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ANALYSIS OF SLUDGE FORMED IN R.M.C PLANT

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ABSTRACT: *Ready-mixed concrete is used in the civil engineering and construction business, for example: bridge, free way, dam and buildings. In RMC plant, concrete is produced at plant and it is delivered to site. Initial setting time of concrete is 30 minutes. To prolong the setting time, plasticizers are used in RMC. Pumpability and Flowability are the major issues in RMC; hence slump is the major criteria with the strength. A transit mixer takes approximately 45min to 180 minutes to deliver concrete and return to the site depending on the distance of site from the plant and other conditions. Some concrete particles/ slurry stick to the blades of transit mixer, walls and floor of the transit mixer which is normally termed as sludge in technical terms. The scope is the analysis of data of daily production of ready mix concrete, sludge formed during the transportation of ready mix concrete form plant to site and back to the site, quantity of water used to wash the Production of Concrete and Sludge Formation in the month of August. Daily production of concrete was recorded for the Plant for one month. The Concrete produced was of different grade but for simplicity we have considered the total production per day ignoring the grade of concrete. Date wise production of sludge was also recorded for three months.*
KEYWORDS: *Ready Mix Concrete, Sludge*

INTRODUCTION

Ready mix concrete plant operations are large consumers of water. Sludge water is the waste wash water from concrete mixing plants and agitator trucks. Approximately 200 liters of water are used to produce one cubic meter of concrete from a central batch plant. The figure from a truck mix plant is higher, at 300 liters. In addition approximately 500 - 1500 liters of water are used to wash down the plant and yard at the end of each production day, plus 100 liters to wash out each mixer - the central mixer and every truck used that day. With the growing demand for ready mixed concrete, the disposal of sludge water is becoming an increasing environmental concern. Each working day approximately 700–1300 liters of wash water are required for a single concrete Truck. Due to the large amount of suspended matter and high alkalinity untreated sludge water cannot be legally discharged into urban sewers. In general, the procedure for sludge water disposal utilizes two series-connected sedimentation basins. The first basin receives leftover concrete and wash water from the concrete plant and trucks. The overflow sludge water containing suspended fine particles is transferred to the second basin. After a settling period, the water from both basins is flushed to the municipal drains. Leftover concrete and sediment from the first basin and muddy sludge from the second basin are placed in a landfill.

The problem of Sludge is severe with:

- *The older transit mixers*
- *More Detention time at site*
- *Failure of transit Mixer*
- *Climatic problem*
- *Severe traffic jam*
- *Any other unforeseen situation*

As the time increases setting are at a faster rate, slump reduces drastically and flowability reduces at a faster rate. It becomes more difficult to remove the settled/sticked sludge formed in the transit mixer. Approximately 120-200 liters of water is used for cleaning of each transit mixture to remove the sludge from the blades of transit mixtures, wall and floor of the transit mixer:

- *To minimize the sludge formed during transportation of Ready Mix Concrete from Plant to site and Back.*
- *To minimize the water usage used during removal of sludge formed in transit mixer and for cleaning of transit mixer.*
- *To find out alternative solution for reutilization of sludge formed during transportation of Ready Mix Concrete and also from the fines coming out of Sediment tanks.*

SCOPE

The scope is the analysis of data of daily production of ready mix concrete, sludge formed during the transportation of ready mix concrete form plant to site and back to the site, quantity of water used to wash the Production of Concrete and Sludge Formation in the month of August.

Daily production of concrete was recorded for the Plant for one month. The Concrete produced was of different grade but for simplicity we have considered the total production per day ignoring the grade of concrete. Date wise production of sludge was also recorded for three months.

Table 1: Production of Concrete and Sludge Formation in the month of August

Date	Production in Cu.m in Aug	Sludge in Cu.m in Aug	Production in Cu.m in sep	Sludge in Cu.m in Sep	Production in Cu.m in Oct	Sludge in Cu.m in Oct
01	95	1.6	202	2.47	100	1.61
02	112	1.61	48	1.39	300	2.95
03	78	1.55	210	2.49	360	3.17
04	230	2.31	260	2.95	310	2.66
05	118	1.64	320	3.45	80	1.56
06	230	2.78	270	3	220	2.25
07	215	6	215	2.55	200	2.19
08	90	1.58	190	2.25	240	2.34
09	110	4.5	110	1.63	210	2.21
10	175	1.71	310	3.21	120	1.63
11	58	1.44	170	2.1	250	2.4
12	64	1.46	180	2.06	70	1.53
13	220	2.17	190	2.31	180	1.73
14	180	1.73	120	1.69	190	2.14
15	125	1.65	150	1.85	220	2.27
16	230	2.79	210	2.53	270	2.39
17	117	1.63	215	2.74	300	2.89
18	110	1.62	110	1.59	350	3.15
19	220	2.24	135	1.73	160	1.62
20	68	1.48	155	1.91	320	3
21	72	1.51	200	2.4	300	2.93
22	52	1.43	215	2.64	270	2.38
23	50	1.42	170	2.15	220	2.28
24	71	1.5	112	1.65	210	2.22
25	60	1.47	146	1.82	270	2.42
26	120	4.55	185	2.21	150	1.67
27	90	1.58	315	3.27	290	2.45
28	80	1.54	300	3.33	225	2.3
29	75	1.55	180	2.09	180	1.88
30	80	1.55	190	2.35	240	2.37
Total	6805	68.59	5783	81	6565	68.59

