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# G+12 Building Design and Performance Parameters Optimization Using ANOVAs Method

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**Abstract- Unique structures require more time for analysis and design due to their time-consuming calculations, if we use manual methods it will require more time for their calculations along with more probability of errors. STAAD Pro is a computer aided software which is used for solving complex engineering problems and provides us a quick results. STAAD Pro is a user friendly, easy to use software which gives us results pretty quickly along with fair level of accuracy. It is used for analysis and design of any structure with its wide scope of problem-solving tools. STAAD Pro has wide scope of sections, material properties, different Codal Provisions inbuilt commands along with user defined assignments. In India, STAAD Pro is used as per Indian Standard and Practices while it gives freedom for the consideration of different countries codes which are applicable to different regions around the globe. We can conclude that this software can save much time and very accurate in analyzing and designing of different structures along with being accurate. An ANOVA method is a statistical method used to find out if the results obtained are significant. In this project, a G+12 Building model is prepared and analyzed with the help of STAAD Pro by considering the various loads viz. dead, live, combination. The results are studied and compared by manual calculations. ANOVA Test is then used in order to find if the results are significant with the help of Microsoft excel. In the STAAD Pro the designing is done by better way for creating Geometry, defining the cross sections for column and beams etc, creating specification and supports according to the requirement. Then the Loads are defined with the help of loads envelop which is available in the loads and definition tab of STAAD Pro. After applying all the loads, the model is checked for any error, and the model is analyzed through 'run analysis' tab. Then the results are obtained by post possessing of the model. The results obtained are then taken into Microsoft excel for the ANOVA test. The analysis of variance is then applied with the help of data analysis in the excel software and the results are interpreted.**

**Keywords- Multistoried, planning, analysis, design, staad.pro, ANOVA, analysis of variance, residential building, building.**

## I. INTRODUCTION

The structural design of a building should ensure that the building can withstand loads safely, operate without excessive deformation or movement that could lead to fatigue of structural elements, cracks or failure of fixtures, fittings or partitions, or failure. Inconvenience to occupants. It must consider the movements and forces due to temperature, creep, cracks, and imposed loads. It must also verify that the design is nearly buildable within acceptable manufacturing tolerances of the materials.

It must allow the architecture to function and the building services to adapt to the building functionally (ventilation, lighting, etc). This project work is to analyze a Multi storied building for different load combinations using STAAD Pro software [1-2].

Now a days due to the over population in the urban cities and high cost of the land, there is a need to accommodate large group of families in multi-storey building. The determination of general shape, specific dimension and size is known as structure analysis, so that it will perform the function for it create and will safely withstand the influences which will act on throughout its useful life.

The entire process of structural planning and designing requires not only imaginations and calculations, but also science knowledge of structural engineering decide knowledge of particle aspect, such bye-laws and design codes, backed by sample experience and judgment. In this project, an effort made on planning, analysis and design of residential building. For analysis and design of building, the plan draft by AUTO-CAD software which plan import in STAAD Pro [3-5].

In every aspect of human civilization, we needed structures to live in or to get what we need. But it is not only building structures but to build efficient structures so that it can fulfill the main purpose for what it was made for. Here comes the role of civil engineering and more precisely the role of analysis of structure [6-10].

## II. BASIC OF BUILDING

The procedure for analysis and design of a given building will depend on the type of building, its complexity, the number of stories etc. First, the architectural drawings of the building are studied, structural system is finalized sizes of structural members are decided and brought to the knowledge of the concerned architect.

The procedure for structural design will involve some steps which will depend on the type of building and also its complexity and the time available for structural design. Often, the work is required to start soon, so the steps in design are to be arranged in such a way the foundation drawings can be taken up in hand within a reasonable period of time.

Further, before starting the structural design, the following information of data is required [11-15]:

- A set of architectural drawings;
- Soil Investigation report (SIR) of soil data;
- Location of the place or type of building in order to decide loadings;
- Data for lifts, water tank capacities on top, special roof features or loadings, etc.

## III. BASIC CODES FOR DESIGN AND LOADS

The design should be carried so as to conform to the following Indian code for reinforced concrete design, published by the Bureau of Indian Standards, New Delhi:

**1. Purpose of Codes:**

National building codes have been formulated in different countries to lay down guidelines for the design and construction of the structure. The codes have evolved from the collective wisdom of expert structural engineers, gained over the years.

