DESIGN AND MATERIAL COST COMPARISON OF RCC AND PRESTRESSED CONCRETE MULTISTOREY BUILDING

MAY-2015

SUBMITTED IN THE PARTIAL FULFILMENT OF THE DEGREE OF
BACHELOR OF TECHNOLOGY

DEPARTMENT OF CIVIL ENGINEERING
JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY
WAKNAGHAT, SOLAN-173234, HIMACHAL PRADESH, INDIA

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CERTIFICATE

This is to certify that the work entitled, **"Design and material cost comparison of RCC and Prestressed concrete multisorey building"** submitted **by Ishan Tyagi-111624** and **Apoorv Goyal-111664** in partial fulfilment for the award of degree of Bachelor of Technology in Civil Engineering of Jaypee University of Information Technology has been carried out under my supervision. This work has not been submitted partially or wholly to any other university or institute for the award of this or any other degree or diploma.

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ACKNOWLEDGEMENT

We are extremely grateful to our project guide **Mr. Chandra Pal Gautam** for giving us directions and providing feedback. His thinking and straight forward attitude has inspired us to work for the project with great pace.

We take this opportunity to express our sincere gratitude to the Head of Department of Civil Engineering**, Dr. Ashok Kumar Gupta** for giving us the opportunity to do project on **“Design and material cost Comparison of RCC and Prestressed concrete multi-storey building”** so as to develop our understanding of the subjects.

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ABSTRACT

Structural design is the primary aspect of civil engineering. The very basis of construction of any building, residential house or dams, bridges, culverts, canals etc. is designing. Structural engineering has existed since humans first started to construct their own structures.

In these modern days the Buildings are made to fulfil our basic aspects and better serviceability. It is not an issue to construct a Building any how its, important to construct an efficient building which will serve for many years without showing any failure. The principle objective of this project is to design the RCC and prestressed concrete multi-storey building using Ms excel and then compare the cost estimation of RCC and prestressed concrete building and later the results will be compared by a software .The idea is to reach a definite conclusion regarding the superiority of the two design over one another.

Overall, the concepts and procedures of designing the basic components of a multistorey building are described. Apart from that, the planning of the building with regard to appropriate directions for the respective rooms, choosing position of beams and columns are also properly explained.

CONTENT

LIST OF FIGURES

APPENDICES

CHAPTER 1:
INTRODUCTION

Without any semblance of doubt, reinforced cement concrete construction has been the most revolutionary construction technique of modern times. Combining the high compressive strength of concrete with high tensile strength and elasticity of steel has resulted in a composite material that is strong, durable and economical. Moreover, it is time tested.

One of the greatest assets of "homo-sapiens" is the quest for excellence. The human being has constantly refused to sit over his laurels and become complacent. This has often resulted in new invention and improved products and techniques. Very weak tensile strength of concrete lead to discovery of R.C.C. The problem of serviceability associated with the R.C.C. structures sent the human mind working over-time. The solution was found in prestressing.

Like ordinary reinforced concrete, prestressed concrete consists of concrete resisting compression and reinforcement carrying tension. Prestressing became essential in many applications in order to fully utilize the compressive strength of reinforced concrete and to eliminate or control cracking and deflection. Prestressed concrete is the most recent major form of construction introduced in the structural engineering. It has become a well-established method of construction as the technology is now available in all developed and in many developing countries. Today, prestressing is used in buildings, underground structures, communication towers, floating storage and offshore structures, power stations, nuclear reactor vessels, and numerous types of bridge systems.

The aim of this project is to design a six storey residential building as close as done by various construction firms. In this project we have working design of structure as well. Next step is to replace some structural elements of this RCC structure with Prestressed elements and compare the material cost of two structures. The idea is to reach a definite conclusion on feasibility and increased use of prestressed concrete in buildings.

1.1. TYPES OF BUILDING

a) HIGH-RISE BUILDINGS

A high rise building is a building that has multiple floors above ground in the building. Multi-storey building aim to increase the area of the building without increasing the area of the land the building is built on, hence saving land and, in most cases money.

b) LOW-RISE BUILDING

Residential buildings are called houses/homes. Single family and multifamily dwellings are typically built as shelter and living space. These building types may range from one-room wood-framed, masonry, or adobe dwellings to multi-million dollar high- rise buildings able to house thousands of people. Generally three rows or less are considered low rise.

1.2. TYPES OF LOADS

DEAD LOAD

Dead loads are permanent or stationary loads which are transferred to the structure throughout their life span. Dead load is primarily due to self-weight of structural members, permanent partition walls, fixed permanent equipment and weighs of different materials.

The unit weights may be taken from IS: 875(part 1)

LIVE LOAD

Live loads are those loads which are transient and can change in magnitude. They include all objects found with in a building during its life as well as external environmental effects such as loads due to the sun, earth or weather. IS 875 (part-2) deals with the imposed loads on roofs, floors, stairs, balconies, etc., for various occupancies.

1.3. MATERIALS

M 25 concrete for RCC, M 40 concrete for prestressed designing, cold twisted high yield strength deformed bars grade Fe 415 conforming to IS: 1786.

1.4. REINFORCED CEMENT CONCRETE

The concrete of the mixture of cement, sand, water and aggregate in a certain proportion with steel bars by a known method is termed as Reinforcement Cement Concrete. Reinforced cement concrete work may be cast-in-situ or Precast as may be directed by Engineer-in-charge according to the nature of work. The most common form of concrete consists of mineral aggregate (gravel & sand), Portland cement and water. After mixing, the cement hydrates and eventually hardens into a stone like material. Recently a large number of additives known as concrete additives are also added to enhance the quality of concrete. Plasticizers, superplasticizers, accelerators, retarders, pozalonic materials, air entertaining agents, fibres, polymers and silica furies are the additives used in concrete. Hardened concrete has high compressive strength and low tensile strength. Concrete is generally strengthened using steel bars or rods known as rebars in tension zone. Such elements are “reinforced concrete” concrete can be moulded to any complex shape using suitable form work and it has high durability, better appearance, fire resistance and economical. For a strong, ductile and durable construction the reinforcement shall have high strength, high tensile strain and good bond to concrete and thermal compatibility.

1.5. PRESTRESSED CONCRETE

Precast concrete consists of concrete (a mixture of cement, water, aggregates and admixtures) that is cast into a specific shape at a location other than its in-service position. The concrete is placed into a form, typically wood or steel, and cured before being stripped from the form, usually the following day. These components are then transported to the construction site for erection into place. Precast concrete can be plant-cast or site-cast, but this book deals specifically with plant-cast concrete. Precast concrete components are reinforced with either conventional reinforcing bars, strands with high tensile strength, or a combination of both. The strands are pretensioned in the form before the concrete is poured. Once the concrete has cured to a specific strength, the strands are cut (detensioned). As the strands, having bonded to the concrete, attempt to regain their original untensioned length, they bond to the concrete and apply a compressive force. This “precompression” increases load-carrying capacity to the components and helps control cracking to specified limits allowed by building codes.

CHAPTER 2:
LITERATURE REVIEW

- **"Research and applications of precast/prestressed concrete systems in Indonesia"**

The capabilities of both state and private sectors to supply good quality low-cost housing units in Indonesia have always been a vital issue. As a country with 220 million inhabitants, the needs of providing low-cost residential units are enormous. Around mid-1980s the Indonesian government started to seriously promote the construction of low-cost multi-storey residential buildings, especially in the big cities. However, not until 2004, i.e. when the State Ministry for People's Housing Affairs launched a national movement to construct *one million* low-cost residential units, precast concrete has been known widely as an appealing alternative building construction material. Since then precast concrete has been used intensively. Several recent research works were Precast Concrete Wall Panel with Precast/Prestressed Half Slab, Beam Column Joint (exterior & interior) and Cast on Site Concrete Wall with Hollow Core Slab plus Topping. It was found that structural construction cost efficiency around 5-10% was generally obtained by replacing conventional structural systems with precast/prestressed concrete. It has also been proved that the construction speed was able to be increased significantly in-line with the achievement of better quality works and more eco-friendly.

- **"Comparative Study of RCC and Prestressed Concrete Flat Slabs"**

This paper presents the comparison of R.C.C. and Prestressed Concrete Flat Slab. This work includes the design and estimates for R.C.C. and Prestressed Concrete flat slabs of various spans. The aim of this work is to design R.C.C. as well as prestressed concrete flat slabs for various spans and then compare the results. Programming in MS EXCEL is done to design both types of flat slabs. The idea is to reach a definite conclusion regarding the superiority of the two techniques over one another. Results reveal that a R.C.C. flat slab is cheaper than pre-stressed concrete flat slab for smaller spans but vice versa is true for larger spans. This work includes the design and estimate for Flat Slabs of various spans, ranging from 6.0 M to 12.0 M, by R.C.C. and Prestressed Concrete techniques. For smaller spans, associated with normal building works, prestressed concrete construction becomes too cumbersome, irrespective of the economics involved. Intensity of assumed loading is kept sufficient enough, so that the factored bending moment will be comparable to that developing in cases of commercial buildings. Post-tensioning is preferred as it is in vogue, in construction of large span slabs. Based on the study conducted, it could be concluded that RCC flat slabs are economical up to 9m span but beyond that pre-stressed concrete flat slabs become a better choice. The cost advantage in percentage terms goes on increasing in favour of prestressed concrete with increasing span. Besides, pre-stressed concrete flat slabs being thinner provide greater headroom & result in lesser seismic forces. Better durability of prestressed concrete structures is already a well-established fact.

- **"Analysis Of Wind-Induced Response Of Tall Reinforced Concrete Building Based On Data Collected By GPS And Precise Inclination Sensor"**

In this study, the behaviour of a tall reinforced concrete building (30 stories) under wind load has been monitored by GPS and inclination sensors. Data collected by these sensors have been analysed in the time and frequency domains. Relative displacements are key to assessing structural dynamics. This paper presents the preliminary results of measurement and analysis of a tall reinforced concrete tall building under a small scale wind loading. The full scale measurement were performed with the aid of GPS, inclination sensor and anemometer. The measured wind induced response of the building from both sensors has been analysed in both the time and frequency domains in order to detect the natural frequency of the building and to compare the measured frequency with the predicted frequency from the Finite Element method (FEM). In this study, GPS, inclinometer and anemometer have been installed on a tall reinforced concrete building. The data have been collected during a small scale wind event, mostly in the South-West direction. The measured wind-induced response of the building from both sensors has been analysed in both the time and frequency domains for the purpose of detecting natural frequency of the building and comparing the sensors with each other as well as comparing the measured frequency with the predicted frequency obtained from FEM.

- **"Comparative study of flexural behaviour of reinforced concrete beam and prestressed concrete beam"**

The aim of present work is to compare the economics and structural behaviour of the reinforced concrete and prestressed concrete beams and finding out the suitability of each. In order to study structural behaviour of reinforced concrete and prestressed concrete flexure members, it is proposed to cast the beams of 2.5 m and 3.0 m spans of each type with the same cross-section of 100 mm width and 150mm overall depth. For reinforced concrete beam, it is proposed to have a concrete grade of M20 and H.Y.S.D. (Fe415) steel reinforcement, which are normally used in practice. For prestressed concrete beam, it is proposed to use a concrete grade M35 and H.T.S. wires of 3.75 mm diameter with ultimate tensile strength of 1475 N/mm^2.As can be seem from the results tabulated and graphs of load v/s deflection that the deflection for first few loads was well matching with the theoretical values. Also the graph shows a linear pattern for these values. But afterwards the rate of increase in deflection increases with load and this may be because of the cracking of concrete. Thus it can be Conclude that the cracking moment is the one at which the linear pattern of graph ends.

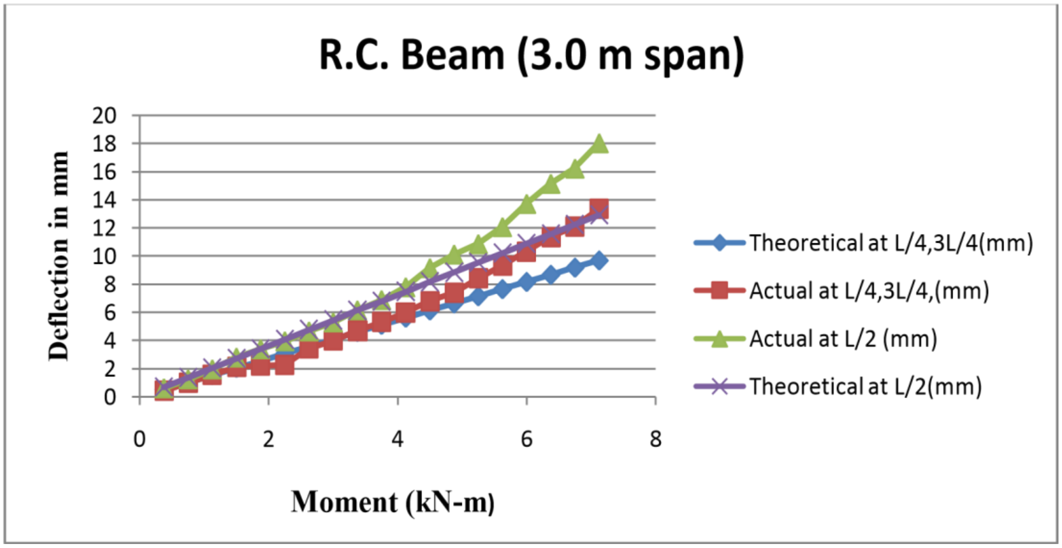


Fig. 1: Moment vs Deflection for RC beam 3m span

CHAPTER 3:

LAYOUT AND DETAILS OF STRUCTURE

We have taken a 6 storey (G+5) residential building which has 6 1BHK apartments on each floor and a common lobby. The building is provided with doglegged staircase for accessing different floors as well as lift facility is also provided. Building has parking area on ground floor and common roof.

The factor that has been considered while selecting the building site is as follows:-

• Access to park & playground.

• Availability of public utility services, especially water, electricity & sewage disposal.

• Contour of land in relation the building cost. Cost of land.

• Distance from places of work.

• Ease of drainage.

• Location with respect to school, collage & public buildings.

• Nature of use of adjacent area.

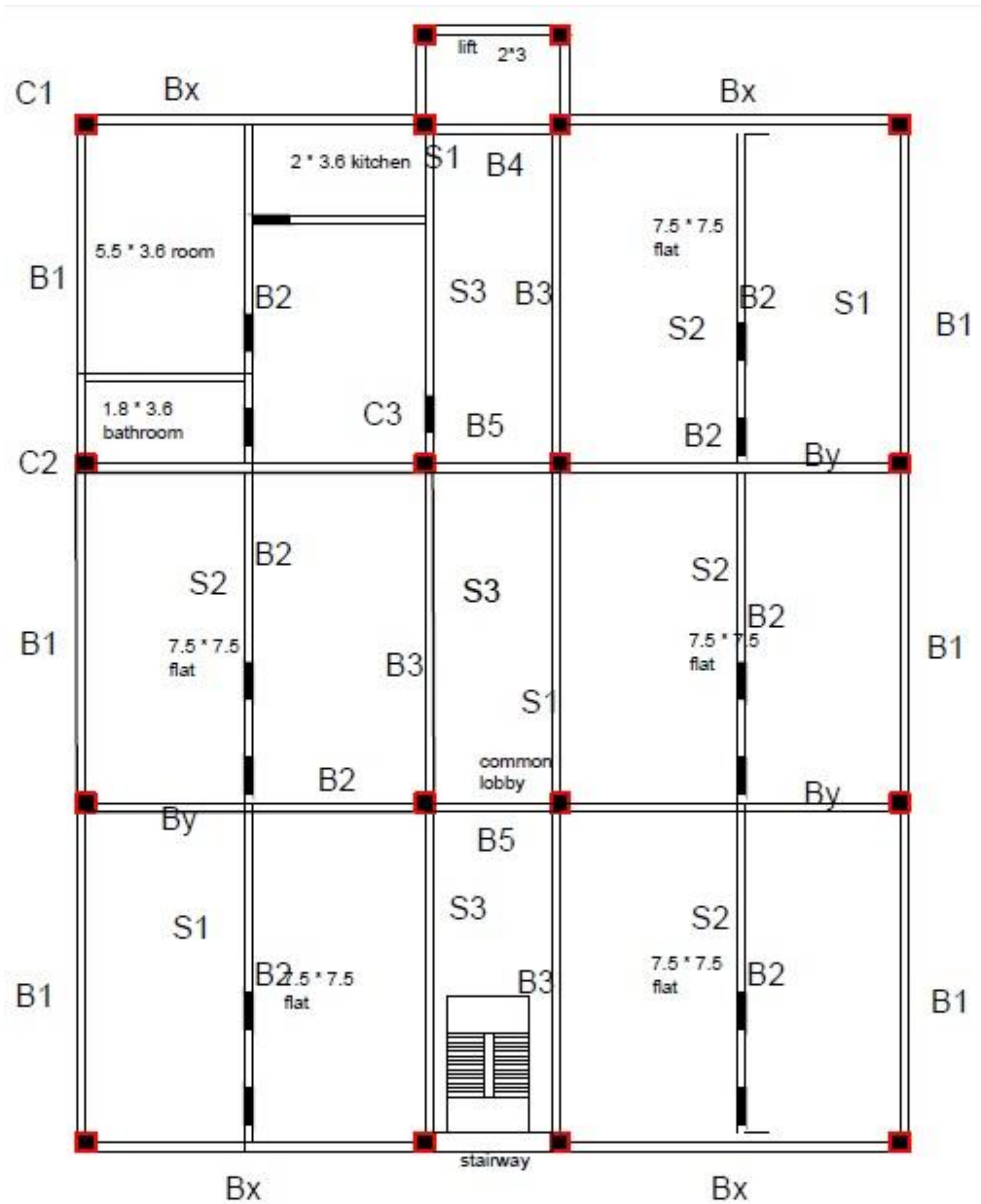
• Transport facilities.