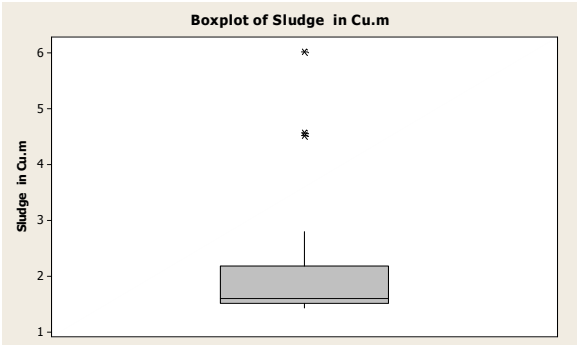

Figure 1: Boxplot of sludge in Cu.m for Aug

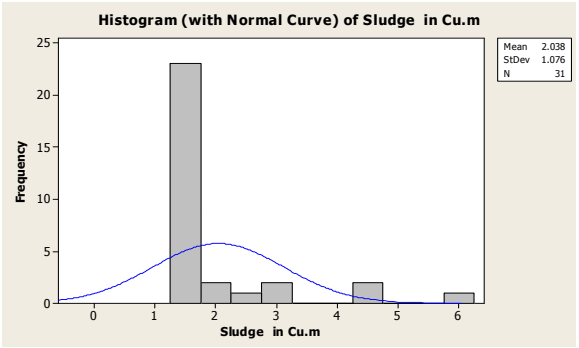

Figure 2: Histogram of Sludge in Cu.m for Aug

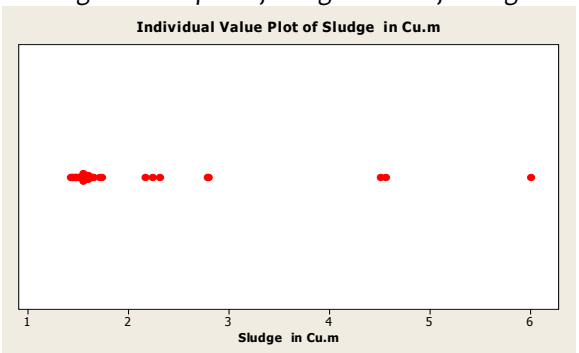

Figure 3: Individual Value Plot of Sludge in Cu.m for Aug

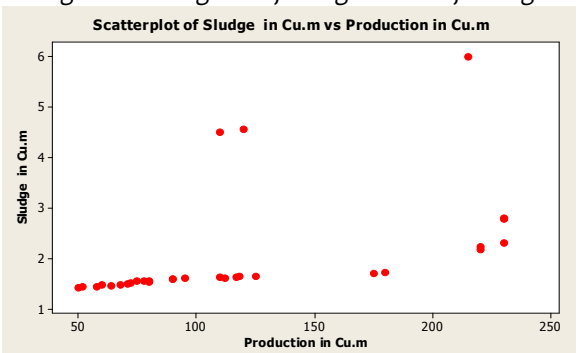

Figure 4: Scatter plot of Sludge in Cu.m Vs Production in cu.m for Aug

Table no 2: Basic Descriptive statistics of Sludge for the month of August

Variable	Mean	SE Mean	St. Dev	Variance	Coef Var	Min	Max	Range	Median	Q1	Q3
Sludge in Cu.m	2.038	0.193	1.076	1.159	52.81	1.42	6.0	4.58	1.6	1.51	2.17

Regression Analysis: Sludge in Cu.m versus Production in Cu.m for Month of August.

The Regression Equation is: Sludge in Cu.m = 1.01 + 0.00866 Production in Cu.m

Table 3: Regression Analysis

Predictor	Coef	SE Coef	T	P
Constant	1.0075	0.3842	2.62	0.014
Production in Cu.m	0.008661	0.002887	3.00	0.005

S = 0.956470 R-Sq = 23.7% R-Sq(adj) = 21.1%

Table 4: Analysis of Variance

Source	DF	SS	MS	F	P
Regression	1	8.2340	8.2340	9.00	0.005
Residual Error	29	26.5302	0.9148		
Total	30	34.7642			

Table 5: Unusual Observations

Obs	Production in Cu.m	Sludge in Cu.m	Fit	SE Fit	Residual	St Resid
7	215	6.000	2.870	0.326	3.130	3.48R
9	110	4.500	1.960	0.174	2.540	2.70R
26	120	4.500	2.047	0.172	2.503	2.66R

R denotes an observation with a large standardized residual.

