summarize how much RAP the responders typically use in surface and no-surface mixes, respectively. The average RAP content used in surface mixes from the survey was 16%, and for non-surface mixes, the average was 20%. Interestingly, 46% of the responses indicated that they typically used the same percentage on RAP in surface and non-surface mixes.

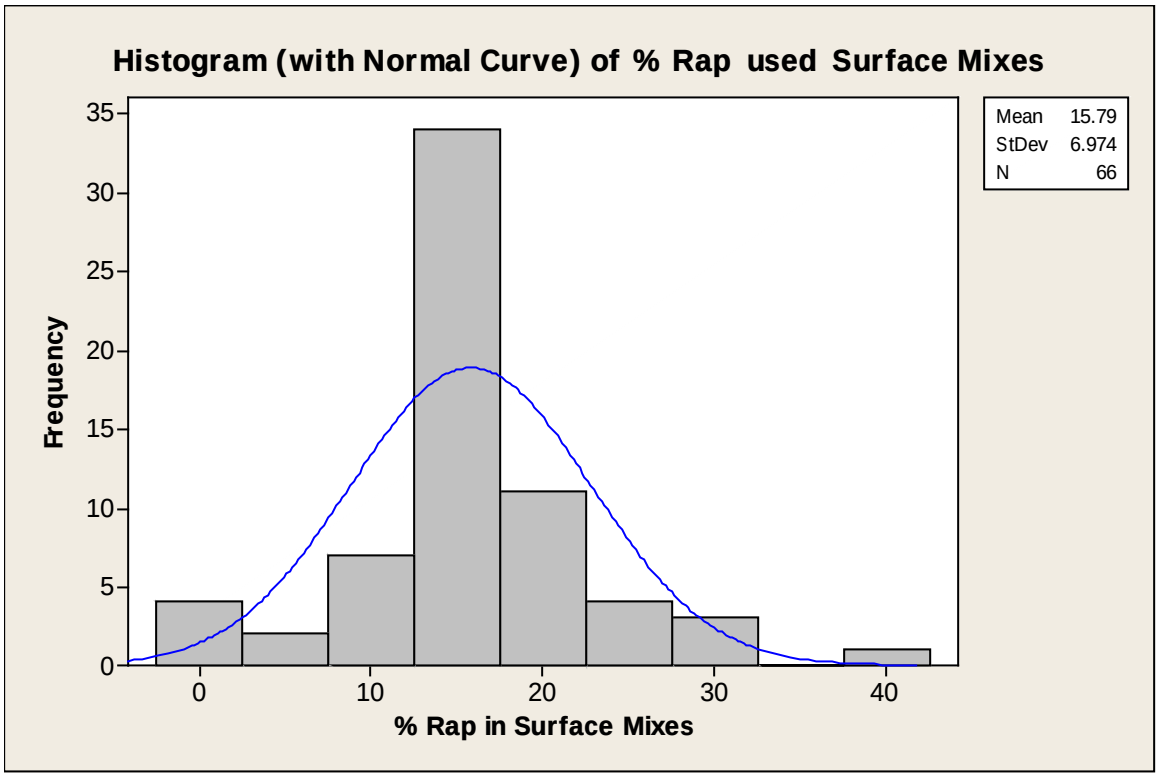

Figure 5. Histogram of Typical % RAP Used in Surface Mixes

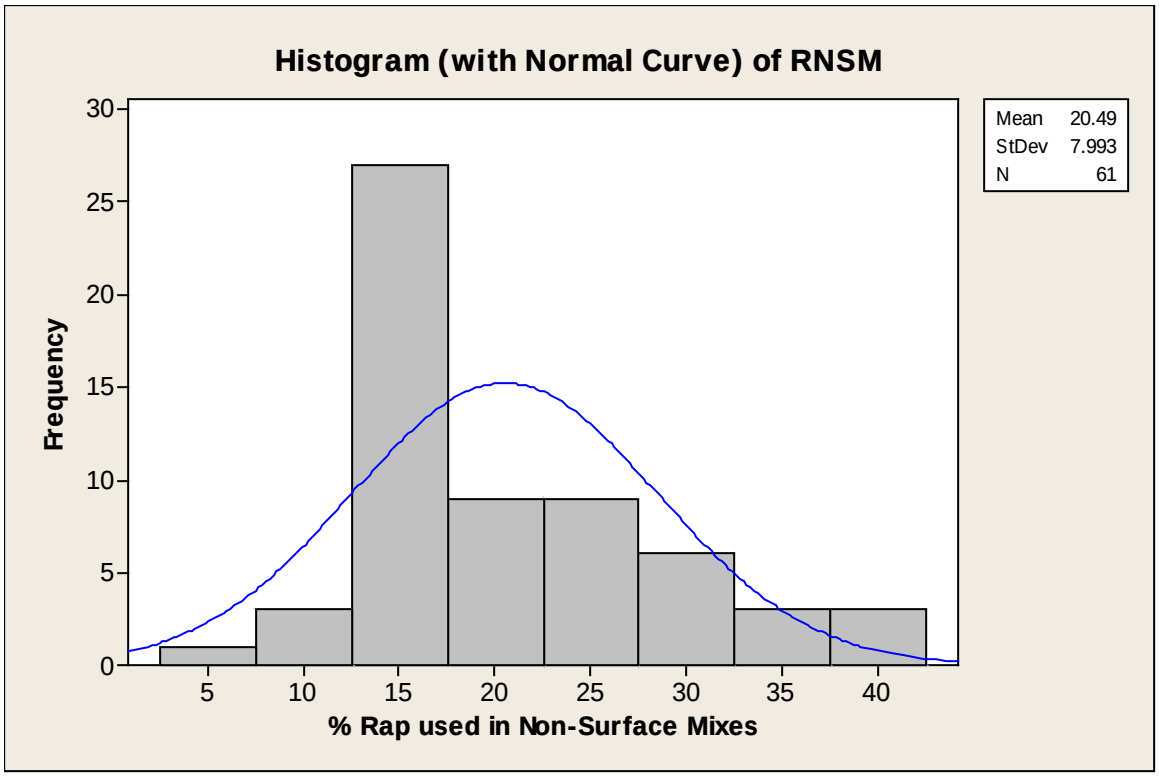

Figure 6. Histogram of %Typical RAP Used in Non-Surface Mixes

The survey did not ask how much of the typical annual production was government work versus commercial work, nor did it ask how much of the overall tonnage is surface mixes.

The survey also explored what were the limiting factors that prevented higher RAP contents in surface and non-surface mixes. Figures 7 and 8 summarize the responses to those questions. As can be seen in Figure 7, which summarizes responses on limitations for surface mixes, plant limitations were either not a factor or only sometimes a factor in using higher RAP contents. A similar response was received on whether RAP variability was a problem that limited RAP contents. In contrast, agency RAP specifications were either always or often a factor in increasing RAP contents. Meeting volumetric properties was considered not a factor or sometimes a limiting factor by the same number of responders, but also had several responders reporting that it was often a factor in trying to use higher RAP contents. The supply of RAP was not a limiting factor for most responders, and sometimes a factor for the second highest response. Responses were similar for non-surface mixes, shown in Figure 8. The noteworthy differences between the two were the lower number of responses that agency specifications were often a limiting factor in using higher RAP contents, which reflects the fact that agency specifications are most restrictive on RAP contents in surface mixes.

