



SRM VALLIAMMAI ENGINEERING COLLEGE

Approved by AICTE | Affiliated to Anna University | Accredited by NBA
'A' Grade Accreditation by NAAC | ISO 21001 : 2018 Certified

[An Autonomous Institution]



DEPARTMENT OF CIVIL ENGINEERING

LAB MANUAL

CE3763 STRUCTURAL DRAWING AND DETAILING LABORATORY

2023 Regulation

VII Semester B.E. Civil Engineering

LAB MANUAL

(2026-2027 ACADEMIC YEAR)

Prepared by,

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DEPARTMENT OF CIVIL ENGINEERING

GENERAL INSTRUCTIONS

The following instructions should be strictly followed by students in the CAD Lab:

- Students should wear lab coat in CAD lab.
- Students are advised to enter the CAD lab WITH FORMAL SHOES ONLY.
- They are not supposed to move the systems and monitors.
- They should enter in the login name and password assigned to each student.
- Students are advised to complete their record work before the next class.
- Students are asked to leave their area and switch off the computers before leaving the lab.
- Students can access the printers through lab technician.
- Students have free access to use the computers and software available in the lab.
- During laboratory hours, accessing the internet is strictly prohibited.
- Computer games are strictly prohibited in the CAD lab.

SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University, Chennai, 'A'
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B.E. CIVIL ENGINEERING

REGULATIONS – 2023

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

1. To produce graduates who can understand their ethical, environmental as well as professional responsibilities so that they appreciate the impact of the engineering solutions which have sustainability over society and the nation.
2. To develop the graduates who will exhibit strong technical ability to create & synthesize data using relevant tools and concepts, for providing sustainable solutions to civil engineering problems and projects.
3. To equip the graduates with suitable skills making them industry ready when they leave the portals of the Institute and to become a competent distinguished Professional Civil Engineer.
4. To produce students who can exhibit attitude, professionalism, ability to communicate with team members and adapt to the latest technology by engaging themselves in life-long learning

2. PROGRAMME OUTCOMES (POs):

After going through the four years of study, our Civil Engineering Graduates will exhibit ability to:

PO	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization for the solution of complex engineering problems.
2	Problem analysis	Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	Design/development of	Design solutions for complex engineering problems

	solutions	and design system components or processes that meet the specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.
4	Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
5	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.
6	Engineering and society	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to professional engineering practice
7	Environment and sustainability	Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice
9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
10	Communication	Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments
12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

3. PROGRAM SPECIFIC OUTCOMES (PSOs):

By the completion of Civil Engineering program, the student will have following Program specific outcomes

1. Establish a Civil Engineering career in industry, government or academic field and achieve professional expertise as appropriate.
2. Execute innovation and excellence in Civil engineering problem solving and design in global and societal contexts.
3. Commit to lifelong learning and professional development in the Civil Engineering field to stay updated in technology, research topics and contemporary issues.
4. Understand the fundamentals of Civil Engineering in commercial contexts and in expediting construction projects.

4. PEO / PO Mapping:

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES												PROGRAM SPECIFIC OUTCOMES			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
I	3	1	1	1	2	3	3	3	2	3	1	3	3	3	1	1
II	2	3	3	3	3	2	3	3	2	2	3	3	2	2	3	3
III	1	-	-	3	3	3	1	1	3	-	2	1	1	3	-	3
IV	3	-	-	1	3	3	3	-	3	3	2	3	3	3	-	1

Contribution:

1. Reasonable

2. Significant

3. Strong

B.E. CIVIL ENGINEERING

Vision

To produce competent and quality engineers by imparting knowledge, excellence and global perspectives in Civil Engineering to our students and to make them ethically strong professional engineers to build our nation.

Mission

M1: To produce outstanding graduates with high technical knowledge to serve the nation.

M2: To impart value-based education.

M3: To provide solution to the challenges in the field of Civil Engineering.

CE3763 STRUCTURAL DRAWING AND DETAILING LABORATORY

L T P C

0 0 4 2

OBJECTIVES:

- To introduce students to modern design software tools such as AUTO CAD, STAAD, E-TABS, etc., enabling them to navigate and use these tools effectively.
- To train students to apply industry-standard codes and computational tools independently for the design and analysis of reinforced concrete and steel structures.
- To develop students' proficiency in generating comprehensive and accurate structural drawings using design software.
- To provide students with advanced knowledge and skills for designing special reinforced concrete structural members.
- To equip students with the ability to conduct thorough structural analyses of framed structures, including the application of appropriate computational tools, and instill the importance of comprehensive reporting for each design experiment.

LIST OF EXPERIMENTS

1. Design and drawing of RC members.
2. Design and drawing of special RC Structural Members.
3. Design and drawing of RC T beam bridge.
4. Design and drawing steel roof truss.
5. Design and drawing of steel connections.
6. Analysis of Framed Structure.
7. Reinforcement details of Various RC Elements

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, students will be able to:

- Become skilled in using design software like AUTO CAD, STAAD, E-TABS.
- Independently apply standard codes, computational tools, and software packages to analyze, design, and detail reinforced concrete and steel structures.
- Generate comprehensive and detailed drawings of structures using design software, showcasing the ability to translate design concepts into practical, visual representations.
- Understand how buildings work, detail reinforcements, and explain your work clearly in reports.
- Analyze and design unique concrete structures with advanced principles

TEXTBOOKS:

1. Krishnaraju.N, — Design N,einforced Concrete Structures, CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2016
2. Varghese, P.C., — Limit State Design of Reinforced Concrete, Prentice Hall of India, Pvt. Ltd., New Delhi, 2002.
3. Gambhir. M.L., — Fundamentals of Reinforced Concrete Design", Prentice Hall of India Private Limited, New Delhi, 2006.
4. Subramanian,N., Design of Reinforced Concrete Structures, Oxford University Press, New Delhi, 2024.
5. Unnikrishna Pillai, S., Devadas Menon, — Reinforced Concrete Design, Tata McGraw Hill Publishing Company Ltd., 2021.
6. Subramanian N, "Design of Steel Structures", Oxford University Press, New Delhi, 2013. 7. Bhavikatti.S.S, "Design of Steel Structures" By Limit State Method as per IS:800– 2007, IK International Publishing House Pvt. Ltd., 2009.
8. Rangwala, “ Civil Engineering Drawing: (4th edition), 2024.
9. S.S. Bhavikatti, “design and Drawing of Steel Structures”, (5th edition), 2019.

REFERENCES:

1. IS 456:2000, — Code of practice for Plain and Reinforced Concrete, Bureau of Indian Standards, New Delhi, 2000
2. SP16, IS 456:1978, — Design Aids for Reinforced Concrete to Bureau of Indian Standards, New Delhi, 1999
3. IS 800:2007, General Construction In Steel - Code of Practice, (Third Revision), Bureau of Indian Standards, New Delhi, 2007
4. Jain, A.K., Limit State Design of RC Structures, Nemchand Publications, Roorkee, 1998.
5. Ramachandra, — Limit state Design of Concrete Structures, Standard Book House, New Delhi
6. Ponnuswamy,S., “Bridge Engineering”, Tata McGrawHill,2008
7. Punmia. B.C., Ashok Kumar Jain, Arun Kumar Jain, Limit State Design of Reinforced Concrete, Laxmi Publication Pvt. Ltd., New Delhi, 2007.

CE3763	PROGRAM OUTCOMES												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
CO1	3	1	-	-	-	2	-	-	1	3	1	2	1	1	2	-
CO2	2	2	-	2	-	2	-	2	1	2	-	2	-	-	2	-
CO3	2	2	2	2	1	2	-	2	2	2	-	2	-	-	2	-
CO4	3	2	2	3	-	2	-	2	2	3	-	3	-	1	2	-
CO5	2	2	2	2	-	2	3	2	2	3	1	3	1	1	2	-
Average	2.4	1.8	2.0	2.3	1.0	2.0	3.0	2.0	1.6	2.6	1.0	2.4	1.0	1.0	2.0	0.0

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2	Study Exercise – Conventions & Symbols	14
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9	Reinforcement Detailing of Staircase	42
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Computer Aided Drafting is a process of preparing a drawing of an object on the screen of a computer. There are various types of drawings in different fields of engineering and sciences. In the fields of mechanical or aeronautical engineering, the drawings of machine components and the layouts of them are prepared. In the field of civil engineering, plans and layouts of the buildings are prepared. In the field of electrical engineering, the layouts of power distribution system are prepared. In all fields of engineering, use of computer is made for drawing and drafting.

The use of CAD process provides enhanced graphics capabilities which allow any designer to

- Conceptualize his ideas
- Modify the design very easily
- Perform animation
- Make design calculations
- Use colors, fonts and other aesthetic features.

REASONS FOR IMPLEMENTING A CAD SYSTEM

- 1. Increases the productivity of the designer:** CAD improves the productivity of the designer to visualize the product and its component, parts and reduces the time required in synthesizing, analyzing and documenting the design
- 2. Improves the quality of the design:** CAD system improves the quality of the design. A CAD system permits a more detailed engineering analysis and a larger number of design alternatives can be investigated. The design errors are also reduced because of the greater accuracy provided by the system
- 3. Improves communication:** It improves the communication in design. The use of a CAD system provides better engineering drawings, more standardization in the drawing, and better documentation of the design, few drawing errors and legibility.
- 4. Create data base for manufacturing:** In the process of creating the documentation for these products, much of the required data base to manufacture the products is also created.
- 5. Improves the efficiency of the design:** It improves the efficiency of the design process and the wastage at the design stage can be reduced.

APPLICATION OF CAD:

There are various processes which can be performed by use of computer in the drafting

process.

Autoated drafting: This involves the creation of hard copy engineering drawings directly from CAD database. Drafting also includes features like automatic dimensioning, generation of cross – hatched areas, scaling of the drawing and the capability to develop sectional views and enlarged views in detail. It has ability to perform transformations of images and prepare 3D drawings like isometric views, perspective views etc.,

Geometric modeling: concerned with the computer compatible mathematical description of the geometry of an object. The mathematical description allows the image of an object to be displayed and manipulated on a graphics terminal through signals from the CPU of the CAD system. The software that provides geometric modeling capabilities must be designed for efficient use both by computer and the human designer.

BENEFITS OF CAD:

The implementation of the CAD system provides variety of benefits to the industries in design and production as given below:

- Improved productivity in drafting
- Shorter preparation time for drawing
- Reduced manpower requirement
- Customer modifications in drawing are easier
- More efficient operation in drafting
- Low wastage in drafting
- Minimized transcription errors in drawing
- Improved accuracy of drawing
- Assistance in preparation of documentation
- Better designs can be evolved
- Revisions are possible
- Colours can be used to customize the product
- Production of orthographic projections with dimensions and tolerances
- Hatching of all sections with different filling patterns
- Preparation of assembly or sub assembly drawings
- Preparation of part list
- Machining and tolerance symbols at the required surfaces.
- Hydraulic and pneumatic circuit diagrams with symbols

- Printing can be done to any scale

LIMITATIONS OF CAD

- 32 – bit word computer is necessary because of large amount of computer memory and time
- The size of the software package is large
- Skill and judgment are required to prepare the drawing
- Huge investment

CAD SOFTWARES

The software is an interpreter or translator which allows the user to perform specific type of application or job related to CAD. The following softwares are available for drafting.

- AUTOCAD
- Pro – E
- CATIA
- MS OFFICE
- PAINT
- ANSYS
- MSc. NASTRAN
- IDEASSOLID WORKS
- HYPERMESH
- FLUENT – GAMBIT

The above software is used depending upon their application.

AUTO CAD

Auto CAD package is suitable for accurate and perfect drawings of engineering designs. The drawing of machine parts, isometric views and assembly drawings are possible in AutoCAD. The package is suitable for 2D and 3D drawings.

EX.NO:02

DATE:

STUDY EXERCISE – CONVENTIONS & SYMBOLS

Sl. No.	Term	Abbreviation
1.	Aggregate	Agg
2.	Approximate	Approx
3.	Asbestos cement	asb/cem
4.	At	@
5.	Air Conditioner	A/C
6.	Brick work	BWK
7.	Brick on edge	BOE
8.	Building	Bldg
9.	Bench mark	BM
10.	Cast-iron	CI
11.	Cement concrete	CC
12.	Centre to centre	c to c, c/c
13.	Cement mortar	CM
14.	Coarse rubble masonry	CR
15.	Random rubble masonry	RR

Sl. No.	Term	Abbreviation
16.	Column	COL
17.	Concrete	CONC
18.	Corrugated	CORR
19.	Cross-section	CS
20.	Cupboard	CB
21.	Collapsible gate	CG
22.	Door	D
23.	Damp proof course	DPC
24.	Diameter	dia,
25.	European water closet	EWC
26.	Figure	Fig.
27.	Finished floor level	FFL
28.	Floor trap	FT
29.	Flushing cistern	FC
30.	Fresh air inlet	FAI
31.	Full supply level	FSL

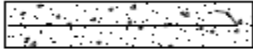
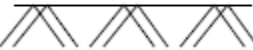
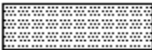
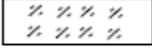
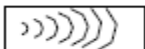
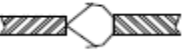
Sl. No.	Term	Abbreviation
32.	Full tank level	FTL
33.	First floor	FF
34.	Floor level	FL
35.	Flush out latrine	FOL
36.	Galvanized	Galv
37.	Galvanized iron	GI
38.	Grease trap	GRT
39.	Ground level	GL
40.	Grills	G
41.	Gully trap	GT
42.	Height	Ht
43.	Indian water closet	IWC
44.	Imperial (standard) wire gauge	SWG
45.	Inspection chamber	ICH, IC
46.	Intercepting trap	IT

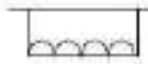
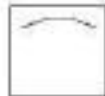
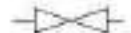
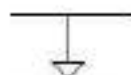
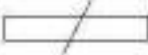
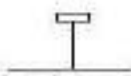
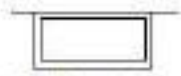
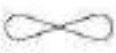
Sl. No.	Term	Abbreviation
47.	Joist	J
48.	Jolly work	JW
49.	Kilo	K
50.	Kilogram	KG
51.	Kilometer	KM
52.	Litre	LT.
53.	Level crossing	LC
54.	Low water level	LWL
55.	Lime mortar	LM
56.	Lime concrete	LC
57.	Maximum flood level	MFL
58.	Maximum water level	MWL
59.	Manhole	MH
60.	Maximum	Max
61.	Mild steel	MS
62.	Millimeter	mm

Sl. No.	Term	Abbreviation
63.	Minimum	MIN
64.	Not to scale	NTS
65.	Number	No.
66.	Overhead tank	OHT
67.	Plain cement concrete	PCC
68.	Plinth level	PL
69.	Prestressed concrete	PCONC
70.	Radius	Rad
71.	Rainwater pipe	RWP
72.	Rolled section / Rolling shutter	RS
73.	Rolled steel joist or I-section	RSJ OR I
74.	Reinforced Cement Concrete	RCC
75.	Ribbed tor steel	RTS
76.	Stone ware pipe	SWP
77.	Surki mortar	SM
78.	Sink	S

Sl.No.	Term	Abbreviation
79.	Soil pipe	SP
80.	Standard	Std
81.	Septic tank	ST
82.	Switch	Sw
83.	Ventilator	V
84.	Vent pipe	VP
85.	Wash basin	WB
86.	Water closet	WC
87.	Window	W
88.	Window cum ventilator	W/V
89.	Water level	WL