These codes are periodically revised to bring them in line with current research, and often, current trends.

- IS 456: 2000 – Plain and Reinforced Concrete – Code of Practice (Fourth Revision)
- Loading Standards-These loads to be considered for structural design are specified in the following loading standards: IS 875 (Part 1-5): 1987 – Code of practice for design loads (other than earthquake) for buildings and structures (second revision)
  - Part 1: Dead loads
  - Part 2: Imposed (live) loads
  - Part 3: RF loads

**2. Load Analysis:**

The main aim of the project is to design a multi - storey building for residential purpose, taking different load combinations into consideration. The design process of multi - storey building require not only imagination and conceptual thinking but also a knowledge in structural engineering and practical aspects such as recent design codes, bye laws, backed up with sample experience.

- Building elements
- Loads
- Load combination
- Basics of design

**3. Building Elements:**

- Foundation
- Beams
- Column
- Staircase

## IV. APPLICATION OF FINITE ELEMENT MODELLING IN BEAM AND OBSERVATION

**1. Concept of Bending/Deformation:**

It is an associative feature based Modeller. This means the model geometry is entered in terms of features which are then sub-divided into finite elements in order to perform the analysis. Increasing the number of elements usually increases the accuracy of the analysis but the time for the analysis to be done will also increase.

In sandwich beam, every element of concrete and soil must be assigned with material constant to define structure properties in term of mass density, poison ratio and modulus of elasticity.

**2. Research Motivation:**

For multistoried buildings, the conventional load bearing structures tends to distribute the loads more uniformly and eliminate the excessive effects of localized loads. Become uneconomical as they require larger sections to resist huge moments and loads.

But in a framed structure, the building frame consists of a network of beams and columns which are built monolithically and rigidly with each other at their joints. Because of this rigidity at the joints, there will be reduction in moments and also the structure Therefore in non-load bearing framed structures, the moments and forces become less which in turn reduces the sections of the members.

**3. Research Objectives:**

Following objectives are perform in this research work-

- To design of Multistory building in staad pro software.
- To analysis of deflection affect each floor level.
- To optimize the maximum values of deflection using sampling ANOVA methods.
- To interpret observation of ANOVA method results.

**4. Structural Systems for Construction Of Multistory Buildings:**

**4.1 Moment resisting frames:** As it may be noticed from Figure, moment resisting frame consist of plane frames configured in two directions perpendicular to each other. Another feature of this system is that column and beams sections should be enlarged since bending moments, shear forces, and axial forces would get larger at the lower storeys. Moreover, the system is claimed to be suitable for about storeys and the joints between columns and beams should be detailed properly since it would become a weak point of the structure during earthquake.

**4.2 Shear Wall Systems:** Due to that fact that the wall takes most of shear base when walls and columns are used in moment resisting buildings, that is why it is named as shear wall system. Shear wall is another type of structural systems used in the construction of multistory buildings. For the same cross-section, it provides superior stiffness compared with columns. As a result, the lateral deflection of the structure is much smaller in comparison to that occurs in the cause of using columns.

**4.3 Frame-Wall or Dual Systems:** Dual wall systems are the combination of shear walls with frame systems. Not only does it offer the benefits of both systems together but also eliminate their drawbacks. Generally, frames are placed around the perimeter of the building and shear walls are placed at the center of the structure around staircases or lifts.

**4.4 Vibration Analysis Response Spectra Method:** The main purpose of the response spectrum analysis is to obtain the design seismic forces, with its distribution to different storey levels along the height of the building and to the various lateral load resisting elements. This method assumes that the dynamic response of the structure may be found by considering the independent response of each natural mode of vibration and then combining in the same way to compute the total response. For analysis, the mass of the structure is assumed to be lumped at the floor levels and only sway displacement is permitted at each storey.

## V. PROPOSED METHODOLOGY

**1. Introduction To ANOVAs:**

A common way to find a reliable treatment would be to analyze the days it took for patients to be treated. We can use a mathematical method that can compare these three treatment samples and show

how these samples differ from one another. Such a strategy, which compares samples on the basis of their methods, is called ANOVA.

