An Experimental Analysis on Beam Structural with Taguchi Orthogonal Array

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Abstract— Taguchi optimization method is a statistical technique to optimize the selected factors and will improvise the quality of compositions. The aim of this paper is to define effective optimization techniques to identify the effective orthogonal array combination using experiments in the beam structure. The Taguchi L9 array has experimented in this study with three different levels and four parameters. After the completion of the experiments, the results are compared with fully factorial methods. The output will be in the form of S/N ratio and graphs. The best-optimized combination is found for minimizing the number of experiments. The size of the beam structure is 1250mm*150mm*150mm.

Keywords— optimization, taguchi, beam deflection, S/N ratio, L9 OA.

I. INTRODUCTION

Taguchi and Konishi developed the method called Taguchi optimization method.[1] It was initially developed for agricultural field and goods manufacture and later its application was expanded for all other engineering fields like biomedical, mechanical .., etc. The key success of this optimization is based on careful selection of parameters on each level. The concrete cubes and beam sections are meticulously casted with appropriate mix design with curtain combinations of Taguchi orthogonal arrays. The test conclusion report was considered during the ages of 7^{th} ,14^{th} and 21th days. These results are indispensable for calculation for sound to noise ration and graphical representation was lustrated at table 8. The main objective of defending S/N ration is to find out the contribution of each parameters (W/C ratio , Fly ash , M-Sand , Sisal Fibre) during various test results.

II. MATERIAL PROPERTIES

Cement

Cement is considered as one the exceptional binding materials in the construction industry. In the contemporary world plethora of other binding materials were introduced to rival with cement paste. The raw cement was conventional one but fly ash is most widely utilized. In this project the cement material was partially replaced with Fly ash. The cost of cement is exorbitant as compared with other binding materials like Fly ash.

Fly ash

The Fly ash is considered as one the most indispensable by-products from cement manufacture. The fly ash considered as a pozzolana material which is almost taken in the consideration of binding material. The hydration process is also imperative chemical reaction. There are various types of ashes available in the market and F-type is selected based on properties.The percentage of replacement was carefully considered using Taguchi orthogonal array.

Fine Aggregates

These aggregates are minute materials in construction. These materials are selected only based on selective size with high quality. In this project fine aggregate is partially filled with M-sand with proper proposing. The sieve analysis testing method had been used for segregation of the fine aggregates with respect to size.

Coarse Aggregates

These aggregates are utilized in most percentage in the concrete mixer. The coarse materials are specifically selected with 20mm in size and no extra admixtures are partially with coarse aggregates. The coarse aggregates plays a vital role in the concrete strength.

Fibers

The sisal fiber is considered as one of the conventional fiber and easily available also cheap as compared to contemporary fibers like steel waste. Vast range of extraction is done and used in the concrete mix (cube and beam). The percentage of fiber used such as 1%,1.5%,2%.

Figure1: Beam structure

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Figure 2:.Reinforcement and curing of fiber mixed concrete.

III. METHODOLOGY

The optimizing techniques considered as one the most cost cutting methods which is highly reduce the material usage as well as cost of the project. There are various other optimizing methods are available to optimize the projects but the most effective methods are always opt. The Taguchi optimizing methods is one of the best optimizing techniques with various levels. There are different levels used in the optimizing methods such as L8,L9 etc., each levels are selected only based on number of parameters.

Hence selection of parameters is very importance in the optimization process. We have to opt the parameter which is most significant in the mixing process and strengthening process. In other words the selected parameters should be inevitable during concreting process. The L9 is one of the simplified levels which can be elected if there are 4 parameters.

This projects deals with four parameter such as W/C ratio, Fly-ash, M-sand and sisal fiber is chosen based on the project and parameter preference. According to L9 orthogonal array there are total nine experiments with various combinations. The goal of this project is to identify the most effective combination among the 9 different combinations.

Smaller is better

It is preferred when the objective is to lessen the reaction. The sound to noise can be considered for smaller the better

$$\frac{S}{N} ratio = -10\, log_{10}\, \frac{1}{n} \sum_{i=1}^{n} yi^2$$

Larger is better

It is preferred while the objective is to make the most of the reaction. The sound to noise is calculated for larger the better.

$$\frac{S}{N} ratio = -10\, log_{10}\, \frac{1}{n} \sum_{i=1}^{n} \frac{1}{yi^2}$$

Nominal is better

It is elected while the objective us to intention the response and it is necessary to base the Sound to noise on the standard deviation only. The Sound to noise is considered for smaller the better.

$$\frac{S}{N} ratio = -10\, log_{10}\, \frac{1}{n} \sum_{i=1}^{n} (y_i - y_0)^2$$

IV. RESULT AND DISCUSSION

The UTM machine is utilized to assess the compressive force of the concrete cubes. [3]There are total of 3 compression values are taken for all combination as shown in Table 6. These combination are taken from a optimizing trial to identify the mean real values.