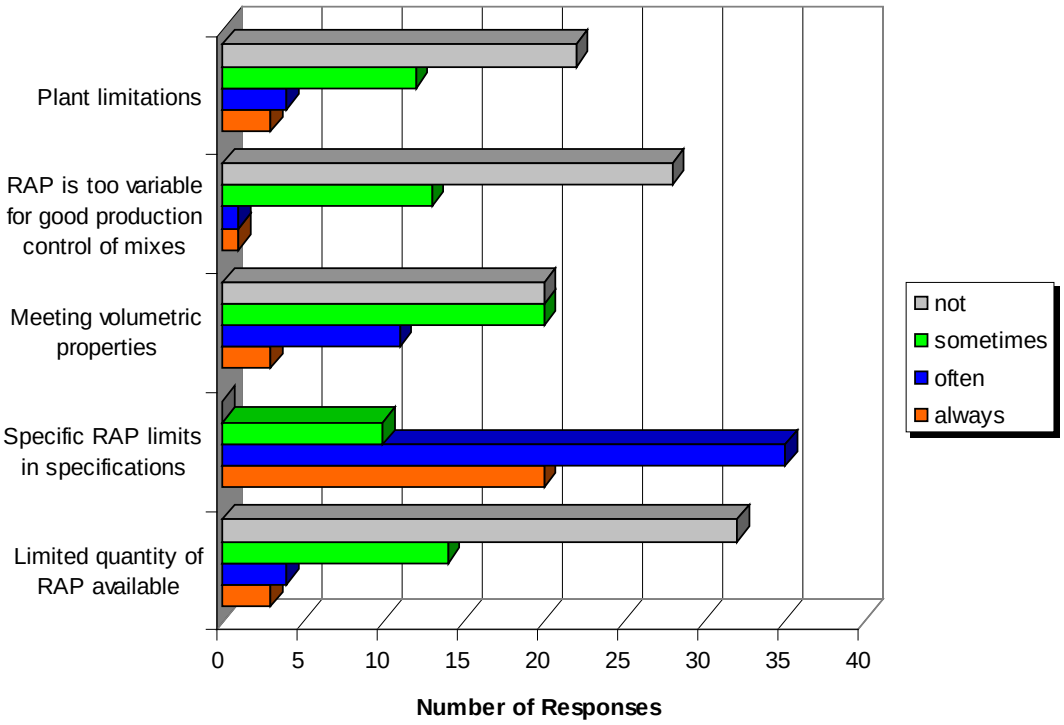

Figure 7. Responses Regarding Factors that Limit Higher RAP Contents in Surface Mixes.

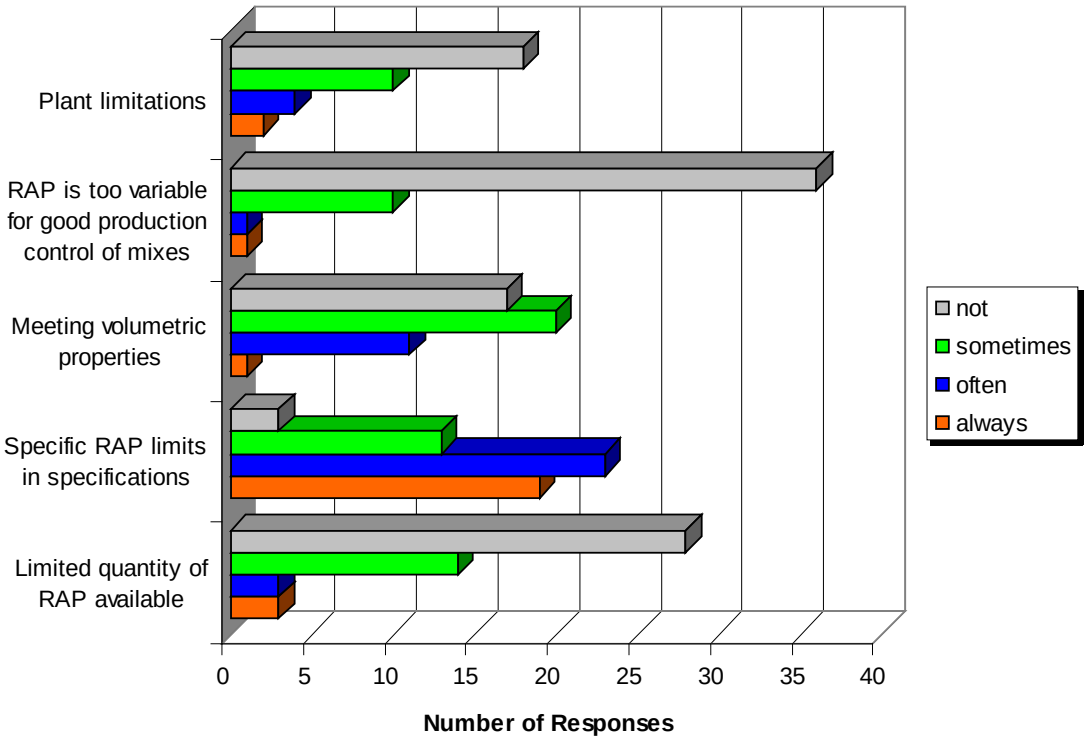

Figure 8. Responses Regarding Factors that Limit Higher RAP Contents in Non-Surface Mixes.

Quality Control

The survey also asked a few questions about quality control practices for RAP materials. One of the questions asked how frequent samples were obtained and tested for asphalt content and gradation. Responses are summarized in Table 2.

Table 2. Frequency of Testing RAP Asphalt Content & Gradation

Testing Frequency (one test per…)	% of Responses
500 tons or less	43%
Greater than 500 tons, less than or equal to 1000 tons	33%
Greater than 1000 tons, less than or equal to 2000 tons	20%
Greater than 2000 tons	4%

The test methods used for determining asphalt contents are summarized in Figure 9. Clearly a very high percentage of responders are using the ignition method. This method requires an aggregate correction factor, which is an unknown for RAP materials. Three respondents noted that they correlated the ignition test results with one of the solvent extraction procedures, which could be used to make adjustments for the unknown aggregate correction factors.

