# A DETAILED SURVEY OF LOADS IN A REINFORCED CONCRETE BUILDING

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## Abstract

*Reinforced concrete (RC) is a versatile composite and one of the most widely used materials in modern construction. Concrete is a relatively brittle material that is strong under compression but less so in tension. Plain, unreinforced concrete is unsuitable for many structures as it is relatively poor at withstanding stresses induced by vibrations, wind loading, and so on. To increase its overall strength, steel rods, wires, mesh or cables can be embedded in concrete before it sets. This reinforcement, often known as rebar, resists tensile forces*

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*Keywords- Column, Reinforced concrete, vibration*

## I INTRODUCTION

Reinforced concrete is extremely durable and requires little maintenance. It has good thermal mass, and is inherently fire resistant. Rebar is generally made from 100% recycled scrap, and at the demolition stage, the concrete and rebar are capable of being separated so that the steel can be recycled. However, concrete has a relatively high embodied energy, resulting from its extraction, manufacture and transportation. Waste materials can be included within the concrete mix such as RCA (Recycled Crushed Aggregate), GGBS (Ground Granulated Blast-Furnace Slag) and PFA (Pulverized Fuel Ash), however, issues such as moisture content and material variability may make its recycling unviable. Concrete is produced by mixing together cement, aggregate and water in a defined proportion. This mixture when hardens gives a material which has brought revolution in the construction industry. The concrete so produced is called plain concrete and is very strong in compression but weak in tension. To make use of this concrete in places where it has to bear tensile forces we introduce steel bars which are known as reinforcing bars (re-bar). Such a product having steel bars embedded in concrete is known as reinforced concrete. To design a structural member made up of reinforced concrete it is very important to study the concept of Structural Analysis [1] which describe how the structure will behave under different types of loads. The theory of reinforced concrete depends upon the bond between steel and concrete. Therefore the steel re-bar used are deformed or ribbed to make a strong bond and avoid chances of slip. If we consider a simply supported beam subjected to downward forces, the beam will bend in such a way that the bottom fibers will have tensile force and the top fiber compressive. Therefore it is required to provide steel in the bottom fibers of such beams or slabs. For example, consider a rectangular section of the beam with "b" as width and "d" as depth. If it is only made up of plain concrete it's centroid will be at the geometric center of the rectangle i.e. d/2 from the base. The strength of such a section can be calculated by using flexure formula "Bending Moment = Bending stress x section modulus". Section modulus is defined as the ratio of Moment of inertia of the section and the distance of the fiber from the centroid. It is evident from the above flexure formula that the maximum bending stress will be at the extreme top or bottom layers of the section. In our case the top will have maximum compressive stress and the bottom maximum tensile stress. Because plain concrete is not good in tension therefore the cracks would develop in the bottom portion of the section at very low stress. although the compression fibers are still able to take the load. So, if we want to increase the strength of concrete we must provide some strong material in the bottom part of the section which should provide sufficient strength to the beam section to carry the imposed load. This is done by providing steel bars at the bottom of the section but they should be covered so that there is no corrosion of steel.

## II BEHAVIOR OF REINFORCED CONCRETE

**Materials –** Concrete is a mixture of coarse (stone or brick chips) and fine (generally sand or crushed stone) aggregates with a paste of binder material (usually Portland cement) and water. When cement is mixed with a small amount of water, it hydrates to form microscopic opaque crystal lattices encapsulating and locking the aggregate into a rigid structure. The aggregates used for making concrete should be free from harmful substances like organic impurities, silt, clay, lignite etc. Typical concrete mixes have high resistance to compressive stresses (about 4,000 psi (28 MPa)); however, any appreciable tension (e.g., due to bending) will break the microscopic rigid lattice, resulting in cracking and separation of the concrete. For this reason, typical non-reinforced concrete must be well supported to prevent the development of tension. If a material with high strength in tension, such as steel, is placed in concrete, then the composite material, reinforced concrete, resists not only compression but also bending and other direct tensile actions. A composite section where the concrete resists compression and reinforcement "rebar" resists tension can be made into almost any shape and size for the construction industry.