3.1 MINIMUM FLOOR AREA & HEIGHT OF ROOMS

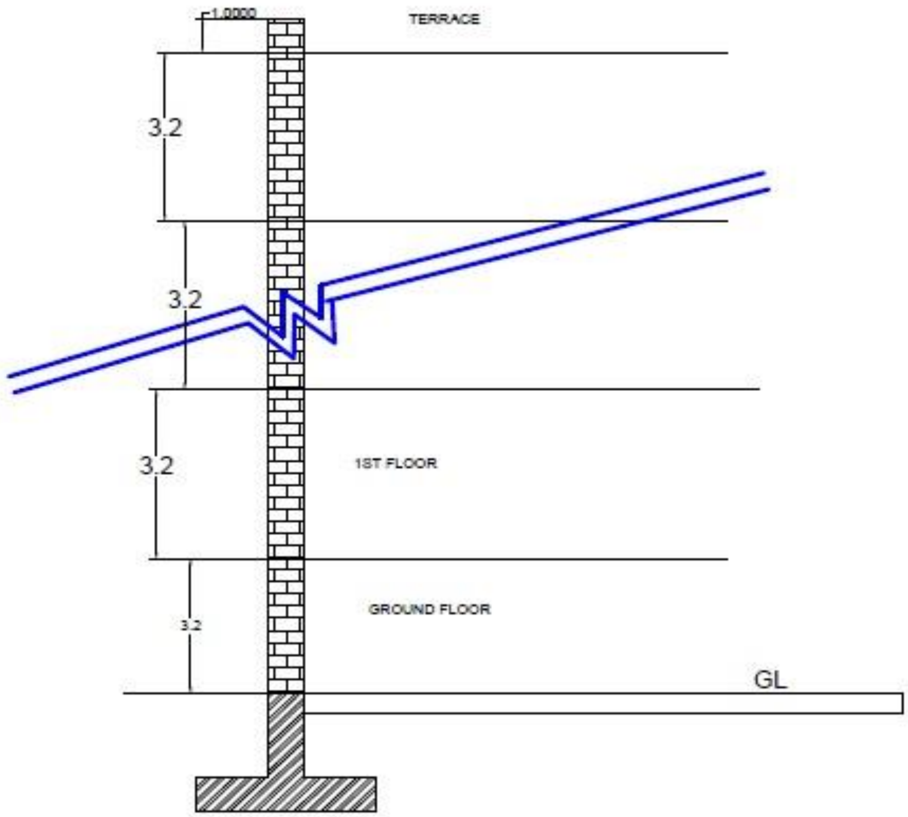
FLOOR AREA

- LIVING 5.3m * 3.6m (19.08 m2)
- BED ROOM 5.5m * 3.6m (19.8 m2)
- KITCHEN 2m *3.6m (7.2 m2)
- BATH & LATTRINE 1.8m * 3.6m (6.48 m2)
- HEIGHT OF EACH FLOOR 3.2 m

1) Plan was made using Autocad.



2) Elevation of building



3.2 LOADING ON STRUCTURE

The structure is designed for dead load and live load cases. Dead load has been calculated using IS code 875:2000 part 1 and live load has been taken for residential building from IS code 875:2000 part 2.

CHAPTER 4:

DESIGN OF STRUCTURE

4.1 DESIGN OF RCC SLAB

4.1.1 GENERAL

A slab is a flat two dimensional planar structural element having thickness small compared to its other two dimensions. It provides a working flat surface or a covering shelter in buildings. It primarily transfer the load by bending in one or two directions. Reinforced concrete slabs are used in floors, roofs and walls of buildings and as the decks of bridges. The floor system of structure can take many forms such as in situ solid slab, ribbed slab or pre-cast units. Slabs maybe supported on monolithic concrete beam, steel beams, walls or directly over the columns. Concrete slab behave primarily as flexural members and the design is similar to that of beams.

4.1.2 CLASSIFICATION OF SLABS

Slabs are classified based on many aspects:

(1) **Based of shape:** Square, rectangular, circular and polygonal in shape.

(2) **Based on type of support:** Slab supported on walls, Slab supported on beams, Slab supported on columns (Flat slabs).

(3) **Based on support or boundary condition:** Simply supported, Cantilever slab, Overhanging slab, Fixed or Continues slab.

(4) **Based on use:** Roof slab, Floor slab, Foundation slab, Water tank slab.

(5) **Basis of cross section or sectional configuration:** Ribbed slab/Grid slab, Solid slab, Filler slab, folded plate

(6) **Basis of spanning directions:**

One way slab – Spanning in one direction

Two way slab _ Spanning in two direction

Two way slabs

There are two types of two way slabs

(a) Simply supported slab

(b) Restrained slabs

a. Two way simply supported slabs

The bending moments Mx and My for a rectangular slabs simply supported on all four edges with corners free to lift or the slabs do not having adequate provisions to prevent lifting of corners are obtained using coefficients given in Table 1 (Table 27,IS 456-2000)

b. Two way Restrained slabs

When the two way slabs are supported on beam or when the corners of the slabs are prevented from lifting the bending moment coefficients are obtained from Table 2 (Table 26, IS456-2000) depending on the type of boundary conditions. These coefficients are obtained using yield line theory. Since, the slabs are restrained; negative moment arises near the supports.We have considered our slabs to be restrained.

We have divided the design of slab on the type of boundary conditions for two way slabs. In our structure we have these two types of two way slabs:

- Two adjacent sides discontinuous (type 1)
- One short edge discontinuous (type 2)

<u>One way slabs</u>

The slabs spanning in one direction and continuous over supports are called one way continuous slabs. These are idealized as continuous beam of unit width. For slabs of uniform section which support substantially UDL over three or more spans which do not differ by more than 15% of the longest, the B.M and S.F are obtained using the coefficients available in Table 12 and Table 13 of IS 456-2000. For moments at supports where two unequal spans meet or in case where the slabs are not equally loaded, the average of the two values for the negative moments at supports may be taken. Alternatively, the moments may be obtained by moment distribution or any other methods.

4.1.3 DESIGN OF ROOF SLAB

Slabs are designed using limit state method as per IS 456:2000. In roof slab we have taken live load=1.5 KN/m2 from table 2 of IS 875:2000 part 2: Imposed loads on various types of roofs. We have taken different panels of slabs and designed them individually and found the critical panel for which the whole slab is designed.

4.1.4 DESIGN OF FLOORS SLAB

Each floor has same structure and same loading so design of slab for one floor gives design of slab of all floors. Live load on floor slab is 2 KN/m2 taken from IS 875: 2000 part 2 for residential buildings. We have taken different panels of slabs and designed them individually and found the critical panel for which the whole slab is designed.

4.2 DESIGN OF RCC BEAMS

Beam is a member which transfers the loads from slab to columns and then foundation to soil.

• Beam is a tension member.

• Span of slabs, which decide the spacing of beams.

<u>Following are the loads which are acting on the beams.</u>

• Dead load

• Live load

In this structure we have considered beams as T and L beams for design purpose. This structure also has secondary beams. We have used yield line theory for load distribution from slabs to beam.

DESIGN OF ROOF SLAB (S1)

1	**Trail depth and effective span**			
	Clear span	length	7.5	m
		width	3.6	m
		L/B ratio	2	
		Type of slab	two way	
	From deflection criteria {l/d=26*m}	depth	123.40	mm
		D	150	mm
		deff	125	mm
		Ly	7.625	m
		Lx	3.725	m
		α(ly/lx)	2.000	
2	**LOAD ON SLAB**			
		Self Weight	3.75	KN/m2
		Imposed Load	1.5	KN/m2
		floor finish	0.3	KN/m2
		Ultimate Load W	8.325	KN/m2
		αx(+)	0.069	
		αy(+)	0.035	
3	**positive moment at mid span**			
		short span	7.97	KNm/m
		long span	16.94	KNm/m
4	**negative moment at edges**			
		short span	10.63	KNm/m
		long span	22.59	KNm/m
5	**Minimum depth required from Maximum BM consideration**			
		d'	82.421	mm
			design is safe	
6	**area of reinforcement(per m width)**			
	short span	ast for + moment	225.000	mm2/m
		ast for - moment	243.356	mm2/m
	long span			
		ast for + moment	396.241	mm2/m
		ast for - moment	539.118	mm2/m
7	**spacing of bars**			
	providing bars of dia		10	mm
		spacing for short span M(+)	300.000	mm/m
		spacing for short span M(-)	300.000	mm/m
		spacing for long span M(+)	198.112	mm/m
		spacing for long span M(-)	145.608	mm/m
8	**check for cracking**			
	steel should be more than 0.15% of the gross area =		225	mm2/m
			ok	
9	**detailing of reinforcement**			
		based on requirements of reinforcements calculated above ,the detailing in middle strip and edge strip(.1Lx or .1Ly) is shown in figure.		
		Nominal top steel(.5 ast) is provided at edges agaist negative moments		
10	**torsional reinforcement at corners**			
		mesh extending 0.2Lx on each side in 4 layers		
		at corner of two edges discontinuous ast =	404.339	mm2/m
		at corner with one edges discontinuous ast=	202.169	mm2/m

KNOWN DATA

M25
FE 415
MONOLITHIC
clear cover 20(mild exposure)
density of conc.=25 kn/m3
dia of main bars =10mm
bc 1 : two adjacent discontinuous
modification factor=1.2

assuming width of beam=250mm

taking dia of bars as 10mm

TABLE 2 IMPOSED LOADS ON VARIOUS TYPES OF ROOFS

(Access provided) IS 875 part 2

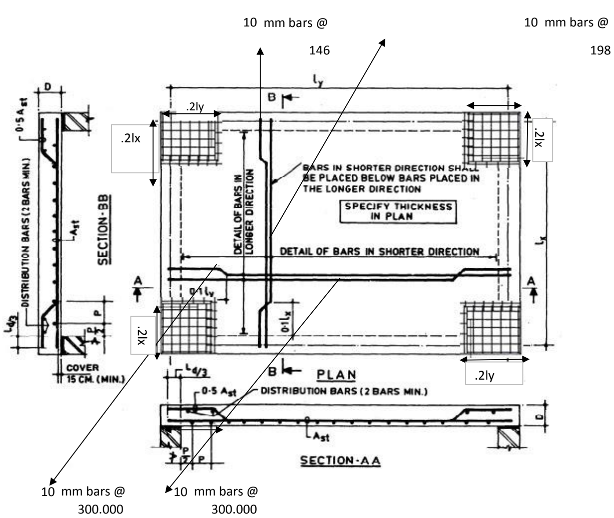
The boundary condition of slab in two adjacent edges	
discontinuous (case 4, Table 9.5.2)	**IS 456-2000**

as αx(-)=4*αx(+)/3

$$\frac{(A_{st})_{reqd}}{bd} = \frac{f_{ck}}{2f_y}\left[1-\sqrt{1-4.598M_u/(f_{ck}bd^2)}\right]$$

check : less than 300mm or 3d whichever is less

300



DESIGN OF ONE WAY SLAB(S3)

KNOWN DATA	**M25**
	FE 415
	MONOLITHIC
	clear cover 20mm(mild exposure)
	density of conc.=25 kn/m3
	modification factor=1.2

1	**Trial depth and effective span**			
	clear span	length	7.5	m
		width	2.6	m
		L/B ratio	2.9	
		type of slab	one way	
	From deflection criteria {l/d=(20+26/2)*m}	depth	103.261	mm
		D	120	mm
		deff	96	mm
		Lx	7.596	m
		Ly	2.696	m

assuming width of beam=250mm

Assume a uniform thickness for both end span and interior span.The 'end span', which is critical, is discontinuous on one edge and continuous at the other.

2	**load on Slab**			
		Self Weight	3	KN/m2
		Imposed Load	1.5	KN/m2
		floor finish	0.3	KN/m2
		factored L.L	2.25	KN/m2
		factored D.L	4.95	KN/m2
3	**Moment calculation**			
	For end span	Mu(end)	-2.181	Knm/m
		Mu(mid)	4.634	Knm/m
		Mu(interior)	-5.415	Knm/m
	For interior span	Mu(mid)	3.611	Knm/m
		Mu(interior)	-5.415	Knm/m

$$M_u = \begin{cases} -\left(\frac{w_{u,DL} + w_{u,LL}}{24}\right)l^2 & \text{at end support} \\ +\left(\frac{w_{u,DL}}{12} + \frac{w_{u,LL}}{10}\right)l^2 & \text{at midspan} \\ -\left(\frac{w_{u,DL}}{10} + \frac{w_{u,LL}}{9}\right)l^2 & \text{at interior support} \end{cases}$$

$$+\left(\frac{w_{u,DL}}{16} + \frac{w_{u,LL}}{12}\right)l^2 \quad \text{at midspan}$$

For interior span

4	**Minimum depth required from Maximum BM**			
		d'	37.331	mm
			design is safe	
5	**area of reinforcement(per m width)**			
	for end span	ast @ end support	63.61	mm2/m
		ast @ mid span	136.94	mm2/m
		ast @ interior support	160.70	mm2/m
	for interior span	ast @ mid span	106.15	mm2/m
		ast @ interior support	160.70	mm2/m
	distribution bars Ast min=.0012bD		144	mm2/m

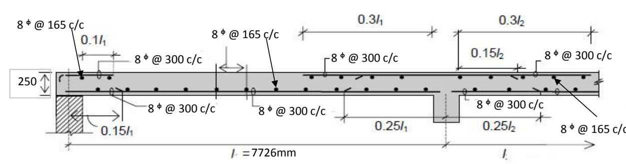
$$\frac{(A_{st})_{reqd}}{bd} = \frac{f_{ck}}{2f_y}\left[1 - \sqrt{1 - 4.598M_u/(f_{ck}bd^2)}\right]$$

6	**spacing of bars**			
	providing bars of dia		10	
	for end span	spacing @ end support	1234	mm/m
		spacing @ mid span	573.2617	mm/m
		spacing @ interior support	488.4778	mm/m
	for interior span	spacing @ mid span	739.5158	mm/m
		spacing @ interior support	488.4778	mm/m
	after check	spacing @ end support	288	mm/m
		spacing @ mid span	288	mm/m
		spacing @ interior support	288	mm/m
		spacing @ mid span	288	mm/m
		spacing @ interior support	288	mm/m
		spacing of distribution steel	288	mm/m

check : less than 300mm or 3d whichever is less

288

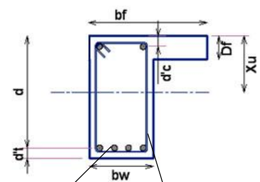
7	**detailing of reinforcement**	
		based on requirements of reinforcements calculated above ,the detailing in middle span, end support(.1Lx or .1Ly) & interior support is shown in figure.



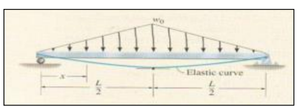
DESIGN OF L-BEAMS IN MAIN SLAB(B1)

KNOWN DATA	
	M25
	FE 415
	MONOLITHIC
	clear cover 25mm
	density of conc.=25 kn/m3
	modification factor =1.2
	τ_{cmax} for M25 =3.1Mpa

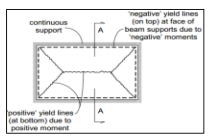
1	**Effective flange width**						
		effective span in long direction	Leff	7.625	m	**from slab design**	
		thickness of slab	Df	150	mm	**from slab design**	
		width of web	bw	250	mm	**as assumed in slab design**	
		width of flange	Bf	1144.79	mm	**Bf=Lo/12+bw+3Df**	
		effective span in short direction	Leff	3.725	m		
		which is acceptable as it is less than bw + clear span of slab					
2	**Overall depth**						
		deflection criteria {l/d=26*m}	depth	244.4	mm		
			D	260.0	mm		
			Deff	222.5	mm		
3	**moment Mu calculation**						
		factored	load from slab	8.33	kn/m2		
			slab load transferred to beam	15.51	kn/m		
		factored	load from parapet wall	1.91	kn/m	for 100 mmparapett brick wall of 1 m height from IS 875-II table 2	
		factored	D.L due to self wt of beam	0.69	Kn/m		
			moment(max at mid span)	131.56	kn-m		
			moment(at supports)	105.25	kn-m		
4	**ast calculation**						
		case 1: let Xu= Df & calculate moment					
			M	246.502	kn-m		
		M resisted by beam is more than M due to load					
			design moment Mu=	131.56	kn-m		
		beam is designed as a singly reinforced rectangular section					
			astreq at mid span	1864.34	mm2		
		providing bars of dia	25				
			n	4.00	bars @	**50**	**mm spacing**
			astreq at supports	1446.65	mm2		
		providing bars of dia	25				
			n	3.00	bars @	**67**	**mm spacing**
5	**design of stirrups**						
		shear force	V	69.02	Kn		
		shaer stress	τv	1.062	N/mm2		
				less than τmax			
		shear strength of conc.	τc	0.51	N/mm2		
				provide min steel			
6	**spacing of stirrups**						
		providing 2 bars of 8mm	Asv	100.48	mm2		
		spacing of bars	Sv	363	mm		
			max spacing	195	mm		
			So spacing	195	mm c/c		



4 bars of dia 25
at 50 mm spacing
8 dia stirrups
195 mm spacing c/c



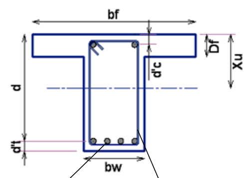
load transferred to beam using yield line theory



DESIGN OF SECONDARY T-BEAMS IN MAIN SLAB(B2)

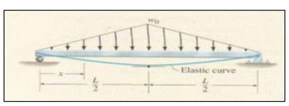
KNOWN DATA	
	M25
	FE 415
	MONOLITHIC
	clear cover 25mm
	density of conc.=25 kn/m3
	τ_{cmax} for M25 =3.1Mpa