Variation analysis (ANOVA) is a mathematical analysis tool that distinguishes the visual visual variations found within the data set into two parts: structural features and random features. Organized objects have a statistical effect on a given data set, whereas random features do not. Analysts used the ANOVA test to determine the effect of independent variability on the variance dependent on the retrospective study.

The t and z test methods developed in the 20th century were used for mathematical analysis until 1918, when Ronald Fisher created a variance analysis method.12 ANOVA is also called Fisher's analysis of variance, and is an extension of t. - and z-test. The term came to prominence in 1925, after Fisher's book, "Statistical Methods for Research Workers."

Variation analysis (ANOVA) is a collection of mathematical models and related measurement methods (such as "differences" between groups) used to analyze differences between group methods in the sample. ANOVA was developed by mathematician Ronald Fisher. ANOVA is based on the law of absolute diversity, in which the observed variability of a particular diversity is subdivided into components caused by different diversity sources. In its simplest form, ANOVA provides a mathematical test that two or more human methods are equal, and then combines t tests beyond two methods.

Differential Analysis (ANOVA) is a measurement method used to compare data sets. This process was developed by R.A. Fisher, and as a result is often referred to as Fisher's ANOVA, too. It is the same with the use of techniques such as t-test and z-test, because it is used to compare methods and related differences between them. However, variance analysis (ANOVA) is best used when more than 2 people or samples are made for comparison.

Statistics Solutions is a world leader in Analysis of Variance (ANOVA) and research statistics. The use of this method of parameter calculations involves some important assumptions, which include the following:

- **Independence of the case:** Independence of the case guesses means that the subject of dependent variability must be independent or the sample must be randomly selected. There should be no pattern in the sample selection.
- **General:** Distribution of each group should be general. The Kolmogorov-Smirnov or Shapiro-Wilk test can be used to confirm the group's familiarity.
- **Homogeneity:** Homogeneity means the differences between groups should be the same. Levene's test is used to assess similarities between groups.

If certain data follows the above assumptions, then variance analysis (ANOVA) is the best way to compare two, or more mathematical methods.

Differential analysis (ANOVA) in EXCEL: In EXCEL, diversity analysis (ANOVA) can be done in many ways. We can perform this test in EXCEL by clicking on the "one-way ANOVA option," which is located in the "comparison methods" option. If we do two or more methods to analyze variability (ANOVA), we may use the "fixed" option found in the GLM menu. EXCEL will provide additional results as well, as part of the eta square, Power, retreat model, post hoc, homogeneity test, etc. Post hoc tests are performed when there are significant differences between the groups and we want to know exactly which group has the most different methods from the other groups.

## VI. RESULT AND ANALYSIS

**1. Design related analysis:**

- Step-1: Importing of center-line plan from staad.
- Step - 2: Representation of beams and columns. By using add beam command beams and columns are drawn with the help of corresponding nodes.
- Step – 3: 3D view of structure Here we have used the 3D view of structure Here the Transitional repeat command in Y direction is used to get the 3D view of structure.

Table 1. Design Specification G+12

| Design Parameters | Values |
|---|---|
| Length | 12 |
| Height | 33 |
| Width | 12 |
| No of bags Length | 4 |
| No of bags Height | 13 |
| No of bags Width | 4 |

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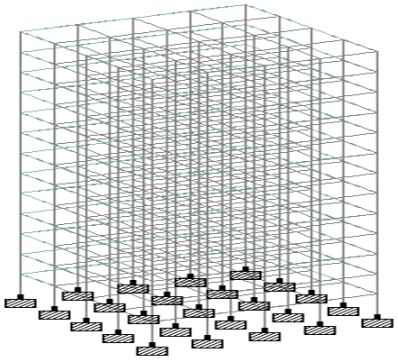

Fig 1. 3D modelling View.

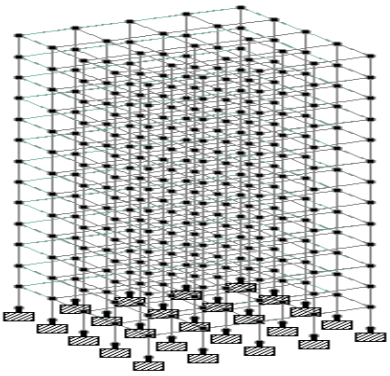

Fig 2. Node Points.

