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Commercial Buliding of Reinforced Concrete design

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Abstract

Structural engineering is a field of civil engineering dealing with the analysis and design of the structure that support or resist the loads. Structural engineers are most commonly involved in the design of buildings and large non building structures. Structural engineers must ensure their designs satisfy given design criteria, predicated on safety (e.g. structures must not collapse without due warning) or serviceability and performance (e.g. building sway must not cause discomfort to the occupants).

Structural engineers ensure that buildings and bridges are built to be strong enough and stable enough to resist all appropriate structural loads (e.g., gravity, wind, snow, rain, seismic (earthquake), earth pressure, temperature, and traffic) in order to prevent or reduce loss of life or injury. They also design structures to be stiff enough to not deflect or vibrate beyond acceptable limits.

In this paper an attempt has been made to analyses and design G+4 commercial building (hospital). We have adopted Limit State Method for analysis and designing the structure. The design is conformation with IS 456-2000. We bear in mind that Structural design should satisfy the ultimate strength, in flexure, shear, compression, tension, torsion, developed under a given system of loads and satisfy the serviceability, which limits deflection and cracking to be within acceptable limit.

Keywords: Structure Engineering, Serviceability,Commercial..

Introduction

Ultimate tensile strength (UTS), often shortened to tensile strength (TS) or ultimate strength, is the maximumstress that a material can withstand while being stretched or pulled before failing or breaking. Tensile strength is not the same as compressive strength and the values can be quite different. Some materials will break sharply, without plastic deformation, in what is called a brittle failure. Others, which are more ductile, including most metals, will experience some plastic deformation and possibly necking before fracture. The UTS is usually found by performing a tensile test and recording the engineering stress versus strain. The highest point of the stress-strain curve (see point 1 on the engineering stress/strain diagrams below) is the UTS. It is an intensive property; therefore its value does not depend on the size of the test specimen. However, it is dependent on other factors, such as the preparation of the specimen, the presence or otherwise of surface defects, and the temperature of the test environment and material.

Tensile strengths are rarely used in the design of ductile members, but they are important in brittle members. They are tabulated for common materials such as alloys, composite materials, ceramics, plastics, and wood. Tensile strength is defined as a stress, which is measured as force per unit area. For some non-homogeneous materials (or for assembled components) it can be reported just as a force or as a force per unit width. In the SI system, the unit is thepascal (Pa) (or a multiple thereof, often megapascals (MPa), using the mega- prefix); or, equivalently to pascals, newtons per square metre (N/m^2). A customary unit is pounds-force per square inch (lbf/in^2 or psi), or kilo-pounds per square inch (ksi, or sometimes kpsi), which is equal to 1000 psi; kilo-pounds per square inch are commonly used for convenience when measuring tensile strengths.

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Application Of Structure Designing

STRUCTURE DISIGNING:

Structural design for frame R.c.c structure can be done by three method

1. WORKING STRESS METHOD
2. ULTIMATE STRENGTH METHOD
3. LIMIT STATE METHOD

WORKING STRESS METHOD OF DESIGN:

It is the earliest method of R.c.c structure. In this method structure element is so design that the stress resulting from the action of service load as computed in linear elastic theory using modular ratio concept do not exceed a pre-design allowable stress which is kept as some fraction of ultimate stress, to avail a margin of safety. Since this method does not utilize full strength of material it result in heavy section. The economy aspect cannot be fully utilize in this method.

ULTIMATE STRENGTH METHOD OF DESIGN:

This method is primarily based on strength concept. In this method the structure element is proportional to withstand the ultimate load, which is obtained by enhancing the service load of some factor referred to as load factor for giving desire margin of safety. Since the method based on actual stress strain behavior of material.