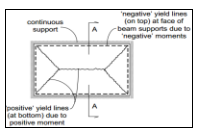
1	**Effective flange width**							
		effective span	Leff	7.625	m	**from slab design**		
		thickness of slab	Df	150	mm	**from slab design**		
		width of web	bw	250	mm	**as assumed in slab design**		
		width of flange	Bf	2039.58	mm	**Bf=Lo/6+bw+6Df**		
		effective span in short direction	Leff	3.725	m			
		which is acceptable as it is less than bw + clear span of slab						
2	**Overall depth**							
		deflection criteria {l/d=26*m}	depth	244.4	mm			
			D	260.0	mm			
			Deff	222.5	mm			
3	**moment Mu calculation**							
		factored	load from slab	8.33	kn/m2			
			slab load transferred to beam	31.01	kn/m			
		factored	D.L due to self wt of beam	0.69	Kn/m			
			moment(max at mid span)	230.37	kn-m			
			moment(at supports)	184.29	kn-m			
4	**ast calculation**							
		case 1: let Xu= Df & calculate moment						
			M	542.43	kn-m			
		M resisted by beam is more than M due to load						
			design moment Mu=	230.37	kn-m			
		beam is designed as a singly reinforced rectangular section						
			astreq at mid span	2678.85	mm2			
		providing bars of dia	25					
			n	6.00	bars @	**33**	**mm spacing**	
			astreq at supports	2101.63	mm2			
		providing bars of dia	25					
			n	5.00	bars @	**40**	**mm spacing**	
5	**design of stirrups**							
		shear force	V	120.85	Kn			
		shaer stress	τv	1.859	N/mm2			
				less than τmax				
		shear strength of conc.	τc	0.51	N/mm2	for M25 & Pt=2% from table 23 is 456: 2000		
				provide min steel				
6	spacing od stirrups							
		providing 2 bars of 8mm	Asv	100.48	mm2			
		spacing of bars	Sv	363	mm			
			max spacing	195	mm			
			So spacing	195	mm c/c			



6.00 bars of dia 25
@ 33 mm c/c

8 dia stirrups
195 mm spacing c/c



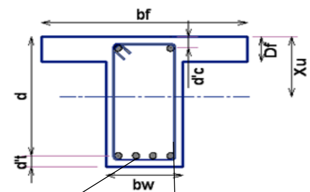


load transferred to beam using yield line theory

DESIGN OF LONG T-BEAMS IN COMMON LOBBY SLAB(B3)

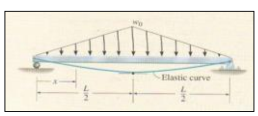
KNOWN DATA	M25
	FE 415
	MONOLITHIC
	clear cover 25mm
	density of conc.=25 kn/m3
	τcmax for M25 =3.1Mpa

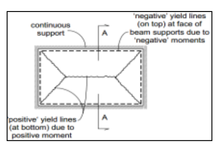
1	**Effective flange width**						
		effective span in longer direction	Leff	7.625	m	**from slab design**	
		thickness of slab	Df	150	mm	**from slab design**	
		width of web	bw	250	mm	**as assumed in slab design**	
		effective span in shorter direction		2.85	m		
		width of flange	Bf	2039.58	mm	**Bf=Lo/12+bw+3Df**	
		which is acceptable as it is less than bw + clear span of slab					
2	**Overall depth**						
		deflection criteria {l/d=2	depth	244.4	mm		
			D	260.0	mm		
			Deff	222.5	mm		
3	**moment Mu calculation**						
		factored	load from slab	8.33	kn/m2		
			slab load transferred to beam	27.73	kn/m		
		factored	D.L due to self wt of beam	0.69	Kn/m		
			moment(max at mid span)	206.55	kn-m		
			moment(at supports)	165.24	Kn=m		
4	**ast calculation**						
		case 1: let Xu= Df & calculate moment					
			M	542.427	kn-m		
		M resisted by beam is more than M due to load					
			design moment Mu=	206.55	kn-m		
		beam is designed as a singly reinforced rectangular section					
			astreq at midspan	2377.33	mm2		
		providing bars of dia	25				
			n	5.00	bars @	**40**	**mm spacing**
			astreq atsupport	1869.77	mm2		
		providing bars of dia	25				
			n	4.00	bars @	**50**	**mm spacing**
5	**design of stirrups**						
		shear force	V	108.35	Kn		
		shaer stress	τv	1.667	N/mm2		
				less than τmax		for M25 & Pt=2%	
		shear strength of conc.	τc	0.51	N/mm2	from table 23 is 456:	
				provide min steel		2000	
6	**spacing od stirrups**						
		providing 2 bars of 8mm	Asv	100.48	mm2		
		spacing of bars	Sv	363	mm		
			max spacing	195	mm		
			So spacing	195	mm c/c		



5.00 bars of dia 25
@ 40 mm c/c

8 dia stirrups
195 mm spacing c/c



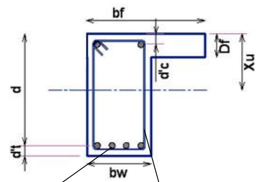


load transferred to beam using yield line theory

DESIGN OF L-BEAMS IN LOBBY (B4)

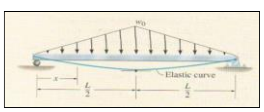
KNOWN DATA	M25
	FE 415
	MONOLITHIC
	clear cover 25mm
	density of conc.=25 kn/m3
	τcmax for M25 =3.1Mpa

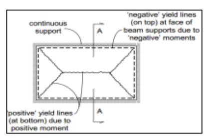
1	**Effective flange width**						
		effective span in shorter dir	Leff	3	m	**from slab design**	
		thickness of slab	Df	230	mm	**from slab design**	
		width of web	bw	400	mm	**as assumed in slab design**	
		width of flange	Bf	2130.00	mm	**Bf=Lo/12+bw+3Df**	
		which is acceptable as it is less than bw + clear span of slab					
2	**Overall depth**						
		let overall depth D=	leff/15=	200.0	mm		
			Deff	230.0	mm		
3	**moment Mu calculation**						
		factored	load from slab	8.33	kn/m2		
			slab load transferred to beam	12.49	kn/m		
		factored	load from parapet wall	1.91	kn/m	for 100 mmparapett brick wall of 1 m height from IS 875-II table 2	
		factored	D.L due to self wt of beam	0.00	Kn/m		
			moment(max at mid span)	16.20	kn-m		
			moment(at support)	12.96	kn-m		
4	**ast calculation**						
		case 1: let Xu= Df & calculate moment					
			M	588.17394	kn-m		
		M resisted by beam is more than M due to load					
			design moment Mu=	16.20	kn-m		
		beam is designed as a singly reinforced rectangular section					
			astreq at mid span	196.37	mm2		
		providing bars of dia	10				
			n	3.00	bars @	**117**	**mm spacing**
			astprov	235.50	mm2		
			astreq at support	156.88	mm2		
		providing bars of dia	10				
			n	2.00	bars @	**175**	**mm spacing**
4	**check for deflection control**						
			%steel	1.00			
			Fs	201.00	N/mm2		
		modification factor	m	0.94	Ref. Fig.4 of IS 456 : 2000]		
			L/d	13.04			
			L/dmax	18.78			
				safe			
5	**design of stirrups**						
		shear force	V	21.60	Kn		
		shaer stress	τv	0.235	N/mm2		
				less than τmax			
		shear strength of conc.	τc	0.4	N/mm2	for M25 & Pt=1% from table 23 is 456: 2000	
				design for (E47-E45)bd			
6	**spacing od stirrups**						
		providing 2 bars of 8mm	Asv	100.48	mm2		
		spacing of bars	Sv	227	mm		
			max spacing	172.5	mm		
			So spacing	172.5	mm c/c		



3 bars of 20mm dia @ 175mm spacing

172.5 mm spacing c/c



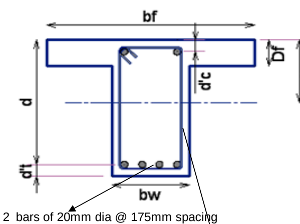


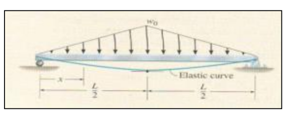
load transferred to beam using yield line theory

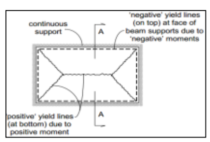
DESIGN OF SHORT T-BEAMS IN LOBBY SLAB(B5)

KNOWN DATA	
	M25
	FE 415
	MONOLITHIC
	clear cover 25mm
	density of conc.=25 kn/m3
	τcmax for M25 =3.1Mpa

1	Effective flange width						
		effective span in shorter dir	Leff	3	m	from slab design	
		thickness of slab	Df	150	mm	from slab design	
		width of web	bw	250	mm	as assumed in slab design	
		effective span in longer dir	L'eff	7.505	m		
		width of flange	Bf	1500.00	mm	Bf=Lo/12+bw+3Df	
		which is acceptable as it is less than bw + clear span of slab					
2	Overall depth						
		let overall depth D=	leff/15=	200.0	mm		
			Deff	150.0	mm		
3	moment Mu calculation						
		factored	load from slab	8.33	kn/m2		
			slab load transferred to beam	24.98	kn/m		
		factored	D.L due to self wt of beam	0.00	Kn/m		
			moment(max at mid span)	28.10	kn-m		
			moment(at support)	22.48	kn-m		
4	ast calculation						
		case 1: let Xu= Df & calculate moment					
			M	176.175	kn-m		
		M resisted by beam is more than M due to load					
			design moment Mu=	28.10	kn-m		
		beam is designed as a singly reinforced rectangular section					
			astreq at midspan	540.38	mm2		
		providing bars of dia	20				
			n	2.00	bars @	100	mm spacing
			astprov	628.00	mm2		
			ast req at support	428.62	mm2		
		providing bars of dia	20				
			n	2.00	bars @	100	mm spacing
5	check for deflection control						
			%steel	1.00			
			Fs	207.00	N/mm2		
		modification factor	m	0.92	Ref. Fig.4 of IS 456 : 2000]		
			L/d	15.00			
			L/dmax	18.45			
				safe			
6	design of stirrups						
		shear force	V	37.46	Kn		
		shaer stress	τv	0.999	N/mm2		
				less than τmax			
		shear strength of conc.	τc	0.4	N/mm2	for M25 & Pt=1% from table 23 is 456: 2000	
				provide min steel			
7	spacing od stirrups						
		providing 2 bars of 8mm	Asv	100.48	mm2		
		spacing of bars	Sv	363	mm		
			max spacing	112.5	mm		
			So spacing	112.5	mm c/c		





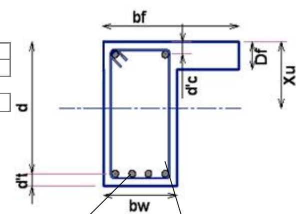


load transferred to beam using yield line theory

DESIGN OF L-BEAMS IN MAIN SLAB(Bx)

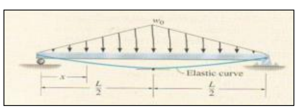
KNOWN DATA	
	M25
	FE 415
	MONOLITHIC
	clear cover 25mm
	density of conc.=25 kn/m3
	modification factor =1.2
	τ_{cmax} for M25 =3.1Mpa

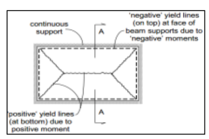
1	**Effective flange width**					
	effective span in long direction	Leff	7.625	m	**from slab design**	
	thickness of slab	Df	150	mm	**from slab design**	
	width of web	bw	250	mm	**as assumed in slab design**	
	width of flange	Bf	1144.79	mm	**Bf=Lo/12+bw+3Df**	
	effective span in short direction	Leff	3.725	m		
	which is acceptable as it is less than bw + clear span of slab					
2	**Overall depth**					
	deflection criteria {l/d=26*m}	depth	244.4	mm		
		D	260.0	mm		
		Deff	222.5	mm		
3	**moment Mu calculation**					
	factored	load from slab	8.33	kn/m2		
		slab load transferred on half beam in form of triangle load	15.51	kn/m		
		concentrated laod due to secondary beam	59.11	kn		
	factored	load from parapet wall	1.91	kn/m	for 100 mmparapett brick wall of 1 m height from IS 875-II table 2	
	factored	D.L due to self wt of beam	0.69	Kn/m		
		max moment at midspan	115.14	kn-m	calculated by drawing BMD	
		moment at support	92.11	kn-m		
4	**ast calculation**					
	case 1: let Xu= Df & calculate moment					
		M	246.502	kn-m		
	M resisted by beam is more than M due to load					
		design moment Mu=	115.14	kn-m		
	beam is designed as a singly reinforced rectangular section					
		astreq at midspan	1600.23	mm2		
	providing bars of dia	25				
		n	4.00	bars @	**50**	**mm spacing**
		astreq at support	1248.22	mm2		
	providing bars of dia	25				
		n	3.00	bars @	**67**	**mm spacing**
5	**design of stirrups**					
	shear force	V	69.02	Kn	calculated by drawing BMD	
	shaer stress	τ_v	1.062	N/mm2		
			less than τ_{max}			
	shear strength of conc.	τ_c	0.51	N/mm2		
			provide min steel			
6	**spacing od stirrups**					
	providing 2 bars of 8mm	Asv	100.48	mm2		
	spacing of bars	Sv	363	mm		
		max spacing	195	mm		
		So spacing	195	mm c/c		



4 bars of dia 25 at 50 mm spacing

8 dia stirrups 195 mm spacing c/c





load transferred to beam using yield line theory

DESIGN OF FLOOR SLAB (F1)

KNOWN DATA

M25
FE 415
MONOLITHIC
clear cover 20(mild exposure)
density of conc.=25 kn/m3
dia of main bars =10mm
bc 1 : two adjacent discontinuous
modification factor=1.2

1	**Trail depth and effective span**			
	Clear span	length	7.5	m
		width	3.6	m
		L/B ratio	2	
		Type of slab	two way	
	From deflection criteria {l/d=26*m}	depth	123.40	mm
		D	150	mm
		deff	125	mm
		Ly	7.625	m
		Lx	3.725	m
		α(ly/lx)	2.000	
2	**LOAD ON SLAB**			
		Self Weight	3.75	KN/m2
		Imposed Load	2	KN/m2
		floor finish	1	KN/m2
		Ultimate Load W	10.125	KN/m2
		αx(+)	0.069	
		αy(+)	0.035	
3	**positive moment at mid span**			
		short span	9.69	KNm/m
		long span	20.60	KNm/m
4	**negative moment at edges**			
		short span	12.93	KNm/m
		long span	27.47	KNm/m
5	**Minimum depth required from Maximum BM consideration**			
		d'	90.896	mm
			design is safe	
6	**area of reinforcement(per m width)**			
	short span	ast for + moment	225.000	mm2/m
		ast for - moment	298.219	mm2/m
	long span			
		ast for + moment	488.208	mm2/m
		ast for - moment	667.999	mm2/m
7	**spacing of bars**			
	providing bars of dia	10	mm	
		spacing for short span M(+)	300.000	mm/m
		spacing for short span M(-)	263.229	mm/m
		spacing for long span M(+)	160.792	mm/m
		spacing for long span M(-)	117.515	mm/m
8	**check for cracking**			
	steel should be more than 0.15% of the gross area =		225	mm2/m
			ok	
9	**detailing of reinforcement**			
		based on requirements of reinforcements calculated above ,the detailing in middle strip and edge strip(.1Lx or .1Ly) is shown in figure.		
		Nominal top steel(.5 ast) is provided at edges agaist negative moments		
10	**torsional reinforcement at corners**			
		mesh extending 0.2Lx on each side in 4 layers		
		at corner of two edges discontinuous ast =	500.999	mm2/m
		at corner with one edges discontinuous ast=	250.500	mm2/m

assuming width of beam=250mm

taking dia of bars as 10mm

TABLE 1 IMPOSED FLOOR LOADS FOR DIFFERENT OCCUPANCIES IS 875-2

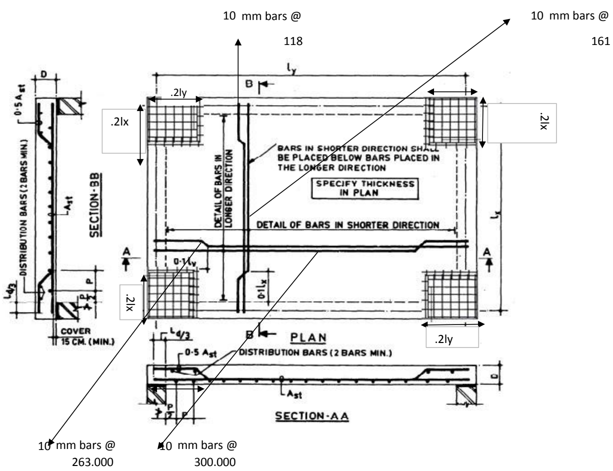
The boundary condition of slab in two adjacent edges discontinuous (case 4, Table 9.5.2) **IS 456-2000**

as αx(-)=4*αx(+)/3

$$\frac{(A_{st})_{reqd}}{bd} = \frac{f_{ck}}{2f_y}\left[1-\sqrt{1-4.598M_u/(f_{ck}bd^2)}\right]$$

check : less than 300mm or 3d whichever is less

300



DESIGN OF ONE WAY SLAB(F3)

KNOWN DATA	M25
	FE 415
	MONOLITHIC
	clear cover 20mm(mild exposure)
	density of conc.=25 kn/m3
	modification factor=1.2

1	**Trial depth and effective span**			
	clear span	length	7.5	m
		width	2.6	m
		L/B ratio	2.9	
		type of slab	one way	
	From deflection criteria {l/d=(20+26/2)*m}	depth	103.261	mm
		D	120	mm
		deff	96	mm
		Lx	7.596	m
		Ly	2.696	m
2	**load on Slab**			
		Self Weight	3	KN/m2
		Imposed Load	2	KN/m2
		floor finish	1	KN/m2
		factored L.L	3	KN/m2
		factored D.L	6	KN/m2
3	**Moment calculation**			
	For end span	Mu(end)	-2.726	Knm/m
		Mu(mid)	5.815	Knm/m
		Mu(interior)	-6.784	Knm/m
	For interior span	Mu(mid)	4.543	Knm/m
		Mu(interior)	-6.784	Knm/m
4	**Minimum depth required from Maximum BM consideration**			
		d'	41.819	mm
			design is safe	
5	**area of reinforcement(per m width)**			
	for end span	ast @ end support	79.74	mm2/m
		ast @ mid span	172.94	mm2/m
		ast @ interior support	202.85	mm2/m
	for interior span	ast @ mid span	134.19	mm2/m
		ast @ interior support	202.85	mm2/m
	distribution bars Ast min=.0012bD		144	mm2/m
6	**spacing of bars**			
	providing bars of dia		10	
	for end span	spacing @ end support	984.4165	mm/m
		spacing @ mid span	453.9046	mm/m
		spacing @ interior support	386.9872	mm/m
	for interior span	spacing @ mid span	585.0117	mm/m
		spacing @ interior support	386.9872	mm/m
	after check	spacing @ end support	288	mm/m
		spacing @ mid span	288	mm/m
		spacing @ interior support	288	mm/m
		spacing @ mid span	288	mm/m
		spacing @ interior support	288	mm/m
		spacing of distribution steel	288	mm/m
7	**detailing of reinforcement**			
		based on requirements of reinforcements calculated above ,the detailing in middle span, end support(.1Lx or .1Ly) & interior support is shown in figure.		

assuming width of beam=250mm

Assume a uniform thickness for both end span and interior span.The ‘end span’, which is critical, is discontinuous on one edge and continuous at the other.