**Key characteristics –** Three physical characteristics give reinforced concrete its special properties:

- The coefficient of thermal expansion of concrete is similar to that of steel, eliminating large internal stresses due to differences in thermal expansion or contraction.
- When the cement paste within the concrete hardens, this conforms to the surface details of the steel, permitting any stress to be transmitted efficiently between the different materials. Usually steel bars are roughened or corrugated to further improve the bond or cohesion between the concrete and steel.
- The alkaline chemical environment provided by the alkali reserve (KOH, NaOH) and the portlandite (calcium hydroxide) contained in the hardened cement paste causes a passivation film to form on the surface of the steel, making it much more resistant to corrosion than it would be in neutral or acidic conditions. When the cement paste is exposed to the air and meteoric water reacts with the atmospheric $CO_2$, portlandite and the calcium silicate hydrate (CSH) of the hardened cement paste become progressively carbonated and the high pH gradually decreases from 13.5 – 12.5 to 8.5, the pH of water in equilibrium with calcite (calcium carbonate) and the steel is no longer passivized.

**Mechanism of composite action of reinforcement and concrete –** The reinforcement in a RC structure, such as a steel bar, has to undergo the same strain or deformation as the surrounding concrete in order to prevent discontinuity, slip or separation of the two materials under load. Maintaining composite action requires transfer of load between the concrete and steel. The direct stress is transferred from the concrete to the bar interface so as to change the tensile stress in the reinforcing bar along its length. This load transfer is achieved by means of bond (anchorage) and is idealized as a continuous stress field that develops in the vicinity of the steel-concrete interface.

**Anchorage (bond) in concrete: Codes of specifications –** the actual bond stress varies along the length of a bar anchored in a zone of tension, current international codes of specifications use the concept of development length rather than bond stress. The main requirement for safety against bond failure is to provide a sufficient extension of the length of the bar beyond the point where the steel is required to develop its yield stress and this length must be at least equal to its development length. However, if the actual available length is inadequate for full development, special anchorages must be provided, such as cogs or hooks or mechanical end plates. The same concept applies to lap splice length mentioned in the codes where splices (overlapping) provided between two adjacent bars in order to maintain the required continuity of stress in the splice zone.

**Anti-corrosion measures –** In wet and cold climates, reinforced concrete for roads, bridges, parking structures and other structures that may be exposed to deicing salt may benefit from use of corrosion-resistant reinforcement such as uncoated, low carbon/chromium (micro composite), epoxy-coated, hot dip galvanized or stainless steel rebar. Good design and a well-chosen concrete mix will provide additional protection for many applications. Uncoated, low carbon/chromium rebar looks similar to standard carbon steel rebar due to its lack of a coating; its highly corrosion-resistant features are inherent in the steel microstructure. It can be identified by the unique ASTM specified mill marking on its smooth, dark charcoal finish. Epoxy coated rebar can easily be identified by the light green colour of its epoxy coating. Hot dip galvanized rebar may be bright or dull grey depending on length of exposure, and stainless rebar exhibits a typical white metallic sheen that is readily distinguishable from carbon steel reinforcing bar. Reference ASTM standard specifications A1035/A1035M Standard Specification for Deformed and Plain Low-carbon, Chromium, Steel Bars for Concrete Reinforcement, A767 Standard Specification for Hot Dip Galvanized Reinforcing Bars, A775 Standard Specification for Epoxy Coated Steel Reinforcing Bars and A955 Standard Specification for Deformed and Plain Stainless Bars for Concrete Reinforcement.

## III Floating Columns

A column is supposed to be a vertical member starting from foundation level and transferring the load to the ground. The term floating column is also a vertical element which ends (due to architectural design/ site situation) at its lower level (termination Level) rests on a beam which is a horizontal member. The beams in turn transfer the load to other columns below it. Such columns where the load was considered as point load.

Theoretically such structures can be analyzed and designed. In practice, the true columns below the termination level [usually the stilt level] are not constructed with care and more liable to failure. Hypothetically, there is no need for such floating columns – the spans of all beams need not be nearly the same and some spans can be larger than others. This way, the columns supporting beams with larger spans would be designed and constructed with greater care.
For Floating columns, the Transfer Girder and columns supporting Transfer Girder needs special attention. If load factor needs to be augmented (for Transfer Girder and its columns) to have additional safety of structure, shall be adopted. In the given system, floating columns need NOT be treated to carry any Earth Quake forces. Therefore entire Earth Quake of the system is shared by the columns/shear walls without considering any contribution from Float columns. However in design and details of Float columns, minimum 25% Earth Quake must be catered in addition to full gravity forces