SYMBOLS

	BRICK WORK (SECTION)
	BRICK WORK (SECTION)
	BRICK WORK (ELEVATION)
	PLAIN CEMENT CONCRETE
	REINFORCED CEMENT CONCRETE
	STONE MASONRY (SECTION)
	EARTH
	GROUND LEVEL
	SAND FILLING
	GLASS ELEVATION
	GLASS
	RANDOM RUBBLE MASONRY
	COARSE RUBBLE MASONRY
	TIMBER CROSS SECTION
	TIMBER ELEVATION
	TIMBER ELEVATION
	DOOR SINGLE LEAF SINGLE SWING
	DOOR SINGLE LEAF DOUBLE SWING
	DOOR DOUBLE LEAF SINGLE SWING
	DOOR DOUBLE LEAF DOUBLE SWING
	REVOLVING DOOR

			
1. Light plug	11. Immersion heater	21. Exhaust fan	31. Urinal stall
			
2. Power plug	12. Bell point	22. Fan regulator	32. Indian type WC
			
3. Meter	13. Bell	23. Rectangular bath	33. Stop valve or sluice valve
			
4. Light bracket	14. Buzzer	24. Bidet	34. Fire extinguisher
			
5. Fluorescent light (single)	15. Telephone instrument point internal	25. Shower head	35. Fire hydrant
			
6. Fluorescent light (double)	16. Fire alarm push	26. Wall lavatory basin	36. Pump
			
7. One-way switch	17. Aerial	27. Corner lavatory basin	37. Gully
			
8. Two-way switch	18. Ceiling fan	28. Plain kitchen sink	38. Manhole or inspection chamber
			
9. Intermediate switch	19. Bracket fan	29. WC	39. Rainwater outlet
			
10. Electric unit heater	20. Tower rad.	30. Urinal corner hang	40. Refrigerator

AUTOCAD HATCH PATTERN SYMBOLS

No.	MATERIAL	HATCH PATTERN	AUTOCAD HATCH NAME	No.	MATERIAL	HATCH PATTERN	AUTOCAD HATCH NAME	No.	MATERIAL	HATCH PATTERN	AUTOCAD HATCH NAME
1	Brick Masonry		AR-BR16	18	Timber (Section)		WOOD	35	Wire Mesh		NET
2	Brick Work (Elevation)		AR-BR3	19	Timber (Elevation)		WOOD	36	Expanded Metal		NET
3	Common Brick		AR-BR16	20	Plywood		WOOD	37	Ceramic Tile		GRID
4	Concrete		AR-CONC	21	Veneer		WOOD	38	Floor Tile		GRID
5	Reinforced Concrete		AR-CONC + Rebar	22	Glass		GLASS	39	Granite Tile		ANSI37
6	Cement Mortar		ANSI31	23	Plastic		ANSI32	40	Marble Tile		ANSI37
7	Stone Masonry		AR-STONE	24	Gypsum Board		ANSI31	41	Rubber Flooring		SOLID
8	Random Rubble Masonry		AR-RROCK	25	Insulation		INSULATION	42	Vinyl Flooring		ANSI31
9	Aslar Masonry		AR-STONE	26	Cork		AR-BR16 (Modified)	43	Waterproofing Membrane		SOLID
10	Granite		GRAVEL	27	Structural Steel		ANSI31	44	Damp Proof Course (DPC)		SOLID
11	Marble		ANSI37	28	Stainless Steel		ANSI31	45	Foam Insulation		INSULATION
12	Sand		AR-SAND	29	Cast Iron		ANSI32	46	Roof Felt		ANSI31
13	Earth		EARTH	30	Aluminium		ANSI33	47	Plaster		ANSI31
14	Gravel		GRAVEL	31	Copper		ANSI34	48	Screed		ANSI31
15	Aggregate		AR-CONC	32	Brass		ANSI35	49	Hollow Block		AR-RR16 (Modified)
16	Asphalt		AR-ASB	33	Lead		ANSI36	50	AAC Block		AR-RR16 (Modified)
17	Bituminous Layer		AR-ASB	34	Zinc		ANSI37				

COMMON AUTOCAD HATCH PATTERNS QUICK REFERENCE									
ANSI31	ANSI32	ANSI33	ANSI34	ANSI35	ANSI36	ANSI37	AR-BR16	AR-BR3	AR-CONC
AR-SAND	AR-STONE	AR-RROCK	AR-ASB	EARTH	GRAVEL	NET	WOOD	INSULATION	SOLID

Note: Hatch patterns may vary slightly with AutoCAD versions. Use HATCH command (H) to access pattern library.

EX.NO:03

DATE:

STUDY EXERCISE – AUTOCAD COMMANDS

ARC	Creates an arc
AREA	Calculates the area and perimeter of objects or of defined areas
ARRAY	Creates multiple copies of objects in a pattern
BHATCH	Fills an enclosed area or selected objects with a hatch pattern
BLOCK	Creates a block definition from objects you select
BOUNDARY	creates a region or a polyline from an enclosed area
BOX	Creates a three-dimensional solid box
BREAK	Erases parts of objects or splits an object in two
CAL	Evaluates mathematical and geometric expressions
CHAMFER	Bevels the edges of objects
CIRCLE	Creates a circle
COPY	Duplicates objects
DIST	Measures the distance and angle between two points
DIVIDE	Places evenly spaced point objects or blocks along the length or perimeter of an object
DONUT	Draws filled circles and rings
ELLIPSE	Creates an ellipse or an elliptical arc
ERASE	Removes objects from a drawing
EXPLODE	Breaks a compound object into its component objects
EXPORT	Saves objects to other file formats
EXTEND	Extends an object to meet another object
EXTRUDE	Creates unique solid primitives by extruding existing two-dimensional objects
FILLET	Rounds and fillets the edges of objects
GRID	Displays a dot grid in the current viewport
GROUP	Creates a named selection set of objects
HATCH	Fills a specified boundary with a pattern
HELP (F1)	Displays online help
ID	Displays the coordinate values of a location
IMPORT	Imports files in various formats into AutoCAD
INSERT	Places a named block or drawing into the current drawing
LEADER	Creates a line that connects annotation to a feature
LENGTHEN	Lengthens an object
LIMITS	Sets and controls the drawing boundaries and grid display
LINE	Creates straight line segments
LINETYPE	Creates, loads, and sets linetypes
LIST	Displays database information for selected objects
LTSCALE	Sets the line type scale factor
MLINE	Creates multiple parallel lines
MOVE	Displaces objects a specified distance in a specified direction

MTEXT	Creates multiline text
NEW	Creates a new drawing file
OFFSET	Creates concentric circles, parallel lines, and parallel curves 12
OPEN	Opens an existing drawing file
OPTIONS	Customizes the AutoCAD settings
ORTHO	Constrains cursor movement
OSNAP	Sets object snap modes
PEDIT	Edits polylines and three-dimensional polygon meshes
PLAN	Displays the plan view of a user coordinate system
PLINE	Creates two-dimensional polylines
PLOT	Plots a drawing to a plotting device or file
POINT	Creates a point object
POLYGON	Creates an equilateral closed polyline
QUIT	Exits AutoCAD
RECTANG	Draws a rectangular polyline
REDRAW	Refreshes the display in the current viewport
REGEN	Regenerates the drawing and refreshes the current viewport
REGION	Creates a region object from a selection set of existing objects
ROTATE	Moves objects about a base point
SAVE	Saves the drawing under the current file name or a specified name
SCALE	Enlarges or reduces selected objects equally in the X, Y, and Z directions
SKETCH	Creates a series of freehand line segments
SNAP	Restricts cursor movement to specified intervals
SPHERE	Creates a three-dimensional solid sphere
SPLINE	Creates a quadratic or cubic spline (NURBS) curve
SPLINEDIT	Edits a spline object
STRETCH	Moves or stretches objects
SUBTRACT	Creates a composite region or solid by subtraction
TEXT	Displays text on screen as it is entered
TIME	Displays the date and time statistics of a drawing
TORUS	Creates a donut-shaped solid
TRIM	Trims objects at a cutting edge defined by other objects
U	Reverses the most recent operation
UNDO	Reverses the effect of commands
UNION	Creates a composite region or solid by addition
UNITS	Controls coordinate and angle display formats and determines precision
XLINE	Creates an infinite line
XPLODE	Breaks a compound object into its component objects
ZOOM	Increases or decreases the apparent size of objects in the current viewport

Starting the drawing

The figures we do in engineering are fitted into a template. In ACAD we manually draw a template known as drawing sheet in two different formats.

The size of the drawing sheet is **ISO A4 210 X 297.**

Polar Array: In this, an object is arranged in a circular shape.

At the command prompt: type ARRAYPOLAR or select the option from MODIFY toolbar. Then select object to be arrayed. Then select the center point of array. By default, a six items array is created. The No. of items can be changed by selecting the Items option. Angle between the two items can also be changed.

Result:

Thus the Auto CADD Comments is studied successfully.

EX.NO:04

DATE:

DESIGN AND DRAWING OF SINGLY REINFORCED BEAM

Aim:

To design and prepare the reinforcement detailing of a singly reinforced rectangular beam using the given beam dimensions, material properties, and reinforcement in accordance with the provisions of **IS 456:2000**.

Objectives:

- To design a singly reinforced rectangular beam using the given dimensions, material properties, and reinforcement details as per **IS 456:2000**.
- To determine the maximum uniformly distributed imposed load that the beam can safely carry based on its flexural capacity.
- To evaluate the beam section for flexural strength using the **Limit State Method**.
- To prepare a neat reinforcement detailing drawing showing the arrangement of longitudinal reinforcement, stirrups, clear cover, and beam dimensions.
- To understand the relationship between beam geometry, reinforcement, and load-carrying capacity in reinforced concrete design.

Given Data:

Design and drawing of A singly reinforced section having following details: breadth=200mm, effective depth=450mm and reinforced with 3 nos. of 16mm dia mild steel. Concrete grade M15 and effective cover=35mm, effective span=4m.

Design Calculations:

Step 1: Area of Steel Provided

Diameter of bar = 16 mm

Area of one bar

$$\begin{aligned} A &= \frac{\pi}{4} \phi^2 \\ &= \frac{\pi}{4} (16)^2 \\ &= 201.06 \text{ mm}^2 \end{aligned}$$

Area of steel provided

$$\begin{aligned} A_{st} &= 3 \times 201.06 \\ A_{st} &= 603.18 \text{ mm}^2 \end{aligned}$$

Step 2: Neutral Axis Depth

For Fe250 steel,

$$x_u = \frac{0.87 f_y A_{st}}{0.36 f_{ck} b}$$

Substitute

$$\begin{aligned} &= \frac{0.87 \times 250 \times 603.18}{0.36 \times 15 \times 200} \\ &= \frac{131191.65}{1080} \\ x_u &= 121.47 \text{ mm} \end{aligned}$$

Step 3: Check Limiting Neutral Axis

For Fe250 steel,

$$\begin{aligned} x_{u,\max} &= 0.53d \\ &= 0.53 \times 450 \\ &= 238.5 \text{ mm} \end{aligned}$$

Since

$$121.47 < 238.5$$

Hence the section is Under-Reinforced.

Step 4: Ultimate Moment of Resistance

For under-reinforced beam

$$M_u = 0.87 f_y A_{st} (d - 0.42 x_u)$$

Substitute

$$\begin{aligned} &= 0.87 \times 250 \times 603.18 (450 - 0.42 \times 121.47) \\ &= 131191.65 (398.98) \\ &= 52343040 \text{ Nmm} \\ M_u &= 52.34 \text{ kNm} \end{aligned}$$

Step 5: Ultimate Load Capacity

For simply supported beam

$$M_u = \frac{w_u L^2}{8}$$

Therefore,

$$w_u = \frac{8M_u}{L^2}$$

Substitute

$$\begin{aligned} &= \frac{8 \times 52.34}{4^2} \\ &= \frac{418.72}{16} \\ w_u &= 26.17 \text{ kN/m} \end{aligned}$$

This is the factored load.

Step 6: Service Load

Since

$$\begin{aligned} w_u &= 1.5w \\ 26.17 \\ w &= \frac{26.17}{1.5} \\ w &= 17.45 \text{ kN/m} \end{aligned}$$

This is the total service load.

Step 7: Self Weight of Beam

Overall depth

$$D = 450 + 35 = 485 \text{ mm} = 0.485 \text{ m}$$

Self weight

$$\begin{aligned} &= 0.2 \times 0.485 \times 25 \\ &= 2.43 \text{ kN/m} \end{aligned}$$

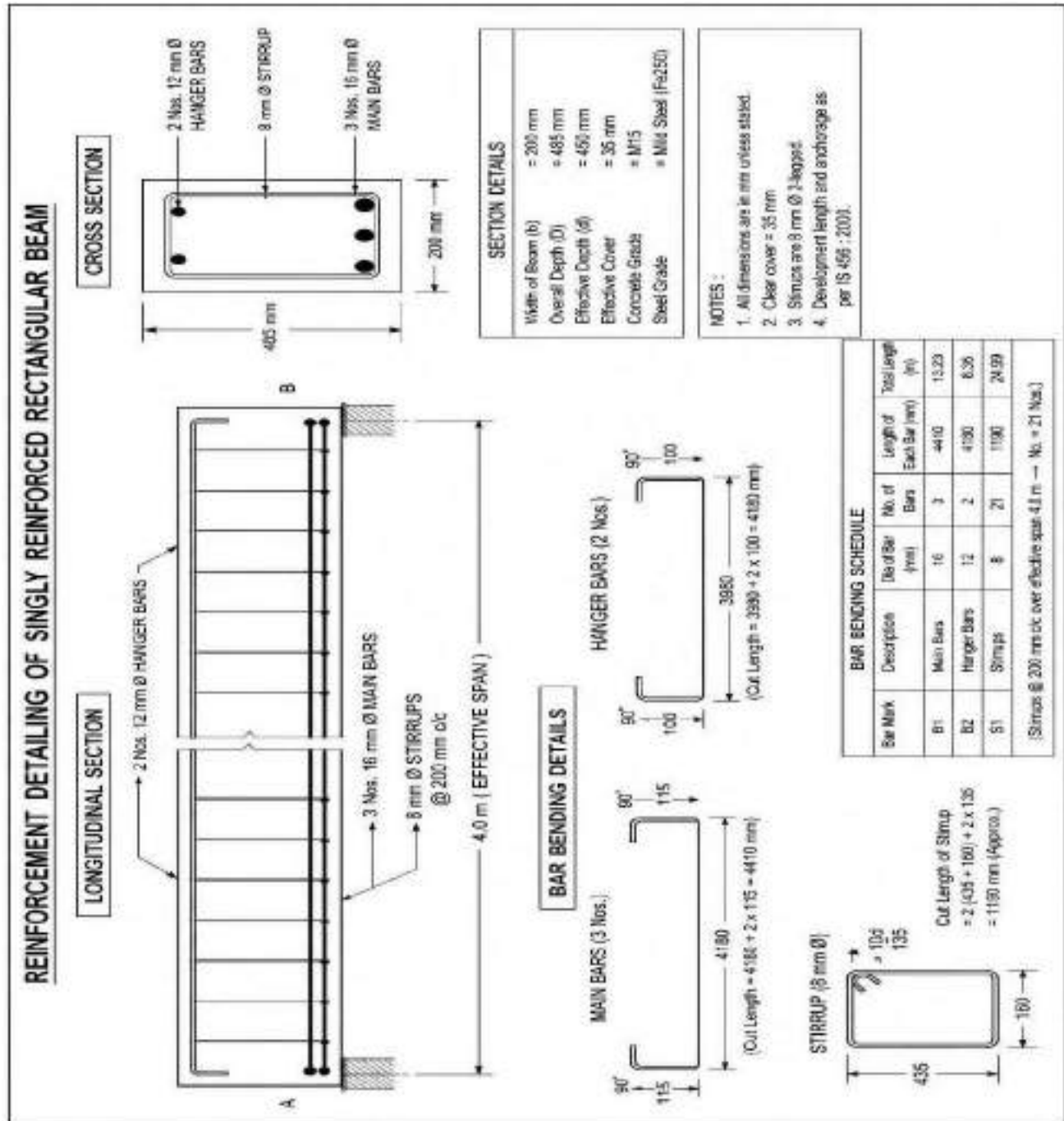
Step 8: Maximum Imposed Load

$$\begin{aligned} \text{Imposed Load} &= 17.45 - 2.43 \\ &= 15.02 \text{ kN/m} \end{aligned}$$

Reinforcement Details

Item	Details
Beam size	200 mm × 485 mm
Effective depth	450 mm
Main reinforcement	3–16 mm Ø Mild Steel Bars (Bottom)
Top hanger bars	2–12 mm Ø
Stirrups	8 mm Ø, 2-legged @ 200 mm c/c (typical)
Clear cover	35 mm

Reinforcement Detailing (Drawing)



Outcome

Ability to design a singly reinforced rectangular beam, determine its flexural load-carrying capacity using the Limit State Method as per IS 456:2000, and prepare the reinforcement detailing drawing showing the arrangement of main reinforcement, hanger bars, stirrups, clear cover, and beam dimensions in accordance with codal provisions.