FROM TABLE 1 IMPOSED LOADS

$$M_u = \begin{cases} -\left(\frac{w_{u,DL}+w_{u,LL}}{24}\right)l^2 & \text{at end support} \\ +\left(\frac{w_{u,DL}}{12}+\frac{w_{u,LL}}{10}\right)l^2 & \text{at midspan} \\ -\left(\frac{w_{u,DL}}{10}+\frac{w_{u,LL}}{9}\right)l^2 & \text{at interior support} \end{cases}$$

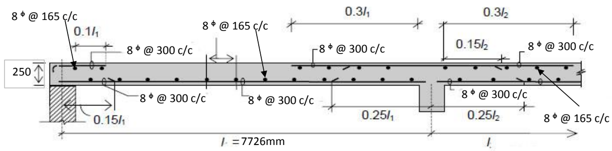
$$+\left(\frac{w_{u,DL}}{16}+\frac{w_{u,LL}}{12}\right)l^2 \quad \text{at midspan}$$

For interior span

$$\frac{(A_{st})_{reqd}}{bd} = \frac{f_{ck}}{2f_y}\left[1-\sqrt{1-4.598M_u/(f_{ck}bd^2)}\right]$$

check : less than 300mm or 3d whichever is less

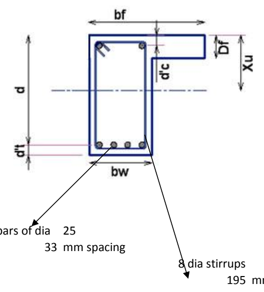
288

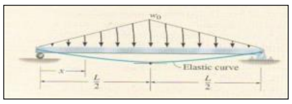


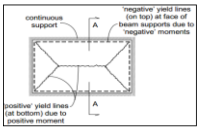
DESIGN OF L-BEAMS IN MAIN SLAB(FB1)

KNOWN DATA	M25
	FE 415
	MONOLITHIC
	clear cover 25mm
	density of conc.=25 kn/m3
	modification factor =1.2
	τcmax for M25 =3.1Mpa

1	**Effective flange width**						
		effective span in long direction	Leff	7.625	m	**from slab design**	
		thickness of slab	Df	150	mm	**from slab design**	
		width of web	bw	250	mm	**as assumed in slab design**	
		width of flange	Bf	1144.79	mm	**Bf=Lo/12+bw+3Df**	
		effective span in short direction	Leff	3.725	m		
		which is acceptable as it is less than bw + clear span of slab					
2	**Overall depth**						
		deflection criteria {l/d=26*m}	depth	244.4	mm		
			D	260.0	mm		
			Deff	222.5	mm		
3	**moment Mu calculation**						
		factored	load from slab	10.13	kn/m2		
			slab load transferred to beam	18.86	kn/m		
		factored	load from Partition wall	6.11	kn/m	for 100 mm thick parapett brick wall from IS 875-II table 2	
		factored	D.L due to self wt of beam	0.69	Kn/m		
			moment(max at mid span)	186.47	kn-m		
			moment(at support)	149.17	kn-m		
4	**ast calculation**						
		case 1: let Xu= Df & calculate moment					
			M	246.502	kn-m		
		M resisted by beam is more than M due to load					
			design moment Mu=	186.47	kn-m		
		beam is designed as a singly reinforced rectangular section					
			astreq at midspan	2851.04	mm2		
		providing bars of dia	25				
			n	6.00	bars @	**33**	**mm spacing**
			astreq at support	2161.53	mm2		
		providing bars of dia	25				
			n	5.00	bars @	**40**	**mm spacing**
5	**design of stirrups**						
		shear force	V	97.82	Kn		
		shaer stress	τv	1.505	N/mm2		
				less than τmax			
		shear strength of conc.	τc	0.51	N/mm2		
				provide min steel			
6	**spacing od stirrups**						
		providing 2 bars of 8mm	Asv	100.48	mm2		
		spacing of bars	Sv	363	mm		
			max spacing	195	mm		
			So spacing	195	mm c/c		





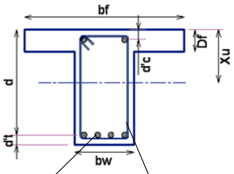


load transferred to beam using yield line theory

DESIGN OF SECONDARY T-BEAMS IN MAIN SLAB(FB2)

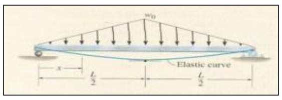
KNOWN DATA	M25
	FE 415
	MONOLITHIC
	clear cover 25mm
	density of conc.=25 kn/m3
	τcmax for M25 =3.1Mpa

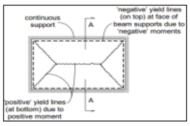
1	**Effective flange width**					
	effective span	Leff	7.625	m	**from slab design**	
	thickness of slab	Df	150	mm	**from slab design**	
	width of web	bw	250	mm	**as assumed in slab design**	
	width of flange	Bf	2039.58	mm	**Bf=Lo/6+bw+6Df**	
	effective span in short direction	Leff	3.725	m		
	which is acceptable as it is less than bw + clear span of slab					
2	**Overall depth**					
	deflection criteria {l/d=26*m}	depth	244.4	mm		
		D	260.0	mm		
		Deff	219	mm		
3	**moment Mu calculation**					
	factored	load from slab	10.13	kn/m2		
		slab load transferred to beam	37.72	kn/m		
	factored	load from Partition wall	6.11	kn/m	for 100 mm thick parapett brick wall from IS 875-II table 2	
	factored	D.L due to self wt of beam	0.69	Kn/m		
		moment(max at mid span)	323.52	kn-m		
		moment(at support)	258.81	kn-m		
4	**ast calculation**					
	case 1: let Xu= Df & calculate moment					
		M	542.43	kn-m		
	M resisted by beam is more than M due to load					
		design moment Mu=	323.52	kn-m		
	beam is designed as a singly reinforced rectangular section					
		astreq at midspan	3930.04	mm2		
	providing bars of dia	32				
		n	5.00	bars @	**40**	**mm spacing**
		astreq at support	3048.08	mm2		
	providing bars of dia	32				
		n	4.00	bars @	**50**	**mm spacing**
5	**design of stirrups**					
	shear force	V	169.71	Kn		
	shaer stress	τv	2.611	N/mm2		
			less than τmax			
	shear strength of conc.	τc	0.51	N/mm2	for M25 & Pt=2% from table 23 is 456: 2000	
			provide min steel			
6	spacing od stirrups					
	providing 2 bars of 8mm	Asv	100.48	mm2		
	spacing of bars	Sv	363	mm		
		max spacing	195	mm		
		So spacing	195	mm c/c		



5.00 bars of dia 32 @ 40 mm c/c

8 dia stirrups 195 mm spacing c/c



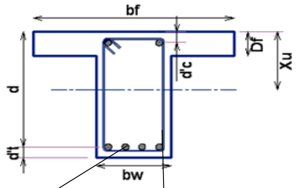


load transferred to beam using yield line theory

DESIGN OF LONG T-BEAMS IN COMMON LOBBY SLAB(FB3)

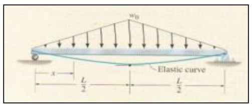
KNOWN DATA	**M25**
	FE 415
	MONOLITHIC
	clear cover 25mm
	density of conc.=25 kn/m3
	τ_{cmax} for M25 =3.1Mpa

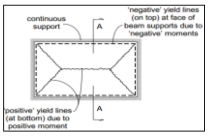
1	**Effective flange width**						
		effective span in longer direction	Leff	7.625	m	**from slab design**	
		thickness of slab	Df	150	mm	**from slab design**	
		width of web	bw	250	mm	**as assumed in slab design**	
		effective span in shorter direction		2.85	m		
		width of flange	Bf	2039.58	mm	**Bf=Lo/12+bw+3Df**	
		which is acceptable as it is less than bw + clear span of slab					
2	**Overall depth**						
		deflection criteria {l/d=2(	depth	244.4	mm		
			D	260.0	mm		
			Deff	222.5	mm		
3	**moment Mu calculation**						
		factored	load from slab	10.13	kn/m2		
			slab load transferred to beam	33.73	kn/m		
		factored	load from Partition wall	6.11	kn/m	for 100 mm thick parapett brick wall	
		factored	D.L due to self wt of beam	0.69	Kn/m	from IS 875-II table 2	
			moment(max at mid span)	294.54	kn-m		
			moment(at support)	235.63	kn-m		
4	**ast calculation**						
		case 1: let Xu= Df & calculate moment					
			M	542.427	kn-m		
		M resisted by beam is more than M due to load					
			design moment Mu=	294.54	kn-m		
		beam is designed as a singly reinforced rectangular section					
			astreq at midspan	3527.37	mm2		
		providing bars of dia		25			
			n	8.00	bars @	**25**	**mm spacing**
			astreq at support	2746.42	mm2		
		providing bars of dia		25			
			n	6.00	bars @	**33**	**mm spacing**
5	**design of stirrups**						
		shear force	V	154.51	Kn		
		shaer stress	τv	2.377	N/mm2		
				less than τmax		for M25 & Pt=2%	
		shear strength of conc.	τc	0.51	N/mm2	from table 23 is 456:	
				provide min steel		2000	
6	**spacing od stirrups**						
		providing 2 bars of 8mm	Asv	100.48	mm2		
		spacing of bars	Sv	363	mm		
			max spacing	195	mm		
			So spacing	195	mm c/c		



8.00 bars of dia 25
@ 25 mm c/c

8 dia stirrups
195 mm spacing c/c



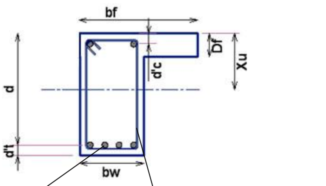


load transferred to beam using yield line theory

DESIGN OF L-BEAMS IN LOBBY (FB4)

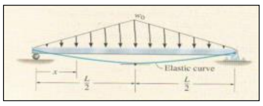
KNOWN DATA	M25
	FE 415
	MONOLITHIC
	clear cover 25mm
	density of conc.=25 kn/m3
	τcmax for M25 =3.1Mpa

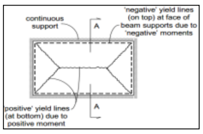
1	Effective flange width						
		effective span in shorter dir	Leff	3	m	from slab design	
		thickness of slab	Df	230	mm	from slab design	
		width of web	bw	400	mm	as assumed in slab design	
		width of flange	Bf	2130.00	mm	Bf=Lo/12+bw+3Df	
		which is acceptable as it is less than bw + clear span of slab					
2	Overall depth						
		let overall depth D=	leff/15=	200.0	mm		
			Deff	230.0	mm		
3	moment Mu calculation						
		factored	load from slab	10.13	kn/m2		
			slab load transferred to beam	15.19	kn/m		
		factored	D.L due to self wt of beam	0.00	Kn/m		
			moment(max at mid span)	17.09	kn-m		
			moment(at support)	13.67	kn-m		
4	ast calculation						
		case 1: let Xu= Df & calculate moment					
			M	588.17394	kn-m		
		M resisted by beam is more than M due to load					
			design moment Mu=	17.09	kn-m		
		beam is designed as a singly reinforced rectangular section					
			astreq at midspan	207.22	mm2		
		providing bars of dia	20				
			n	2.00	bars @	175	mm spacing
			astprov	628.00	mm2		
			astreq at support	165.54	mm2		
		providing bars of dia	20				
			n	2.00	bars @	175	mm spacing
5	check for deflection control						
			%steel	1.00			
			Fs	79.00	N/mm2		
		modification factor	m	1.28	Ref. Fig.4 of IS 456 : 2000]		
			L/d	13.04			
			L/dmax	25.62			
				safe			
6	design of stirrups						
		shear force	V	22.78	Kn		
		shaer stress	τv	0.248	N/mm2		
				less than τmax			
		shear strength of conc.	τc	0.4	N/mm2	for M25 & Pt=1% from table 23 is 456: 2000	
				design for (E47-E45)bd			
7	spacing od stirrups						
		providing 2 bars of 8mm	Asv	100.48	mm2		
		spacing of bars	Sv	227	mm		
			max spacing	172.5	mm		
			So spacing	172.5	mm c/c		



2 bars of 20mm dia @ 175mm spacing

172.5 mm spacing c/c



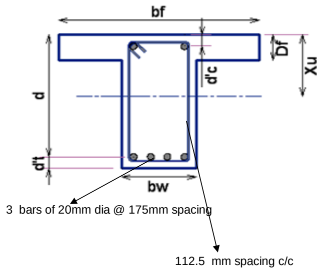


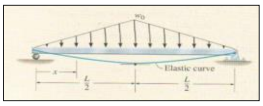
load transferred to beam using yield line theory

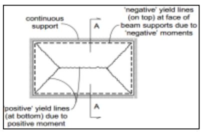
DESIGN OF SHORT T-BEAMS IN LOBBY SLAB(FB5)

KNOWN DATA	
	M25
	FE 415
	MONOLITHIC
	clear cover 25mm
	density of conc.=25 kn/m3
	τcmax for M25 =3.1Mpa

1 **Effective flange width**						
	effective span in shorter dir	Leff	3	m	**from slab design**	
	thickness of slab	Df	150	mm	**from slab design**	
	width of web	bw	250	mm	**as assumed in slab design**	
	effective span in longer dir	L'eff	7.505	m		
	width of flange	Bf	1500.00	mm	**Bf=Lo/12+bw+3Df**	
	which is acceptable as it is less than bw + clear span of slab					
2 **Overall depth**						
	let overall depth D=	leff/15=	200.0	mm		
		Deff	150.0	mm		
3 **moment Mu calculation**						
	factored	load from slab	10.13	kn/m2		
		slab load transferred to beam	30.38	kn/m		
	factored	D.L due to self wt of beam	0.00	Kn/m		
		moment(max at mid span)	34.17	kn-m		
		moment(at support)	27.34	kn-m		
4 **ast calculation**						
	case 1: let Xu= Df & calculate moment					
		M	176.175	kn-m		
	M resisted by beam is more than M due to load					
		design moment Mu=	34.17	kn-m		
	beam is designed as a singly reinforced rectangular section					
		astreq at midspan	663.49	mm2		
	providing bars of dia	20				
		n	3.00	bars @	**67**	**mm spacing**
		astprov	942.00	mm2		
		astreq at support	525.16	mm2		
	providing bars of dia	20				
		n	2.00	bars @	**100**	**mm spacing**
5 **check for deflection control**						
		%steel	2.00			
		Fs	170.00	N/mm2		
	modification factor	m	1.03	Ref. Fig.4 of IS 456 : 2000]		
		L/d	20.00			
		L/dmax	20.52			
			safe			
6 **design of stirrups**						
	shear force	V	45.56	Kn		
	shaer stress	τv	1.215	N/mm2		
			less than τmax			
	shear strength of conc.	τc	0.4	N/mm2	for M25 & Pt=1% from table 23 is 456: 2000	
			provide min steel			
7 **spacing od stirrups**						
	providing 2 bars of 8mm	Asv	100.48	mm2		
	spacing of bars	Sv	363	mm		
		max spacing	112.5	mm		
		So spacing	112.5	mm c/c		





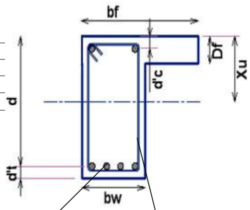


load transferred to beam using yield line theory

DESIGN OF L-BEAMS IN MAIN SLAB(FBx)

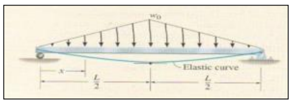
KNOWN DATA	
	M25
	FE 415
	MONOLITHIC
	clear cover 25mm
	density of conc.=25 kn/m3
	modification factor =1.2
	τcmax for M25 =3.1Mpa

1	**Effective flange width**						
		effective span in long direction	Leff	7.625	m	**from slab design**	
		thickness of slab	Df	150	mm	**from slab design**	
		width of web	bw	250	mm	**as assumed in slab design**	
		width of flange	Bf	1144.79	mm	**Bf=Lo/12+bw+3Df**	
		effective span in short direction	Leff	3.725	m		
		which is acceptable as it is less than bw + clear span of slab					
2	**Overall depth**						
		deflection criteria {l/d=26*m}	depth	244.4	mm		
			D	260.0	mm		
			Deff	222.5	mm		
3	**moment Mu calculation**						
		factored	load from slab	10.13	kn/m2		
			slab load transferred on half beam in form of triangle load	18.86	kn/m		
			concentrated laod due to secondary beam	71.90	kn		
		factored	load from Partition wall	6.11	kn/m	for 100 mm thick parapett brick wall	
		factored	D.L due to self wt of beam	0.69	Kn/m	from IS 875-II table 2	
			max moment at midspan	145.68	kn-m	calculated by drawing BMD	
			moment at support	116.54	kn-m		
4	**ast calculation**						
		case 1: let Xu= Df & calculate moment					
			M	246.502	kn-m		
		M resisted by beam is more than M due to load					
			design moment Mu=	145.68	kn-m		
		beam is designed as a singly reinforced rectangular section					
			astreq at midspan	2101.27	mm2		
		providing bars of dia	25				
			n	5.00	bars @	**40**	**mm spacing**
			astreq at support	1622.34	mm2		
		providing bars of dia	25				
			n	4.00	bars @	**50**	**mm spacing**
5	**design of stirrups**						
		shear force	V	85.04	Kn	calculated by drawing BMD	
		shaer stress	τv	1.308	N/mm2		
				less than τmax			
		shear strength of conc.	τc	0.51	N/mm2		
				provide min steel			
6	**spacing od stirrups**						
		providing 2 bars of 8mm	Asv	100.48	mm2		
		spacing of bars	Sv	363	mm		
			max spacing	195	mm		
			So spacing	195	mm c/c		

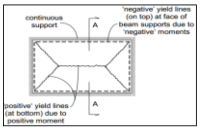


5 bars of dia 25
at 40 mm spacing

8 dia stirrups
195 mm spacing c/c



load transferred to beam using yield line theory



4.3 DESIGN OF RCC COLUMNS

Columns are compression members.