Table 1 levels and Parameters:

Parameters		1st Level	2nd Level	3rd Level
W/C ratio	A	0.40	0.45	0.5
Fly- ash (%)	B	20%	25%	30%
M -Sand (%)	C	30%	35%	40%
Sisal (%)	D	1%	1.5%	2%

Basically, there will be 3 standard sound to noise equations are largely used to list -

- larger the better
- smaller the better
- Nominal the best.

In the current project compressive force must be greater hence our aim is also to make the most of the strength. The standard sound to noise ratio is specified below.

$$\frac{S}{N} ratio = -10\, log_{10}\, \frac{1}{n} \sum_{i=1}^{n} \frac{1}{yi^2}$$

The above expressions are used for all the 9 experiments and their final values are listed

Table 3. orthogonal array (L_9)3^4

Ex No.	Parameter A	Parameter B	Parameter C	Parameter D
1	1	1	1	1
2	1	2	2	2
3	1	3	3	3
4	**2**	**1**	**2**	**3**
5	2	2	3	1
6	2	3	1	2
7	3	1	3	2
8	3	2	1	3
9	3	3	2	1

Table 4. Experimental design (L_9)3^4

x No	Parameter A Water binder/ratio	Parameter B Fly ash (%)	Parameter C M sand (%)	Parameter D Sisal fiber (%)
.	0.4	20%	30%	1%
.	0.4	25%	35%	1.5%
.	0.4	30%	40%	2%
.	**0.45**	**20%**	**35%**	**2%**
.	0.45	25%	40%	1%
.	0.45	30%	30%	1.5%
.	0.5	20%	40%	1.5%
.	0.5	25%	30%	2%
.	0.5	30%	35%	1%

Table 5. Flexural result conventional beam (1250mm*150mm*150mm)

SNO	Ultimate load	Flexural strength
1	28.5KN	8.02 N/MM^2

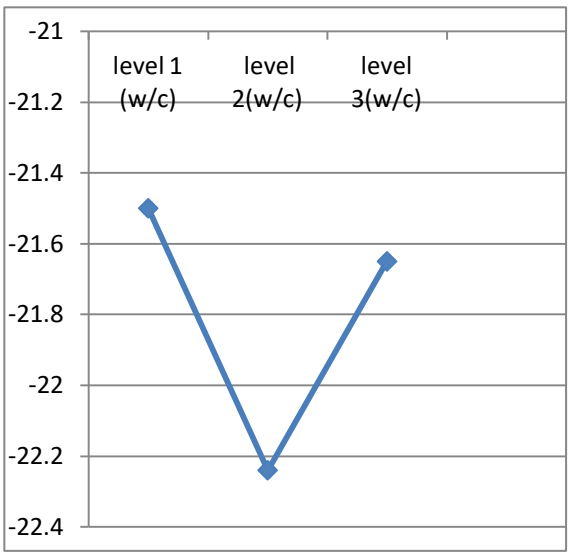
Table 6. Flexural result special beam (1250mm*150mm*150mm)

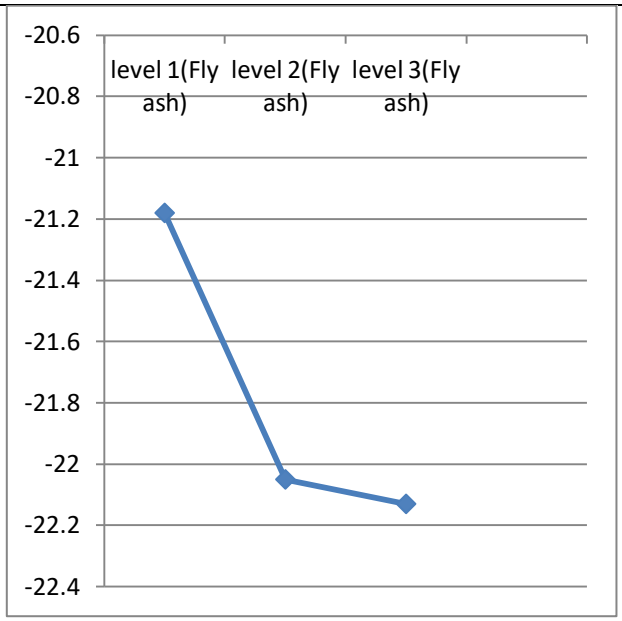
FLEXURAL TEST RESULT			
SNO	Ultimate load	Flexural strength	S/N ratio
1	42.6	10.45	-20.38
2	45.8	12.20	-21.72
3	47.2	13.10	-22.34
4	**47.7**	**13.42**	**-22.55**
5	46.3	12.60	-22.00
6	46.5	12.85	-22.17
7	43.5	10.75	-20.62
8	47.5	13.25	-22.44
9	46.0	12.43	-21.88

