

# **KB&G Introduction of Cusum for concrete QC**

## Single, Multigrade, Multivariable Cusum

**CUSUM (or cumulative sum control chart) is a sequential analysis statistical technique developed in the 1950s and widely used in the concrete industry.**

**The most common application of control charts is as a means of continuously assessing compressive strength results in order to:**

- check whether target strengths are being achieved;
- measure the variations from target (all products vary);
- identify magnitude of any variation;

### **For a single concrete type, determine your target strength**

**Principle of the cusum system** The essential principle is that differences between results and their target values are calculated and added cumulatively to form a cumulative sum (cusum). When this cusum is plotted graphically against the sequence of results, a visual presentation of the trend relative to the target level is produced.

For a single concrete type, determine your target strength

### Margin and target mean strength

$$f_m = f_c + k s$$

where

$f_m$  = the target mean strength

$f_c$  = the specified characteristic strength

$ks$  = the margin, which is the product of:

$s$  = the standard deviation,

$k$  = a constant

The constant  $k$  is derived from the mathematics of the normal distribution and increases as the proportion of defectives is decreased, thus:

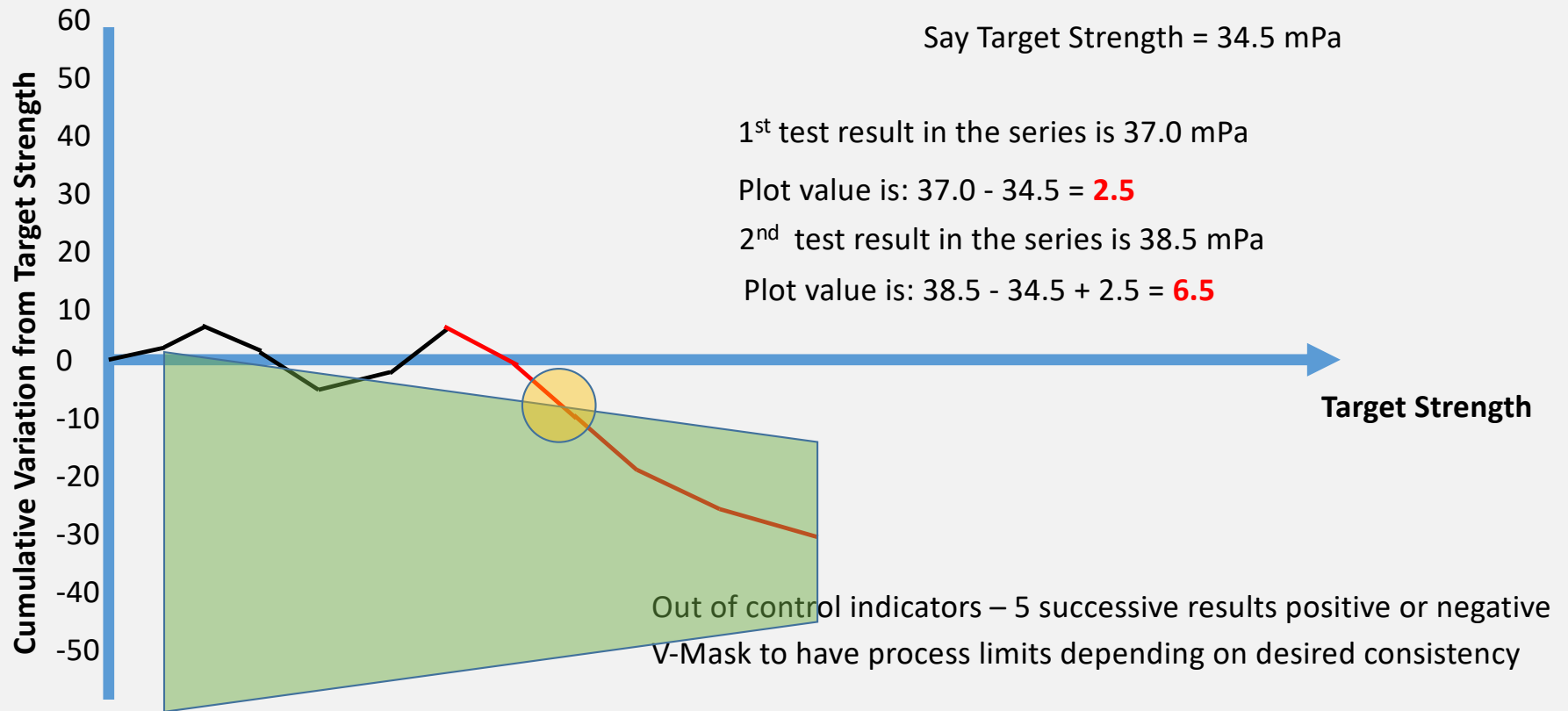
**$k$  for 10% defectives = 1.28**

**$k$  for 5% defectives = 1.64**

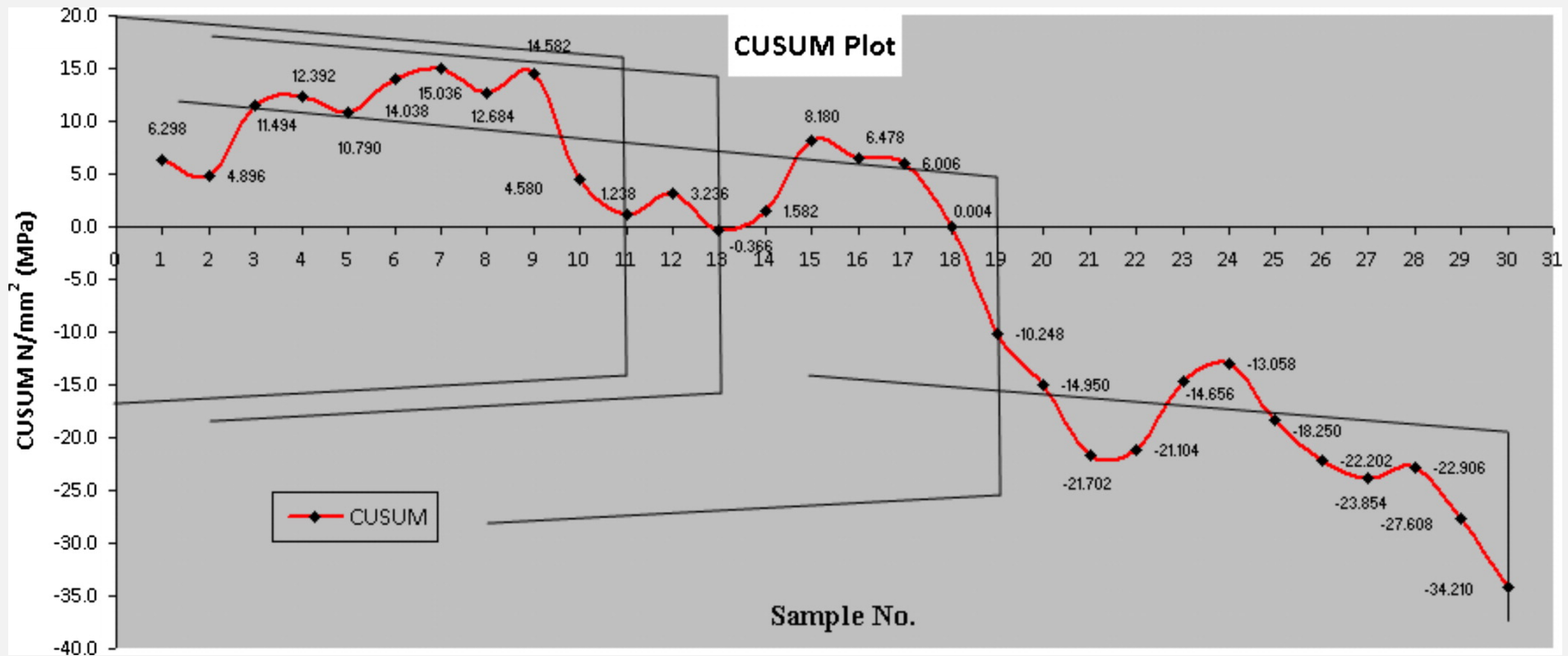
**$k$  for 2.5% defectives = 1.96**

**$k$  for 1% defectives = 2.33**

## Setting up your data to perform a Cusum analysis



**Our tools help improve profitability & customer experience**



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**Multigrade CUSUM** – incorporating different concrete types into a single analysis

**Multi variable** – based on the same time frame, including variable such as plant efficiency, constituent material quality, labour, weather – anything measurable that a target can be defined

**Optimising compressive strengths** and therefore binder quantity and type

Big driver for CUSUM is **consistency**, as per any statistical method, the lower the standard deviation, the lower the target – making the multi-variable CUSUM especially powerful for concrete

The amount of genuine QC that is done in aggregates – **80% of the volume of concrete**

Over 75% of the world concrete is batched with **3 or fewer aggregate bins/silos**

Keep it simple, the industry is not Labcrete, **methodologies need to be robust and simple**