• Larger spacing columns because stocking columns in lower stores of multi storied buildings.

• Columns are transmitted loads which are coming from slabs to foundations. Larger spans of beams shall also be avoided from the consideration of controlling the deflection & cracking.

COLUMNS:

The column which takes load are:

(a) Slab loads

(b) Beam loads

(c) Wall loads

(d) Self. Weight of column

DESIGN OF COLUMN C11

KNOWN DATA
M25
FE 415
MONOLITHIC
clear cover 30mm
density of conc.=25 kn/m3
modification factor =1.2

1	**slenderness ratio and column classification**					
		length	L	3200	mm	unsupported length
		width	B	300	mm	
		thickness	D	300	mm	
		Ley	Lex	2080	mm	restrained in motion and rotation
			Lex/D	6.9		
			Lex/B	6.9		
				short column		

2	**minimum eccentricity check**				
			ex	20	mm
			ey	20	mm
		ex min	.05D	15	mm
		ey min	.05B	15	mm
			design for moment		

3	**loading on column**				
		factored load	Pu	365.84	KN
		Moment	My	22.64	KNm
		Moment	Mz	27.28	KNm

4	**calculation of moment capacity of section**					
		for first trial				
		let percentage of steel	p	0.400		
			p/Fck	0.0160		
		Uniaxial moment capacity in x-x				
			let d'	40.00	mm	
			d'/D	0.13		
			chart for d'/D =.15 will be used			
			Pu/fckBD	0.16		
			Mu/fckBD^2	0.07		using chart 45
			Mux1	47.25	KNm	
		Uniaxial moment capacity in y-y				
			let d'	40.00	mm	
			d'/D	0.13		
			chart for d'/D =.15 will be used			
			Pu/fckBD	0.16		
			Mu/fckBD^2	0.07		using chart 45
			Muy1	47.25	KNm	
		calculation of Puz				
			p	0.400		
			Puz/Ag	12.5		using chart 63
			Puz	1125	KN	
			Pu/Puz	0.33		
			Muz/Mux1	0.58		
			Muy/Muy1	0.48		
		referring chart 64 the permissible values are				
			Muz/Mux1	0.6		using chart 64
			hence 0k			

5	**area of steel (Asc)**				
			Asc	360	mm2
			Ast min	720	mm2
			Ast max	3600	mm2
			Ast provided	720	mm2

6	**no of bars and pitch of tie reinforcement**				
		providing bars of dia	10	mm	
		no of bars	n	10	bars
		pitch of tie bars of 8mm stirrups			
		least lateral dimension		300	mm
		16 times least bar dia		160	mm
		maximum spacing required		300	mm
			spacing provided	120	mm

DESIGN OF COLUMN C12

KNOWN DATA	M25
	FE 415
	MONOLITHIC
	clear cover 30mm
	density of conc.=25 kn/m3
	modification factor =1.2

1	**slenderness ratio and column classification**					
	length	L	3200	mm		unsupported length
	width	B	350	mm		
	thickness	D	200	mm		
	Ley	Lex	2080	mm		restrained in motion and rotation
		Lex/D	10.4			
		Lex/B	5.9			
			short column			

2	**minimum eccentricity check**				
		ex	20	mm	
		ey	20	mm	
	ex min	.05D	10	mm	
	ey min	.05B	17.5	mm	
		design for moment			

3	**loading on column**			
	factored load	Pu	66.258	KN
	Moment	My	5.348	KNm
	Moment	Mz	58.53	KNm

4	**calculation of moment capacity of section**				
	for first trial				
	let percentage of steel	p	1.200		
		p/Fck	0.05		
	Uniaxial moment capacity in x-x				
		let d'	40.00	mm	
		d'/D	0.20		
		chart for d'/D =.2 will be used			
		Pu/fckBD	0.04		
		Mu/fckBD^2	0.1		using chart 46
		Mux1	35	KNm	
	Uniaxial moment capacity in y-y				
		let d'	40.00	mm	
		d'/D	0.11		
		chart for d'/D =.15 will be used			
		Pu/fckBD	0.04		
		Mu/fckBD^2	0.13		using chart 45
		Muy1	79.625	KNm	
	calculation of Puz				
		p	1.200		
		Puz/Ag	15.5		using chart 63
		Puz	1085	KN	
		Pu/Puz	0.06		
		Muz/Mux1	0.15		
		Muy/Muy1	0.74		
	referring chart 64 the permissible values are				
		Muz/Mux1	0.25		using chart 64
		hence 0k			

5	**area of steel (Asc)**			
		Asc	840	mm2
		Ast min	560	mm2
		Ast max	2800	mm2
		Ast provided	840	mm2

6	**no of bars and pitch of tie reinforcement**			
	providing bars of dia	10	mm	
	no of bars	n	11	bars
	pitch of tie bars of 8mm stirrups			
	least lateral dimension		200	mm
	16 times least bar dia		160	mm
	maximum spacing required		300	mm
		spacing provided	120	mm

DESIGN OF COLUMN C13

KNOWN DATA	**M25**	**FE 415**	**MONOLITHIC**	**clear cover 30mm**	**density of conc.=25 kn/m3**
	modification factor =1.2				

1	**slenderness ratio and column classification**					
	length	L	3200	mm	unsupported length
	width	B	300	mm	
	thickness	D	300	mm	
	Ley	Lex	2080	mm	restrained in motion and rotation
		Lex/D	6.9		
		Lex/B	6.9		
			short column		

2	**minimum eccentricity check**			
		ex	20	mm
		ey	20	mm
	ex min	.05D	15	mm
	ey min	.05B	15	mm
		design for moment		

3	**loading on column**			
	factored load	Pu	41.34	KN
	Moment	My	31.73	KNm
	Moment	Mz	27.7	KNm

4	**calculation of moment capacity of section**				
	for first trial				
	let percentage of steel	p	1.200		
		p/Fck	0.0480		
	Uniaxial moment capacity in x-x				
		let d'	40.00	mm	
		d'/D	0.13		
		chart for d'/D =.15 will be used			
		Pu/fckBD	0.02		
		Mu/fckBD^2	0.08		using chart 45
		Mux1	54	KNm	
	Uniaxial moment capacity in y-y				
		let d'	40.00	mm	
		d'/D	0.13		
		chart for d'/D =.15 will be used			
		Pu/fckBD	0.02		
		Mu/fckBD^2	0.08		using chart 45
		Muy1	54	KNm	
	calculation of Puz				
		p	1.200		
		Puz/Ag	15.5		using chart 63
		Puz	1395	KN	
		Pu/Puz	0.03		
		Muz/Mux1	0.59		
		Muy/Muy1	0.51		
	referring chart 64 the permissible values are				
		Muz/Mux1	0.5		using chart 64
		hence 0k			

5	**area of steel (Asc)**			
		Asc	1080	mm2
		Ast min	720	mm2
		Ast max	3600	mm2
		Ast provided	1080	mm2

6	**no of bars and pitch of tie reinforcement**			
	providing bars of dia	12	mm	
	no of bars	n	10	bars
	pitch of tie bars of 8mm stirrups			
	least lateral dimension		300	mm
	16 times least bar dia		192	mm
	maximum spacing required		300	mm
		spacing provided	152	mm

FLOOR NO	COLUMN	DIMENSION(mm*mm)	Pu (KN)	My (KNm)	Mz (KNm)	DIA OF BAR(mm)	NO. OF BARS	STRIRRUPS SPACING (mm)
6	1	300*300	365.84	22.64	27.28	10	10	120
	2	350*200	66.258	5.348	58.53	10	10	120
	3	300*300	41.34	31.73	27.7	12	10	150
5	1	300*300	731.426	35.72	43.63	12	12	150
	2	350*200	178.97	3.91	94.66	16	8	160
	3	300*300	111.12	49.56	44.93	16	10	215
4	1	300*300	1097.6	30.43	37.11	16	9	215
	2	350*200	358.17	3.87	77.99	16	8	160
	3	300*300	221.43	41.61	37.8	16	10	215
3	1	300*300	1464.51	30.5	37.27	16	10	215
	2	350*200	537.42	3.04	78.49	16	8	160
	3	300*300	331.98	41.71	38.03	16	11	215
2	1	350*350	1832.4	33.874	41.65	20	11	260
	2	350*250	716.72	2.179	88.36	16	11	210
	3	300*300	442.3	46.17	42.79	16	12	216
1	1	350*350	2201.535	24.2	30.09	20	12	260
	2	350*250	896.15	1.43	66.05	20	8	210
	3	300*300	552.14	34.665	30.97	20	8	260

4.4 DESIGN OF RCC FOOTINGS

Loads from columns is transferred to footings which is ultimately transferred to ground. Since our structure is designed for live and dead load only thus we have designed the foundations as square foundations. Bearing capacity of soil has been taken as 250 kN/m^2 for a site “THE ORCHARD” in sector-128 of NOIDA (U.P).

4.4.1 The important purpose of foundation are as follows;

1. To transfer forces from superstructure to firm soil below.
2. To distribute stresses evenly on foundation soil such that foundation soil neither fails nor experiences excessive settlement.
3. To develop an anchor for stability against overturning.
4. To provide an even surface for smooth construction of superstructure.

4.4.2 Based on the position with respect to ground level, Footings are classified into two types;

1. Shallow Foundations
2. Deep Foundations

Types of Shallow Foundations

4.4.3 The different types of shallow foundations are as follows:

• Isolated Footing
• Combined footing
• Strap Footing
• Strip Footing
• Mat/Raft Foundation
• Wall footing

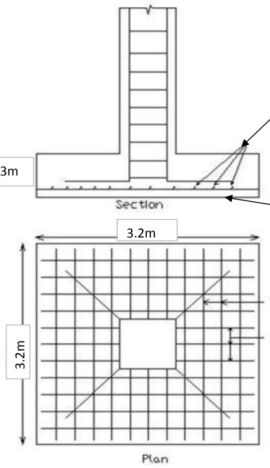
➢ **We have designed our foundation as isolated footings.**

DESIGN OF FOOTING F1

KNOWN DATA	M25
	FE 415
	depth of footing =1.5 m
	MONOLITHIC
	clear cover 50mm
	density of conc.=25 kn/m3
	modification factor =1.2

1	FORCE ON COLUMN					
		dimension of column	a	350	mm	
			P	2201.535	KN	
		bearing force check	.45fck(A1*A2)½	1378.125	KN	
	bearing capacity of soil		q	250	KN/m2	
		area of footing	A	9.69	m2	
		side of rect footing	L	3200	mm	
			bearing pressure	322.49	KN/m2	
2	THICKNESS FROM ONE WAY SHEAR					
			soil pressure	0.32	N/mm2	
		assuming	p	0.25	%	
			τc	0.36	N/mm2	
			Vu	1152	d	Table 19 of IS 456
			Vu actual	1031.97	((L-B)/2-d)	
			since Vu>=Vu actual			
			d	673.341	mm	
			D	730	mm	assuming 50mm cover .73m
3	THICKNESS FROM TWO WAY SHEAR					
	shear strength of concrete		2*.25(fck)^.5*(2B+2d)d	3445.29	KN	
	shear stress		1.5*Pu-((pu/B^2)((B+d)(B+d)-B^2))	3004.09	KN	
			depth from one way shear			
4	GROSS BEARING CAPACITY					
			P	2201.535	KN	
		weight of footing	W	186.88	KN	
		weight of soil	w	143.624	KN	
		total	Wu	2532.039	KN	
		gross Bearing Press	Q	247.269	kN/m2	
				ok		
5	BENDING MOMENT					
			Mu	1047.77	KNm	
			Mu resisting	5005.41	KNm	
				greater		
6	Ast required					
			Ast	4463.65	mm2	
			.25% steel	5840	mm2	
				greater than Astmin		
			providing bars of dia	25	mm	
			no of bars	12	bars	
			spacing	83	mm	
				less than 300	mm	c/c
			Ast in other direction	5840	mm2	
			providing bars of dia	25	mm	
			no of bars	12	bars	
			spacing	83	mm	
				less than 300	mm	c/c
7	DEVELOPMENT LENGTH CHECK					
		Ld	fs*dia/(4*τbd)	1007.394	mm	
		length available	l	2800	mm	
				safe for Ld		

$$\frac{(A_{st})_{reqd}}{bd} = \frac{f_{ck}}{2f_y}\left[1-\sqrt{1-4.598M_u/(f_{ck}bd^2)}\right]$$



25 dia bars
@ 83 mm

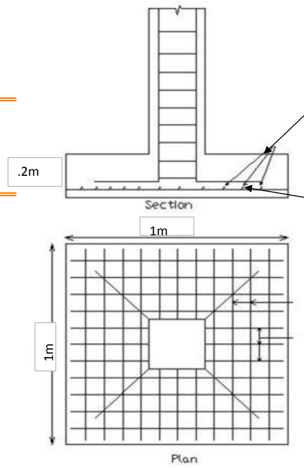
25 dia bars
@ 83 mm

DESIGN OF FOOTING F2

KNOWN DATA	
	M25
	FE 415
	depth of footing=1.5 m
	MONOLITHIC
	clear cover 50mm
	density of conc.=25 kn/m3
	modification factor =1.2

1	**FORCE ON COLUMN**					
		dimension of column	a	350	mm	
			b	250	mm	
			P	192.63	KN	
		bearing force check	.45fck(A1*A2)½	1378.125	KN	
	bearing capacity of soil		q	250	KN/m2	
		area of footing	A	0.85	m2	
		side of rect footing	L	1000	mm	
			bearing pressure	288.95	KN/m2	
2	**THICKNESS FROM ONE WAY SHEAR**					
			soil pressure	0.29	N/mm2	
		assuming	p	0.25	%	
			τc	0.36	N/mm2	
			Vu	360	d	Table 19 of IS 456
			Vu actual	288.95	((L-B)/2-d)	
			since Vu>=Vu actual			
			d	144.707	mm	
			D	200	mm	assuming 50mm cover
3	**THICKNESS FROM TWO WAY SHEAR**					
	shear strength of concrete		2*.25(fck)^.5*(2B+2d)d	357.94	KN	
	shear stress		1.5*Pu-((pu/B^2)((B+d)(B+d)-B^2))	253.63	KN	
			depth from one way shear			
4	**GROSS BEARING CAPACITY**					
			P	192.63	KN	
		weight of footing	W	5	KN	
		weight of soil	w	26.267	KN	
		total	Wu	223.897	KN	
		gross Bearing Press	Q	223.897	kN/m2	
				ok		
5	**BENDING MOMENT**					
			Mu	15.26	KNm	
			Mu resisting	72.24	KNm	
				greater		
6	**Ast required**					
			Ast	302.60	mm2	
			.25% steel	500	mm2	
				greater than Astmin		
			providing bars of dia	10	mm	
			no of bars	7	bars	
			spacing	142	mm	
				less than 300	mm	c/c
			Ast in other direction	500	mm2	
			providing bars of dia	10	mm	
			no of bars	7	bars	
			spacing	142	mm	
				less than 300	mm	c/c
7	**DEVELOPMENT LENGTH CHECK**					
		Ld	fs*dia/(4*τbd)	402.958	mm	
		length available	l	600	mm	
				safe for Ld		

$$\frac{(A_{st})_{reqd}}{bd} = \frac{f_{ck}}{2f_y}\left[1-\sqrt{1-4.598M_u/(f_{ck}bd^2)}\right]$$



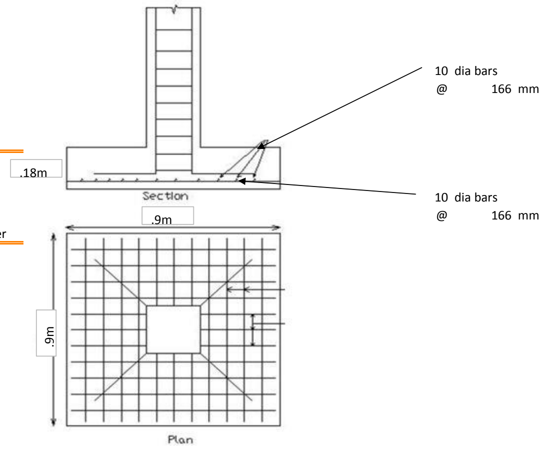
10 dia bars @ 142 mm

10 dia bars @ 142 mm

DESIGN OF FOOTING F3

1	**FORCE ON COLUMN**					
		dimension of column	a	300	mm	
			P	147	KN	
		bearing force check	.45fck(A1*A2)½	1012.5	KN	
	bearing capacity of soil		q	250	KN/m2	
		area of footing	A	0.65	m2	
		side of rect footing	L	900	mm	
			bearing pressure	272.22	KN/m2	
2	**THICKNESS FROM ONE WAY SHEAR**					
			soil pressure	0.27	N/mm2	
		assuming	p	0.25	%	
			ῑc	0.36	N/mm2	
			Vu	324	d	
			Vu actual	245.00	((L-B)/2-d)	Table 19 of IS 456
			since Vu>=Vu actual			
			d	129.174	mm	
			D	180	mm	
3	**THICKNESS FROM TWO WAY SHEAR**					assuming 50mm cover
	shear strength of concrete		2*.25(fck)^.5*(2B+2d)d	277.19	KN	
	shear stress		1.5*Pu-((pu/B^2)((B+d)(B+d)-B^2))	194.86	KN	
			depth from one way shear			
4	**GROSS BEARING CAPACITY**					
			P	147	KN	
		weight of footing	W	3.645	KN	
		weight of soil	w	21.384	KN	
		total	Wu	172.029	KN	
		gross Bearing Press	Q	212.381	kN/m2	
				ok		
5	**BENDING MOMENT**					
			Mu	11.03	KNm	
			Mu resisting	51.81	KNm	
				greater		
6	**Ast required**					
			Ast	244.98	mm2	
			.25% steel	405	mm2	
				greater than Astmin		$\frac{(A_{st})_{reqd}}{bd} = \frac{f_{ck}}{2f_y}\left[1-\sqrt{1-4.598M_u/(f_{ck}bd^2)}\right]$
			providing bars of dia	10	mm	
			no of bars	6	bars	
			spacing	166	mm	
				less than 300	mm	c/c
			Ast in other direction	405	mm2	
			providing bars of dia	10	mm	
			no of bars	6	bars	
			spacing	166	mm	
				less than 300	mm	c/c
7	**DEVELOPMENT LENGTH CHECK**					
		Ld	fs*dia/(4*ῑbd)	402.958	mm	
		length available	l	550	mm	
				safe for Ld		

KNOWN DATA	**M25**
	FE 415
	depth of footing=1.5 m
	MONOLITHIC
	clear cover 50mm
	density of conc.=25 kn/m3
	modification factor =1.2



4.5 DESIGN OF RCC STAIRS

Stairs consist of steps arranged in a series for purpose of giving access to different floors of a building. Since a stair is often the only means of communication between the various floors of a building, the location of the stair requires good and careful consideration.

