STUDY ON THE CONCRETE QUALITY ANALYSIS FOR WATER RETAINING STRUCTURES IN MONARAGALA

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Abstract - The concrete used for the structures for the storage of liquids where the exposure conditions for concrete are within the specified limits. Such structures include those retaining water or sewage, public swimming pools, etc. This concrete generally called as the concrete for water retaining structures. In order to construct durable and high quality concrete components, the transportation, placing and compacting of fresh concrete should be carried out with care, make sure that all the aspects regarding that can affect the quality of the concrete . In this study of "Study on the concrete quality analysis for water retaining structures in Monaragala", the Kumbukkana water treatment plant under the Monaragala- Buttala integrated water supply project was selected. It is recently completed water supply project in Monaragala district. The scope of this study to analysis the quality of concrete for water retaining structures used in the Kumbukkana water treatment plant by used the statistical quality controlled charts and statistical tools by analysed tested sample results of fresh and hardened concrete. The concrete samples were prepared at the site and laboratory test were carried out at project laboratory. Statistically analysed the test results to quality analysis for concrete for water retaining structures by used statistical package Minitab 16 version. This study shows that based on the laboratory results and statistical analysis, According to National Water Supply and Drainage Boards "Specification for the Civil Engineering works" , mix design and statistical quality control technique Xbar Chart results, it can be conclude that the concrete for water retaining structure which tested samples were good in quality.

Keywords - Quality of concrete, Water retaining structures, quality controlled charts, Xbar Chart, mix design.

I. INTRODUCTION

The concrete used for the structures for the storage of liquids where the exposure conditions for concrete are within the specified limits. Such structures include those retaining water or sewage, public swimming pools, etc. This concrete generally called as the concrete for water retaining structures. In order to construct durable and high-quality concrete components, the transportation, placing and compacting of fresh concrete should be carried out with care, make sure that all the aspects regarding that can affect the quality of the concrete. The scope of this study to analysis the quality of concrete for water retaining structures used in the Kumbukkana water treatment plant by used the statistical quality-controlled charts.

1. Concrete for Water Retaining Structure

There are several specified standards used presently but in Sri Lanka the BS 8007 the standard specification for water retaining structures is the most popular standard. Concrete for all water retaining structures shall be grade 35A, having a characteristic strength of 35 N/mm2. In general, the cement to be used should be ordinary Portland cement; however, sulphate resisting Portland cement shall be used for foundations at locations where soluble sulphate content of ground water is excessive if confirmed by soil investigations. The water cement ratio (kg of free water/ kg of cement) shall not exceed 0.50 for the Grade C35A [1].

2. Quality Control Chart for Concrete Quality.

A quality control chart is a graph that shows whether a sample of data falls within the common or normal range of variation. A quality control chart has upper and lower control limits that separate common from assignable causes of variation. The common range of variation is defined by the use of quality control chart limits. [4]. A process is out of control when a plot of data reveals that one or more samples fall outside the control limits. The x axis represents samples (#1, #2, #3, etc.) taken from the process over time. The y axis represents the quality characteristic that is being monitored such as concrete compressive strength, concrete slump, concrete density, etc. The centre line (CL) of the quality control chart is the mean, or average, of the quality characteristic that is being measured. In Fig 1 the mean is 16 ounces. The upper control limit (UCL) is the maximum acceptable variation from the mean for a particular process that is in a state of control. Similarly, the lower control limit (LCL) is the minimum acceptable variation from the mean for a particular process that is in a state of control. [4].

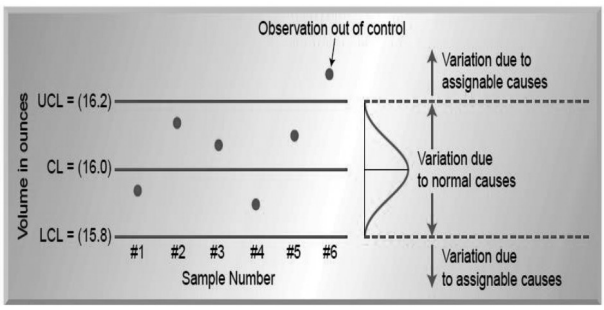

Fig 1: The Xbar Chart (Source : [4])

The quality of concrete depends on the constituent materials, their proportions, mixing, transporting, placing, compaction and curing of concrete. The concrete with proper mix

proportion has the needed workability and develops the targeted compressive strength. In order to obtain an enhanced control of the high scatter and variability of achieved construction quality concrete structures, it is necessary to have some performance based durability requirements which can be verified and controlled for quality assurance during concrete structures construction. Even before the concrete is placed in the formwork, the quality of the concrete may show a high scatter and variability [2]. The quality control charts have been used by most manufacturing industries for many years as an aid in reducing variability and increasing efficiency in production. Methods are well established for the setting up of such charts and are outlined in convenient form in the ASTM Manual on quality control of materials.