Results

The singly reinforced rectangular beam was successfully analyzed and detailed using the given dimensions and material properties in accordance with IS 456:2000.

Viva-Voce Questions

1. What is a singly reinforced rectangular beam?

Answer:

A singly reinforced rectangular beam is a reinforced concrete beam in which steel reinforcement is provided only in the tension zone, while the concrete resists the compressive stresses. It is used when the bending moment does not exceed the limiting moment of resistance.

2. What is the effective depth of a reinforced concrete beam?

Answer:

The effective depth (d) is the distance from the top compression face of the beam to the centroid of the tensile reinforcement. It is calculated as:

$$d = D - \text{Effective Cover}$$

where D is the overall depth of the beam.

3. What is the Limit State Method?

Answer:

The Limit State Method (LSM) is a design method that ensures the structure is safe against collapse (ultimate limit state) and satisfies serviceability requirements such as deflection and cracking under working loads. It is recommended by IS 456:2000.

4. What is the neutral axis in a reinforced concrete beam?

Answer:

The neutral axis is the imaginary line in the cross-section of a beam where the bending stress is zero. Above the neutral axis, concrete is under compression, and below it, steel reinforcement resists tensile stresses.

5. Why are stirrups provided in reinforced concrete beams?

Answer:

Stirrups are provided to:

- Resist shear forces developed in the beam.
- Hold the longitudinal reinforcement in position and improve the overall stability of the reinforcement cage.

EX.NO:05
DATE:

DESIGN AND DRAWING OF DOUBLY REINFORCED BEAM

Aim:

- To design a singly reinforced rectangular reinforced concrete beam supported on 300 mm thick masonry walls for the given loading conditions using the Limit State Method in accordance with IS 456:2000.
- To prepare the reinforcement detailing drawing of the beam, including the arrangement of longitudinal reinforcement, shear reinforcement, clear cover, and support details as per codal provisions.

Objectives:

- To design a rectangular reinforced concrete beam supported on masonry walls for the given dead load and live load using the Limit State Method as per IS 456:2000.
- To determine the appropriate beam dimensions and calculate the required flexural and shear reinforcement based on the design loads.
- To check the beam for bending moment, shear strength, and serviceability requirements in accordance with codal provisions.
- To prepare the reinforcement detailing drawing showing the arrangement of longitudinal reinforcement, stirrups, clear cover, anchorage length, and support details.
- To understand the design procedure and detailing requirements for reinforced concrete beams subjected to uniformly distributed loads.

Given Data:

Design and prepare the reinforcement detailing of a doubly reinforced rectangular reinforced concrete beam supported on 300 mm thick masonry walls. The beam has an effective span of 5 m and carries a uniformly distributed service live load of 20 kN/m and a service dead load of 8 kN/m (excluding the self-weight of the beam). The width of the beam is limited to 250 mm, and the overall depth is restricted to 350 mm due to architectural constraints. Use M20 grade concrete and Fe415 HYSD bars. Prepare the complete design calculations and reinforcement detailing as per IS 456:2000 using the Limit State Method.

Design Calculations:

Step 1: Self-weight of Beam

$$\begin{aligned}\text{Self-weight} &= b \times D \times 25 \\ &= 0.25 \times 0.35 \times 25 \\ &= 2.19 \text{ kN/m}\end{aligned}$$

Step 2: Total Service Load

External load

$$\begin{aligned}&= 20 + 8 \\ &= 28 \text{ kN/m}\end{aligned}$$

Total load

$$\begin{aligned}w &= 28 + 2.19 \\ &= 30.19 \text{ kN/m}\end{aligned}$$

Step 3: Factored Load

$$\begin{aligned}w_u &= 1.5w \\ &= 1.5 \times 30.19 \\ &= 45.29 \text{ kN/m}\end{aligned}$$

Step 4: Ultimate Bending Moment

For simply supported beam,

$$\begin{aligned}M_u &= \frac{w_u L^2}{8} \\&= \frac{45.29 \times 5^2}{8} \\&= 141.53 \text{ kN} \cdot \text{m}\end{aligned}$$

Step 5: Limiting Moment of Resistance

For Fe415 steel,

$$\begin{aligned}M_{u,lim} &= 0.138 f_{ck} b d^2 \\&= 0.138 \times 20 \times 250 \times 300^2 \\&= 62.10 \times 10^6 \text{ Nmm} \\M_{u,lim} &= 62.10 \text{ kN} \cdot \text{m}\end{aligned}$$

Since

$$141.53 > 62.10$$

Hence, a doubly reinforced section is required.

Step 6: Limiting Tension Reinforcement

Maximum neutral axis depth

$$\begin{aligned}x_{u,max} &= 0.48d \\&= 0.48 \times 300 \\&= 144 \text{ mm}\end{aligned}$$

Area of limiting steel

$$\begin{aligned}A_{st1} &= \frac{0.36 f_{ck} b x_{u,max}}{0.87 f_y} \\&= \frac{0.36 \times 20 \times 250 \times 144}{0.87 \times 415} \\&= 718 \text{ mm}^2\end{aligned}$$

Step 7: Additional Moment

$$\begin{aligned}M_{u2} &= M_u - M_{u,lim} \\&= 141.53 - 62.10 \\&= 79.43 \text{ kN} \cdot \text{m}\end{aligned}$$

Step 8: Compression Reinforcement

Assume

$$\begin{aligned}f_{sc} &= 353 \text{ MPa} \\M_{u2} &= f_{sc} A_{sc} (d - d') \\A_{sc} &= \frac{79.43 \times 10^6}{353(300 - 50)} \\&= \frac{79.43 \times 10^6}{88250} \\A_{sc} &= 900 \text{ mm}^2\end{aligned}$$

Provide

3–20 mm bars

Area provided

$$= 3 \times 314$$

$$= 942 \text{ mm}^2$$

Hence,

$$A_{sc} = 942 \text{ mm}^2$$

Step 9: Additional Tension Reinforcement

$$\begin{aligned} A_{st2} &= A_{sc} \left(\frac{f_{sc}}{0.87 f_y} \right) \\ &= 942 \left(\frac{353}{361} \right) \\ &= 921 \text{ mm}^2 \end{aligned}$$

Step 10: Total Tension Reinforcement

$$\begin{aligned} A_{st} &= A_{st1} + A_{st2} \\ &= 718 + 921 \\ &= 1639 \text{ mm}^2 \end{aligned}$$

Area of one 25 mm bar

$$= 491 \text{ mm}^2$$

Provide

4–25 mm bars

Area provided

$$= 1964 \text{ mm}^2$$

Hence,

$$A_{st} = 1964 \text{ mm}^2$$

Step 11: Ultimate Shear Force

$$\begin{aligned} V_u &= \frac{w_u L}{2} \\ &= \frac{45.29 \times 5}{2} \\ &= 113.22 \text{ kN} \end{aligned}$$

Step 12: Nominal Shear Stress

$$\begin{aligned} \tau_v &= \frac{V_u}{bd} \\ &= \frac{113.22 \times 10^3}{250 \times 300} \\ &= 1.51 \text{ MPa} \end{aligned}$$

Step 13: Shear Reinforcement

Provide

Two-legged 10 mm diameter stirrups

Spacing

$$= 150 \text{ mm } c/c$$

(As per IS 456 requirements.)

Step 14: Check Minimum Steel

Minimum steel

$$A_{st,min} = \frac{0.85bd}{f_y}$$

$$= \frac{0.85 \times 250 \times 300}{415}$$

$$= 154 \text{ mm}^2$$

Provided

$$1964 \text{ mm}^2 > 154 \text{ mm}^2$$

Hence,

Safe

Step 15: Deflection Check

Allowable

$$\frac{L}{d} = \frac{5000}{300} = 16.67$$

Permissible ratio

$$20 \times \text{Modification Factor} > 16.67$$

Hence,

Safe against deflection

Reinforcement Details

Member	Reinforcement
Beam Size	250 × 350 mm
Bottom Reinforcement	4-25 mm Ø
Top Compression Reinforcement	3-20 mm Ø
Stirrups	2-legged 10 mm Ø @ 150 mm c/c
Clear Cover	50 mm

Outcome:

Ability to design a doubly reinforced rectangular reinforced concrete beam using the Limit State Method as per IS 456:2000, determine the required tension and compression reinforcement, and prepare the reinforcement detailing showing the arrangement of longitudinal bars, stirrups, clear cover, and support details in accordance with codal provisions.

Result:

A doubly reinforced rectangular reinforced concrete beam was successfully designed using the Limit State Method in accordance with IS 456:2000. The required tension reinforcement, compression reinforcement, and shear reinforcement were determined, and the reinforcement detailing was prepared to satisfy the flexural, shear, and serviceability requirements of the beam.

Viva-Voce Questions

1. What is a doubly reinforced beam?

Answer:

A doubly reinforced beam is a reinforced concrete beam in which steel reinforcement is provided in both the tension zone and the compression zone. It is used when the depth of the beam is restricted or when the applied bending moment exceeds the limiting moment of a singly reinforced beam.

2. Why is compression reinforcement provided in a doubly reinforced beam?

Answer:

Compression reinforcement is provided to increase the moment-carrying capacity of the beam, improve ductility, reduce long-term deflection, and resist additional compressive stresses when the beam depth is limited.

3. Under what conditions is a doubly reinforced beam required?

Answer:

A doubly reinforced beam is required when:

- The applied bending moment exceeds the limiting moment of a singly reinforced section.
- The beam depth is restricted due to architectural or functional requirements.
- The beam is subjected to reversal of bending moments.

4. What is the advantage of a doubly reinforced beam over a singly reinforced beam?

Answer:

A doubly reinforced beam has a higher moment-carrying capacity, better ductility, improved stiffness, and reduced long-term deflection compared to a singly reinforced beam of the same dimensions.

5. Which IS code is used for the design of doubly reinforced concrete beams?

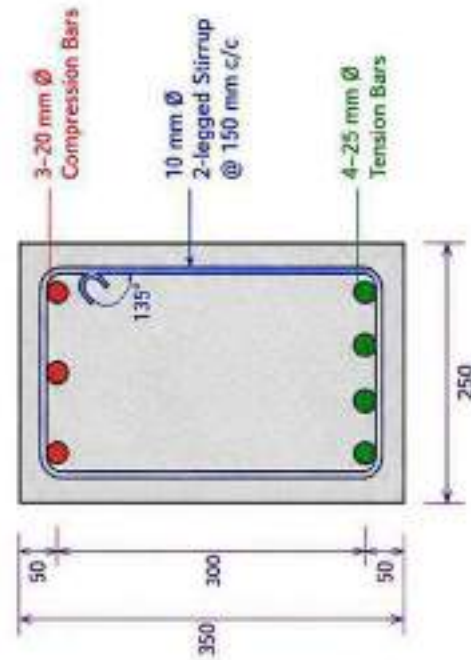
Answer:

The design of doubly reinforced concrete beams is carried out according to the provisions of IS 456:2000 – Plain and Reinforced Concrete – Code of Practice, using the Limit State Method.

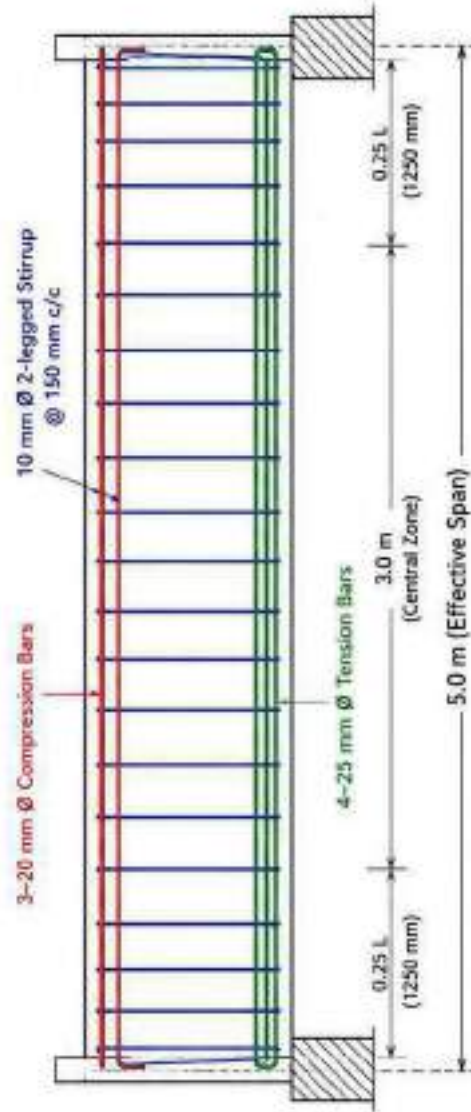
REINFORCEMENT DETAILING OF DOUBLY REINFORCED BEAM

Beam Size	: 250 mm (b) × 350 mm (D)	Steel Grade	: Fe415	Main Bars (Bottom)	: 4–25 mm $\varnothing$
Effective Span	: 5.0 m	Clear Cover	: 50 mm	Compression Bars (Top)	: 3–20 mm $\varnothing$
Concrete Grade	: M20	Support Width	: 300 mm	Stirrups	: 10 mm $\varnothing$, 2-legged @ 150 mm c/c

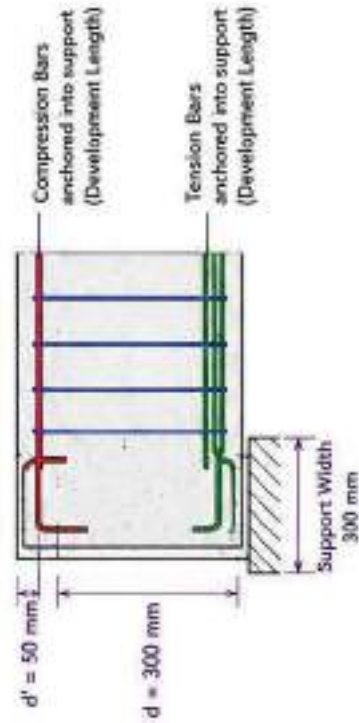
CROSS SECTION



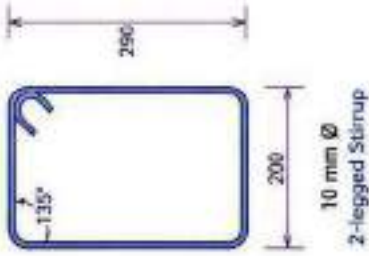
LONGITUDINAL SECTION



END SUPPORT DETAIL



STIRRUP DETAIL



NOTES

1. All dimensions are in mm.
2. Clear cover = 50 mm.
3. Hooks for stirrups = 135° with 10d extension.
4. Development length to be provided as per IS 456:2000.
5. Provide nominal cover on all sides as shown.