4.5.1 Types of stair cases

- **Geometric classification**

1. Straight stairs (with or without intermediate landing)
2. quarter-turn stairs
3. dog-legged stairs
4. Open well stairs
5. Spiral stairs
6. Helicoidally stairs
7. Slab less stair case
8. Free standing stair case

- **Structural Classification**

1. Stairs with cantilever steps
2. Stair slab spanning transversely (or horizontally between stringer beams or walls)
3. Stair slab spanning longitudinally
4. Slabless or raiser and tread type
5. Spiral stair case
6. Helicoidally slab stair case
7. 3D or free standing stair slab

- **Classification based on span**

Based on type of span, following are the two types of stair cases;

_ Horizontally spanning or transversely spanning stairs. Figure 1

_ Longitudinally spanning stairs. For details refer IS: 456-2000 and SP (34).

- **We have designed dog legged stairs for our structure.**

DESIGN OF STAIRCASE

KNOWN DATA	M25
	FE 415
	MONOLITHIC
	clear cover 30mm
	density of conc.=25 kn/m3
	modification factor =1.2

1	PROPORTIONING OF STAIRS					
	riser	R	180	mm		
	trade	T	250	mm		
	inclined length of step	(R^2+T^2)^.5	308.1	mm		
		H	3.2	m		
	height of each flight		1.6	m		
	no of risers	r	9			
	no of steps	s	8			
	length of going	Lg	2000	mm		
	widht of hall		3600	mm		
	width of landing	b	800	mm		
	gap between flights		200	mm		
	width of steps	w	800	mm		
2	DEPTH OF WAIST SLAB					
	effective span of going	Lg	2250	mm		
	effective span of landing	Ll	925	mm		
	using deflection criteria	d	132	mm		
		D	160	mm		
		d	135	mm	greater than 80mm	
3	LOAD CALCULATIONS					
	loads on going					
	dead load of waist slab		3.246	KN/m2		
	weight of floor finish		0.5	KN/m2		
	weight of steps		2.25	KN/m2		
	imposed load		3	KN/m2	from is 875-II	
	total load		8.996	KN/m2		
	factored load	W1	13.49	KN/m2		
	loads on landing slabs					
	self weight of landing slab		4	KN/m2		
	floor finish		0.5	KN/m2		
	imposed loads		3	KN/m2		
	total load		7.5	KN/m2		
	factored load	W2	11.25	KN/m2		
4	BENDING MOMENT AND SHEAR FORCES					
	max positive moment	M(+)	8.54	KNm/m		
	max negative moment	M(-)	5.693	KNm/m		
	max shear force	V	15.181	KN/m		
5	CHECK FOR DEPTH					
	limiting depth	d lim	55.623	mm		
			ok			
6	CHECK FOR SHEAR					
	nominal shear stress	Ʈv	0.10	N/mm2		
	percentage of steel	p	0.222			
	shear strength of conc	Ʈc	0.29	N/mm2	(cl. 40.2.11 of IS 456)	
		depth safe against shear				
7	CALCULATION OF AREA OF STEEL					
	waist slab					
		Ast main	240	mm2/m		
	landing slab					
		Ast main	240	mm2/m		
	distribution bars					
		Ast	192	mm2/m		
8	NO OF BARS AND SPACING					
	waist slab					
	taking dia of bars as	8	mm			
		no of bars	5	bars/m		
		spacing of bars	200	mm/m	c/c	
	landing slab					
	taking dia of bars as	8	mm			
		no of bars	5	bars/m		
		spacing of bars	200	mm/m	c/c	
	distribution bars					
	taking dia of bars as	8	mm			
		no of bars	4	bars/m		
		spacing of bars	250	mm/m	c/c	
	development length	Ld	235	mm		

4.6 DESIGN OF PRESTRESSED CONCRETE SLABS

4.6.1 ADVANTAGES OF POST-TENSIONED FLOORS

The primary advantages of post-tensioned floors over conventional reinforced concrete in-situ floors may be summarized as follows:

a. Longer Spans

Longer spans can be used reducing the number of columns. This results in larger, column free floor areas which greatly increase the flexibility of use for the structure and can result in higher rental returns.

b. Overall Structural Cost

The total cost of materials, labour and formwork required to construct a floor is reduced for spans greater than 7 metres, thereby providing superior economy.

c. Reduced Floor to Floor Height

For the same imposed load, thinner slabs can be used. The reduced section depths allow minimum building height with resultant savings in facade costs. Alternatively, for taller buildings it can allow more floors to be constructed within the original building envelope.

d. Deflection Free Slabs

Undesirable deflections under service loads can be virtually eliminated.

e. Waterproof Slabs

Post-tensioned slabs can be designed to be crack free and therefore waterproof slabs are possible. Achievement of this objective depends upon careful design, detailing and construction. The choice of concrete mix and curing methods along with quality workmanship also plays a key role.

f. Early Formwork Stripping

The earlier stripping of formwork and reduced back propping requirements enable faster construction cycles and quick re-use of formwork. This increase in speed of construction is explained further in the next section on economics.

g. Materials Handling

The reduced material quantities in concrete and reinforcement greatly benefit on-site carnage requirements. The strength of post-tensioning strand is approximately 4 times that of conventional reinforcement. Therefore the total weight of reinforcing material is greatly reduced.

h. Column and Footing Design

The reduced floor dead loads may be utilized in more economical design of the reinforced concrete columns and footings. In multi-storey buildings, reduced column sizes may increase the floor net let table area.

These advantages can result in significant savings in overall costs. There are also some situations where the height of the building is limited, in which the reduced storey height has allowed additional storey‘s to be constructed within the building envelope.

4.6.2 MODIFICATION IN THE STRUCTURE

In RCC design we had to use secondary beams because the slab span was too long but by using the advantage of longer spans in prestressed design we have taken effective span of slab as 7.625 m, by doing this we were able to remove secondary beams in the structure. This way we have tried to reduce the cost and bring out the comparison between the two designs.

4.6.3 SPECIFICATIONS OF PRESTRESSED DESIGN

- Grade of concrete: 40 N/mm^2
- Specification of strand: 7 wire strands EN 10138 – BS 5896
- Cost of strand = Rs. 40/kg

Nominal diameter	Tensile strength	Mass	Cross Sectional	Tolerance on mass	Minimum breaking strength	Maximum breaking strength	Yield strength at 0.1 % Elongation
mm	Mpa	g/m	mm2	%	KN	KN	KN
12.5	1860	726.3	93.0	± 2	173.0	199.0	149.0

DESIGN OF TWO WAY PRESTRESSED SLAB

1	**Depth of slab and effective span**			
	clear span	L	7.5	m
		B	7.5	m
		L/B ratio	1	
			two way	
	From deflection criteria	depth	149.0384615	mm
	{l/d=50}	D	150	mm
		Ly	7.65	m
		Lx	7.65	m
		α(Iy/Ix)	1	
2	**Load and moment calculation**			
	self weight of slab	w1	5.625	KN/m2
	Live load on slab	w2	2.25	KN/m2
	Floor finish	w3	0.45	KN/m2
	total ultimate load	W	8.325	KN/m2
	Moment in middle strip			
		Mx	22.90	KNm/m
		My	17.05	KNm/m
	Total Moment	Mx	175.17	KNm
		My	130.45	KNm
3	**Prestressing force**			
	taking cover to reinforcement		25	mm
	dist b/w top kern & cable		85.0	mm
	Prestressing force	Px	2060.9	KN
		Py	1534.7	KN
	Force in each cable	F	149	KN
	No. of cables	Nx	14	
		Ny	11	
4	**Spacing of tendons**			
		Sx	410	mm
		Sy	522	mm
	THE CABLE PROFILE IS LINEAR			
5	**Check for Limit state of collapse**			
	dia of strand	D	12.5	mm
	Area of 7 wire strand	Ap	651	mm2
	Tensile Srength	Fp	1860	N/mm2
		Fck	40	N/mm2
		ApFp/bdFck	0.202	
		Fpu/.87Fp	0.94	
		Fpu	1521.108	N/mm2
		Xu/d	0.414	
		Xu	62.1	
	Limiting moment	Mu	150.05	
			safe	

TABLE 2 IMPOSED LOADS ON VARIOUS TYPES OF ROOFS					
(Access provided)		**IS 875 part 2**			

7 wire strands					
EN 10138 – BS 5896					
BS	**12.5**	**1860**	**726.3**	**93**	**149**

From IS 1343-1980

From IS 1343-1980

CHAPTER 5:
COST ESTIMATION OF STRUCTURE

Cost estimation of the structure has been done by preparing the bar bending schedule for area of steel calculated. Cost of concreting has been estimated by calculating the volume of each structural element and multiplying it by cost of per m^3 of concrete.

Cost of $1m^3$ of M25 grade concrete = Rs. 3615.60
Cost of $1m^3$ of M40 grade concrete = Rs. 4728.00
Cost of 415 grade steel per kg = Rs. 42

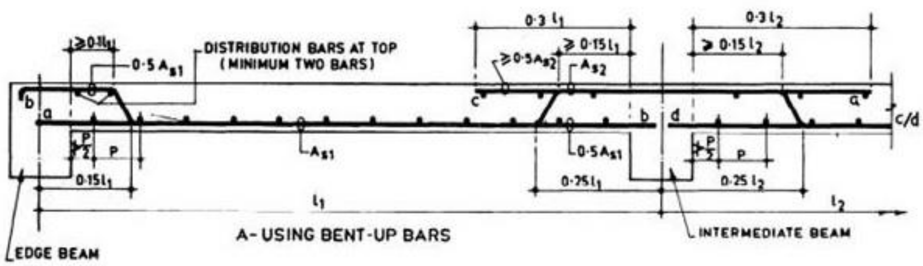


Fig 2. Reinforcement details of primary beams

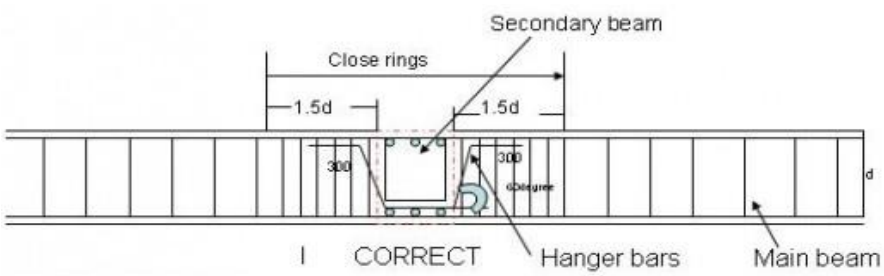


Fig 3. Reinforcement details of secondary beams

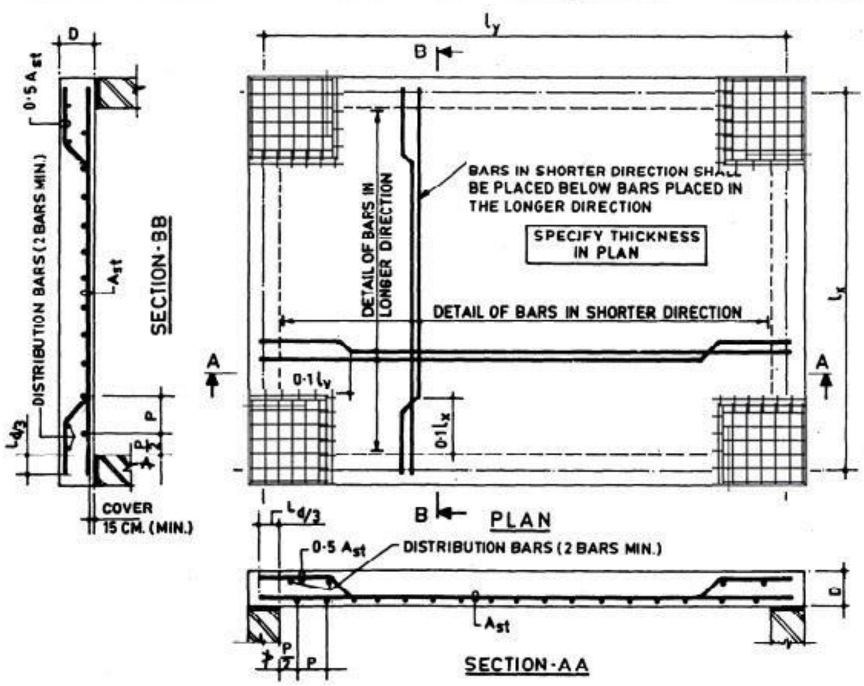
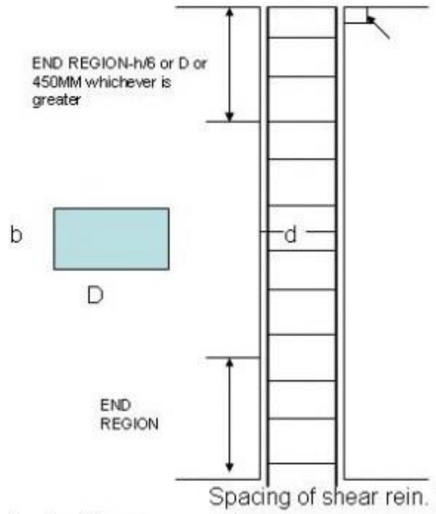


Fig 4. Reinforcement details of slabs



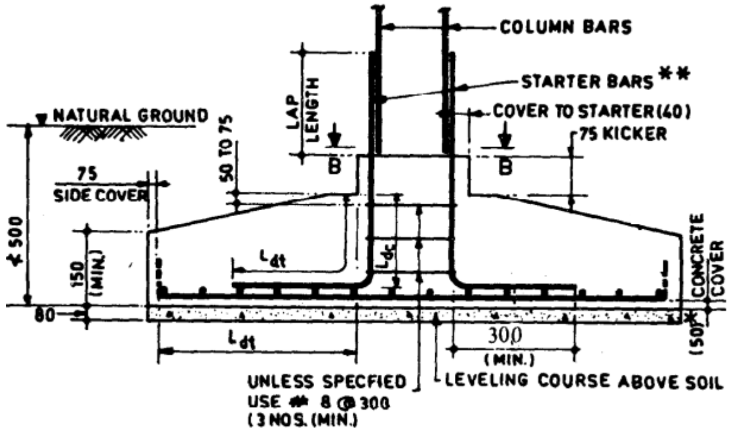


Fig 5. Reinforcement details of column

Fig 6.Reinforcement details of footings

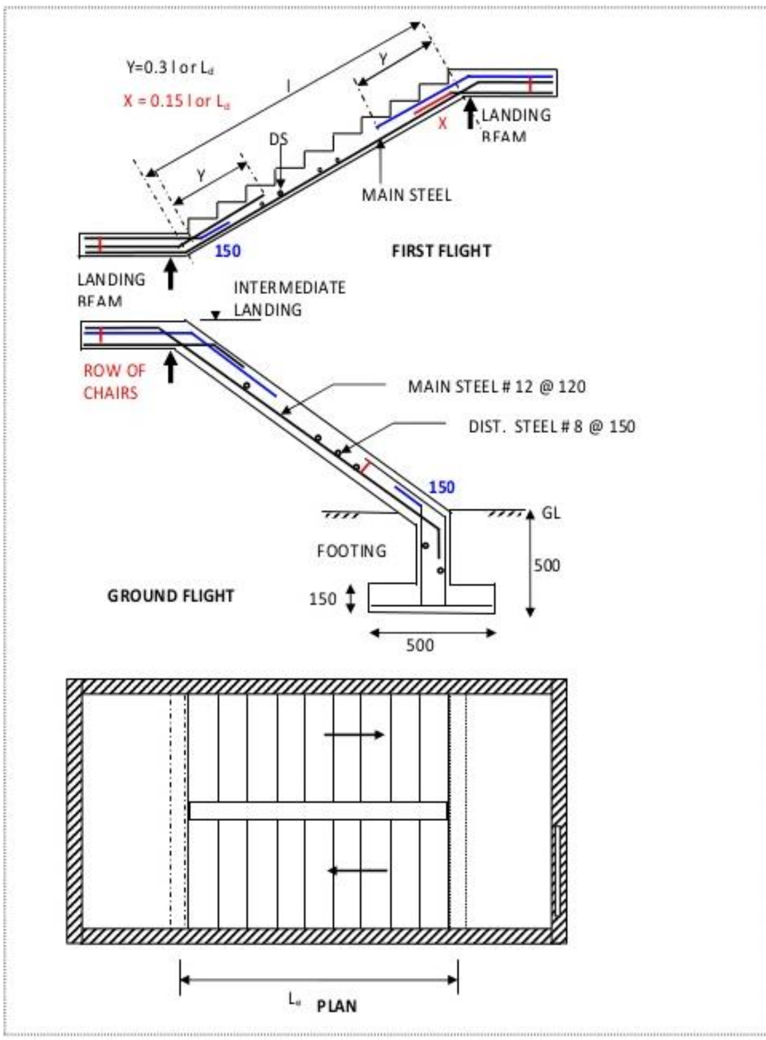


Fig 7. Reinforcement details of stairs

CONCRETE COST ESTIMATION

ROOF SLAB

Element	No.s	Length	Width	Height	Volume	Cost
S 1	4	7.625	3.725	0.15	17.04	61616.6
S 2	8	7.625	3.725	0.15	34.08	123233.2
S 3	3	7.596	2.696	0.12	7.372	26655.55