II. HIGHLIGHTS

- Analysed the quality of concrete used for water retaining structure.
- The Xbar chart was generated for concrete quality parameters such as unit weight, strength, strength gain and slump separately for each parameters.
- All the samples of all the Xbar chart were observed that statistically within control limits.
- As per the mix design the mean unit weight of 28 days concrete is to be 2440.2 Kg/m3 but here achieved as 2420.6 Kg/m3, it is just only 0.8% of reductions from targeted unit weight .So that we can say that proper compaction of concrete have done.

III. METHODOLOGY

In this study, the Kumbukkana water treatment plant under the Monaragala- Buttala integrated water supply project was selected. For the analysis the tested samples results of fresh and hardened concrete of Kumbukkana water treatment plant was used. The concrete samples and cube prepared at the respective site, test done and results were recorded. Statistically analysed the tested results to the quality analysis for concrete for water retaining structures by used statistical quality control chart. Here the quality of concrete analysed by used X bar control chart by used statistical package Minitab 16 version and results were compared with NWSDB's Specification for the civil engineering works [3] and mix designs of concrete.

To construct a mean chart manually, first need to construct the center line of the chart. To do this, the multiple samples was taken and estimated the mean. Each sample has its own mean. The center line of the chart is then computed as the mean of all k sample means, where k is the number of samples

$$\bar{\mathbf{x}} = \frac{x1+x2+....+xk}{k}$$

To construct the upper and lower control limits of the chart, the following formulas can be used:

Upper control limit (UCL) = $\overline{X} + Z\,\sigma$ (2)

Lower control limit (LCL) = $\overline{X} - Z\,\sigma$ (3)

where

$\overline{X}$ - The average of the sample means

Z - Standard normal variable

σ - Standard deviation of the distribution of sample means

IV. RESULTS AND ANALYSIS

1. The Xbar Chart of unit weight of 28 days concrete in Kg/m3

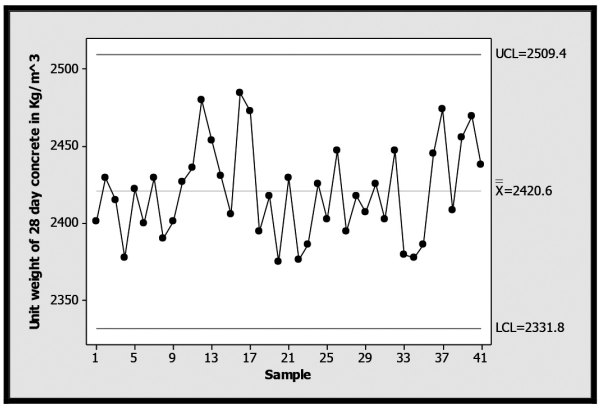

Fig 2: The Xbar Chart of unit weight of 28 day concrete in Kg/m3

The mean unit weight of 28 days concrete is 2420.6Kg/m3 , the upper control limit (UCL) is 2509.4 Kg/m3 and the lower control limit (LCL) is 2331.8Kg/m3. There are random variation in the unit weight but all the samples were observed within the control limits. As per the mix design the mean unit weight of 28 days concrete is to be 2440.2 Kg/m3 but it was achieved as 2420.6 Kg/m3 with slight deviations.

2. The Xbar Chart of 7 days Concrete Compressive Strength in N/mm2

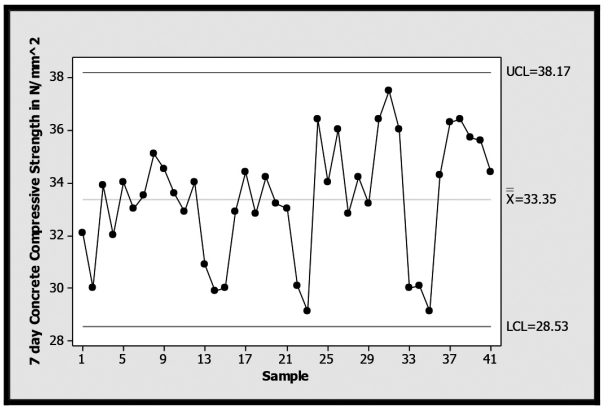

Fig 3: The Xbar Chart of 7 day Concrete Compressive Strength in N/mm2

The mean 7 day concrete compressive strength is 33.35 N/mm2, the UCL is 38.17 N/mm2, and LCL is 28.53 N/mm2. There are random variation in the 7 day concrete compressive strength observed but all the samples were observed within the control limits.