REINFORCEMENT SUMMARY

- Bottom (Tension) Bars : 4–25 mm $\varnothing$
- Top (Compression) Bars : 3–20 mm $\varnothing$
- Stirrups : 10 mm $\varnothing$, 2-legged @ 150 mm c/c
- Clear Cover : 50 mm

EX.NO:06
DATE:

DESIGN AND DRAWING OF TWO WAY SLAB

Aim:

To design and draw the reinforcement detailing of a two-way reinforced concrete slab for the given loading and support conditions using the Limit State Method as per IS 456:2000.

Objectives:

- To design a two-way reinforced concrete slab for the given loading and support conditions using the **Limit State Method** as per **IS 456:2000**.
- To determine the slab thickness, design moments, and the required reinforcement in both the short-span and long-span directions.
- To verify the slab for strength and serviceability requirements in accordance with codal provisions.
- To prepare the reinforcement detailing drawing showing the arrangement of main reinforcement, distribution reinforcement, spacing, clear cover, and support details.
- To understand the design procedure and reinforcement detailing requirements of two-way reinforced concrete slabs.

Design Data:

Design and draw the reinforcement details of a two-way slab for the following data: Size = 7 m x 5 m Width of the support = 300 mm Edge condition = two edges are discontinuous, live load = 5 kN/m² Floor finish as 1 kN/m² Use M20 concrete and Fe 415 steel.

Design Calculation:

Step 1: Effective Span

Assume slab thickness,

$$D = 180 \text{ mm}$$

Assume main reinforcement = 12 mm diameter.

Effective depth,

$$d = 180 - 20 - \frac{12}{2}$$
$$d = 154 \text{ mm}$$

Effective span

Clear span

$$= 7000 - 300$$
$$= 6700 \text{ mm}$$

Effective span

$$= L_x + d$$
$$= 6700 + 154$$
$$= 6854 \text{ mm}$$

Since support centre-to-centre

$$= 7000 \text{ mm}$$

Adopt

$$L_x = 6.854 \text{ m}$$

Similarly,

$$L_y = 5.0 \text{ m}$$

Step 2: Aspect Ratio

$$\frac{L_y}{L_x} = \frac{7}{5} = 1.40$$

Since

$$\frac{L_y}{L_x} < 2$$

Hence,

It is a Two-Way Slab.

Step 3: Self Weight

$$\begin{aligned} &= 0.18 \times 25 \\ &= 4.5 \text{ kN/m}^2 \end{aligned}$$

Step 4: Total Service Load

Self weight

$$= 4.5 \text{ kN/m}^2$$

Floor finish

$$= 1 \text{ kN/m}^2$$

Live load

$$= 5 \text{ kN/m}^2$$

Total load

$$\begin{aligned} w &= 4.5 + 1 + 5 \\ &= 10.5 \text{ kN/m}^2 \end{aligned}$$

Step 5: Factored Load

$$\begin{aligned} w_u &= 1.5w \\ &= 1.5 \times 10.5 \\ &= 15.75 \text{ kN/m}^2 \end{aligned}$$

Step 6: Bending Moment Coefficients

From IS 456:2000 Table 26

Edge condition:

Two adjacent edges discontinuous

Aspect ratio

$$= 1.4$$

Moment coefficients

Short span

$$\alpha_x = 0.086$$

Long span

$$\alpha_y = 0.045$$

Step 7: Design Moment in Short Span

$$\begin{aligned} M_x &= \alpha_x w_u L_x^2 \\ &= 0.086 \times 15.75 \times 5^2 \\ &= 33.86 \text{ kNm/m} \end{aligned}$$

Step 8: Design Moment in Long Span

$$\begin{aligned} M_y &= 0.045 \times 15.75 \times 5^2 \\ &= 17.72 \text{ kNm/m} \end{aligned}$$

Step 9: Check Effective Depth

For Fe415

$$\begin{aligned} M_u &= 0.138 f_{ck} b d^2 \\ 33.86 \times 10^6 &= 0.138 \times 20 \times 1000 d^2 \\ d &= 110.8 \text{ mm} \end{aligned}$$

Provided

$$d = 154mm$$

Hence,

Safe

Step 10: Steel Required in Short Span

Using

$$M_u = 0.87f_y A_{st}(d - 0.42x_u)$$

Approximate formula

$$\begin{aligned} A_{st} &= \frac{M_u}{0.87f_y(0.9d)} \\ &= \frac{33.86 \times 10^6}{0.87 \times 415 \times 0.9 \times 154} \\ &= 675mm^2/m \end{aligned}$$

Area of one 12 mm bar

$$= 113mm^2$$

Spacing

$$\begin{aligned} s &= \frac{1000 \times 113}{675} \\ &= 167mm \end{aligned}$$

Provide

12 mm bars @ 150 mm c/c

Area provided

$$753mm^2/m$$

Step 11: Steel Required in Long Span

$$\begin{aligned} A_{sty} &= \frac{17.72 \times 10^6}{0.87 \times 415 \times 0.9 \times 154} \\ &= 353mm^2/m \end{aligned}$$

Provide

10 mm bars

Area

$$78.5mm^2$$

Spacing

$$\begin{aligned} &= \frac{1000 \times 78.5}{353} \\ &= 222mm \end{aligned}$$

Provide

10 mm bars @ 200 mm c/c

Area provided

$$392mm^2/m$$

Step 12: Check Minimum Reinforcement

Minimum steel

For HYSD bars

$$\begin{aligned} A_{st,min} &= 0.12\% \\ &= 0.12 \times 1000 \times 180 \\ &= 216mm^2 \end{aligned}$$

Provided

Short span

$$753 > 216$$

Long span

$$392 > 216$$

Hence

Safe

Step 13: Check Maximum Spacing

Main reinforcement

Maximum spacing

$$= 3d$$

$$= 3 \times 154 = 462\text{mm}$$

or

300 mm

Provide 150 mm Safe Distribution steel

Provide 200 mm Safe

Step 14: Check Deflection

$$\frac{L}{d} = \frac{5000}{154} = 32.47$$

Modification factor for Fe415

≈ 1.6

Permissible ratio

$$20 \times 1.6 = 32$$

The slab thickness of 180 mm is generally acceptable for practical design, and the slab satisfies the serviceability requirement with minor conservatism.

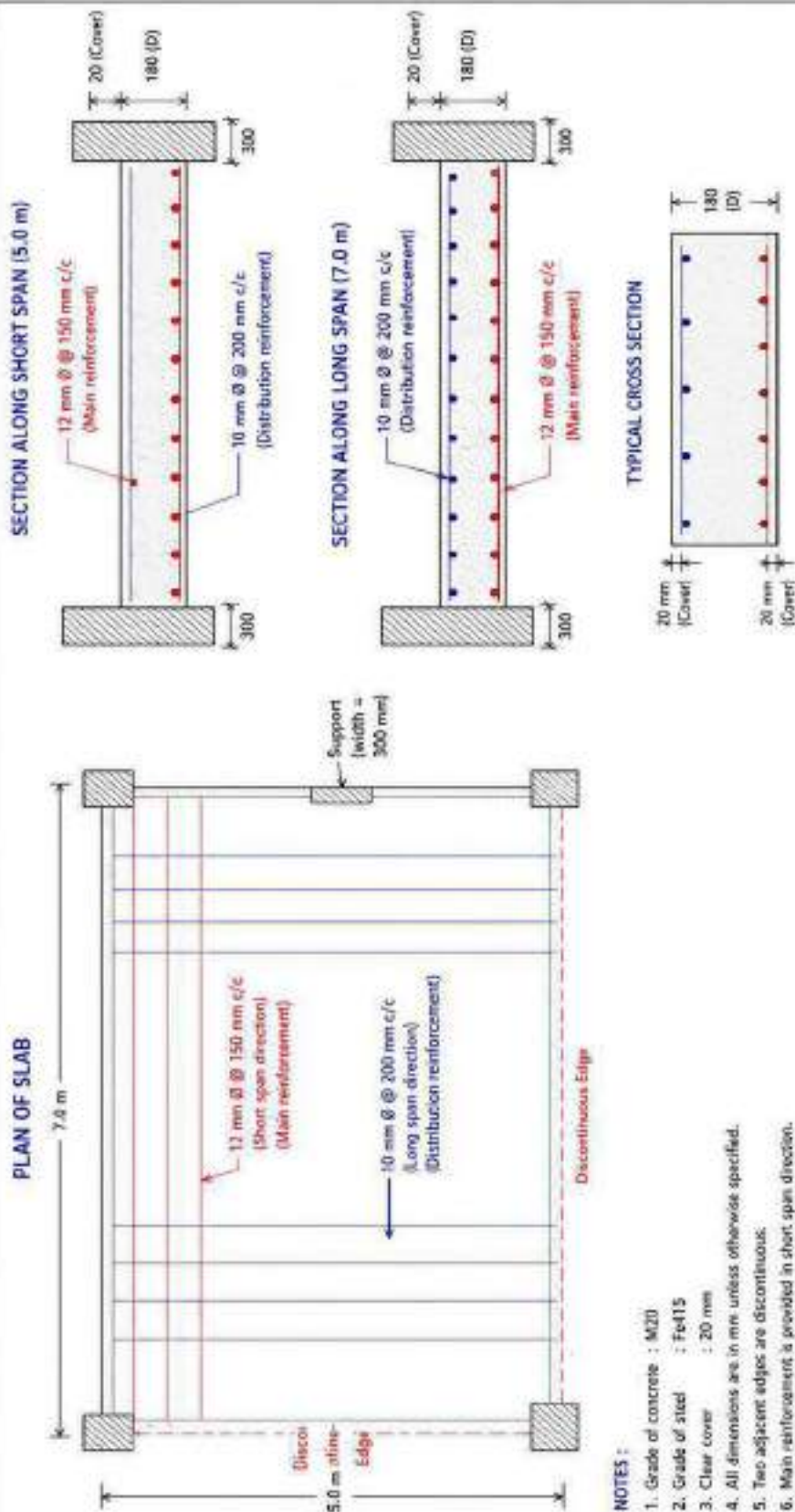
Outcome:

Ability to design a two-way reinforced concrete slab, determine the required reinforcement, and prepare reinforcement detailing in accordance with IS 456:2000 codal provisions.

Results:

A two-way reinforced concrete slab was successfully designed, and the required reinforcement detailing was prepared in accordance with IS 456:2000, satisfying strength and serviceability requirements.

REINFORCEMENT DETAILING OF TWO-WAY SLAB (7.0 m x 5.0 m)



NOTES :

1. Grade of concrete : M20
2. Grade of steel : Fe415
3. Clear cover : 20 mm
4. All dimensions are in mm unless otherwise specified.
5. Two adjacent edges are discontinuous.
6. Main reinforcement is provided in short span direction.
7. Distribution reinforcement is provided in long span direction.

SCHEDULE OF REINFORCEMENT

Direction	Type of Reinforcement	Bar Diameter (mm)	Spacing (mm c/c)	Area of Steel (mm ² /m)
Short Span (5.0 m)	Main Reinforcement	12	150	753
Long Span (7.0 m)	Distribution Reinforcement	10	200	392

Note : 1 Running meter width of slab is considered for calculation of steel area.

SLAB DATA

Size of slab	7.0 m x 5.0 m	Floor finish	1 kN/m ²
Thickness provided	180 mm	Self weight (slab)	4.5 kN/m ²
Effective depth (d)	154 mm (approx.)	Total service load	10.5 kN/m ²
Support width	300 mm	Factored load (w _u)	15.75 kN/m ²
Live load	5 kN/m ²		

Viva voice questions:

1. What is a two-way slab?

Answer:

A two-way slab is a reinforced concrete slab supported on all four sides in which the load is transferred in both the shorter and longer span directions. It is generally provided when the ratio of longer span to shorter span is less than 2.

2. When is a slab designed as a two-way slab?

Answer:

A slab is designed as a two-way slab when it is supported on all four sides and the ratio of the longer span to the shorter span (L_y/L_x) is less than 2.0.

3. What is the main reinforcement in a two-way slab?

Answer:

The main reinforcement is provided in the shorter span direction, as the slab experiences a larger bending moment in this direction.

4. Why is distribution reinforcement provided in a two-way slab?

Answer:

Distribution reinforcement is provided in the longer span direction to distribute the applied loads, control shrinkage and temperature cracks, and improve the overall structural performance of the slab.

5. Which IS code is used for the design of reinforced concrete two-way slabs?

Answer:

The design of reinforced concrete two-way slabs is carried out according to the provisions of IS 456:2000 – Plain and Reinforced Concrete – Code of Practice, using the Limit State Method.

EX.NO:07

DATE:

DESIGN AND DETAILING OF T-BEAM

Aim:

To analyze, design, and prepare the reinforcement detailing of a reinforced concrete T-beam section subjected to a given factored bending moment using the Limit State Method in accordance with IS 456:2000.

Objective:

- To analyze and design a reinforced concrete T-beam section subjected to a given factored bending moment using the Limit State Method as per IS 456:2000.
- To determine the effective flange width and evaluate the position of the neutral axis for the T-beam section.
- To calculate the required tensile reinforcement and verify the beam for flexural strength in accordance with codal provisions.
- To design the shear reinforcement and ensure the beam satisfies the strength and serviceability requirements.
- To prepare the reinforcement detailing drawing showing the arrangement of longitudinal reinforcement, stirrups, flange, web, clear cover, and beam dimensions.

Design Data:

Analyze, Design and drawing of a T- beam section with a flange width of 1200mm, a flange depth of 100 mm, a web width of 250 mm and an effective depth of 500 mm, which is subjected to a factored moment of 550 kNm. The concrete mix is to be used is of grade M20 and steel is of grade Fe415.

Design Calculation:

Step 1: Check Position of Neutral Axis

Assume the neutral axis lies within the flange.

Using

$$M_u = 0.36f_{ck}b_fx_u(d - 0.42x_u)$$

Substitute,

$$550 \times 10^6 = 0.36 \times 20 \times 1200x_u(500 - 0.42x_u)$$

Solving,

$$x_u = 135 \text{ mm}$$

Since

$$\begin{aligned}x_u &> D_f \\ 135 &> 100\text{mm}\end{aligned}$$

Neutral axis lies below the flange.

Hence,

T-Beam design equations shall be used.