LIMIT STATE METHOD OF DESIGN:

During the past several years extension research work have been carried out on the different aspects of the research in the actual behavior of member and structure has led to the development and approach of limit state method of design

CONCEPT

In lm the working load is multiplied by partial factor of safety in accordance with clause 36.4.1 of IS-456-2000; and also the strength of material is divide by the partial design factor in accordance with chause 36.4.1 of IS-456-2000; partial safety factor is introduced to reduce the probability of failure to about zero. When a structure or a part of structure becomes unfit for use , it is used to have a reached a limit state unfitness for use can arise I n various ways and aim of limit state method of design to be provided and acceptable probability that the structure will not reach limit state during its service life span limit state can be broadly classified into two main categories:

1) LIMIT STATE OF COLLAPSE :-It is the limit state of attainment of which the structure is likely to collapse. It is relate to stability and strength of structure. Design to this limit ensure safety of structure from collapse.

2) LIMIT STATE OF SERVICIABLITY: It is related to performance of structure at working load and is based on causes affecting serviceable of structure. This limit state is concerned with cracking and deflection of structure. In limit state method , the structure shall be design to withstand safely all loads likely to act on it through out its life. The objective of design is to achieve a structure that will remain fit for use during its life with acceptable target reliability. Steel structure are to be designed and constructed to safety the design requirement with regard to stability, strength & durability.

BEAN BEND:

A beam bends under bending moment, resulting in a small curvature. At the outer face (tensile face) of the curvature the concrete experiences tensile stress, while at the inner face (compressive face) it experiences compressive stress.

A singly reinforced beam is one in which the concrete element is only reinforced near the tensile face and the reinforcement, called tension steel, is designed to resist the tension.

A doubly reinforced beam is one in which besides the tensile reinforcement the concrete element is also reinforced near the compressive face to help the concrete resist compression. The latter reinforcement is called compression steel. When the compression zone of a concrete is inadequate to resist the compressive moment (positive moment), extra reinforcement has to be provided if the architect limits the dimensions of the section.

An under-reinforced beam is one in which the tension capacity of the tensile reinforcement is smaller than the combined compression capacity of the concrete and the compression steel (under-reinforced at tensile face). When the reinforced concrete element is subject to increasing bending moment, the tension steel yields while the concrete does not reach its ultimate failure condition. As the tension steel yields and stretches, an "under-reinforced" concrete also yields in a ductile manner, exhibiting a large deformation and warning before its ultimate failure. In this case the yield stress of the steel governs the design.

An over-reinforced beam is one in which the tension capacity of the tension steel is greater than the combined compression capacity of the concrete and

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the compression steel (over-reinforced at tensile face). So the "over-reinforced concrete" beam fails by crushing of the compressive-zone concrete and before the tension zone steel yields, which does not provide any warning before failure as the failure is instantaneous.

A balanced-reinforced beam is one in which both the compressive and tensile zones reach yielding at the same imposed load on the beam, and the concrete will crush and the tensile steel will yield at the same time. This design criterion is however as risky as over-reinforced concrete, because failure is sudden as the concrete crushes at the same time of the tensile steel yields, which gives a very little warning of distress in tension failure.

Steel-reinforced concrete moment-carrying elements should normally be designed to be under-reinforced so that users of the structure will receive warning of impending collapse.

The characteristic strength is the strength of a material where less than 5% of the specimen shows lower strength.

The design strength or nominal strength is the strength of a material, including a material-safety factor. The value of the safety factor generally ranges from 0.75 to 0.85 in Permissible stress design.

The ultimate limit state is the theoretical failure point with a certain probability. It is stated under factored loads and factored resistances.

Reinforced Concrete (RC) structures are normally designed according to rules and regulations or recommendation of a code such as ACI-318, CEB, CP110 or the like. WSD, USD or LRFD methods are used in design of RC structural members. Analysis and design of RC members can be carried out by using Linear or Non-Linear approaches. By applying safety factors, the building codes normally propose Linear approach and for some cases Non-Linear approaches. To see an example on Non-Linear calculation.

SLAB DESIGN

Slab are plain structure member forming floors and roof of building whose thickness is quiet small compare to their other dimension. This carry load primarily by flexure and are in various shapes such as square, rectangle, triangle and circle etc. in building tanks etc, inclined slab may b used as ramp for multistory as parking. A stare case is considered to be a inclined slab.