Pearson correlation of Production in Cu.m and Sludge in Cu.m = 0.487

INTERPRETATION OF RESULTS

The p-value in the Analysis of Variance table (0.005) is less then 0.05 hence we reject the null hypothesis, indicating that the relationship between Sludge in Cu.m and Production in Cu.m is statistically very significant at an α-level of .05. This is also shown by the p-value for the estimated coefficient of Sludge in Cu.m, which is 0.005. However the R^2 value shows that Sludge in Cu.m explains 23.% of the variance in Production in Cu.m, indicating that the model does not fits the data extremely well.

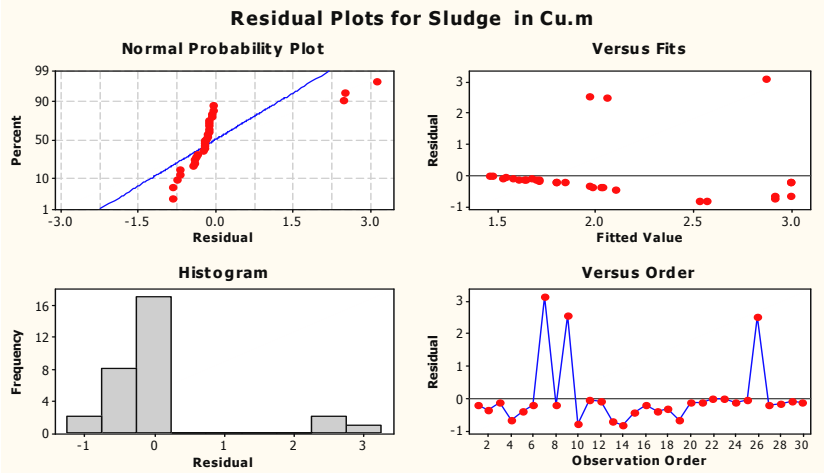

Figure 5: Residual plots for sludge in cu.m for Month of Aug.

There are three outliners observation 7, 9 and 26 where Residual is more than the standard Residual indicating some special cause of variation.

Thus from this result we understand that though there is correlation between the sludge produced and the Production of RMC other factors other then Production have to be considered for formation of sludge.

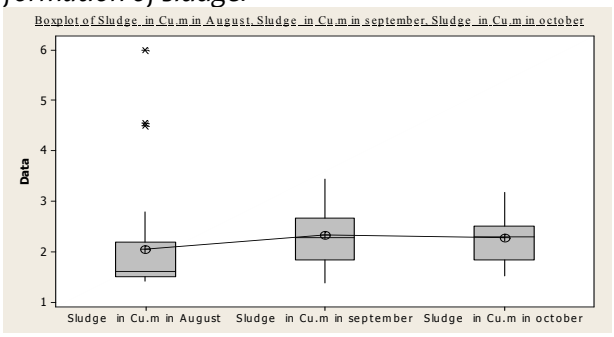

Figure 6: Box plot of Sludge for Aug, Sept, Oct

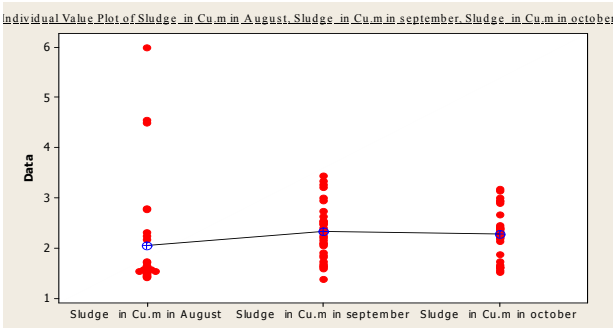

Figure 7: Indivual Value plot of sludge in cu.m

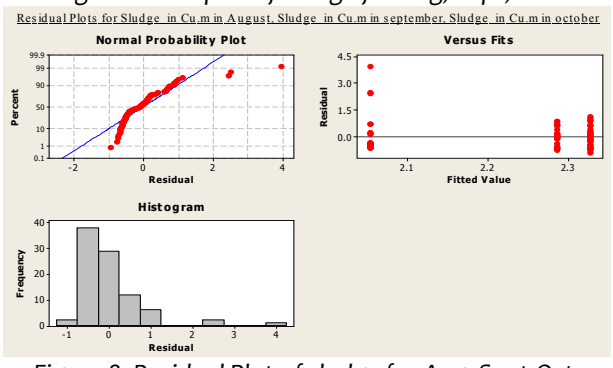

Figure 8: Residual Plot of sludge for Aug, Sept,Oct.