Total cost of concrete			Rs	211505.4

ROOF BEAM

Element	No.s	Length	Width	Height	Volume	Cost
B 1	6	7.625	0.25	0.26	2.974	10751.89
B 2	6	7.625	0.25	0.26	2.974	10751.89
B 3	6	7.625	0.25	0.26	2.974	10751.89
B 4	2	3	0.25	0.26	0.39	1410.084
B 5	2	3	0.25	0.26	0.39	1410.084
B x	8	7.625	0.25	0.26	3.965	14335.85

Total of cost of concrete			Rs	49411.69

FLOOR SLAB

Element	No.s	Length	Width	Height	Volume	Cost
F 1	4	7.625	3.725	0.15	17.042	61616.6
F 2	8	7.625	3.725	0.15	34.08	123233.2
F 3	3	7.596	2.696	0.12	7.37	26655.55

Totoal cost of concrete			Rs	211505.4
Total cost of concrete in all 5 floors			Rs	1057527

FLOOR BEAM

Element	No.s	Length	Width	Height	Volume	Cost
FB 1	6	7.625	0.25	0.26	2.97375	10751.89
FB 2	6	7.625	0.25	0.26	2.97375	10751.89
FB 3	6	7.625	0.25	0.26	2.97375	10751.89
FB 4	2	3	0.25	0.26	0.39	1410.084
FB 5	2	3	0.25	0.26	0.39	1410.084
FB x	8	7.625	0.25	0.26	3.965	14335.85

Total cost of concrete			Rs	49411.69
Total cost of concrete in all 5 floors			Rs	247058.5

COCNCRETE COST ESTIMATION

cost of 1 m3 of concrete *3615.6 Rs*

COLUMNS

Element	No.s	Length	Width	Height	Volume	Cost
C 11	4	3.2	0.3	0.3	1.152	4165.171
C 12	8	3.2	0.35	0.2	1.792	6479.155
C 13	4	3.2	0.3	0.3	1.152	4165.171
C 21	4	3.2	0.3	0.3	1.152	4165.171
C 22	8	3.2	0.35	0.2	1.792	6479.155
C 23	4	3.2	0.3	0.3	1.152	4165.171
C 31	4	3.2	0.3	0.3	1.152	4165.171
C 32	8	3.2	0.35	0.2	1.792	6479.155
C 33	4	3.2	0.3	0.3	1.152	4165.171
C 41	4	3.2	0.3	0.3	1.152	4165.171
C 42	8	3.2	0.35	0.2	1.792	6479.155
C 43	4	3.2	0.3	0.3	1.152	4165.171
C 51	4	3.2	0.35	0.35	1.568	5669.261
C 52	8	3.2	0.35	0.25	2.24	8098.944
C 53	4	3.2	0.3	0.3	1.152	4165.171
C 61	4	3.2	0.35	0.35	1.568	5669.261
C 62	8	3.2	0.35	0.25	2.24	8098.944
C 63	4	3.2	0.3	0.3	1.152	4165.171
				TOTAL	RS	95104.74

COCNCRETE COST ESTIMATION

cost of 1 m3 of concrete *3615.6 Rs*

FOOTING

Details	Element	No.s	Length	Width	Height	Volume	Cost
Footing Base	F 1	4	3.2	3.2	0.73	29.9008	108109.3
Footing Column		4	0.35	0.35	1	0.49	1771.644
				Total		109881	Rs
Footing Base	F 2	4	1	1	0.2	0.8	2892.48
Footing Column		4	0.35	0.25	1	0.35	1265.46
				Total		4157.94	Rs
Footing base	F 3	8	0.9	0.9	0.18	1.1664	4217.236
Footing base		8	0.3	0.3	1	0.72	2603.232
				Total		6820.468	Rs

STAIRS CASE

	Element	No.s	Length	Width	Height	Volume	Cost
Going	steps	96	0.8	0.25	0.18	1.728	6247.757
Going	slab	12	2	0.8	0.16	3.072	11107.12
Landing	slab	26	0.8	0.8	0.16	2.6624	9626.173
				Total		26981.05	Rs

BBS Ref:

Bar Mark	Description of Elements	ø of Bars	Nºof Elmts	Nºof Bars	Total Nº	Cutting length (m)	Code	A	B	C	D	E	F	Shape	Weight (Kg)
								SLAB S1							
1	MAIN REINFROCEMENT	T10	4	13	13 Nº	10.1139	222	6862.5	41.4	3210	100			6862.5 41.4 3210 100	324.163
2	MAIN REINFROCEMENT	T10	4	53	212 Nº	4.9139	222	3193.9	41.4	1620	100			3193.9 41.4 1620 100	642.102
3	MAIN REINFROCEMENT	T10	4	13	13 Nº	10.1139	222	9150	41.4	922.5	100			9150 41.4 922.5 100	324.163
4	MAIN REINFROCEMENT	T10	4	53	212 Nº	4.9139	222	4281.4	41.4	532.5	100			4281.4 41.4 532.5 100	642.102
5	TORSIONAL BARS	T8	24	3	72 Nº	1.525	100	1525						1525	43.314
6	TORSIONAL BARS	T8	24	3	72 Nº	0.725	100	725						725	20.592
								SLAB S2							
1	MAIN REINFROCEMENT	T10	16	13	13 Nº	10.1139	222	6862.5	41.4	3210	100			41.4 6862.5 3210 100	1296.654
2	MAIN REINFROCEMENT	T10	8	53	424 Nº	4.9139	222	3193.9	41.4	1620	100			41.4 3193.9 1620 100	1284.205
4	MAIN REINFROCEMENT	T10	8	53	424 Nº	4.9139	222	4281.4	41.4	532.5	100			41.4 9150 922.5 100	1284.205
5	TORSIONAL BARS	T8	32	3	96 Nº	1.525	100	1525						4281.4	57.751
6	TORSIONAL BARS	T8	32	3	96 Nº	0.725	100	725						1525	27.456
								SLAB S3							
1	MAIN REINFROCEMENT	T10	3	10	10 Nº	10.1139	222	6862.5	41.4	3210	100			6862.5 41.4 3210 100	187.017
2	DISTRIBUTION BARS	T8	3	27	81 Nº	3.045	200	160	2725	160				160 2725 160	97.296
														TOTAL STEEL IN SLABS	6231

Bar Mark	Description of Elements	ø of Bars	Nºof Elmts	Nºof Bars	Total Nº	Cutting length (m)	Code	A	B	C	D	E	F	Shape	Weight (Kg)
								BEAM B1							
1	ANCHORAGE BARS	T10	6	2	12 Nº	7.625	100	7625						7625	56.481
2	MAIN BARS	T25	6	2	12 Nº	8.7875	200	200	8388	200				200 8387.5 200	406.83
3	BENTUP BARS	T25	6	3	18 Nº	10.08029	483	1089.3	74.5	5686	180	3050		1089.28 74.52 74.52 3050 180 5686.48	700.02
4	STIRRUPS	T8	6	40	240 Nº	0.82	501	202	192	32				202 32 192	77.748
								BEAM B2							
1	ANCHORAGE BARS	T10	6	2	12 Nº	7.625	100	7625						7625	56.481
2	MAIN BARS	T25	6	3	18 Nº	8.7875	200	200	8388	200				200 8387.5 200	610.24
3	BENTUP BARS	T25	6	5	30 Nº	14.27404	483	3050	74.5	7845	180	3050		3050 74.52 74.52 3050 180 7845	1652.1
4	STIRRUPS	T8	6	40	240 Nº	0.82	501	202	192	32				202 32 192	77.748
								BEAM B3							
1	ANCHORAGE BARS	T10	6	2	12 Nº	7.625	100	7625						725	56.481
2	MAIN BARS	T25	6	3	18 Nº	8.7875	200	200	8388	200				200 8387.5 200	610.24
3	BENTUP BARS	T25	6	4	24 Nº	14.27404	483	3050	74.5	7845	180	3050		3050 74.52 3050 180 7845	1321.7
4	STIRRUPS	T8	6	40	240 Nº	0.82	501	202	192	32				202 32 192	77.748
								BEAM B5							
1	ANCHORAGE BARS	T10	2	2	4 Nº	3	100	3000						3000	7.4074
2	MAIN BARS	T25	2	1	2 Nº	3.7	200	200	8388	200				200 8387.5 200	28.549
3	BENTUP BARS	T25	2	2	4 Nº	5.94904	483	1200	74.5	3220	180	1200		1200 74.52 74.52 1200 180 3220	91.806
4	STIRRUPS	T8	2	40	80 Nº	0.82	501	202	192	32				202 32 192	25.916
								BEAM B4							
1	ANCHORAGE BARS	T10	2	2	4 Nº	3.625	100	3625						725	8.9506
2	MAIN BARS	T10	2	2	4 Nº	4.1475	200	80	3988	80				80 3987.5 80	10.241
3	BENTUP BARS	T10	2	1	2 Nº	5.08029	483	517.86	74.5	2858	180	1450		517.857 74.52 74.52 1450 180 2857.91	6.272
4	STIRRUPS	T8	2	21	42 Nº	0.82	501	202	192	32				202 32 192	13.606
								MAIN BARS WITH SECONDARY LOAD							
1	ANCHORAGE BARS	T10	8	2	16 Nº	7.625	100	7625						725	75.309
2	MAIN BARS	T25	8	2	16 Nº	8.7875	200	200	8388	200				200 8387.5 200	542.44
3	BENTUP BARS	T25	8	3	24 Nº	14.27404	483	3050	74.5	7845	180	3050		3050 74.52 3050 180 7845	1321.7
4	STIRRUPS	T8	8	50	400 Nº	0.82	501	202	192	32				202 32 192	129.58
5	HANGER BARS	T10	8	5	40 Nº	0.649	483	300	74.5	200	180	74.5		6862.5 41.4 41.4 100 3210	16.025
														TOTAL STEEL IN BEAMS	7981.6

Type your name of company here.

Name of Project RESIDENTIAL BUILDING

Name of Structure ROOF SLAB AND BEAMS

SUMMARY OF REINFORCEMENT STEEL								
Size of bar	**T8**	**T10**	**T12**	**T16**	**T20**	**T25**	**T32**	**Total**
Weight (Kg)	**649**	**6278**	**0**	**0**	**0**	**7286**	**0**	**14213**
						TOTAL COST		₹ 596,928.07

BBS Ref:

Bar Mark	Description of Elements	ø of Bars	Nºof Elmts	Nºof Bars	Total Nº	Cutting length (m)	Code	A	B	C	D	E	F	Shape	Weight (Kg)
SLAB S1															
1	MAIN REINFROCEMENT	T10	4	13	13 Nº	10.1139	222	6862.5	41.4	3210	100			6862.5 41.4 3210 100	324.163
2	MAIN REINFROCEMENT	T10	4	48	192 Nº	4.9139	222	3193.9	41.4	1620	100			3193.9 41.4 1620 100	581.527
3	MAIN REINFROCEMENT	T10	4	15	15 Nº	10.1139	222	9150	41.4	922.5	100			9150 41.4 922.5 100	374.035
4	MAIN REINFROCEMENT	T10	4	53	212 Nº	4.9139	222	4281.4	41.4	532.5	100			4281.4 41.4 532.5 100	642.102
5	TORSIONAL BARS	T8	24	3	72 Nº	1.525	100	1525						1525	43.314
6	TORSIONAL BARS	T8	24	3	72 Nº	0.725	100	725						725	20.592
SLAB S2															
1	MAIN REINFROCEMENT	T10	16	13	13 Nº	10.1139	222	6862.5	41.4	3210	100			6862.5 41.4 3210 100	1296.654
2	MAIN REINFROCEMENT	T10	8	38	304 Nº	4.9139	222	3193.9	41.4	1620	100			3193.9 41.4 1620 100	920.750
4	MAIN REINFROCEMENT	T10	8	53	424 Nº	4.9139	222	4281.4	41.4	532.5	100			9150 41.4 922.5 100	1284.205
5	TORSIONAL BARS	T8	32	3	96 Nº	1.525	100	1525						4281.4	57.751
6	TORSIONAL BARS	T8	32	3	96 Nº	0.725	100	725						1525	27.456
SLAB S3															
1	MAIN REINFROCEMENT	T10	3	10	10 Nº	10.1139	222	6862.5	41.4	3210	100			6862.5 41.4 3210 100	187.017
2	DISTRIBUTION BARS	T8	3	27	81 Nº	3.045	200	160	2725	160				160 2725 160	97.296
														TOTAL STEEL IN SLABS	5856.9
BEAM B1															
1	ANCHORAGE BARS	T10	6	2	12 Nº	7.625	100	7625						7625	56.481
2	MAIN BARS	T25	6	2	12 Nº	8.7875	200	200	8388	200				200 8387.5 200	406.83
3	BENTUP BARS	T25	6	5	30 Nº	10.08029	483	1089.3	74.5	5686	180	3050		1089.285 74.52 74.52 3050 180 5686.484	1166.7
4	STIRRUPS	T8	6	40	240 Nº	0.82	501	202	192	32				202 32 192	77.748
BEAM B2															
1	ANCHORAGE BARS	T10	6	2	12 Nº	7.625	100	7625						7625	56.481
2	MAIN BARS	T32	6	2	12 Nº	8.7875	200	200	8388	200				200 8387.5 200	666.55
3	BENTUP BARS	T32	6	4	24 Nº	14.27404	483	3050	74.5	7845	180	3050		3050 74.52 74.52 3050 180 7845	2165.4
4	STIRRUPS	T8	6	40	240 Nº	0.82	501	202	192	32				202 32 192	77.748
BEAM B3															
1	ANCHORAGE BARS	T10	6	2	12 Nº	7.625	100	7625						725	56.481
2	MAIN BARS	T25	6	2	12 Nº	8.7875	200	200	8388	200				200 8387.5 200	406.83
3	BENTUP BARS	T25	6	2	12 Nº	14.27404	483	3050	74.5	7845	180	3050		3050 74.52 3050 180 7845	660.84
4	STIRRUPS	T8	6	40	240 Nº	0.82	501	202	192	32				202 32 192	77.748
BEAM B5															
1	ANCHORAGE BARS	T10	2	2	4 Nº	3	100	3000						3000	7.4074
2	MAIN BARS	T25	2	1	2 Nº	3.7	200	200	8388	200				200 8387.5 200	28.549
3	BENTUP BARS	T25	2	2	4 Nº	5.94904	483	1200	74.5	3220	180	1200		1200 74.52 74.52 1200 180 3220	91.806
4	STIRRUPS	T8	2	40	80 Nº	0.82	501	202	192	32				202 32 192	25.916
BEAM B4															
1	ANCHORAGE BARS	T10	2	2	4 Nº	3.625	100	3625						725	8.9506
2	MAIN BARS	T10	2	2	4 Nº	4.1475	200	80	3988	80				80 3987.5 80	10.241
3	BENTUP BARS	T10	2	1	2 Nº	5.08029	483	517.86	74.5	2858	180	1450		517.8571 74.52 74.52 1450 180 2857.912	6.272
4	STIRRUPS	T8	2	21	42 Nº	0.82	501	202	192	32				202 32 192	13.606
MAIN BARS WITH SECONDARY LOAD															
1	ANCHORAGE BARS	T10	8	2	16 Nº	7.625	100	7625						725	75.309
2	MAIN BARS	T25	8	2	16 Nº	8.7875	200	200	8388	200				200 8387.5 200	542.44
3	BENTUP BARS	T25	8	4	32 Nº	14.27404	483	3050	74.5	7845	180	3050		3050 74.52 3050 180 7845	1762.2
4	STIRRUPS	T8	8	50	400 Nº	0.82	501	202	192	32				202 32 192	129.58
5	HANGER BARS	T10	8	5	40 Nº	0.649	483	300	74.5	200	180	74.5		6862.5 41.4 41.4 100 3210	16.025
														TOTAL STEEL IN BEAMS	8594.2

Type your name of company here.