Slab may be supported by beams or by walls and may b simply supported or continuous over one or more support. When the ratio of the length to the width of a slab is more than 2 and then most of the loads is carried by short span and in such a case is known as one way slab in case of ratio less then 2 is known two way slab which are further classified as resistance and simple support slab

Thickness of reinforced cement concrete slab vary from 75mm – 300 mm slabs are designed first like beam keeping the breadth of slab as units depending on the system of unit. Thus the total slab is assumed to be to the consisting of strip of unit width compression reinforced concrete is used only in exceptional basis in a slab. Shears stress in a slab are very low and hence shear reinforcement is never provided and if necessary it is preferred to increase the depth of the slab to reduce the stress then providing the reinforced concrete. Temperature reinforced concrete is provided at right angle to the main longitudinal reinforcement in a slab. The design of slab is purely in accordance with the code IS-456-2000; the design process of the slab following assumptions are made M-20 and FE415 steel are used both for design and execution process.

- ❖ The overall depth of the slab is resistible to 150mm with a Clare cover of 20mm
- ❖ The main reinforced consists of tor steel bar and temperature reinforced concrete consists of mild steel bar
- ❖ The total depth of the section is obtained from the maximum bending moment of all moments of the span

DESIGN OF COLUMN

A vertical member whose effective length is greater than 3 times its least lateral dimension carrying compressive load is called as column. Column transfer the loads from the beams or slab to the footing or foundation. Generally the column may be square, rectangle or circular in shape. Concrete is strong in compression, longitudinal steel bars are placed in the column to reduce the size of column or to increase the load carrying capacity and the tension.

A column is a compressive member which is used primarily of support axial compressive load and with a height of at least three time its least lateral dimension.

A reinforcement concrete column is said to be subjected to axiually loaded when the line of the resultant thrust of load support by the column is coincided upon the architecture requirement and the load to be supported. R.c.c column may be cast in various shape such as square, rectangle, hexagonal and circular etc.

The longitudinal bars are held in position by transferring reinforcement or lateral binder. The

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binder prevent displacement of the longitudinal bars during concreting operation and also check the tendency of their bulking outward under load.

TYPES OF COLUMN

1. Based on types of reinforcement: depending up on the reinforcement used reinforced column are classified into
   (a) Tied column: when the main longitudinal bars of the column are classified with in closely spaced lateral tiles, it is called tied column.
   (b) Spiral column: when the main longitudinal bars of the column are enclosed with in closely spaced and continuously wound spiral reinforcement, it is called as spiral column.
   (c) Composite column: when the longitudinal reinforcementis in the form os structural steel section or pipe with or without longitudinal bars, it is called as composite column.

2. Based on type of loading: depending upon the type of loading, columns may be classified into the following types:
   (a) Axially loaded column: when the line of action of the resultant compressive force coincides with the center of gravity of the cross section of the column, it is called as axially loaded column.
   (b) Eccentrically loaded columns (uniaxial or biaxial):when the line of action of the resultant compressive force doesn't coincide with the center of gravity of cross section of column, it is called as eccentrically loaded column. Eccentrically loaded column have to be designed for combined axial force and bending moments.

3. Based on slenderness ratio: depending up on the slenderness ratio (ratio of effective length to least lateral dimension of the column), the columns are classified as:
   (a) short column: when the ratio of effective length of column to the least lateral dimension is less than 12, the column is called as short column. A short column fails by crushing (pure compression failure)
   (b) long column: if the ratio effective length of a column to the least lateral dimension exceed 12 , it is called long column. A long column fails by bending or buckling.

EFFECTIVE LENGTH:

The effective length of column is define as the lengt between the point of contract flexure of the bulking column. The code has given certain value of effective length for normal usage assuming idealize and condition shown in the appendix D of IS-456-2000

A column may be classified by the following based on the type of load

1. Axially loaded column.
2. A column is subjected to axial load and uni-axial bending.
3. A column may be subjected to axial load and bi-axial bending.

AXIAL FORCE

If a load on the column is applied through the centre of gravity of its cross-section, it is called as axial load.

