

Design of Reinforced Concrete Cement Structure- A Case Study

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ABSTRACT

Now-a-days Reinforced Concrete Structures are in increasing demand in this modern world. Prior to any kind of construction, we need a RCC structure. This RCC structure explains the underlying design principle of the RCC components where the analysis and detail requirements are met. Design procedures also include flow charts, worked examples, concrete material properties, analysis of steel considerations, design arrangements, strength and serviceability requirements, details and calculation of beams, 1-way slab, slab 2 tracks, columns, beams, retaining walls and foundations. The codes referred to are ICC (International Code Council), IBC (International Building Code). In this document we will analyse the different design procedures in which the person must have experience in certain fields such as: - Concrete technology, Materials science and structural engineering tests, Material and repair techniques. We would discuss the different components of the buildings where the loads are divided and together with the safety provisions taken in accordance with the codes.

KEYWORDS: - Reinforced Concrete Cement (RCC), International Code Council (ICC), International Building Code (IBC).

I. INTRODUCTION

1.1-ANALYSIS OF STRUCTURE

In design analysis of reinforced concrete (RC) members, there will be problems arising regarding how the material behaves in both tension & Compression and it can be considered in either elastic or inelastic nature are being completely neglected. [1-8]. Analysis of structure is determination of the loads and their effects on physical structure with their different components. Structures that are subjected to above conditions are Buildings, Bridges, Soil Strata. These analysis has a very wide field of applications like applied mechanics, material science and applied mathematics so that it can be computed for structure deformation, different stresses, internal forces, accelerations. Analysis of structure or Structural Analysis is a key part for any Civil Engineer or Structural Engineer where he/she has to design the structure with different loadings and keeping in view the factor of safety with the structures serviceability for long time. [9].

1.2-STRUCTURAL CLASSIFICATION & LOADINGS

The classification of structure is the key combination of different structural elements with their materials. It is an essential part for any Civil Engineer to be able to classify the structure by either it's form or it's functions that should be by recognising it's various elements which are included in that structure. The element that comprise of forces from the materials are connecting rods, truss, beam, column it also includes cables, arch, cavity wall or channel, an angle or a frame etc.[10]. Once the dimensional requirement for a structure has been defined, it is necessary to determine the loads that the structure must support. The structural design, therefore, begins with the specification of loads that act on the structure. The design load for a structure is often specified in building codes. There are two types of codes: general construction codes and design codes, engineers must comply with all the requirements of the code so that the structure remains reliable. There are two types of loads that the engineering of structures must find in the design. The first type of charges are dead charges consisting of the weights of the various structural members and the weights of any object that is permanently attached to the structure. For example, columns, beams, beams, the floor slab, ceilings, walls, windows, pipes, electrical accessories and other miscellaneous accessories. The second type of charges are live loads that vary in their magnitude and location

1.3-LIMITATIONS

Each method has notable limitations. The method of material mechanics is limited to very simple structural elements under relatively simple loading conditions. However, the structural elements and the permitted loading conditions are sufficient to solve many useful engineering problems. The theory of elasticity allows the solution of structural elements of general geometry in general load conditions, in principle. The analytical solution, however, is limited to relatively simple cases. The solution of elasticity problems also requires the solution of a system of partial differential equations, which is considerably more mathematically demanding than the solution of problems of the mechanics of materials, which require at most the solution of a common differential equation. The finite element method is perhaps the most restrictive and most useful at the same time. This method itself is based on other structural theories (like the other two that are analyzed here) to solve equations.

II. CASE STUDY ON STRCUTURAL ANALYSIS METHODS

The simplest of the 3 methods are discussed below:

2.1-CLASSICAL METHOD

The method of material mechanics is available for simple structural elements subject to specific loads, such as axially loaded bars, prismatic beams in pure bending state and circular axes subject to torsion. The solutions can be superimposed under certain conditions using the superposition principle to analyze a member that is in a combined charge. There are solutions for special cases for common structures, such as thin-walled pressure vessels. For the analysis of complete systems, this approach can be used together with the static ones, giving rise to the method of the sections and to the method of the junctions for the truss analysis, the moment distribution method for small rigid frames and the framework of the portal and Cantilever method for large rigid frames. Except for the moment distribution, which came into use in the 1930s, these methods were developed in their current forms in the second half of the nineteenth century.

2.2-ELASTICITY METHOD

Elasticity methods are generally available for an elastic solid of any shape. You can model individual members, such as beams, columns, axes, plates and casings. The solutions are derived from the linear elasticity equations. The elasticity equations are a system of 15 partial differential equations. Due to the nature of the mathematics involved, analytical solutions can only be produced for relatively simple geometries. For complex geometries, a numerical solution method is required as a finite element method.

2.3-ANALITICAL METHOD

To perform a precise analysis, a structural engineer must determine information such as structural loads, geometry, support conditions and material properties. The results of this analysis typically include support reactions, stresses and displacements. This information is compared with the criteria that indicate the failure conditions. Advanced structural analysis can examine the dynamic response, stability and nonlinear behavior. There are three approaches to analysis: the mechanics of materials approach (also known as material resistance), the elasticity theory approach (which is actually a special case of the more general field of continuity mechanics) and the finite element approach. The first two make use of analytical formulations that mostly apply simple linear elastic models, which lead to closed-form solutions, and which can often be solved by hand. The finite element approach is actually a numerical method to solve differential equations generated by theories of mechanics such as the theory of elasticity and the resistance of materials. However, the finite element method depends to a large extent on the processing power of computers and is more applicable to structures of arbitrary size and complexity. [11] Regardless of the approach, the formulation is based on the same three fundamental relationships: equilibrium, constructive and compatibility. The solutions are approximate when any of these relations are only satisfied approximately, or only an approximation of reality.