3. The Xbar Chart of 28 days Concrete Compressive Strength in N/mm2

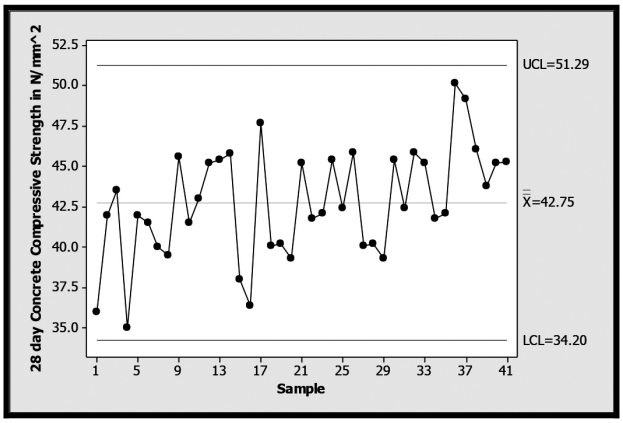

Fig 4: The Xbar Chart of 28 day Concrete Compressive Strength in N/mm2

The mean 28 days concrete compressive strength is 42.75 N/mm2, the UCL is 51.29 N/mm2, and LCL is 34.20 N/mm2. There are random variation in the 28 days concrete compressive strength observed but all the samples were observed within the control limits.

4. The Xbar Chart of Strength Gain of Concrete in N/mm2

The mean strength gain of concrete from Seven day to Twenty Eight days is 9.40 N/mm2, UCL is located at 17.89 N/mm2, and LCL is 0.9 N/mm2. There are random variation strength gain of concrete from Seven day to Twenty Eight day observed but all the samples were observed within the control limits.

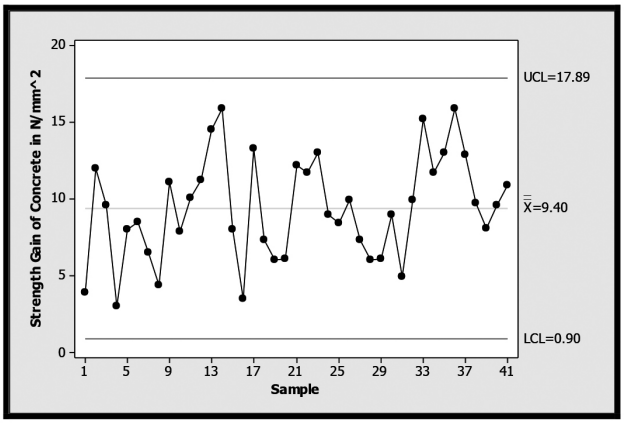

Fig 5: The Xbar Chart of Strength Gain of Concrete in N/mm2

5. The Xbar Chart for Slump of concrete at site in mm

The mean Slump of concrete at site is 176.2 mm, UCL is located at 223.1 mm and LCL is located at 129.3 mm. There are random variation in the Slump of concrete at site observed but the all sample were within the control limits.

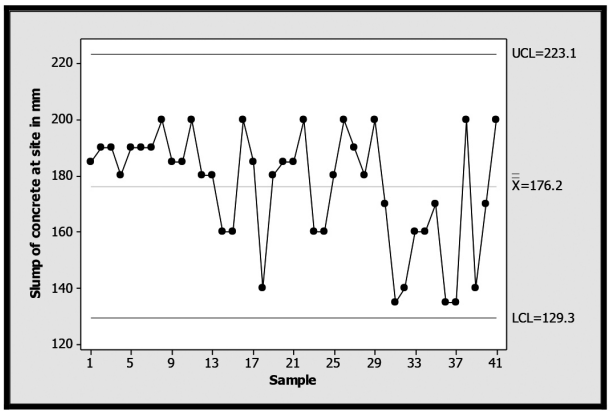

Figure 6: The Xbar Chart for Slump of concrete at site in mm

V. CONCLUSIONN

This study shows that based on the laboratory results and statistical analysis, According to National Water Supply and Drainage Boards "Specification for the Civil Engineering works" , mix design and statistical quality control technique Xbar Chart results, it can be conclude that the concrete for water retaining structure which were tested were good in quality. It is recommended to use the Xbar Chart at site level to check the quality of concrete instead of taking decisions only based on quality parameters of individual sample.

References

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