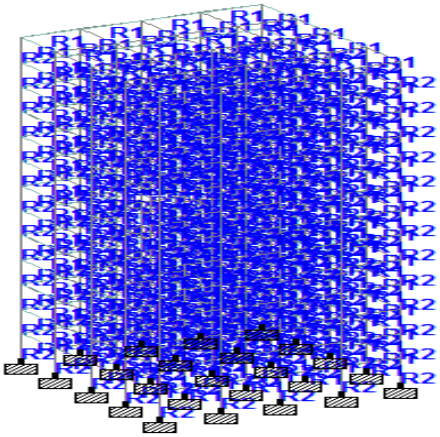

Fig 3. Reaction forces.

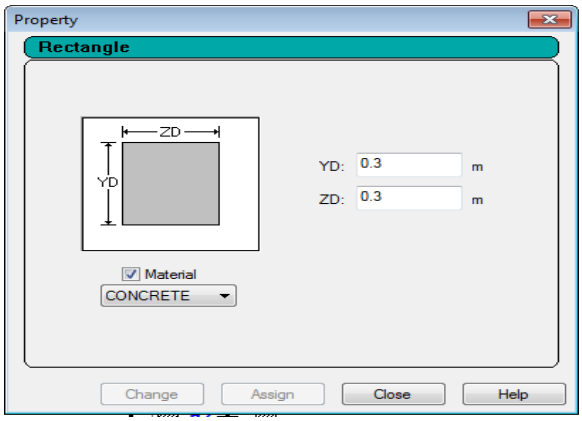


Fig 4. Beam Specification.

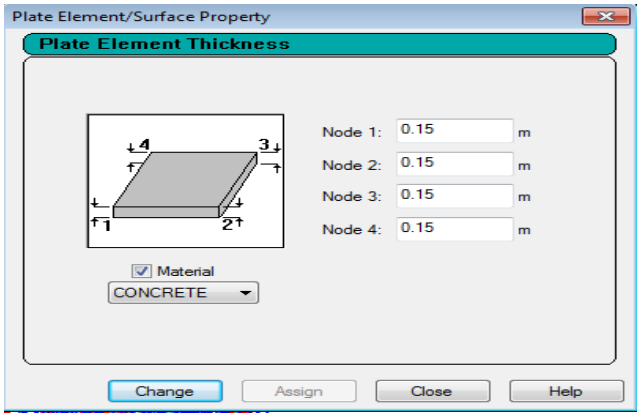


Fig 5. Slab Specification.

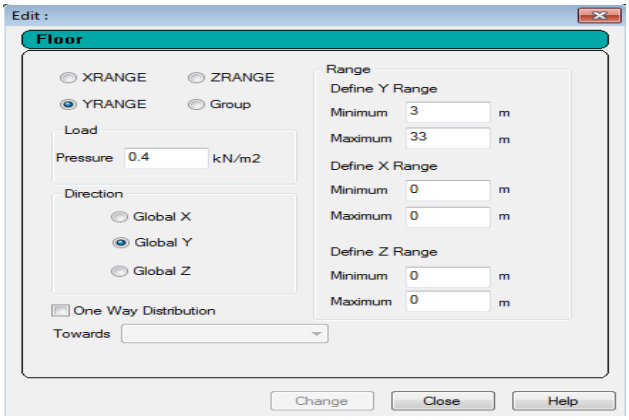


Fig 6. Load Specification.

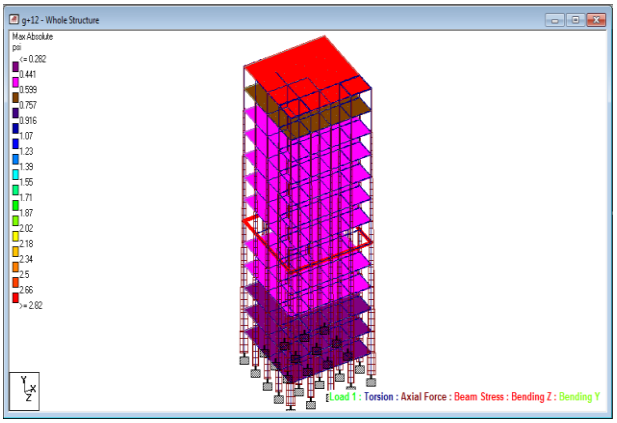


Fig 7. Dead load Effects.