Table 6: One-way ANOVA: Sludge in Cu.m for August, September, October using Minitab

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Source  DF      SS      MS      F       P
Factor   2   1.312   0.656   1.13   0.328
Error   87  50.582   0.581
Total   89  51.894

S = 0.7625   R-Sq = 2.53%   R-Sq(adj) = 0.29%
Level                      N    Mean   StDev
Sludge  in Cu.m in Aug     30  2.0530  1.0918
Sludge  in Cu.m in sep     30  2.3270  0.5634
Sludge  in Cu.m in Oct     30  2.2863  0.4846

                           Individual 95% CIs For Mean Based on
                           Pooled StDev
Level                      ---------+---------+---------+---------+
Sludge  in Cu.m in Aug     (----------*----------)
Sludge  in Cu.m in sep               (----------*----------)
Sludge  inCu.m  in Oct          (----------*----------)
                           ---------+---------+---------+---------+
                                  2.00      2.25      2.50      2.75

Pooled StDev = 0.7625
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ANALYSIS OF VARIANCE (ANOVA) OF SLUDGE PRODUCTION FOR THE MONTH OF AUGUST, SEPTEMBER AND OCTOBER

Analysis Of Variance (ANOVA) helps determine whether the variations are due to variability between or within methods. The within-method variations are variations due to individual variation within treatment groups, whereas the between-method variations are due to differences between the methods. In other words, it helps assess the sources of variation that can be linked to the independent variables and determine how those variables interact and affect the predicted variable.

The ANOVA is based on the following assumptions:

- *The treatment data must be normally distributed.*
- *The variance must be the same for all treatments.*
- *All samples are randomly selected.*
- *All the samples are independent.*

Analysis of variance tests the null hypothesis that all the population means are equal at a significance level α:

The null hypothesis will be:

H_0 : μ_1(Sludge in Cu.m in Aug) = μ_2(Sludge in Cu.m in Sept) = μ_3(Sludge in Cu.m in Oct)

The Alternate hypothesis will be:

H_a : μ_1(Sludge in Cu.m in Aug) ≠ μ_2(Sludge in Cu.m in Sept) ≠ μ_3(Sludge in Cu.m in Oct)

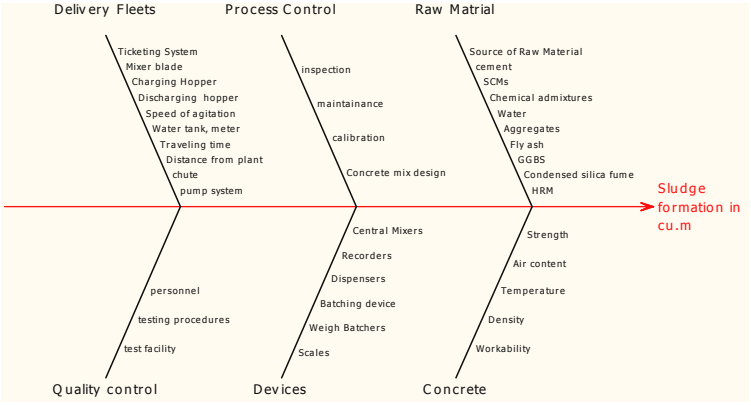

Figure 9 : Cause and Effect Diagram

INTERPRETATION OF RESULTS

From Minitab we find F stat= 1.33, from F-table the critical value of F for α = 0.05 with the degrees of freedom n_1=2 and n_2=87 is 3.1. Because 3.1 is greater than 1.33, we cannot reject the null hypothesis. We conclude that there is not a statistically significant difference between the means of formation of sludge in Cu.m in the month of August, September and October i.e there is no variation in the formation of sludge with respect to time.

CAUSE AND EFFECT DIAGRAM

A Cause and effect Diagram was created to find out the causes of the formation of Sludge after brainstorming with the Quality Manager and the Project. The following causes were found to be the reasons for the formation of sludge as shown in the diagram below. Each of the caused was investigated and scope of improvement was identified.

CONCLUSIONS

This study analysis the formation of sludge in RMC plant. From the study we try the find out the possible reasons for formation of Sludge. By using Regression analysis we try to find the correlation of formation of sludge and the production of Concrete. The regression analysis clearly shows that there is a correlation between the production of Concrete and formation of sludge.

By use of Analysis of variation we tried to find out if the formation of sludge was seasonal. The study clearly showed that the formation of sludge was not seasonal i.e. that there is not a statistically significant difference between the means of formation of sludge in Cu.m in the month of August, September and October i.e there is no variation in the formation of sludge with respect to time.

The cause and effect diagram helped us to identify the possible causes for formation of sludge and by studying each of the above process in depth we would be able to improvement in each of the processes and how the improvement in processes could reduce formation of sludge.

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