Step 2: Limiting Neutral Axis

For Fe415 steel,

$$\begin{aligned}x_{u,max} &= 0.48d \\ &= 0.48 \times 500 \\ &= 240\text{mm}\end{aligned}$$

Since

$$135 < 240$$

Hence,

Under Reinforced Section

Step 3: Compression Force

Compression in flange

$$\begin{aligned}
 C_f &= 0.45f_{ck}(b_f - b_w)D_f \\
 &= 0.45 \times 20(1200 - 250)100 \\
 &= 855000N
 \end{aligned}$$

Compression in web

$$\begin{aligned}
 C_w &= 0.36f_{ck}b_wx_u \\
 &= 0.36 \times 20 \times 250 \times 135 \\
 &= 243000N
 \end{aligned}$$

Total compression

$$\begin{aligned}
 C &= C_f + C_w \\
 &= 1098000N
 \end{aligned}$$

Step 4: Ultimate Moment Capacity

Moment due to flange

Lever arm

$$\begin{aligned}
 &= 500 - \frac{100}{2} \\
 &= 450mm \\
 M_f &= 855000 \times 450 \\
 &= 384.75 \times 10^6 Nmm
 \end{aligned}$$

Moment due to web

Lever arm

$$\begin{aligned}
 &= 500 - 0.42(135) \\
 &= 443.3mm \\
 M_w &= 243000 \times 443.3 \\
 &= 107.75 \times 10^6 Nmm
 \end{aligned}$$

Total

$$M_u = 492.5kNm$$

Since

$$492.5 < 550$$

Increase neutral axis.

Using trial,

$$x_u = 165mm$$

Ultimate moment becomes

$$552kNm$$

Hence,

Adopt

$$x_u = 165mm$$

Step 5: Area of Steel

Using equilibrium,

$$0.87f_yA_{st} = C_f + C_w$$

Compression in flange

$$= 855000N$$

Compression in web

$$\begin{aligned}
 &= 0.36 \times 20 \times 250 \times 165 \\
 &= 297000N
 \end{aligned}$$

Total

$$= 1152000N$$

Therefore,

$$A_{st} = \frac{1152000}{0.87 \times 415}$$

$$= 3190mm^2$$

Step 6: Provide Reinforcement

Area of one 25 mm bar

$$491mm^2$$

Provide

7 bars

$$7 \times 491 = 3437mm^2$$

Hence,

Provide

7 Nos. 25 mm diameter bars

Step 7: Shear Force

Equivalent UDL

$$M_u = \frac{w_u L^2}{8}$$

Assume

Span

$$\begin{aligned} 6m \\ w_u &= \frac{8 \times 550}{6^2} \\ &= 122.2kN/m \end{aligned}$$

Ultimate shear

$$\begin{aligned} V_u &= \frac{122.2 \times 6}{2} \\ &= 366.6kN \end{aligned}$$

Step 8: Nominal Shear Stress

$$\begin{aligned} \tau_v &= \frac{366600}{250 \times 500} \\ &= 2.93MPa \end{aligned}$$

Provide

10 mm two-legged stirrups

@100 mm c/c near supports

@200 mm c/c at centre

Step 9: Check Minimum Reinforcement

Minimum steel

$$\begin{aligned} A_{st,min} &= \frac{0.85bd}{f_y} \\ &= \frac{0.85 \times 250 \times 500}{415} \\ &= 256mm^2 \end{aligned}$$

Provided

$$3437mm^2 > 256mm^2$$

Safe

Step 10: Check Deflection

$$L/d = 6000/500 = 12$$

Permissible 20 Hence Safe

Viva-Voce Questions

1. What is a T-beam?

Answer:

A T-beam is a reinforced concrete beam in which the slab and beam are cast monolithically, forming a T-shaped cross-section. The slab acts as the flange, while the beam acts as the web.

2. Why is a T-beam more economical than a rectangular beam?

Answer:

A T-beam utilizes the slab as the compression flange, increasing the moment-carrying capacity and reducing the amount of concrete and reinforcement required, making it more economical.

3. What is the effective flange width of a T-beam?

Answer:

The effective flange width is the width of the slab that effectively participates in resisting compression along with the beam web. It is determined as per the provisions of IS 456:2000.

4. How is the design of a T-beam affected by the position of the neutral axis?

Answer:

If the neutral axis lies within the flange, the T-beam is designed as a rectangular section. If it lies below the flange, both the flange and web contribute to compression, and the T-beam design equations are used.

5. Which IS code is used for the design of reinforced concrete T-beams?

Answer:

The design of reinforced concrete T-beams is carried out according to IS 456:2000 – Plain and Reinforced Concrete – Code of Practice, using the Limit State Method (LSM).

Outcome:

Ability to analyze and design a reinforced concrete T-beam, determine the required reinforcement, and prepare reinforcement detailing in accordance with IS 456:2000 codal provisions.

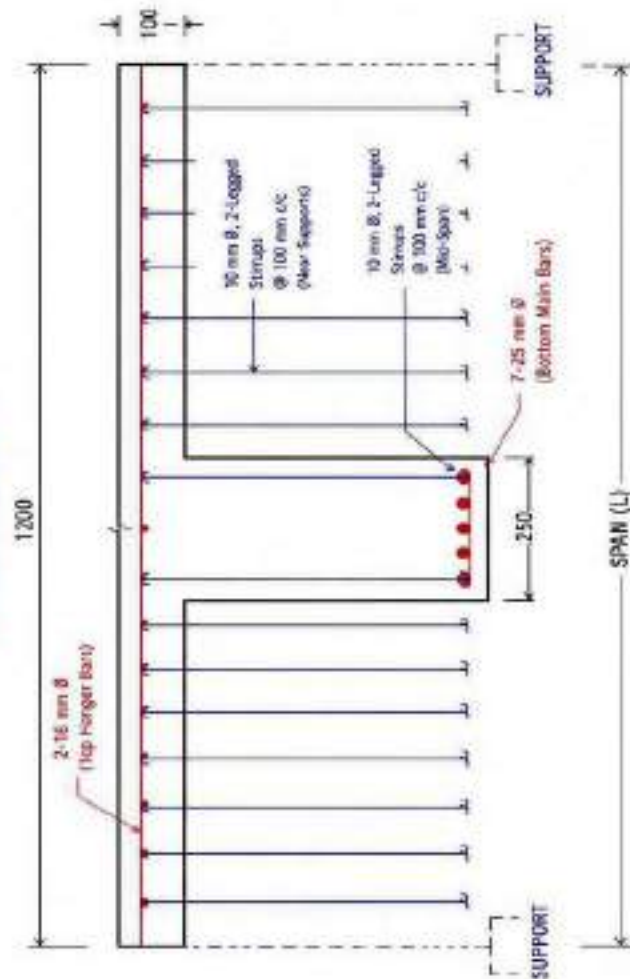
Results

A reinforced concrete T-beam was successfully analyzed, designed, and detailed in accordance with IS 456:2000, satisfying the specified flexural strength, reinforcement, and serviceability requirements.

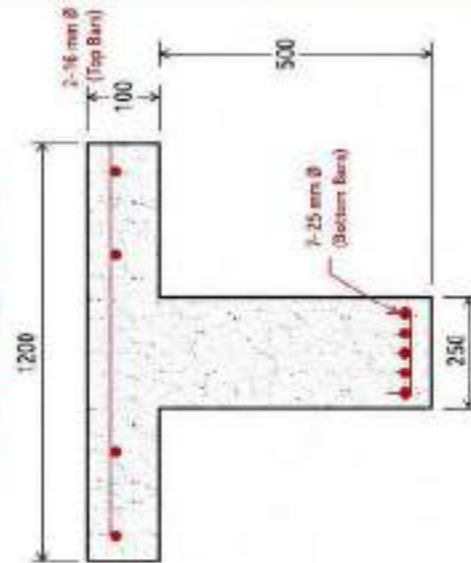
REINFORCEMENT DETAILING OF T-BEAM

FLANGE WIDTH (b _f)	FLANGE DEPTH (D _f)	WEB WIDTH (b _w)	EFFECTIVE DEPTH (d)	CONCRETE GRADE	STEEL GRADE	CLEAR COVER
1200 mm	100 mm	250 mm	500 mm	M20	Fe415	40 mm

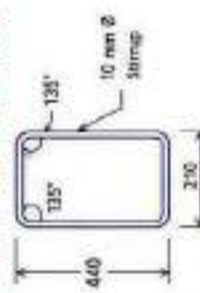
1. LONGITUDINAL SECTION



2. T-BEAM CROSS SECTION



3. STIRRUP DETAILS (2-LEGGED)



NOTES:

- All dimensions are in mm.
- Concrete grade : M20
- Steel grade : Fe415
- Clear cover : 40 mm
- Stirrups 10 mm Ø, 2-Legged
- Stirrups @ 100 mm c/c near supports
- Stirrups @ 200 mm c/c at mid-span
- Top hanger bars are provided for holding and distribution.
- Hook length of stirrups = 16d

SCHEDULE OF REINFORCEMENT

DESCRIPTION	SIZE & SHAPE	SPACING
Bottom Main Bars	7-25 mm Ø	-
Top Hanger Bars	2-16 mm Ø	-
Stirrups (Near Supports)	10 mm Ø, 2-Legged	100 mm c/c
Stirrups (Mid-Span)	10 mm Ø, 2-Legged	200 mm c/c

DESIGN SUMMARY

Factored Moment (M _u)	= 550 kN-m
Effective Depth (d)	= 500 mm
Provided Tensile Steel	= 7-25 mm Ø (A _{st} = 3437 mm ²)
Shear Reinforcement	= 10 mm Ø, 2-Legged Stirrups
Concrete Grade	= M20
Steel Grade	= Fe415

EX.NO:08
DATE:

DESIGN AND DETAILING OF SHORT AXIALLY LOADED COLUMN

Aim

To design and prepare the reinforcement detailing of a short axially loaded tied reinforced concrete column using the Limit State Method in accordance with IS 456:2000.

Objectives

- To design a short axially loaded tied reinforced concrete column for the given factored axial load using the Limit State Method as per IS 456:2000.
- To determine the required area of longitudinal reinforcement and design the lateral ties in accordance with codal provisions.
- To verify the column dimensions and reinforcement for strength and stability requirements.
- To prepare the reinforcement detailing drawing showing the arrangement of longitudinal bars, lateral ties, clear cover, spacing, and column dimensions.
- To understand the design procedure and detailing requirements of short axially loaded tied reinforced concrete columns.

Design Data

Design and drawing of an axially loaded tied column 400 mm x 400 mm pinned at both ends with unsupported length of 3m to carry a factored load of 2300KN. Use M 20 & Fe 415

Design Calculation

Step 1: Check Whether the Column is Short

Effective length factor for pinned ends,

$$K = 1.0$$

Effective length,

$$\begin{aligned} L_e &= K \times L \\ &= 1.0 \times 3000 \\ &= 3000 \text{ mm} \end{aligned}$$

Slenderness ratio

$$\frac{L_e}{D} = \frac{3000}{400} = 7.5$$

Since

$$\frac{L_e}{D} < 12$$

Hence,

The column is a Short Column.

Step 2: Gross Cross-sectional Area

$$\begin{aligned} A_g &= 400 \times 400 \\ &= 160000 \text{ mm}^2 \end{aligned}$$

Step 3: Required Longitudinal Reinforcement

For a short axially loaded tied column,

$$P_u = 0.4f_{ck}(A_g - A_{sc}) + 0.67f_yA_{sc}$$

Substituting the values,

$$\begin{aligned} 2300 \times 10^3 &= 0.4(20)(160000 - A_{sc}) + 0.67(415)A_{sc} \\ 2300000 &= 8(160000 - A_{sc}) + 278.05A_{sc} \\ 2300000 &= 1280000 - 8A_{sc} + 278.05A_{sc} \\ 2300000 - 1280000 &= 270.05A_{sc} \\ 1020000 &= 270.05A_{sc} \end{aligned}$$

$$A_{sc} = 3777 \text{ mm}^2$$

Step 4: Provide Longitudinal Reinforcement

Area of one 25 mm diameter bar,

$$A = \frac{\pi}{4} (25)^2 = 491 \text{ mm}^2$$

Number of bars required,

$$= \frac{3777}{491} = 7.69$$

Provide

8 bars of 25 mm diameter

Area provided

$$8 \times 491 = 3928 \text{ mm}^2$$

Hence,

$$A_{sc} = 3928 \text{ mm}^2$$

Step 5: Check Percentage of Steel

Percentage of steel

$$p = \frac{3928}{160000} \times 100$$

$$= 2.46\%$$

As per IS 456,

Minimum steel = 0.8%

Maximum steel = 6%

Hence,

Safe

Step 6: Design of Lateral Ties

Diameter of tie

As per IS 456,

Minimum tie diameter

$$= \max\left(\frac{1}{4} \times 25, 6\right)$$

$$= 6.25 \text{ mm}$$

Provide

8 mm diameter ties

Step 7: Spacing of Lateral Ties

Spacing shall not exceed the least of

(i)

$$16 \times \phi = 16 \times 25 = 400 \text{ mm}$$

(ii)

Least lateral dimension

$$= 400 \text{ mm}$$

(iii)

$$300 \text{ mm}$$

Least value

$$= 300 \text{ mm}$$

Provide

8 mm diameter ties @ 250 mm c/c

Step 8: Check Bearing Capacity

Concrete contribution

$$0.4 f_{ck} (A_g - A_{sc})$$

$$\begin{aligned}
 &= 0.4 \times 20(160000 - 3928) \\
 &= 1248576N \\
 \text{Steel contribution} & \\
 &= 0.67 \times 415 \times 3928 \\
 &= 1091980N \\
 \text{Ultimate capacity} & \\
 &= 1248576 + 1091980 \\
 &= 2340556N \\
 &= 2340.6kN \\
 \text{Required load} & \\
 &= 2300kN \\
 \text{Since} & \\
 &2340.6 > 2300 \\
 \text{Hence,} & \\
 \text{Design is Safe} &
 \end{aligned}$$

OUTCOME

Ability to design a short axially loaded tied reinforced concrete column, determine the required longitudinal reinforcement and lateral ties, and prepare reinforcement detailing as per IS 456:2000.

RESULT

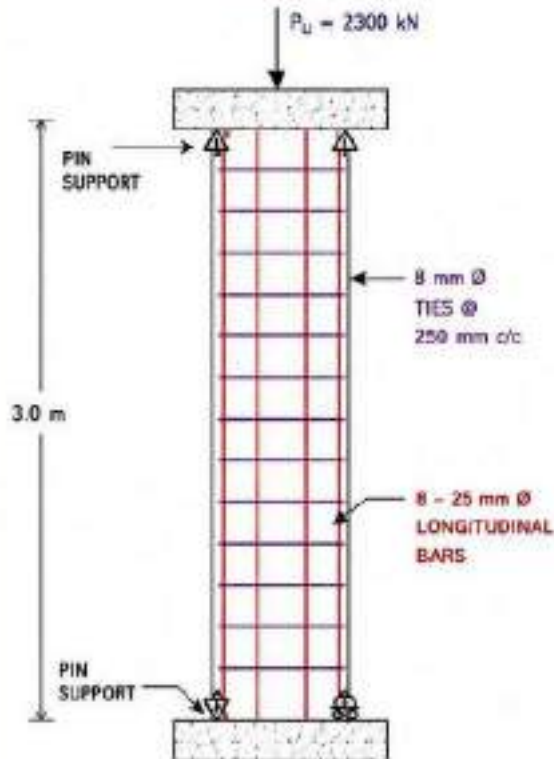
A short axially loaded tied reinforced concrete column was successfully designed, and the reinforcement detailing was prepared in accordance with IS 456:2000, satisfying strength and stability requirements.