## IV LITERATURE REVIEW

Meghana B .S. and T.H. Sadashiva Murthy [1] investigate the many buildings are planned and constructed with architectural complexities. The complexities include various types of irregularities like floating columns at various level and locations. These floating columns are highly disadvantageous in building built in seismically active areas. The earthquake forces that are developed at different floor levels in building need to be carried down along the height to ground by shortest path, but due to floating column there is discontinuity in the load transfer path which results in poor performance of building. In this paper we focus on steel concrete composite structure with floating column in different positions in plan, in buildings of various heights such as G+3, G+10 and G+15 in lower and higher earthquake prone zones. Linear static analysis is carried using ETABS software, Comparison of various parameters such as storey shear, storey drift and storey displacement is done.
Kirankumar Gaddad and Vinayak Vijapur [2] the behavior of structure when obtaining floating columns, obtaining shear wall, and both shear wall and floating columns structure with comparing the normal structure. Also comparing the parameters like storey displacements, storey drift, storey shear, time period. Considering G+20 storey building, four models. First model will consider the normal building, second model will consider floating columns structure, third model will consider shear wall structure, fourth model will consider both shear walls and floating columns structure. The seismic analysis of G+20 storey structure is analyzed by both equivalent static and response spectrum method. Using Indian Standard code IS 1893(Part-1) 2002 and ETABS-2016 software. Obtained storey displacements, storey shear, storey drift, time period for seismic zone V. Consider the both equivalent static method and response spectrum method. 1.2(DL+LL+RSY) load combination is critical and increased displacements model II is 6%, decreased 45% in model III, 40% in model IV. The storey drift compared normal structure increased drifts in model II is 9%, decreased 40% in model III, and 31% in model IV. The storey shear compared normal structure decreased shears in model II is 4.5%, increased 24% in model III, and 23% in model IV. Comparing all four models the time period of floating column building model II is greater than all three building. Model III is better performances lesser displacements, more strength comparing all models.

K.-W. Liu and R. Kerry Rowe [3] The short-term and long-term performance of reinforced, deep mixing method (DMM) floating-column supported embankments with and without prefabricated vertical drains (PVDs) are investigated using a fully 3D coupled model. The concurrent use of PVDs with the other two forms of soft ground improvement significantly shortens time for subsoil consolidation and also substantially reduces post consolidation lateral displacements and post-construction crest settlements. The combined use of PVDs and surcharge preloading to meet a requirement of 100 mm post-construction crest settlement for a bridge approach embankment is examined. Compared to a comparable case with surcharge preloading but without PVDs, the synergistic effects of PVDs and 0.5 m fill surcharge preloading diminish the calculated post-construction crest settlement from 0.228 m to 0.036 m and reduce the post consolidation horizontal movement below the toe at the ground surface level from 0.115 m to 0.067 m even though embankment is constructed 5 times faster in the case with PVDs
Agbomerie Charles Odijie et al. [4]In this investigation, Column stabilized semisubmersible is one of the most commonly used hull systems for the design and development of drilling and production platforms used for offshore deep water operations. Recent reconfiguration and design alterations have improved its hydrodynamic behavior in rough weather conditions and, thus, its application and functionality in ocean engineering. Semisubmersible dry-trees applications and large wind turbine foundation systems in ultra-deep waters require high payload integration for reduced motion responses in all degrees of freedom. This paper presents a review of recent industrial and academic contributions to the development of column stabilized semisubmersible hulls used for deep water operations. It also provides an overview of the motion and structural attachments of

semisubmersibles. The type and formation of dry-trees semisubmersibles are discussed. The dynamic behavior and comparative advantages of them are also explained.

Ryohei Ishikura et al. [5] Ground improvement using floating soil cement columns with shallow stabilization is an effective technique forth treatment of deep soft soil layers under infrastructure embankments. In order to investigate the settlement performance of this improvement technique, model load testing of model column analog ues for visualization of ground behavior under plane strain conditions was performed and field observations at full scale test The concurrent use of PVDs with the other two forms of soft ground improvement significantly shortens time for subsoil consolidation and also substantially reduces post consolidation lateral displacements and post-construction crest settlements. The combined use of PVDs and surcharge preloading to meet a requirement of 100 mm post-construction crest settlement for a bridge approach embankment is examined. Compared to a comparable case with surcharge preloading but without PVDs, the synergistic effects of PVDs and 0.5 m fill surcharge preloading diminish the calculated post-construction crest settlement from 0.228 m to 0.036 m and reduce the post consolidation horizontal movement below the toe at the ground surface level from 0.115 m to 0.067 m even though embankment is constructed 5 times faster in the case with PVDs
Maison and Neuss [6] analysis of an existing forty four story steel frame high-rise Building to study the influence of various modeling aspects on the predicted dynamic properties and computed seismic response behaviours. The predicted dynamic properties are compared to the building's true properties as previously determined from experimental testing. The seismic response behaviors are computed using the response spectrum (Newmark and ATC spectra) and equivalent static load methods.