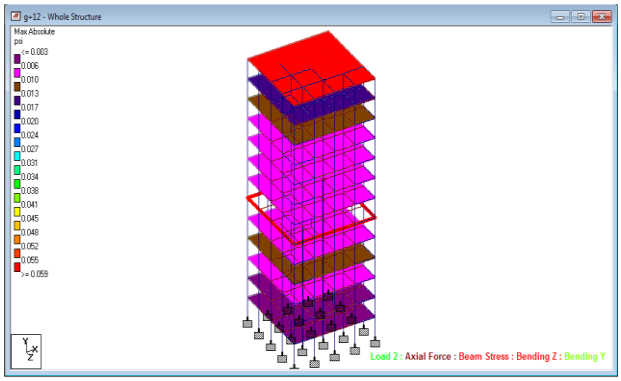


Fig 8. Live load Effects.

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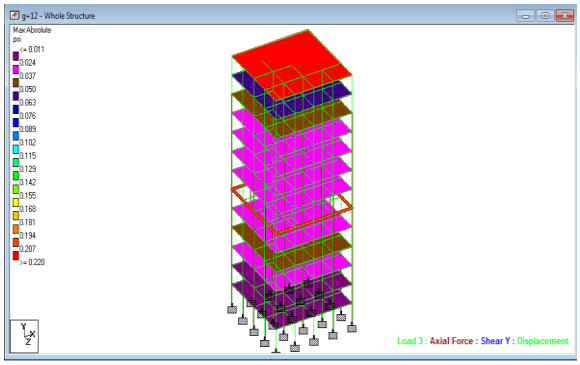

Fig 9. Floor load effects.

## 2. ANOVA Analysis:

Table 2. Initial slab data collection.

| Distance (m) | Bending Moment (KNm) |
|---|---|
| 0 | -0.316 |
| 0.076200167 | -0.308 |
| 0.152400335 | -0.287 |
| 0.228600502 | -0.253 |
| 0.304800669 | -0.208 |
| 0.381000837 | -0.15 |
| 0.457201004 | -0.079 |
| 0.533401171 | 0.003 |
| 0.609601339 | 0.099 |
| 0.685801506 | 0.206 |
| 0.762001673 | 0.326 |
| 0.838201841 | 0.458 |
| 0.914402008 | 0.602 |

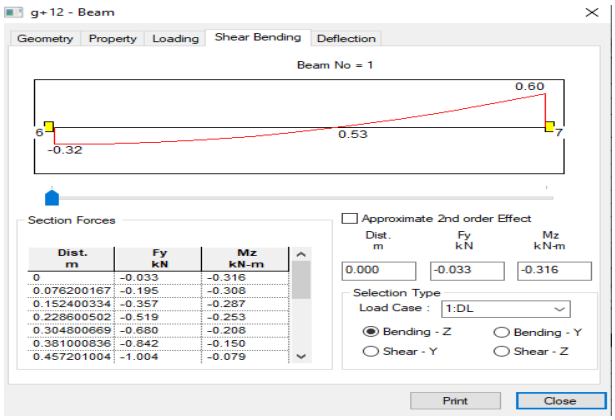


Fig 10. Shear bending.

Table 3. Regression Statistics 1.

| SUMMARY OUTPUT | |
|---|---|
| Regression Statistics | |
| Multiple R | 0.531493 |
| R Square | 0.282485 |
| Adjusted R Square | 0.199152 |
| Standard Error | 0.475048 |
| Observations | 13 |

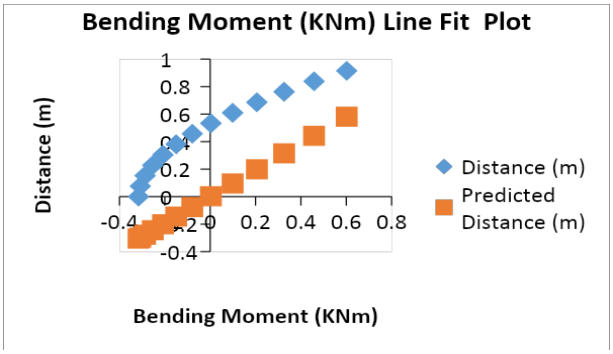


Fig 11. Move force Line Fit Plot-1.