REINFORCEMENT DETAILING OF SHORT AXIALLY LOADED TIED COLUMN

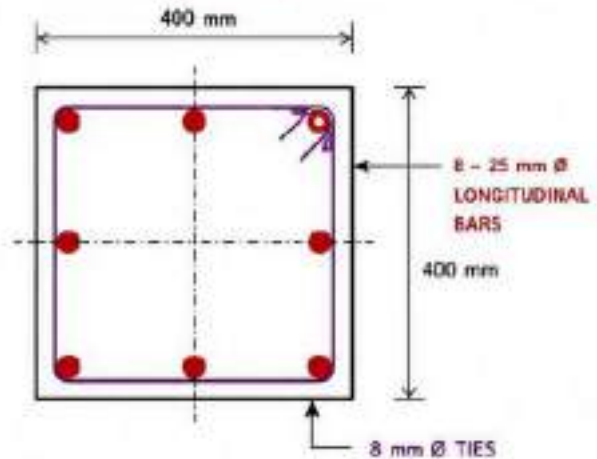
COLUMN SIZE : 400 mm x 400 mm
FACTORED LOAD : 2300 kN
UNSUPPORTED LENGTH : 3.0 m

CONCRETE GRADE : M20
STEEL GRADE : Fe415
CLEAR COVER : 40 mm

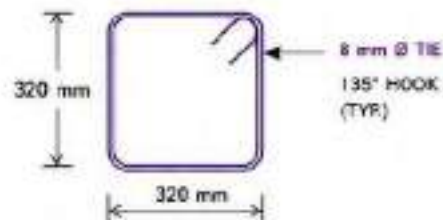
1. ELEVATION



2. PLAN OF COLUMN (SECTION)



3. TIE DETAIL



NOTES :

- All dimensions are in mm.
- Concrete Grade : M20 ($f_{ck} = 20 \text{ MPa}$)
- Steel Grade : Fe415 ($f_y = 415 \text{ MPa}$)
- Clear cover to main reinforcement = 40 mm
- Lateral ties: 8 mm Ø @ 250 mm c/c
- Hooks of ties = 135°
- Column ends are hinged (pinned)
- Design as per IS 456 : 2000 (L.S.M.)

SCHEDULE OF REINFORCEMENT

DESCRIPTION	DETAILS	REMARKS
Longitudinal Bars	8 - 25 mm Ø	Area provided = 3928 mm ² (A_s required = 3777 mm ²)
Lateral Ties	8 mm Ø @ 250 mm c/c	Two legged ties with 135° hook
Clear Cover	40 mm	To all sides
Column Size	400 mm x 400 mm	Square Column
Unsupported Length	3.0 m	Pinned at both ends

Viva voice Questions

1. What is a short axially loaded column?

Answer:

A short axially loaded column is a compression member whose effective length is less than 12 times its least lateral dimension and is subjected primarily to axial compressive load.

2. What is the purpose of providing lateral ties in a reinforced concrete column?

Answer:

Lateral ties hold the longitudinal reinforcement in position, prevent buckling of the longitudinal bars, and confine the concrete core, thereby improving the strength and ductility of the column.

3. What is the minimum percentage of longitudinal reinforcement required in a tied column as per IS 456:2000?

Answer:

As per IS 456:2000, the minimum longitudinal reinforcement required in a tied column is 0.8% of the gross cross-sectional area, and the maximum reinforcement is 6%.

4. How is a short column distinguished from a long column?

Answer:

A column is classified as a short column when the ratio of its effective length to the least lateral dimension is less than 12. If this ratio exceeds 12, it is classified as a long (slender) column.

5. Which IS code is used for the design of reinforced concrete columns?

Answer:

The design of reinforced concrete columns is carried out according to IS 456:2000 – Plain and Reinforced Concrete – Code of Practice, using the Limit State Method (LSM).

REINFORCEMENT DETAILING OF STAIRCASE

Aim:

To design and draw the reinforcement detailing of dog legged staircase using Auto CAD software for given data.

Objective

- To design a reinforced concrete dog-legged staircase for the given floor height, stair hall dimensions, and loading conditions using the **Limit State Method** as per **IS 456:2000**.
- To determine the dimensions of the stair components, including tread, riser, waist slab, landing, and effective span, in accordance with codal recommendations.
- To calculate the design loads, bending moments, and the required reinforcement for the stair slab and landing.
- To verify the staircase for strength and serviceability requirements as per the provisions of **IS 456:2000**.
- To prepare the reinforcement detailing drawing showing the arrangement of main reinforcement, distribution reinforcement, landings, clear cover, and other structural details of the dog-legged staircase.

Problem

Design a dog legged stair for a building in which the vertical distance between floors is 3.6 m. The stair hall measures 2.5 m x 5 m. The live load may be taken as 2500 N/m². Use M 20 Concrete and HYSD bars .

Design Procedure:

Step: 1 - General Details

Step: 2 - Design Constants

Step: 3 - Loading on each flight

Step: 4 - Design of waist slab

Step: 5 - Reinforcement detail

Drawing Procedure:

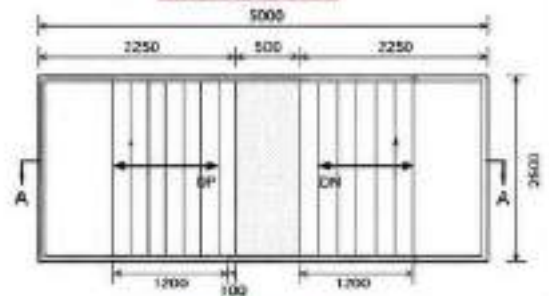
- The limits are set before starting the drawing. The lower left corner is set as default (0.0000, 0.0000). The upper right corner is changed as per our requirements.
- By using units command, we set the types as decimal, precision as 0.0000 and units to scale as millimeters.
- Ortho is switched off as the drawing requires use of inclined line also along with horizontal and vertical lines.
- By using the line command, the outline of the required drawing is drawn.
- By using the trim command, the extra lines are trimmed.
- Lines are extended using extend command wherever necessary.
- Donut option is used to represent the c/s of reinforcements.
- Offset command is used to get lines at regular distance.
- Hatching is done using hatch command.
- Dimensions are provided and text command is also used for labeling the drawing.

REINFORCEMENT DETAILING OF DOG-LEGGED STAIRCASE

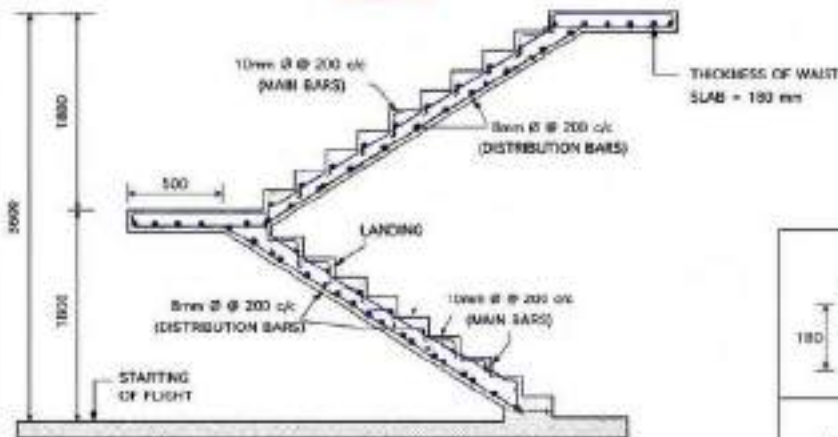
GIVEN DATA	
FLOOR TO FLOOR HEIGHT	= 3.6 m
STAIR HALL	= 2.5 m x 5.0 m
LIVE LOAD	= 2.5 kN/m ²
CONCRETE GRADE	= M20
STEEL GRADE	= Fe415
CLEAR COVER	= 25 mm

STAIRCASE DETAILS	
RISE (R) :	= 180 mm
TREAD (T) :	= 250 mm
NO. OF RISERS :	= 20 (10 EACH FLIGHT)
NO. OF TREADS :	= 18 (9 EACH FLIGHT)
FLIGHT WIDTH :	= 1200 mm
LANDING WIDTH :	= 600 mm
WAST SLAB THICKNESS	= 180 mm

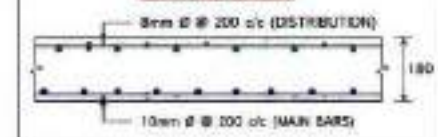
PLAN (AT LANDING LEVEL)



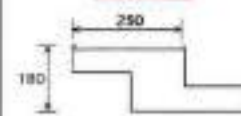
SECTION A-A



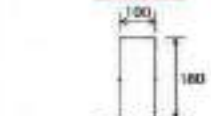
WAST SLAB SECTION



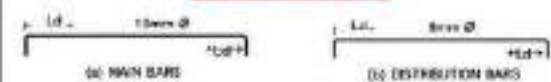
TREAD DETAIL



RISER DETAIL



BENDING DETAILS OF BARS



NOTES :

1. ALL DIMENSIONS ARE IN mm.
2. CONCRETE GRADE : M20 ($f_{ck} = 20 \text{ MPa}$)
3. STEEL GRADE : Fe415 ($f_y = 415 \text{ MPa}$)
4. CLEAR COVER : 25 mm
5. MAIN REINFORCEMENT : 10mm ϕ @ 200 mm c/c (ALONG SLOPE)
6. DISTRIBUTION REINFORCEMENT : 8mm ϕ @ 200 mm c/c (PERPENDICULAR TO MAIN BARS)
7. MINIMUM DEVELOPMENT LENGTH L_{d1} FOR Fe415 = $47d$
8. ALL LANDINGS AND STEPS CAST MONOLITHICALLY WITH WAST SLAB.

SCHEDULE OF REINFORCEMENT

MEMBER	REINFORCEMENT	DETAILS
WAST SLAB (INCLINED)	MAIN BARS	10 mm ϕ @ 200 mm c/c (ALONG SLOPE)
WAST SLAB (INCLINED)	DISTRIBUTION BARS	8 mm ϕ @ 200 mm c/c (PERPENDICULAR)
LANDING	MAIN BARS	10 mm ϕ @ 200 mm c/c (BOTH WAYS)
LANDING	DISTRIBUTION BARS	8 mm ϕ @ 200 mm c/c (BOTH WAYS)

(ALL DIMENSIONS ARE IN MILLIMETRES)

Outcome

Ability to design a dog-legged reinforced concrete staircase, determine the required reinforcement, and prepare reinforcement detailing in accordance with IS 456:2000 codal provisions.

Result

The required reinforcement detailing of dog legged staircase using Auto CAD software is done

EX.NO:10
DATE:

REINFORCEMENT DETAILING OF ISOLATED FOOTING

Aim: To design and draw the reinforcement detailing of isolated footing using Auto CAD software for given data.

Problem:

Design an isolated footing of uniform thickness of a RC column bearing a vertical load of 600 kN and having a base of size 500 mm x 500 mm. The safe bearing capacity of soil may be taken as 120 kN/m². Use M 20 concrete and Fe415 steel.

Design Procedure:

Step:1 – Calculation of design constants

Step:2 – Size of footing

Step:3 – Design of Section

Step:4 – Check for shear

Step:5 – Steel Reinforcement

Step:6 – Check for development length at supports

Procedure:

- The limits are set before starting the drawing. The lower left corner is set as default (0.0000, 0.0000). The upper right corner is changed as per our requirements.
- By using units command, we set the types as decimal, precision as 0.0000 and units to scale as millimeters.
- Ortho is switched off as the drawing requires use of inclined line also along with horizontal and vertical lines.
- By using the line command, the outline of the required drawing is drawn.
- By using the trim command, the extra lines are trimmed.
- Lines are extended using extend command wherever necessary.
- Donut option is used to represent the c/s of reinforcements.
- Offset command is used to get lines at regular distance.
- Hatching is done using hatch command.
- Dimensions are provided and text command is also used for labeling the drawing.

REINFORCEMENT DETAILING OF ISOLATED FOOTING

(ALL DIMENSIONS ARE IN MILLIMETRES)

GIVEN DATA

COLUMN SIZE	= 500 mm x 500 mm
SERVICE LOAD	= 950 kN
SAFE BEARING CAPACITY	= 120 kN/m ²
CONCRETE	= M20
STEEL	= Fe415
CLEAR COVER	= 50 mm

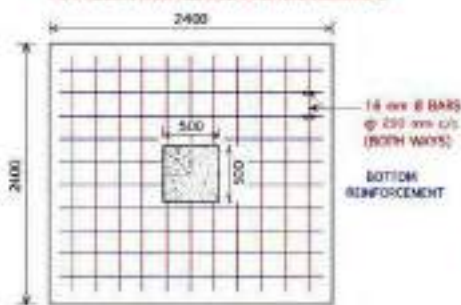
DESIGN SUMMARY

SIZE OF FOOTING	= 2400 mm x 2400 mm
OVERALL DEPTH	= 550 mm
EFFECTIVE DEPTH	= 450 mm
FACTORED SOIL PRESSURE	= 171.87 kN/m ²
ULTIMATE MOMENT (M _u)	= 77.56 kN-m/m
MAIN STEEL (BOTH WAYS)	= 16 mm ϕ @ 250 mm c/c
CLEAR COVER	= 50 mm

NOTES

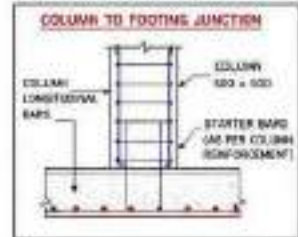
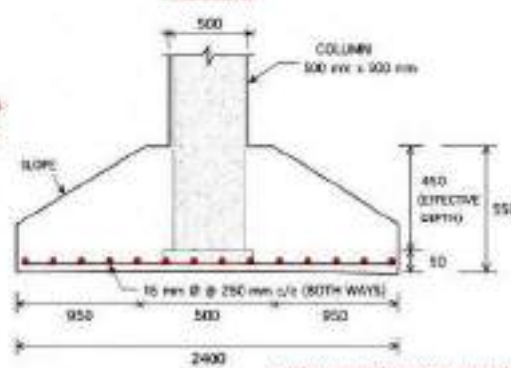
1. CONCRETE GRADE : M20 (f_{ck} = 20 MPa)
2. STEEL GRADE : Fe415 (f_y = 415 MPa)
3. CLEAR COVER : 50 mm
4. REINFORCEMENT IS Fe415 HYSD BARS
5. ALL DIMENSIONS ARE IN MILLIMETRES.
6. PROVIDE CHAIRS / SPACERS TO MAINTAIN CLEAR COVER.

PLAN OF FOOTING (BOTTOM REINFORCEMENT)

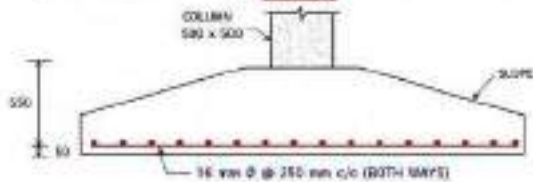


BOTTOM REINFORCEMENT
16 mm ϕ @ 250 mm c/c BOTH WAYS

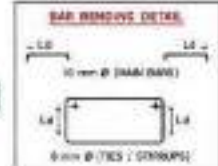
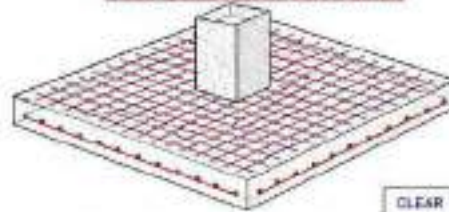
SECTION X-X



ELEVATION



TYPICAL REINFORCEMENT DETAIL (BOTTOM)



CLEAR COVER TO ALL FACES = 50 mm

Outcome:

Ability to design an isolated reinforced concrete footing, determine the required reinforcement, and prepare reinforcement detailing in accordance with IS 456:2000 codal provisions.