Name of Project RESIDENTIAL BUILDING

Name of Structure FLOOR SLABS AND BEAMS

SUMMARY OF REINFORCEMENT STEEL

Size of bar	T8	T10	T12	T16	T20	T25	T32	Total
Weight (Kg)	649	5904	0	0	0	5066	2832	14451

TOTAL COST ₹ 606,943.83

BBS Ref:

Bar Mark	Description of Elements	ø of Bars	Nºof Elmts	Nºof Bars	Total Nº	Cutting length (m)	Code	A	B	C	D	E	F	Shape	Weight (Kg)
C11															
1	MAIN REINFORCEMENT	10	4	5	20	3.776	222	1400	96	2280	15			1400 96 2280 15	46.548
2	MAIN REINFORCEMENT	10	4	5	20	3.776	222	2200	96	1480	15			2200 96 1480 15	46.548
3	STIRRUPS	8	4	27	108	1.448	501	265	265	192				265 265 192	61.69
					0										0
C12															
1	MAIN REINFORCEMENT	10	8	5	40	3.776	222	1400	96	2280	15			1400 96 2280 15	93.097
2	MAIN REINFORCEMENT	10	8	6	48	3.776	222	2200	96	1480	15			2200 96 1480 15	111.72
3	STIRRUPS	8	8	27	216	1.348	501	165	320	192				165 320 192	114.86
															0
C13															
1	MAIN REINFORCEMENT	12	4	5	20	3.776	222	1400	96	2280	15			1400 96 2280 15	67.03
2	MAIN REINFORCEMENT	12	4	5	20	3.776	222	2200	96	1480	15			2200 96 1480 15	67.03
3	STIRRUPS	8	4	22	88	1.448	0	265	265	192				265 265 192	50.266
															0
C21															
1	MAIN REINFORCEMENT	12	4	6	24	4.096	222	1400	96	2600	15			1400 96 2600 15	87.252
2	MAIN REINFORCEMENT	12	4	6	24	4.096	222	2200	96	1800	15			2200 96 1800 15	87.252
3	STIRRUPS	8	4	22	88	1.448	501	265	265	192				265 265 192	50.266
															0
C22															
1	MAIN REINFORCEMENT	16	8	4	32	4.096	222	1400	96	2600	15			1400 96 2600 15	206.82
2	MAIN REINFORCEMENT	16	8	4	32	4.096	222	2200	96	1800	15			2200 96 1800 15	206.82
3	STIRRUPS	8	8	20	160	1.348	501	165	315	192				165 315 192	85.081
															0
C23															
1	MAIN REINFORCEMENT	16	4	5	20	4.096	222	1400	96	2600	15			1400 96 2600 15	129.26
2	MAIN REINFORCEMENT	16	4	5	20	4.096	222	2200	96	1800	15			2200 96 1800 15	129.26
3	STIRRUPS	8	4	15	60	1.448	501	265	265	192				265 265 192	34.272
					0										
C31															
1	MAIN REINFORCEMENT	16	4	4	16	4.096	222	1400	96	2600	15			1400 96 2600 15	103.41
2	MAIN REINFORCEMENT	16	4	4	16	4.096	222	2200	96	1800	15			2200 96 1800 15	103.41
3	STIRRUPS	8	1	15	15	1.448	501	265	265	192				265 265 192	8.568
C32															
1	MAIN REINFORCEMENT	16	8	4	32	4.096	222	1400	96	2600	15			1400 96 2600 15	206.82
2	MAIN REINFORCEMENT	16	8	4	32	4.096	222	2200	96	1800	15			2200 96 1800 15	206.82
3	STIRRUPS	8	8	20	160	1.348	501	165	315	192				165 315 192	85.081
C33															
1	MAIN REINFORCEMENT	16	4	5	20	4.096	222	1400	96	2600	15			1400 96 2600 15	129.26
2	MAIN REINFORCEMENT	16	4	5	20	4.096	222	2200	96	1800	15			2200 96 1800 15	129.26
3	STIRRUPS	8	4	15	60	1.448	501	265	265	192				265 265 192	34.272
C41															
1	MAIN REINFORCEMENT	16	4	5	20	4.096	222	1400	96	2600	15			1400 96 2600 15	129.26
2	MAIN REINFORCEMENT	16	4	5	20	4.096	222	2200	96	1800	15			2200 96 1800 15	129.26
3	STIRRUPS	8	4	15	60	1.448	501	265	265	192				265 265 192	34.272
C42															
1	MAIN REINFORCEMENT	16	8	4	32	4.096	222	1400	96	2600	15			1400 96 2600 15	206.82
2	MAIN REINFORCEMENT	16	8	4	32	4.096	222	2200	96	1800	15			2200 96 1800 15	206.82
3	STIRRUPS	8	8	20	160	1.348	501	165	315	192				165 315 192	85.081
C43															
1	MAIN REINFORCEMENT	16	4	6	24	4.096	222	1400	96	2600	15			1400 96 2600 15	155.11
2	MAIN REINFORCEMENT	16	4	6	24	4.096	222	2200	96	1800	15			2200 96 1800 15	155.11

Type your name of company here.

Name of Project RESIDENTIAL BUILDING

Name of Structure COLUMNS OF ALL 6 FLOORS

SUMMARY OF REINFORCEMENT STEEL

Size of bar	T8	T10	T12	T16	T20	T25	T32	Total
Weight (Kg)	966	298	309	3464	1939	0	0	6976

TOTAL COST ₹ 292,972.25

3	STIRRUPS	8	4	15	60	1.448	501	265	265	192				265 265 192	34.272

C51															
1	MAIN REINFORCEMENT	20	4	6	24	4.096	222	1400	96	2600	15			1400 96 2600 15	242.37
2	MAIN REINFORCEMENT	20	4	6	24	4.096	222	2200	96	1800	15			2200 96 1800 15	242.37
3	STIRRUPS	8	4	13	52	1.648	501	315	315	192				315 315 192	33.805

C52															
1	MAIN REINFORCEMENT	16	8	6	48	4.096	222	1400	96	2600	15			1400 96 2600 15	310.23
2	MAIN REINFORCEMENT	16	8	6	48	4.096	222	2200	96	1800	15			2200 96 1800 15	310.23
3	STIRRUPS	8	8	16	128	1.548	501	215	315	192				215 315 192	78.163

C53															
1	MAIN REINFORCEMENT	16	4	6	24	4.096	222	1400	96	2600	15			1400 96 2600 15	155.11
2	MAIN REINFORCEMENT	16	4	6	24	4.096	222	2200	96	1800	15			2200 96 1800 15	155.11
3	STIRRUPS	8	4	15	60	1.448	501	265	265	192				265 265 192	34.272

C61															
1	MAIN REINFORCEMENT	20	4	6	24	4.096	222	1400	96	2600	15			1400 96 2600 15	242.37
2	MAIN REINFORCEMENT	20	4	6	24	4.096	222	2200	96	1800	15			2200 96 1800 15	242.37
3	STIRRUPS	8	4	13	52	1.648	501	315	315	192				315 315 192	33.805

C62															
1	MAIN REINFORCEMENT	20	8	4	32	4.096	222	1400	96	2600	15			1400 96 2600 15	323.16
2	MAIN REINFORCEMENT	20	8	4	32	4.096	222	2200	96	1800	15			2200 96 1800 15	323.16
3	STIRRUPS	8	8	16	128	1.548	501	215	315	192				215 315 192	78.163

C63															
1	MAIN REINFORCEMENT	20	4	4	16	4.096	222	1400	96	2600	15			1400 96 2600 15	161.58
2	MAIN REINFORCEMENT	20	4	4	16	4.096	222	2200	96	1800	15			2200 96 1800 15	161.58
3	STIRRUPS	8	4	13	52	1.448	501	265	265	192				265 265 192	29.703

BBS Ref:

Bar Mar	Description of Elements	ø of Bar	Nºof Elmt	Nºof Bars	Total Nº	Cutting length (m)	Code	A	B	C	D	E	F	Shape	Weight (Kg)
F1															
1	MAIN REINFORCEMENT	25	4	12	48	3.45	200	200	3050	200				200 3050 200	637.94
2	MAIN REINFORCEMENT	25	4	12	48	3.45	200	200	3050	200				200 3050 200	637.94
3	STARTER BARS	20	4	4	16	2	111	500	1500					500 1500	78.895
4	STIRRUPS	8	4	5	20	1.544	501	315	315	192				315 315 192	12.181
F2															
1	MAIN REINFORCEMENT	10	4	7	28	3.21	200	80	3050	80				80 3050 80	55.399
2	MAIN REINFORCEMENT	10	4	7	28	3.21	200	80	3050	80				80 3050 80	55.399
3	STARTER BARS	10	4	4	16	1.9	111	400	1500					400 1500	18.738
4	STIRRUPS	8	4	5	20	1.344	501	215	315	192				215 315 192	10.604
F3															
1	MAIN REINFORCEMENT	10	8	6	48	3.21	200	80	3050	80				80 3050 80	94.97
2	MAIN REINFORCEMENT	10	8	6	48	3.21	200	80	3050	80				80 3050 80	94.97
3	STARTER BARS	10	8	4	32	1.9	111	400	1500					400 1500	37.475
4	STIRRUPS	8	8	5	40	1.344	501	265	265	192				215 265 192	21.207

Type your name of company here.

Name of Project RESIDENTIAL BUILDING

Name of Structure FOOTINGS

SUMMARY OF REINFORCEMENT STEEL

Size of bar	T8	T10	T12	T16	T20	T25	T32	Total
Weight (Kg)	44	357	0	0	79	1276	0	1756

TOTAL COST 73,740.57

BBS Ref:

Bar Mar	Description of Elements	ø of Bars	Nºof Elmt	Nºof Bars	Total Nº	Cutting length (m)	Code	A	B	C	D	E	F	Shape	Weight (Kg)
STAIRS															
1	MAIN REINFORCEMENT	8	11	5	55	3.68	222	840	2000	840				840 2000 840	79.842
2	LANDING REINFORCEMENT	8	11	10	110	2.15	304	350	840	100	860			860 100 350 840	93.294
3	DISTRIBUTION REINFORCEMENT	8	11	24	264	0.75	100	750						750	78.107
FIRST STAIR															
1	MAIN REINFORCEMENT	8	1	5	5	3.68	213	840	840	2000				840 840 2000	7.2584
2	LANDING REINFORCEMENT	8	1	10	10	2.15	304	350	840	100	860			860 100 350 840	8.4813
3	DISTRIBUTION REINFORCEMENT	8	1	24	24	0.75	100	750						750	7.1006

Type your name of company here.

Name of Project RESIDENTIAL BUILDING

Name of Structure STAIRS

SUMMARY OF REINFORCEMENT STEEL								
Size of bar	**T8**	**T10**	**T12**	**T16**	**T20**	**T25**	**T32**	**Total**
Weight (Kg)	**274**	**0**	**0**	**0**	**0**	**0**	**0**	**274**

TOTAL COST 11,511.48

COST ESTIMATION OF PRESTRESSED SLABS

CONCRETE COST

S NO.	ELEMENT	LENGTH(m)	WIDTH(m)	DEPTH(mm)	VOLUME(m3)	COST/m3	TOTAL COST
1	SLAB	7.65	7.65	150	8.78	4728	41,504.16
					TOTAL COST OF 6*6 SLABS		1,494,149.65

STRANDS COST

S NO.	ELEMENT	DIAMETER(mm)	NO OF STRANDS	LENGTH(m)	WEIGHT/LENGTH(gm)	TOTAL WEIGHT(kg)	COST/Kg	TOTAL COST
1	7 wire strands	12.5	25	7.65	726.3	138.90	40	5556.20
2	7 wire strands	12.5	30	7.65	726.3	166.69	40	6667.43
					TOTAL COST OF 6*6 SLABS			233,360.19

RESULTS

The result of this project is shown in this table which shows the material cost of all the elements of the structure separately and thus bringing out the comparison of effectiveness of two methods.

CONCRETE COST

In PSC design we have replaced only two way RCC slabs with PSC slabs and removed the secondary beams (B2) from each floor and increasing the depth of rest of the beams by 40 mm.

RCC	COST	PSC	COST
TWO WAY SLABS	11,09,098.80	TWO WAY SLABS	14,94,149.65
ONE WAY SLABS	1,59,933.30	ONE WAY SLABS	1,59,933.30
BEAMS	2,96,470.19	BEAMS	2,65,041.56
COLUMNS	95,104.74	COLUMNS	95,104.74
FOOTINGS	1,20,859.40	FOOTINGS	1,20,859.40
STAIRS	26,981.05	STAIRS	26,981.05
TOTAL COST	**18,08,447.50**	**TOTAL COST**	**21,62,069.70**

Percentage increase in the cost of concrete using PSC slabs = 19.55 %

REINFORCEMENT COST

In PSC design we have used strands only in two way slabs and distributed the steel of secondary beams to other beams.

RCC	COST	PSC	COST
TWO WAY SLABS	14,20,004.12	TWO WAY SLABS	2,33,360.19
ONE WAY SLABS	71,646.87	ONE WAY SLABS	71,646.87
BEAMS	21,40,009.20	BEAMS	21,40,009.20
COLUMNS	2,92,972.25	COLUMNS	2,92,972.25
FOOTINGS	73,740.57	FOOTINGS	73,740.57
STAIRS	11,511.48	STAIRS	11,511.48
TOTAL	**40,09,884.50**	**TOTAL**	**28,23,240.56**

Percentage decrease in the cost of reinforcement using PSC design = 29.59 %

Total percentage saving in material cost of whole structure by PSC design in slabs = 14.30 %

CONCLUSION

There is a definite trend towards large spans in buildings due to the fact that there is now more emphasis on providing large uninterrupted floor space which can result in higher rental returns. Post-tensioning is an economical way of achieving these larger spans. For spans 7.5 meters and over, post-tensioning will certainly be economic and, as the spans increase, so do the savings.
The most significant factor affecting the cost of slab system post-tensioning is the tendon length. Other factors create a scatter of results leading to an upper and lower bound. Not with standing this, it is always advisable to obtain budget prices from a post-tensioning supplier.

However, other factors such as floor to floor heights, services, etc., must be taken into account in the selection of the floor structure. For high rise construction and highly repetitive floor plates, the use of more specialized structural schemes are appropriate with emphasis on systems formwork.
In our structure of residential building using post tensioned slabs we are able to save 14% cost.

FUTURE SCOPE

Due to increasing trend of large span floors with uninterrupted floor space the future scope of this project is substantial. In this project we have used post tensioned slabs of span 7.5m. In future the structure could be designed with longer spans. Also one can use PSC in other elements of structure like beams, columns etc. and then compare the material cost of two structures. And to assess the actual effectiveness of replacing RCC with PSC can be done by comparing the overall cost of structure including the installation cost of strands, transportation cost, type of labour required in erection of structure, material handling cost, speed of erection of structure and many other factors that may increase or decrease the cost of structure using these two design methods. Thus whether the use of PSC in design of buildings should increase or not can be truly ascertained.

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APPENDIX I

STRAND SPECIFICATIONS

7 wire strands
EN 10138 – BS 5896

	Nominal diameter	Tensile strength	Mass	Cross sectional area	Tolerance on mass	Minimum breaking strength	Maximum breaking strength	Yield strength at 0.1 % elongation
	mm	MPa	g/m	mm^2	%	kN	kN	kN
	6.85	2060	220.2	28.2	± 2	58.1	66.8	51.1
BS	7	2060	234.3	30.0	± 2	61.8	71.1	54.4
	8	1860	296.8	38.0	± 2	70.7	81.3	60.8
BS	9.3	1860	406.1	52.0	± 2	96.7	111.0	83.2
BS	9.6	1960	429.6	55.0	± 2	102.0	117.0	87.7
BS	11.3	1860	585.8	75.0	± 2	140.0	161.0	120.0
BS	12.5	1860	726.3	93.0	± 2	173.0	199.0	149.0
BS	12.9	1860	781.0	100.0	± 2	186.0	214.0	160.0
BS	15.2	1770	1086.0	139.0	± 2	246.0	283.0	212.0
BS	15.2	1860	1086.0	139.0	± 2	259.0	298.0	223.0
	15.3	1770	1093.0	140.0	± 2	248.0	285.0	213.0
BS	15.7	1770	1172.0	150.0	± 2	266.0	306.0	229.0
	15.7	1860	1172.0	150.0	± 2	279.0	321.0	240.0

APPENDIX II

- **MIX DESIGN OF M25**

As per IS 10262-2009 & MORT&H

mass of cement	320 kg/m3	(SSD condition)	
mass of water	138 kg/m3		
mass of fine agg,	751 kg/m3	vol. of fine agg.	0.449 m3
mass of coarse agg.	1356 kg/m3		
mass of 20 mm	977 kg/m3	vo. Of coarse agg.	0.574 m3
mass of 10 mm	380 kg/m3	vol. of coarse agg.	0.237 m3
mass of admixture	1.6 kg/m3		
water cement ratio	0.43		

cost of cement	6.2 Rs/kg	
cost of water	free	
cost of fine agg.	1200 Rs/ m3	
cost of coarse agg.	1300 Rs/ m3	(10 mm)
cost of coarse agg.	1350 Rs / m3	(20 mm)
cost of admixture	6 Rs / kg	

total cost of cement	1984	Rs.
total cost c of fine agg.	539	Rs.
total cost c of coarse agg. (10 mm)	308	Rs.
total cost of coarse agg. (20 mm)	775	Rs.
total cost of admixture	9.6	Rs.
total cost of 1 m3 of concrete	**3615.6**	**Rs.**

APPENDIX III

- **MIX DESIGN OF M40**

M40 MIX DESIGN AND COST		
mass of Cement	445 kg/m3	
mass of Water	160 kg/m3	
mass of Fine aggregate	520 kg/m3	
mass of Coarse aggregate 20 mm	361 kg/m3	
mass of Coarse aggregate 10 mm	896 kg/m3	
Admixture = 0.6 % by weight of cement	4.4 kg/m3	
cost of cement	6.2 Rs/kg	
cost of water	free	
cost of fine agg.	.7 Rs/kg	
cost of coarse agg. (10mm)	1 Rs/kg	
cost of coarse agg. (20mm)	.9 Rs/kg	
cost of admixture	100 Rs /m3	
total cost of cement	2759	Rs.
total cost of fine agg.	364	Rs.
total cost of coarse agg. (10 mm)	361	Rs.
total cost of coarse agg. (20 mm)	806.4	Rs.
total cost of admixture	440	Rs.
total cost of 1 m3 of concrete	**4730.4**	Rs.

APPENDIX IV

- **COST OF Fe415 GRADE TMT REINFORCEMENT.**

size(mm)	rates rs/kg	VAT(4%)	sales tax/kg	total cost /kg	weight Kg/m
8	41	4	1.64	42.64	0.395
10	40.5	4	1.62	42.12	0.617
12	40	4	1.6	41.6	0.888
16	40	4	1.6	41.6	1.5
18	40	4	1.6	41.6	2
20	40	4	1.6	41.6	2.47
22	40	4	1.6	41.6	2.98
25	40	4	1.6	41.6	3.85
28	40	4	1.6	41.6	4.83
32	40	4	1.6	41.6	6.31