2.4-SAFETY PROVISION

The load factors are applied to the loads and a member that will have enough force to resist the factored loads is selected. In addition, the theoretical strength of the limb is reduced by the application of a resistance factor. The criterion that must be fulfilled in the selection of a member is the Factual Force $\geq$ Factual Charge. The factored load is actually the sum of all the workloads that the member must support, each multiplied by its own load factor. For example, dead loads will have load factors that are different from those of live loads. The factorized force is the theoretical force multiplied by a force reduction factor. Therefore, it can be written as Nominal strength reduction factor $\times$ force $\geq$ Load factors $\times$ load. Since the factored load is a failure load greater than the actual work load, the load of factors is generally greater than unity.

2.5-DESIGN OF STRENGTH

The strength of a particular structural unit calculated using the currently established procedures is called "nominal resistance". For example, in the case of a beam, the moment resistance capacity of the section calculated using the equilibrium equations and the properties of concrete and steel is called the "nominal momentum capacity" of the section.

The purpose of the force reduction factor f is:

- to allow members with little resistance due to variations in the strengths and dimensions of the material
- Allow inaccuracies in the design provisions.
- to reflect the degree of ductility and the required probability of the member under the load effects considered
- Reflect the importance of the member in the structure.

2.6-ALLOWABLE STRESSES DESIGN

• As an alternative to the resistance design method, the members can be provided so that the stresses in the steel and concrete resulting from the normal service loads are within the specified limits (a permissible or permissible voltage or load). These limits, known as allowable stresses, are only fractions of the material's fault voltages. The allowed voltage design is also known as "working voltage design".

• For example, in the design of steel structures, this allowable stress will be in the elastic range of the material and will be less than the yield stress F_y . A typical value could be $0.60F_y$. The permitted tension is obtained by dividing the yield stress F_y or the tensile strength F_u by a factor of safety. This design approach is also called elastic design or work stress design. The work voltages are those due to the workloads, which are the loads applied. A properly designed member will not be subject to more effort than the effort allowed when subjected to workloads. The work stress method can be expressed as follows:

Permissible stresses (f)

$$f \leq (1.2)$$

where:

f = An elastic tension calculated, for example, using the bending formula

$f = M/I$ for beam.

f_{allow} = A limit stress prescribed by a building code as a percentage of the compressive strength f'_c for concrete, or of the yield stress, and f for steel reinforcing bars.

III. CONCLUSION

In this topic, we have discussed the different loads that are being applied in any structure and the provision of security that is provided in accordance with the codes. The service capacity of the structure is the most important aspect for any civil engineer. The design must be such that it meets all the basic requirements for those problems due to which a structure reaches a failure stage before the time period is granted. The charges are needed to tell where and how the charges come and what are the different procedures adopted to calculate and counteract those charges. The main issue which is a major concern is the Security Factor, it is the part of the calculation where a structure is taken for additional loads in its service capacity and then they are designed.

REFERENCES:-

- [1]. Amir M. Alani, Morteza Aboutalebi, "Mechanical Properties of Fibre Reinforced Concrete - A Comparative Experimental Study", International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering, Vol:7, No:9, 2013.
- [2]. Ashwini R. Kulkarni, Mr. Vijaykumar Bhusare, "Structural Optimization of Reinforced Concrete Structures", International Journal of Engineering Research & Technology (IJERT), Vol. 5 Issue 07, July-2016.
- [3]. M. Yao and T. Y. Li, "Isolated Structures Research and Comparative with Traditional Seismic Structures", Advanced Materials Research, Vols. 594-597, pp. 1734-1739, 2012.
- [4]. B. Prasad, "Modelling considerations in optimum design of reinforced structures", Applied Mathematical Modelling · June 1984.
- [5]. H. Quan, "Design of Reinforced Concrete Block Masonry Basement", Advanced Materials Research, Vols. 639-640, pp. 160-163, 2013.
- [6]. X. F. Zhan et al., "Thermal Experiment of a Reinforced Approach Pavement for Semi-Integral Abutment Jointless Bridge", Advanced Materials Research, Vols. 639-640, pp. 183-190, 2013.
- [7]. S. W. Zhang et al., "With Different Axial Compression, the Finite Element Analysis of Concrete Frame Column that Reinforced by Assemble Inclined Web Steel Truss", Advanced Materials Research, Vols. 1079-1080, pp. 177-182, 2015.
- [8]. M. M. Guo et al., "Research on Material Fatigue Test of Steel Fiber Reinforced Concrete under Tension and Compression Loading", Key Engineering Materials, Vol. 730, pp. 353-357, 2017.
- [9]. L. T. Gao et al., "Experimental Investigation on the Fire Resistance Performance of L Special-Shaped Steel Reinforced Concrete Columns", Applied Mechanics and Materials, Vols. 204-208, pp. 3433-3440, 2012.
- [10]. Y. T. Niu et al., "Fracture Failure Mechanism Analysis of a Type of Tracklayer Gearbox Casing Based on Mechanical Mechanics and Material Properties", Advanced Materials Research, Vol. 738, pp. 97-102, 2013.
- [11]. Zhizhou Zhang, Kahraman Demir, Grace X. Gu, "Computational analysis of thermally induced stress concentration in structures with geometric constraints", Elsevier, March, 2019.