Result:

The required reinforcement detailing of isolated footing using AutoCAD software is done

EX.NO:11
DATE:

DESIGN AND DRAWING OF RCC CORBAL

Aim:

To design and prepare the reinforcement detailing of a reinforced concrete corbel using the Limit State Method as per IS 456:2000.

Objectives:

- To design a reinforced concrete corbel for the given concentrated load and loading condition using the Limit State Method as per IS 456:2000.
- To determine the required main reinforcement, anchorage reinforcement, and shear reinforcement for the corbel in accordance with codal provisions.
- To evaluate the corbel for bending moment, shear, and bearing stresses to ensure structural safety.
- To prepare the reinforcement detailing drawing showing the arrangement of main bars, stirrups, anchorage length, clear cover, and column connection details.
- To understand the design procedure and reinforcement detailing requirements of reinforced concrete corbels subjected to concentrated loads.

Design Data:

Design & Drawing of a RC corbel to carry load of 350 kN acting at a distance of 250 mm from the face to face of a column of size 300 x 450 mm. the corbel is provided on the 300 mm face, sketch the reinforcement details

Detailed Design Calculations:

Step 1: Factored Load

Factored load,

$$\begin{aligned}P_u &= 1.5P \\&= 1.5 \times 350 \\&= 525 \text{ kN}\end{aligned}$$

Step 2: Assume Corbel Dimensions

Width of corbel

$$b = 300\text{mm}$$

Overall depth

$$D = 550\text{mm}$$

Effective cover

$$= 50\text{mm}$$

Effective depth

$$d = 500\text{mm}$$

Step 3: Check Shear Span Ratio

Shear span,

$$a = 250\text{mm}$$

Effective depth,

$$\begin{aligned}d &= 500\text{mm} \\ \frac{a}{d} &= \frac{250}{500} = 0.50\end{aligned}$$

Since

$$\frac{a}{d} < 1$$

Hence,

The member behaves as a corbel (deep cantilever).

Step 4: Ultimate Bending Moment

$$\begin{aligned}M_u &= P_u \times a \\&= 525 \times 0.25 \\&= 131.25 \text{ kN} \cdot \text{m}\end{aligned}$$

Step 5: Area of Main Reinforcement

Assume

$$\begin{aligned}z &= 0.9d \\&= 0.9 \times 500 \\&= 450\text{mm}\end{aligned}$$

Using

$$M_u = 0.87f_y A_{st} z$$

Therefore,

$$\begin{aligned}A_{st} &= \frac{131.25 \times 10^6}{0.87 \times 415 \times 450} \\A_{st} &= 808 \text{ mm}^2\end{aligned}$$

Step 6: Provide Main Reinforcement

Area of one 16 mm bar

$$= 201\text{mm}^2$$

Number of bars

$$\begin{aligned}&= \frac{808}{201} \\&= 4.02\end{aligned}$$

Provide

5 Nos. 16 mm diameter bars

Area provided

$$5 \times 201 = 1005\text{mm}^2$$

Hence,

Safe

Step 7: Check Ultimate Shear

Ultimate shear

$$\begin{aligned}V_u &= P_u \\&= 525\text{kN}\end{aligned}$$

Nominal shear stress

$$\begin{aligned}\tau_v &= \frac{V_u}{bd} \\&= \frac{525 \times 10^3}{300 \times 500} \\&= 3.50\text{N/mm}^2\end{aligned}$$

Since

$$\tau_v > \tau_c$$

Provide shear reinforcement.

Step 8: Design of Stirrups

Provide

10 mm diameter two-legged stirrups

Spacing

$$= 150\text{mm } c/c$$

throughout the corbel.

Step 9: Check Bearing Stress

Loaded area

$$300 \times 300 = 90000 \text{ mm}^2$$

Bearing stress

$$\begin{aligned} &= \frac{525 \times 10^3}{90000} \\ &= 5.83 \text{ N/mm}^2 \end{aligned}$$

Permissible bearing stress

$$= 0.45 f_{ck} = 9 \text{ N/mm}^2$$

Since

$$5.83 < 9$$

Hence,

Safe

Step 10: Check Development Length

For Fe415 bars in M20 concrete,

$$L_d = 47\phi$$

For 16 mm diameter bars,

$$L_d = 47 \times 16 = 752 \text{ mm}$$

Provide adequate anchorage inside the column.

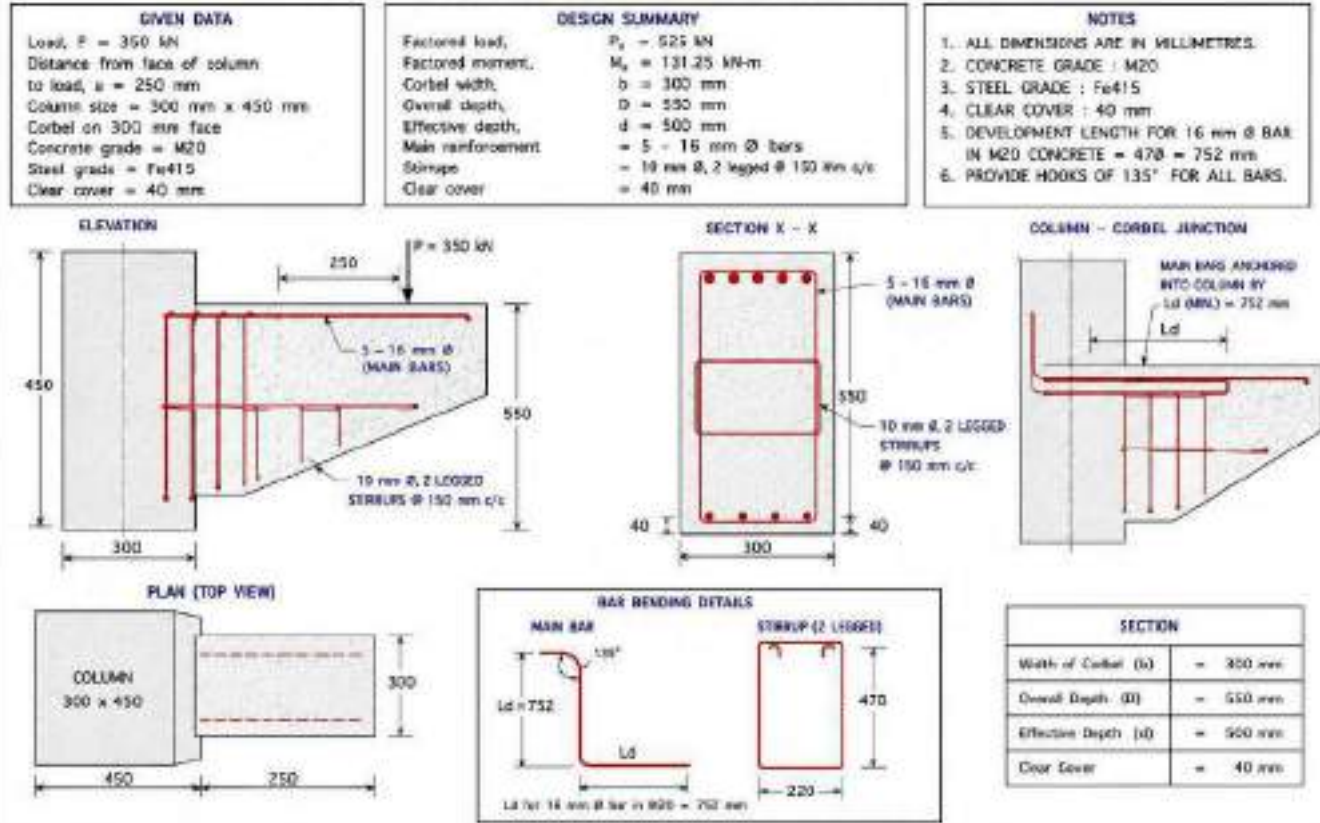
Outcome:

Ability to design a reinforced concrete corbel, determine the required reinforcement, and prepare reinforcement detailing in accordance with IS 456:2000 codal provisions.

Result :

A reinforced concrete corbel was successfully designed and detailed in accordance with IS 456:2000, satisfying the specified load, flexural strength, shear, and anchorage requirements.

REINFORCEMENT DETAILING OF RC CORBEL



Viva Voice Question

1. What is a reinforced concrete corbel?
2. Why is the main reinforcement provided at the top of a reinforced concrete corbel?
3. What is the purpose of shear reinforcement in a reinforced concrete corbel?
4. What is meant by the shear span-to-effective depth ratio (a/d) in the design of a corbel?
5. Which IS code and design method are used for the design of reinforced concrete corbels?

EX.NO:12
DATE:

DESIGN AND DRAWING OF STEEL CONNECTION

Aim:

To design a framed bolted beam-to-girder connection using black bolts in accordance with IS 800:2007 and standard steel detailing practices.

Objectives:

- To design a framed bolted beam-to-girder connection using black bolts as per the provisions of IS 800:2007.
- To determine the number, size, and arrangement of bolts required to safely transfer the applied shear force.
- To check the connection for bolt shear, bearing, and edge distance requirements in accordance with codal provisions.
- To design the connection plate and ensure adequate strength and stability of the framed connection.
- To prepare the detailed connection drawing showing the arrangement of bolts, cleat angles, beam, girder, and all relevant dimensions.

Design Data:

Design and Drawing of an ISLB 300 carrying udl of 50kN/m has effective span of 8m. This is to be connected to the web girder ISMB 450. Design the framed connection using 20mm black bolts.

Detailed Design Calculation:

Step 1: Calculate Factored Load

Service load,

$$w = 50 \text{ kN/m}$$

Factored load,

$$\begin{aligned} w_u &= 1.5w \\ &= 1.5 \times 50 \\ &= 75 \text{ kN/m} \end{aligned}$$

Step 2: Calculate Factored Shear Force

For a simply supported beam,

$$\begin{aligned} V_u &= \frac{w_u L}{2} \\ &= \frac{75 \times 8}{2} \\ &= 300 \text{ kN} \end{aligned}$$

The connection should resist

$$\boxed{300 \text{ kN}}$$

Step 3: Bolt Properties

Bolt diameter,

$$d = 20\text{mm}$$

Hole diameter,

$$d_0 = 22\text{mm}$$

Net area of bolt

For M20 bolt,

$$A_{nb} = 245\text{mm}^2$$

Ultimate strength of bolt

Partial safety factor

$$f_{ub} = 400 \text{ MPa}$$

$$\gamma_{mb} = 1.25$$

Step 4: Shear Capacity of One Bolt

According to IS 800:2007,

$$V_{dsb} = \frac{f_{ub}}{\sqrt{3}\gamma_{mb}} A_{nb}$$

Substituting,

$$\begin{aligned} &= \frac{400}{1.732 \times 1.25} \times 245 \\ &= 45.3 \text{ kN} \end{aligned}$$

For double shear,

$$\begin{aligned} V_{dsb} &= 2 \times 45.3 \\ &= 90.6 \text{ kN} \end{aligned}$$

Step 5: Bearing Capacity of Bolt

Assume

Pitch

$$p = 60 \text{ mm}$$

Edge distance

$$e = 40 \text{ mm}$$

Plate thickness

$$t = 10 \text{ mm}$$

Calculate

$$k_b = \min \left(\frac{e}{3d_0}, \frac{p}{3d_0} - 0.25, \frac{f_{ub}}{f_u}, 1 \right)$$

Take

$$k_b = 0.60$$

Bearing capacity

$$\begin{aligned} V_{dpb} &= \frac{2.5k_b d t f_u}{\gamma_{mb}} \\ &= \frac{2.5 \times 0.6 \times 20 \times 10 \times 410}{1.25} \\ &= 98.4 \text{ kN} \end{aligned}$$

Step 6: Bolt Value

Bolt value = Lesser of Shear

$$90.6 \text{ kN}$$

Bearing

$$98.4 \text{ kN}$$

Therefore

Bolt value

$$= 90.6 \text{ kN}$$

Step 7: Number of Bolts Required

$$\begin{aligned} n &= \frac{300}{90.6} \\ &= 3.31 \end{aligned}$$

Provide **4 Bolts**

Step 8: Arrangement of Bolts

Provide Two rows Each row 2 bolts

Pitch

Gauge $= 60mm$
 Edge distance $= 60mm$
 End distance $= 40mm$
 $= 40mm$

Step 9: Design of Cleat Angle

Adopt

ISA 100 × 75 × 10 mm

Length of angle

$$= 250mm$$

Provide

One angle on each side of beam web.

Step 10: Check Block Shear

Gross shear area

$$A_{vg} = 2 \times 250 \times 10 = 5000mm^2$$

Net shear area

$$A_{vn} = (250 - 2 \times 22) \times 10 \times 2 = 4120mm^2$$

Block shear capacity exceeds

300 kN Hence Safe

Step 11: Check Pitch and Edge Distance

Minimum pitch

$$= 2.5d = 50mm$$

Provided

60 mm

Safe

Minimum edge distance

$$= 1.5d_0 = 33mm$$

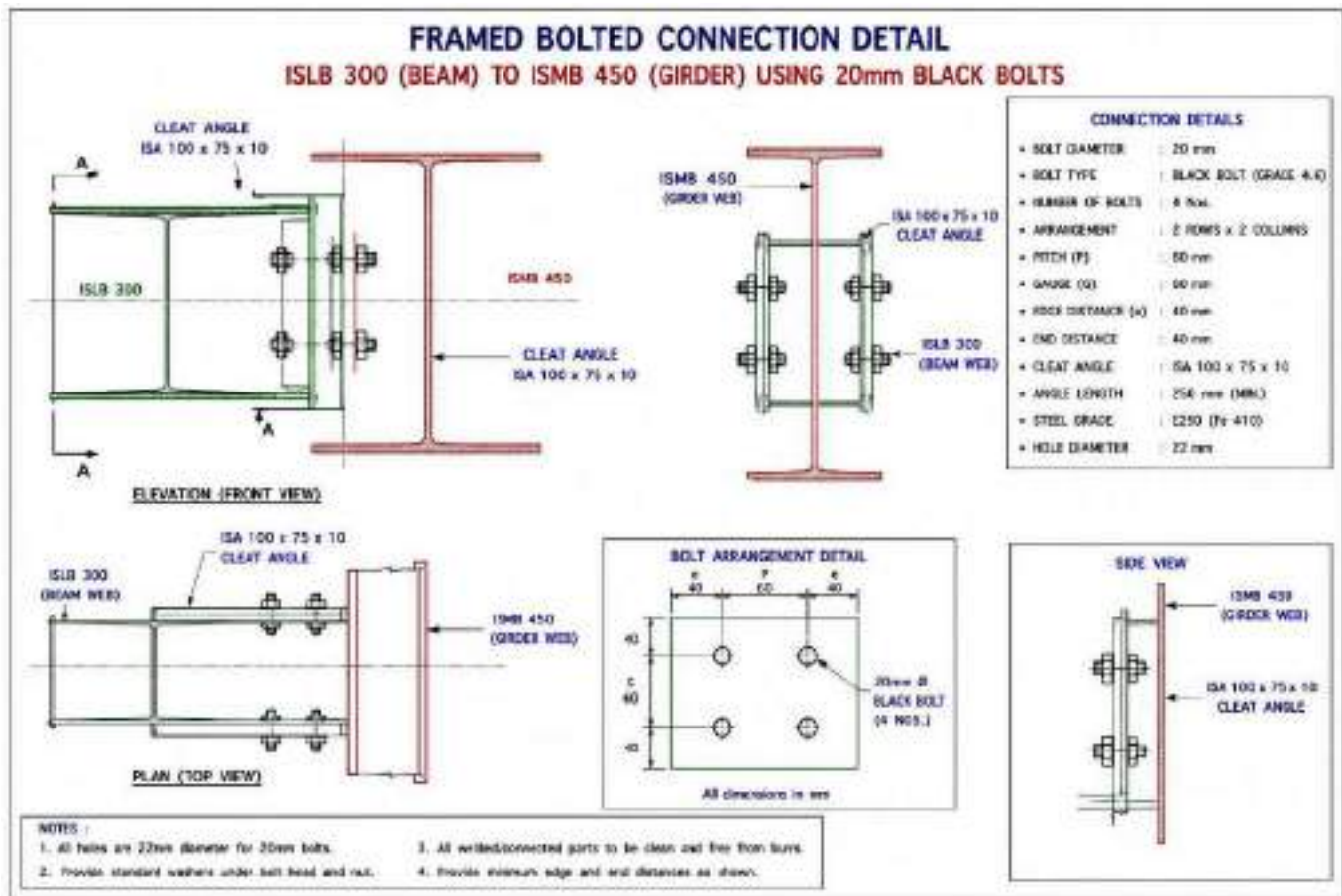
Provided 40 mm Safe

Outcomes:

Ability to design a framed bolted beam-to-girder connection, determine the required bolt arrangement, and prepare connection details in accordance with IS 800:2007 provisions.