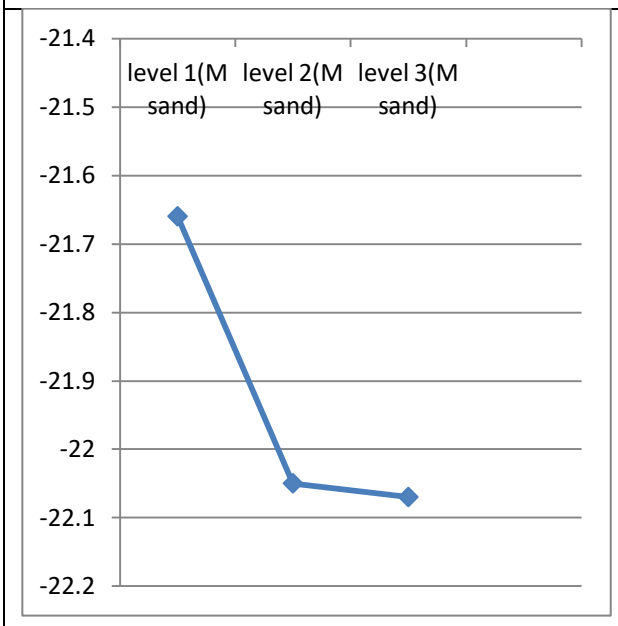
Table 7: parameters calculations(S/N ratio)

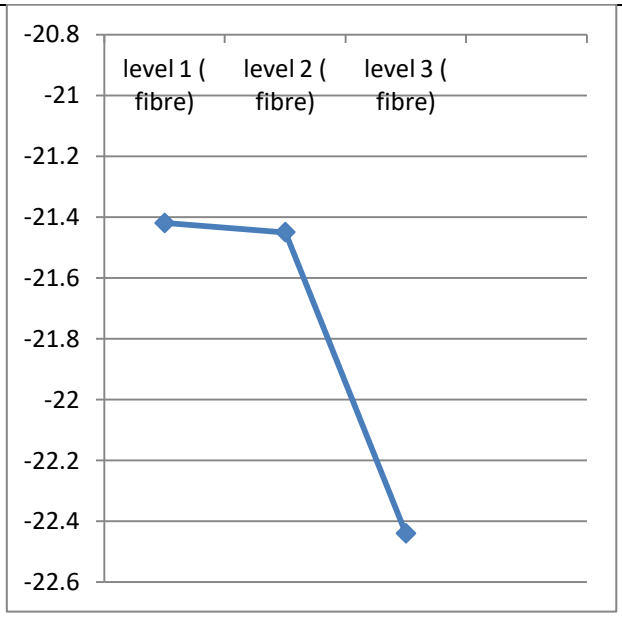
SNO	W/C		FLY ASH		M SAND		SISAL FIBRE	
	SUM	Avg (sound to noise) ratio	SUM	Avg (sound to noise) ratio	SUM	Avg (sound to noise) ratio	SUM	Avg (sound to noise) ratio
1	-64.44	-21.5	-63.55	-21.18	-64.99	-21.66	-64.26	-21.42
2	-66.72	-22.24	-66.16	-22.05	-66.15	-22.05	-64.34	-21.45
3	-64.94	-21.65	-66.39	-22.13	-66.22	-22.07	-67.33	-22.44

Table 8:Charts showing parameters level vs S/N Ratio









V. CONCLUSION

This manuscript illustrates the function of the factors (fly ash, M-sand, sisal fibre and W/C ratio) design of Taguchi method in the optimization techniques. The conclusion can be pinched based on the experimental results of this experimental study

- The optimum combination of the experiments is identified (SNO: 4).
- The S/N ratio of the each control factors is considered to identify the effect of each parameter in the optimization level.
- Taguchi process of parameter can be performing with limited of experimentations as compare to fully factorial technique.
- Taguchi technique can be practical for analyzing and any other sort of effort.

This method of optimization can be implemented in the field of medicine, agricultural etc and this methodology is highly preferred in reducing the total number of experiments..

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