pavement work tips

Asphalt Statistical Process Control

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BACKGROUND

In 1997, AAPA published a guide to asphalt plant process control. The purpose of the guide is to provide an introduction to the use of statistically based process control charts for control of asphalt production.

Control charts can provide:

- the producer with tools to analyse and improve the consistency and quality of the asphalt production
- the purchaser with increased assurance of quality.

The underlying premise is that quality is improved, not by inspection and testing, but by determining causes. The application of suitable process control procedures and effective use of statistically based measures of quality should also allow a reduction in the amount and type of traditional tests used to audit the quality of outputs.

INTRODUCTION TO CONTROL CHARTS

Control charts come in a variety of types but have a number of common features.

The types of charts referred to here can only be used when there is measurable data that is recorded in a time sequence. Data points are plotted on a chart that normally shows, as a minimum, the process average and upper and lower control limits. Such charts allow analysis of system changes over time.

Charts are used to minimise making two kinds of mistake:

- acting as though something out of the ordinary happened when nothing did (overcontrolling); and
- failing to act when something out of the ordinary did happen (undercontrolling).

Variations due to error or process change, detected by statistical methods, are termed assignable causes.

Control limits or action limits are upper and lower boundaries established by statistical analysis of the process. They are used to identify assignable causes as an outcome of production going outside the control limits.

Key Summary

This issue of 'pavement work tips' provides a guide to the application of statistical process control charts to the manufacture of asphalt

It is important to understand the distinction that control limits are not the same as specification limits although specification limits and target values can also be shown on the chart for comparison with specification compliance.

A capable process is generally one where the control limits lie within the specification limits. Where the control limits are outside one or more of the specification limits there is greater risk of falsely reacting to chance or random causes. Corrective action, when there is no clear evidence of a process problem, is likely to increase, rather than decrease, process variability.

Further data on a chart can include warning limits established within the upper and lower control limits to warn of possible problems and need for corrective action.

SELECTING CONTROL CHARTS

There are four main types of control chart applicable to asphalt work. The following descriptions are somewhat abbreviated and more detailed information can be obtained from the references.

Individual /Moving Range

This is one of the simplest of all control charts. It plots results of individual samples

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and a moving range that is the simple difference between two consecutive results.

Moving Average /Moving Range

This is a variation of the individual moving range chart and is used to plot the results of single samples as a rolling average of a number (e.g. 5) of consecutive results and the range of that group of results. By averaging the data, it reduces the risk of reacting to false out of control conditions when the process has not changed.

This type of chart is particularly applicable to monitoring routine production where data is obtained from single samples.

Average/Range

This chart plots the average of groups of results and the range of results in those groups. As it uses more data, it is considered a more powerful tool for analysing whether a process is stable and predictable than the above chart types. The AAPA Guide provides an example of this type of analysis in establishing control charts for asphalt production.

Average/Standard Deviation

This is a variation of the average/range chart. It uses the standard deviation rather than range to provide a better guide to process variability. It requires more calculation but can be applicable, for example, to the analysis of compaction testing where results are obtained from groups of samples and the standard deviation of the sample group is generally calculated and recorded.

USING AND INTERPRETING CONTROL CHARTS

As well as the recording of test results undertaken for assurance inspection purposes, control charts can be used for monitoring a number of processes, particularly those upstream of the assurance inspection process. Examples of applications other than assurance inspection include:

- Grading of incoming aggregates
- Aggregate and filler batch weights
- Binder batch weight
- Temperature of mixed asphalt.

Charts based on assurance inspection test results of manufacture can include:

- Grading (e.g. one sieve below nominal size, 2.36 mm and 0.075 mm sieves)
- Binder content
- Maximum density.

Setting Control Limits

Control limits are commonly set at $\pm$ 3 times the standard deviation (σ) for single samples or $3\sigma/\sqrt{n}$ where n is the number of samples in a group.

Warning limits are commonly set at $\frac{2}{3}$ the control limits.

Decision Rules

Control charts require decision rules. Following are typical examples of decision rules for action indicated by assignable causes.

Determine and correct assignable cause if:

- One point lies outside control limits
- Two out of three points lie outside warning limits.

Investigate for possible assignable cause and need for corrective action if:

- Nine points in a row are on one side of the central line
- Six points in a row are steadily increasing or decreasing
- Two out of three points lie outside the warning line.

CONCLUSION

Most of the data required for process control charts is already available in production facilities. Some effort is required to set up, maintain, and interpret systems to improve both efficiency and quality of asphalt production.

REFERENCES

AAPA (1997) Implementation Guide IG-3, Asphalt Plant Process Control Guide

AS 3942 Quality Control – Variables charts – Guide.

For more information on any of the construction practices discussed in "pavement work tips", please contact either your local AUSTROADS Pavement Reference Group representative or AAPA — tel (03) 9853 3595; fax (03) 9853 3484; e-mail: info@aapa.asn.au

A complete list of "pavement work tips" issues is available on AAPA's web site: www.aapa.asn.au

Issues may be downloaded using Adobe Acrobat Reader. Copies may also be obtained from AAPA.

This edition was prepared by John Rebbechi in consultation with members of the National Asphalt Research Coordination Group (NARC).