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Optimizing the concrete materials by L9 orthogonal array

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Abstract

This manuscript presents the outcome of an experimental investigation conceded out to optimize the mix proportions of the concrete by the Taguchi method of parameter design. In order to reduce the number of mix combination in concrete, the Taguchi method is used. In this project the cement sand and aggregate are partially replaced by cement as fly ash, river sand as M-sand and the compression values are taken and the value is compared with the conventional concrete special concrete compression value is compared with the conventional concrete and S/N value is taken from the compression value and the comparison of the values are done. In order to attain good strength and to avoid cracks, sisal fiber is added in the concrete with a percentage of (1, 1.5, and 2).

Introduction

Sisal fibre concrete based application such as agricultural: farm and animal storage structure, wall, silos, paving, etc. commercial: Exterior and interior floors, polished concrete, slabs, parking areas and roadways. Elevated Decks: Commercial and industrial composite steel deck construction and elevated formwork at airports, commercial buildings, shopping centers, etc. highways, roadways & bridges: sound attenuation barriers etc. mining & tunneling, Ports & Airports, Precast Concrete & Products, Residential, Structural Reinforcement, Warehouse & Industrial, Waterways.

Sisal fiber reinforced cement composites were studied by K. Bilba, M.A. Arsene and A. Ouensanga Various fibre-cement composites were prepared and influence various parameters on the setting of the composite materials were studied. Botanical components, thermal and chemical treatment of Sisal fibres were also studied. The natural fibre composites may undergo a reduction in strength and toughness as a result of weakening of fibres by the combination of alkali attack and mineralisation through the migration of hydrogen products to lumens and spaces. Romildo D. Toledo Filho, Khosrow Ghavami, George L. England and Karen Scrivener (2003) reported their study on development of vegetable fibre-mortar composites of improved durability.

The fly ash is used in various applications such as Fill Material, Fly ash in Concrete, Fly ash in Portland cement concrete, Fly ash for Roads, Fly ash Bricks, Fly ash Product-Mosaic tile, Light Weight Aggregates.

In this, the Taguchi method are used to optimize the combination of a selected parameters because it has so many numbers of combination that is a full factorial method and it is difficult to do project so that Taguchi method are used to optimize the number of combination to make the project cost-effective [1]. The concrete mix designs are done by the L9 orthogonal array that is 34. When a new material is used in the concrete all the mix variables are taken into account so that it may cost so much, it means more need for money and material, personnel, time. In order to reduce the number of mix combination in concrete, the Taguchi method is used In this the materials are partially replaced with cement to fly ash, Sand to m-sand, and coarse aggregate is replaced by the selected percentage and sisal fiber is added to avoid the cracks fiber is mixed with the concrete and cubes are casted.

An advantage of the Taguchi method is that it emphasizes a mean performance characteristic value close to the target value rather than a value within certain specific limits, thus improving the product quality. Additionally, Taguchi's method for experimental design is straightforward and easy to apply to many engineering situations, making it a powerful yet simple tool. It can be used to quickly narrow the scope of a research project or to identify problems in a manufacturing process from data already in existence (Fraley et al., 2006). The main disadvantage of the Taguchi method is that the results obtained are only relative and do not exactly indicate what parameter has the highest effect on the performance characteristic value [3]. Also, since orthogonal arrays do not test all variable combinations, this method should not be used with all relationships between all variables. Taguchi method has been criticized in the literature for its difficulty in accounting for interactions between parameters. Another limitation is that the Taguchi methods are offline, and therefore inappropriate for a dynamically changing process such as a simulation study. Furthermore, since the Taguchi methods deal with designing quality rather than correcting for poor quality, they are applied most effectively at early stages of process development (Unitek Miyachi Group, 1999).

The concrete cube should be properly cast and the compaction should be done properly so that no air bubbles will not be present inside the concrete cube. After the concrete cube are cast. The cubes are cured and they are tested for 7 days, 14 days and 28-day compression test [2]. This test is done in a compression machine. The outcome of an experimental study carried out to optimize the mix size of the concrete by the Taguchi method. The compression values that are conventional concrete and special concrete compression value are compared with the conventional concrete so that we will get a

compression graph and S/N value is taken from the compression mean value. The mean value and the S/N values are plotted in the graph so the graphs are compared and we can get a final value.

Section snippets

Cement

Ordinary Portland cement (7.5 Grade) was used in all test specimen. Properties are tested by referring IS 12269-1987. The specific gravity of cement was 3.13. Standard consistency of cement is 34%. The fly ash was used as a partial replacement of cement by different proportions....

Fly ash

Fly ash is one of the binding materials used in this project with cement and it is partially replaced with cement. Fly ash particles are totally spherical in shape, allowing them to flow and blend freely in mixtures [2]. ...

Methodology

Taguchi technique is a tool for optimizing the recital characteristic of a process. The aim of the research is to spot and design the method parameters that optimize the chosen quality characteristic and they are least to noise factors [5]. In the current study, the goal of the job is to see the effects of the method parameters on the concert and the optimum blend of control factors that would increase the compressive strength of the concrete which is elected as the quality attribute. The...

Result and discussion

The universal testing machine is used to measure the compressive strength of the concrete cubes. The three compression readings are recorded for each combination as shown in Table 5. These parameters are taken from a designed experiment to analyze the mean function.

Generally, there are three standard S/N equations are widely used to classify the objective function-larger the better, smaller the better or nominal the best.

In the present study compressive strength should be larger so that and our ...

Conclusion

The parameters of the mix design are optimized by Taguchi method. An L9 orthogonal array with four control factors and three levels. Selected parameters along with the levels are; water/ binding ratio (0.40, 0.45, 0.50); fly ash (20, 25, 30); M-sand (30, 35, 40); sisal fiber (1, 1.5, 2). In this orthogonal

combination (2, 1, 2, 3) gives more strength when compared with other orthogonal combination. The forth combination of orthogonal array (L9) is considered as the most optimum level as…

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>
> …The three levels for the three factors of this experiment are shown in Table 5 [67]. Accordingly, an L9(34) ("L" refers to the orthogonal table, and "9" refers to the number of test groups [68–70]) orthogonal array was obtained to guide the subsequent experiments, as listed in Table 6 [71,72]. During the orthogonal experiments, the notations (A, B and C) represent Ni, CF and Gr, respectively.…

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> …Figs. 1-4. It is one of the imperative binding materials (Pozzolanic materials) in the concrete world [14–20]. In this research it was partially mixed with constant cement material with plethora of combinations (nine combinations) [21–26].…

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…The cube size of about 100 mm is opted for both conventional method and special concreting method. All cubes were casted and allowed for 28th and 60th respectively for curing [26]. The empty cube weight should have been measured for further calculations.…

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…Also, since orthogonal arrays do not test all variable combinations, this method should not be used with all relationships between all variables. Taguchi method has been criticized in the literature for its difficulty in accounting for interactions between parameters [6]. Another limitation is that the Taguchi methods are offline, and therefore inappropriate for a dynamically changing process such as a simulation study.…

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