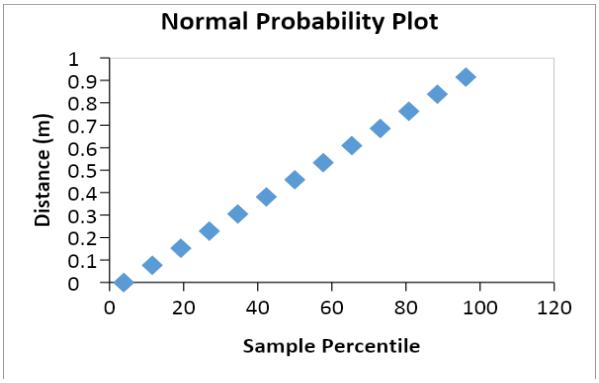


Fig 12. Normal Probability Plot-1.

Table 4. Top floor data collection.

| Distance (m) | Bending Moment (KNm) |
|---|---|
| 0 | -1.48 |
| 0.076200167 | -1.281 |
| 0.152400335 | -1.07 |
| 0.228600502 | -0.846 |
| 0.304800669 | -0.61 |
| 0.381000837 | -0.361 |
| 0.457201004 | -0.101 |
| 0.533401171 | 0.172 |
| 0.609601339 | 0.458 |
| 0.685801506 | 0.756 |
| 0.762001673 | 1.066 |
| 0.838201841 | 1.388 |
| 0.914402008 | 1.723 |

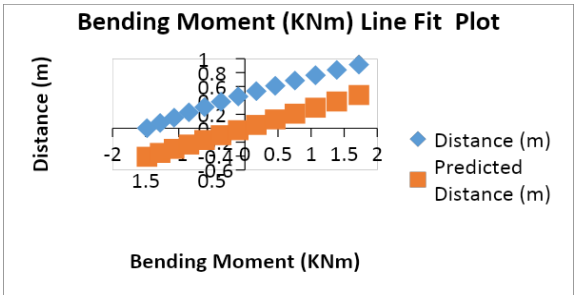


Fig 13. Move force Line Fit Plot-2.

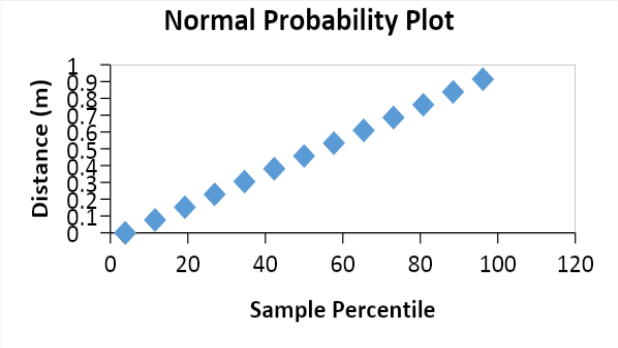


Fig 14. Normal Probability Plot-2.

Table 5. Regression Statistics 2.

| SUMMARY OUTPUT | |
|---|---|
| Regression Statistics | |
| Multiple R | 0.515429 |
| R Square | 0.265667 |
| Adjusted R Square | 0.182334 |
| Standard Error | 0.480583 |
| Observations | 13 |

## VI. CONCULSION

In this research work are conclude following highlights points given blow as- This research paper result and simulation section shows balanced multistory building design using staad pro software. Also identified lower deflection parameters in each floor. Now ANOVA method result prediction values obtain in ground and top floor Distance (m) is varies 0 to 0.914402008 with respect Bending Moment (KNm) is also varies 3.846 to 96.153%. The observation R2 values in ground floor 0.282 and top floor is 0.265. Hence lower bending occurred in top floor with respect to ground floor in prediction case. The further study of this research work to used advanced AI and ML technique to improve regression factor value in multiple decimal.

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