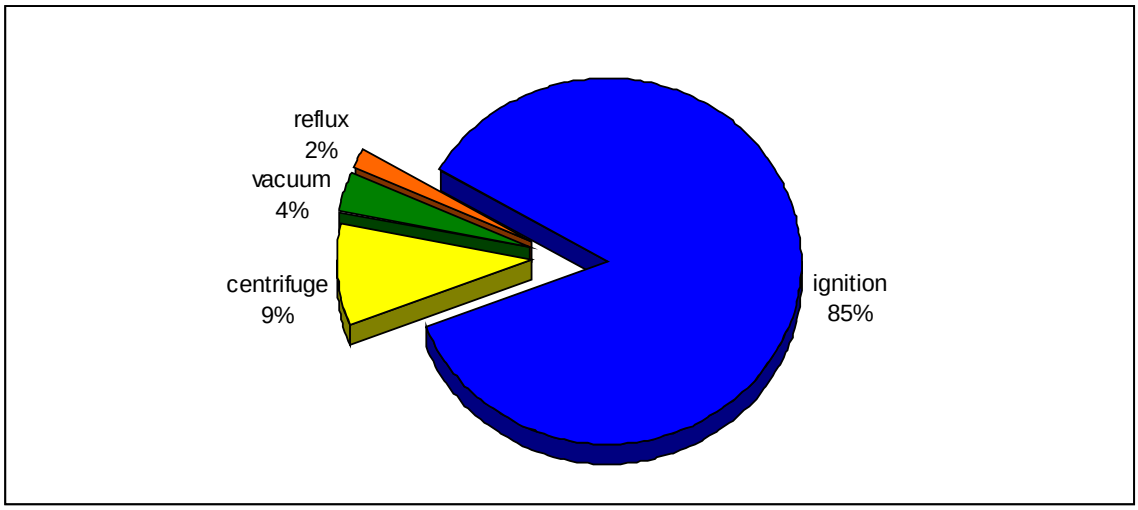

Figure 9. Methods Used to Determining Asphalt Content of RAP Stockpiles.

Responders were asked to input average and standard deviations for their RAP quality control data. These statistics were gathered on asphalt content and gradation on two sieves: the 75 micron sieve and the median sieve size. The median sieve size is the sieve that is closest to having 50% passing of the extracted RAP aggregate. For 72% of the stockpiles with reported data, the median sieve was the No. 8 (2.36 mm). Other reported

median sieves were the 3/8 inch (9.5 mm sieve) 3%, the No.4 (4.75 mm) sieve, 10%, the No. 16 (1.18 mm) sieve, 10%, and the No. 30 (0.60 mm) sieve, 4%.

Table 3. Summary of QC Statistics for RAP Stockpiles.

RAP property	n	Average (%)	Standard Deviation (%)	
			Average	Range
Asphalt Content	70	5.0	0.46	0.1 to 1.5
% Passing Median Sieve	58	51.7	4.32	0.78 to 9.0
% Passing 75 micron Sieve	58	7.37	1.09	0.3 to 3.0

Summary

Based on the responses of this detailed on-line survey which received responses from plant operations across the U.S., some general observations can be made

Most contractors currently follow simple practices of managing RAP materials. Half of the plants combine RAP materials from different sources into a single pile and then process it into a usable RAP material by crushing and/or screening. The other half of responders keep separate stockpiles for RAP from different sources. Many that do this, do so because the state specifications require it.

Regardless of whether the contractors keep RAP from different sources separated or combine them, the vast majority crush all RAP to pass a single size screen. The most common screen size is 1/2 inch. The majority of the contractors follow the same RAP stockpile management practices as with other aggregates. Relatively few take additional steps to minimize moisture content in RAP stockpiles.

Overall, the general perception of the responders is that the main limitation to increasing RAP contents is agency specifications. Other factors that sometime limit higher RAP contents were meeting volumetric requirements, plant limitations, and supply of suitable RAP. The responders also tend to consistently believe that RAP variability is not a limitation on increasing RAP contents in asphalt mixes.

Many contractors sample RAP stockpiles for quality control at frequencies of one test per 500 tons or less. About three quarters of responders used sampling frequencies of one test per 1000 tons or less.