- A force is applied parallel to the centerline of shaft.
- A uniaxial force is a force applied only in one direction directly on the axis direction

Axial force is a compression or tension force acting on a member. If the axial force act through the centre of the member it is called as concentric loading. If the force is not acting through the centroid its called eccentric loading. Eccentric loading produce a moment on the beam as a result of the load being a distance away from the centroid.

AXIAL LOAD AND UNIAXIAL BENDING

The member subjected to axial force and uniaxial bendingshall be design on the bases of

- The maximum compression strain in concrete in axial compression is lak as 0.02
- The maximum compressiln strain in concrete at the highly compressed extreme fiber in concrete is subjected to axial compression and where there is no tension on the section shall be 0.0035 minus 0.75 time and the strain at the least compressed extreme fiber.

AXIALLY LOADED AND BI AXIAL BENDING

The resistance of a member is subjected to axial force and biaxial bending shall be obtain on the bases of assumption given in38.1 and 38.2 with neutral axisso chosen as to satisfy the equilibrium of load and moment about two axis.

Alternatevly such member may be design by the following equation

M_{UX},M_{UY}=Moment about X amd Y axis due to design load

M_{UXB},M_{UB}=MAXIMUM UNI AXIAL MOMENY CAPACITY FOR AN AXIAL LOAD OF P_U

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BENDING ABOUT X AND Y AXIS RESPECTIVALY AND IT IS RELATED TO P_U/P_{UZ}
$P_{UZ}=0.45F_{CK}A_C+0.75F_YA_{SC}$
$P_U/P_{UZ}=0.2\text{-}0.8$, THE VALUE OF AN VARIES FROM 1-2

1. FOR VALUE LESS THAN 0.2=1
2. FOR VALUE GREATER THEN 0.8=2

COLUMN POSITIONS

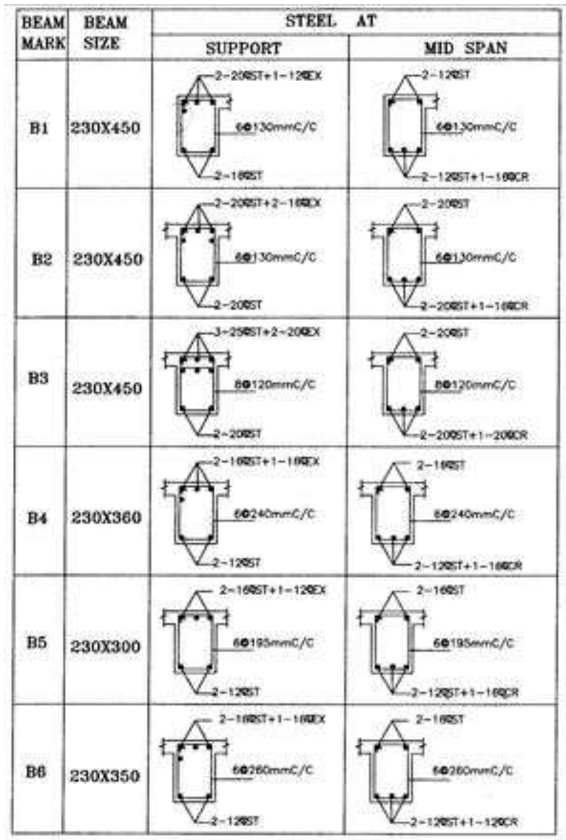
- Positioning of columns

Following are some of the guidelines principles for positioning of columns.

1. Column should be preferably located at or near the corner of the building and at intersection of the walls, because the function of the column is to support beams which are normally placed under walls to support them. The columns, which are near to property line, can be exception from above consideration as the difficulties are encountered in providing footing for such columns.

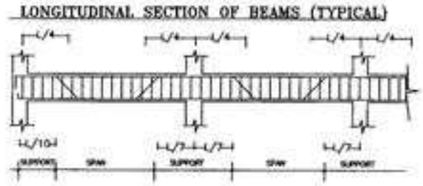
When center to center distance between the intersection of the walls is large or where there are no cross walls, the spacing between two column is governed by limitations on spans of supported beams because spacing of column beside the span of the beams. As the span of the beam increase as the required depth increase and hence its self weight. On the other hand increase in total load is negligible in case of column due to increase in length. Therefore, column are generally cheaper compared to beams on basis of unit cost. Therefore, large spans of beam should be avoided for economy reasons.