Maison and Ventura [7] it was computed dynamic properties and response behaviours OF THIRTEEN-STORY BUILDING and this result are compared to the true values as determined from the recorded motions in the building during two actual earthquakes and shown that state-of-practice design type analytical models can predict the actual dynamic properties, using Hamiltons principle, are solved in conjunction with Naviers solutions. The free vibration results are obtained employing the standard eigenvalue analysis whereas the displacement/stress responses in time domain for the curved nano beams subjected to rectangular pulse loading are evaluated based on New marks time integration scheme. The formulation is validated considering problems for which solutions are available. A comparative study is done here by different theories obtained through the formulation. The effects of various structural parameters such as thickness ratio, beam length, rise of the curved beam, loading pulse duration, and nonlocal scale parameter arebrought out on the dynamic behaviors of curved Nano beams

Arlekar, Jain et al. [8], in this paper investigation features were highly undesirable in buildings built in seismically active areas; this has been verified in numerous experiences of strong shaking during the past earthquakes. They highlighted the importance of explicitly recognizing the presence of the open first storey in the analysis of the building, involving stiffness balance of the open first storey and the storey above, were proposed to reduce the irregularity introduced by the open first storey.

Awkar and Lui [9] studied responses of multi-story flexibly connected frames subjected to earthquake excitations using a computer model. The model incorporates connection flexibility as well as geometrical and material nonlinearities in the analyses and concluded that the study indicates that connection flexibility tends to increase upper stories' inter-storey drifts but reduce base shears and base overturning moments for multi-story frames.

Balsamoa et al. [10] performed pseudo dynamic tests on an RC structure repaired with CFRP laminates. The opportunities provided by the use of Carbon Fiber Reinforced Polymer (CFRP) composites for the seismic repair of reinforced concrete (RC) structures were assessed on a full-scale dual system subjected to pseudo dynamic tests in the ELSA laboratory. The aim of the CFRP repair was to recover the structural properties that the frame had before the seismic actions by providing both columns and joints with more deformation capacity. The repair was characterized by a selection of different fiber textures depending on the main mechanism controlling each component. The driving principles in the design of the CFRP repair and the outcomes of the experimental tests are presented in the paper. Comparisons between original and repaired structures are discussed in terms of global and local performance. In addition to the validation of the proposed technique, the experimental results will represent a reference database for the development of design criteria for the seismic repair of RC frames using composite materials.
Vasilopoulos and Beskos [11] performed rational and efficient seismic design methodology for plane steel frames using advanced methods of analysis in the framework of Eurocodes 8 and 3 . This design methodology employs an advanced finite element method of analysis that takes into account geometrical and material

nonlinearities and member and frame imperfections. It can sufficiently capture the limit states of displacements, strength, stability and damage of the structure.

Bardakis & Dritsos [12]This paper evaluated the American and European procedural assumptions for the assessment of the seismic capacity of existing buildings via pushover analyses. The FEMA and the Euro code-based GRECO procedures have been followed in order to assess a four-storeyed bare framed building and a comparison has been made with available experimental results..

Mortezaei et al. [12] recorded data from recent earthquakes which provided evidence that ground motions in the near field of a rupturing fault differ from ordinary ground motions, as they can contain a large energy, or ‘‘directivity” pulse. This pulse can cause considerable damage during an earthquake, especially to structures with natural periods close to those of the pulse. Failures of modern engineered structures observed within the near-fault region in recent earthquakes have revealed the vulnerability of existing RC buildings against pulse-type ground motions. This may be due to the fact that these modern structures had been designed primarily using the design spectra of available standards, which have been developed using stochastic processes with relatively long duration that characterizes more distant ground motions. Many recently designed and constructed buildings may therefore require strengthening in order to perform well when subjected to near-fault ground motions. Fiber Reinforced Polymers are considered to be a viable alternative, due to their relatively easy and quick installation, low life cycle costs and zero maintenance requirements.

Ozyigit [13] performed free and forced in-plane and out-of-plane vibrations of frames are investigated. The beam has a straight and a curved part and is of circular cross section. A concentrated mass is also located at different points of the frame with different mass ratios. FEM is used to analyze the problem.
Williams, Gardoni & Bracci [14] studied the economic benefit of a given retrofit procedure using the framework details. A parametric analysis was conducted to determine how certain parameters affect the feasibility of a seismic retrofit. A case study was performed for the example buildings in Memphis and San Francisco using a modest retrofit procedure. The results of the parametric analysis and case study advocate that, for most situations, a seismic retrofit of an existing building is more financially viable in San Francisco than in Memphis.

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