Architecture



BEAM MARK	BEAM SIZE	STEEL AT	
		SUPPORT	MID SPAN
B1	230X450	2-20ØST+1-12ØEX; 6Ø130mmC/C; 2-16ØST	2-12ØST; 6Ø130mmC/C; 2-12ØST+1-16ØCR
B2	230X450	2-20ØST+2-16ØEX; 6Ø130mmC/C; 2-20ØST	2-20ØST; 6Ø130mmC/C; 2-20ØST+1-16ØCR
B3	230X450	3-25ØST+2-20ØEX; 8Ø120mmC/C; 2-20ØST	2-20ØST; 8Ø120mmC/C; 2-20ØST+1-20ØCR
B4	230X360	2-16ØST+1-16ØEX; 6Ø240mmC/C; 2-12ØST	2-16ØST; 6Ø240mmC/C; 2-12ØST+1-16ØCR
B5	230X300	2-16ØST+1-12ØEX; 6Ø195mmC/C; 2-12ØST	2-16ØST; 6Ø195mmC/C; 2-12ØST+1-16ØCR
B6	230X350	2-16ØST+1-16ØEX; 6Ø260mmC/C; 2-12ØST	2-16ØST; 6Ø260mmC/C; 2-12ØST+1-12ØCR

LONGITUDINAL SECTION OF BEAMS (TYPICAL)



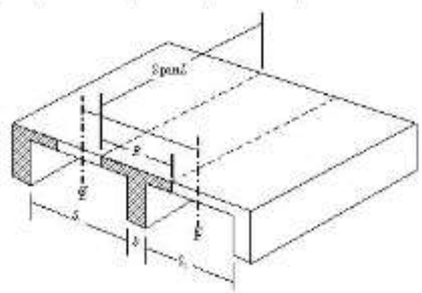


FIG 2- Slab-beam floor system.

NOTATION
A =AREA
A_{SC} =AREA OF STEEL OF COMPRESSION
A_{ST} =AREA OF STEEL OF TENSION
A_g =AREA OF GROSS SECTION
A_c =AREA OF CONCRETE
B =BREABTH OF SLAB

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B_f =EFFECTIVE WIDTH OF FLANGE
B_w =BREADTH OF WEB
B =BREADTH OF BEAM
D =OVER ALL DEPTH OF BEAM
D_f =THICKNESS OF SLAB
D =EFFECTIVE DEPTH OF BEAM OR SLAB
F_{ck} =COMPRESSIVE STRENGTH OF CONCRETE
F_y = COMPRESSIVE STRENGTH OF STEEL
L_{eft} =EFFECTIVE SPAN
L_x =SHORT SPAN
L_y =LONG SPAN
M =BENDING MOMENT
Mx =B.M ALONG SHORT SPAN
M =MODULAR RATIO
P_0 =SAFE BEARING CAPACITY OF SOIL
Q =MOMENT OF RESISTANCE CONSTANT
S_v =SPACING OF STIRRUPS
S =SPACING OF BARS
ζ =TORSIONAL MOMENT
ζ_v =NOMINAL SHEAR STRESS
ζ_c =SHEAR STRESS IN CONCRETE
ζbd =BOND STRESS
$\zeta_{c\ max}$ =MAXIMUM SHEAR STRESS IN CONCRETE
V= SHEAR FORCE
w =DISTRIBUTION LOAD PER UNIT AREA
W =TOTAL LOAD
X_c =CRITICAL LOAD
X_a =ACTUAL NEUTRAL AXIS

Conclusion

The above paper conclude the design requirements of concrete floor systems with nonprestressed reinforcement according to ACI 318-05. It is important to note that once the required flexure and shear reinforcement have been determined, the reinforcing bars must be developed properly in accordance . The structural integrity requirements must be satisfied as well.

Reference

[1] *ACI 318-05 Code and Commentary;*
[2] *D. Fanella, I. Alsamsam, "The Design of Concrete Floor Systems", PCA Professional Development Series, 2005*.