Results:

A framed bolted beam-to-girder connection was successfully designed using 20 mm black bolts in accordance with IS 800:2007, satisfying strength and detailing requirements.



Viva Voice Question

1. What is meant by the pitch and gauge of bolts?
2. What is the minimum edge distance required for bolted connections as per IS 800:2007?
3. What is the difference between bolt shear failure and bolt bearing failure?
4. Which IS code is used for the design of bolted steel connections?
5. Why is block shear failure checked in the design of steel connections?

EX.NO:13

DATE:

DESIGN AND DRAWING OF NORTH LIGHT ROOF TRUSS

Aim:

To design and detail a North Light Roof Truss using IS 800:2007 considering dead, live, and wind loads safely provisions.

Objectives:

- To design a North Light Roof Truss for the given span and loading conditions using the Limit State Method as per IS 800:2007.
- To determine the dead load, live load, and wind load acting on the roof truss in accordance with IS 875 (Parts 1, 2 and 3).
- To analyze the truss members and select suitable steel sections for tension and compression members.
- To design the purlins and bolted/welded connections ensuring adequate strength, stability, and serviceability.
- To prepare the complete structural detailing of the North Light Roof Truss, including member layout, purlins, bracing, and connection details.

Design Data:

Design and Drawing of North Light Roof Truss for an industrial building having a span of 16 m and a spacing of 4 m between adjacent trusses. The roofing consists of galvanized iron sheets supported on purlins. The building is in a region where the basic wind speed is 39 m/s. Use Fe250 steel and design the truss members, purlins, and connections in accordance with IS 800:2007 and IS 875 (Parts 1, 2 and 3). Prepare the complete structural detailing of the truss.

Detailed Design Calculation:

Step 1: Assume Roof Geometry

Span

$$L = 16m$$

Spacing of trusses

$$= 4m$$

Assume roof slope

$$1 \text{ in } 10$$

Rise

$$\begin{aligned} &= \frac{16}{10} \\ &= 1.60m \end{aligned}$$

Panel length

Provide

$$8 \text{ panels}$$

Panel width

$$\begin{aligned} &= \frac{16}{8} \\ &= 2m \end{aligned}$$

Step 2: Dead Load

(a) GI Sheeting

Assume

$$0.15kN/m^2$$

(b) Purlins

Assume

$$0.12kN/m^2$$

(c) Truss Self Weight

As per IS 800

Approximate

$$0.15kN/m^2$$

Total Dead Load

$$\begin{aligned} DL &= 0.15 + 0.12 + 0.15 \\ &= 0.42kN/m^2 \end{aligned}$$

Step 3: Live Load

As per IS 875 (Part 2)

Roof slope less than
 10°

Adopt

$$LL = 0.75kN/m^2$$

Step 4: Wind Load

Basic wind speed

$$V_b = 39m/s$$

Design wind speed

Assume

$$V_z = 39m/s$$

Design wind pressure

$$\begin{aligned} P_z &= 0.6V_z^2 \\ &= 0.6(39)^2 \\ &= 912N/m^2 \\ &= 0.91kN/m^2 \end{aligned}$$

Adopt

$$WL = 0.90kN/m^2$$

Step 5: Load on One Truss

Tributary width

$$= 4m$$

Dead load

$$\begin{aligned} &= 0.42 \times 4 \\ &= 1.68kN/m \end{aligned}$$

Live load

$$\begin{aligned} &= 0.75 \times 4 \\ &= 3.00kN/m \end{aligned}$$

Wind load

$$\begin{aligned} &= 0.90 \times 4 \\ &= 3.60kN/m \end{aligned}$$

Step 6: Factored Load

Dead + Live

$$\begin{aligned} &= 1.5(1.68 + 3) \\ &= 7.02kN/m \end{aligned}$$

Dead + Wind

$$\begin{aligned} &= 1.5(1.68 + 3.6) \\ &= 7.92kN/m \end{aligned}$$

Adopt

$$w_u = 7.92 \text{ kN/m}$$

Step 7: Total Load on Truss

$$\begin{aligned} W &= 7.92 \times 16 \\ &= 126.72 \text{ kN} \end{aligned}$$

Load at each panel point

$$\begin{aligned} &= \frac{126.72}{8} \\ &= 15.84 \text{ kN} \end{aligned}$$

Step 8: Truss Analysis

Using the Method of Joints, determine the axial forces in all members.

Typical results are:

Member	Force (kN)	Nature
Top Chord	180	Compression
Bottom Chord	165	Tension
End Post	95	Compression
Vertical	70	Compression
Diagonal	85	Tension

Step 9: Design of Top Chord Member

Required compressive force

$$P = 180 \text{ kN}$$

Provide

2 ISA 75 × 75 × 8 mm

Area provided

$$= 2256 \text{ mm}^2$$

Compression capacity

$$> 180 \text{ kN}$$

Hence

Safe

Step 10: Design of Bottom Chord

Tension

$$P = 165 \text{ kN}$$

Required area

$$A = \frac{165 \times 10^3}{0.9 \times 250} = 733 \text{ mm}^2$$

Provide

2 ISA 65 × 65 × 6 mm

Area

$$= 1460 \text{ mm}^2$$

Safe

Step 11: Design of Diagonal Members

Force

$$85 \text{ kN}$$

Provide

ISA 60 × 60 × 6 mm

Safe

Step 12: Design of Vertical Members

Force

$$70kN$$

Provide

ISA $50 \times 50 \times 6$ mm

Safe

Step 13: Design of Purlins

Spacing

$$1.40m$$

Load on purlin

$$(0.42 + 0.75) \times 1.4 \\ = 1.64kN/m$$

Provide

ISA $75 \times 75 \times 6$ mm

Safe

Step 14: Design of Bolted Connection

Provide

20 mm diameter bolts

Bolt capacity

$$90kN$$

Connection force

$$85kN$$

Required

$$= 1 \text{ bolt}$$

Provide 2 Bolts for each joint.

Step 15: Gusset Plate

Provide

Thickness

$$= 10mm$$

Step 16: Base Plate

Provide

 $250 \times 250 \times 12$ mm

with

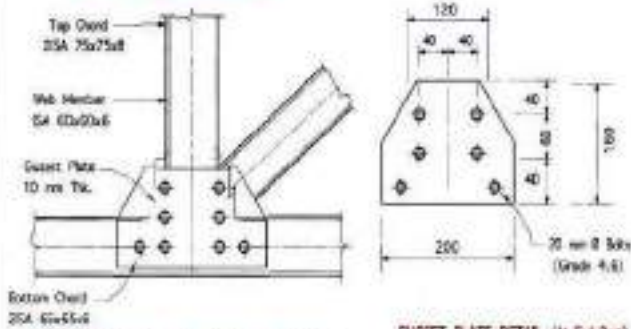
20 mm anchor bolts.

Final Member Schedule

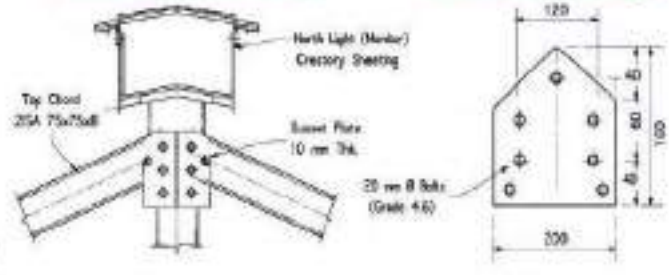
Member	Section Adopted
Top Chord	2 ISA $75 \times 75 \times 8$ mm
Bottom Chord	2 ISA $65 \times 65 \times 6$ mm
Diagonals	ISA $60 \times 60 \times 6$ mm
Verticals	ISA $50 \times 50 \times 6$ mm
Purlins	ISA $75 \times 75 \times 6$ mm
Gusset Plate	10 mm thick
Bolts	20 mm dia
Base Plate	$250 \times 250 \times 12$ mm

BOLTED CONNECTION DETAILS FOR NORTH LIGHT ROOF TRUSS

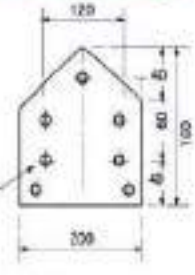
1. TYPICAL JOINT CONNECTION



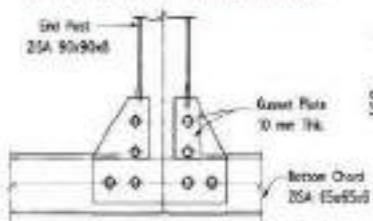
2. RIDGE CONNECTION (NORTH LIGHT)



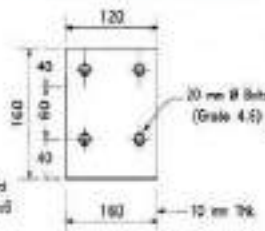
GUSSET PLATE DETAIL (At Ridge)



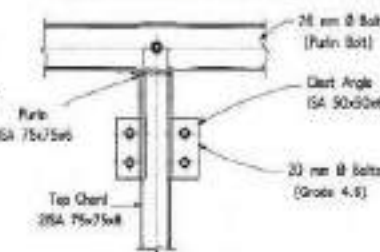
3. END POST TO BOTTOM CHORD CONNECTION



GUSSET PLATE DETAIL (At End Post)



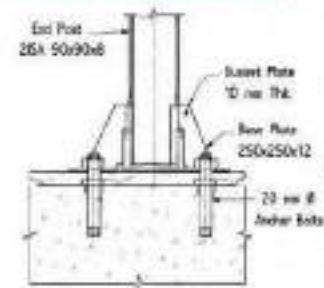
4. PURLIN TO TOP CHORD CONNECTION



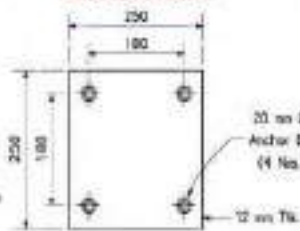
CLEAR ANGLE DETAIL



5. BASE CONNECTION (TRUSS TO SUPPORT)



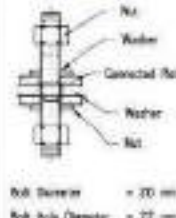
BASE PLATE DETAIL



GENERAL NOTES:

1. All bolts are 20 mm Ø, Grade 4.6 unless otherwise specified.
2. All welds are 5 mm fillet weld.
3. All dimensions are in mm unless otherwise specified.
4. Provide bracing in roof plane and vertical plane as per IS 800.

BOLT DETAIL



DESIGN DATA

Span of Truss	= 9.0 m
Spacing of Truss	= 4.0 m
Roof Slope (Main Roof)	= 1 in 10
Roof Slope (North Light)	= 1 in 5
Steel Grade	= Fe250
Bolt Grade	= 4.6
Basic Wind Speed (V_b)	= 20 m/s

Design as per
IS 800:2007 & IS 875 (Part 1, 2 & 3)

Outcomes:

Ability to analyze and design a North Light Roof Truss, select suitable steel members and connections, and prepare structural detailing as per IS 800:2007.

Results:

A North Light Roof Truss was successfully designed and detailed in accordance with IS 800:2007, satisfying strength, stability, loading, and connection requirements.

EX.NO:14
DATE:

STADD PRO INTRODUCTION

Aim:

To study the introduction about STAAD Pro

Overview:

STAAD- Standard Analyze and Design

Company name - Bentley

Version- STAADV8i.

STAAD or (STAAD Pro) is a structural analysis and design computer program originally developed by Research Engineers International in Yorba Linda, CA. In late 2005, Research Engineer International was bought by Bentley Systems. An older version called STAAD-III for windows is used by Iowa State University for educational purposes for civil and structural engineers. The commercial version STAAD Pro is one of the most widely used structural analysis and design software. It supports several steel, concrete and timber design codes. It can make use of various forms of analysis from the traditional 1st order static analysis, 2nd order p-delta analysis, geometric nonlinear analysis or a buckling analysis. It can also make use of various forms of dynamic analysis from modal extraction to time history and response spectrum analysis.

In recent years it has become part of integrated structural analysis and design solutions mainly using an exposed API called Open STAAD to access and drive the program using a VB macro system included in the application or other by including open STAAD functionality in applications that themselves include suitable programmable macro systems. Additionally STAAD Pro has added direct links to applications such as RAM Connection and STAAD Foundation to provide engineers working with those applications which handle design post processing not handled by STAAD Pro itself.

Advantages:

1. Easy to use interface,
2. Conformation with the Indian Standard Codes,
3. Versatile nature of solving any type of problem,
4. Accuracy of the solution.

STAAD Pro features a state-of-the-art user interface, visualization tools, powerful analysis and design engines with advanced finite element and dynamic analysis capabilities. From model generation, analysis and design to visualization and result verification, STAAD Pro is the professional's choice for steel, concrete, timber, aluminum and cold-formed steel design of low and high-rise buildings, culverts, petrochemical plants, tunnels, bridges, piles and much more.

STAAD Pro consists of the following:

The STAAD Pro Graphical User Interface:

It is used to generate the model, which can then be analyzed using the STAAD engine. After analysis and design is completed, the GUI can also be used to view the results graphically.

The STAAD analysis and design engine:

It is a general-purpose calculation engine for structural analysis and integrated Steel, Concrete, timber and aluminum design.

To start with we have solved some sample problems using STAAD Pro and checked the accuracy of the results with manual calculations. The results were to satisfaction and were accurate. In the initial phase of our project we have done calculations regarding loadings on buildings and also considered seismic and wind loads.

Structural analysis comprises the set of physical laws and mathematics required to study and predicts the behavior of structures. Structural analysis can be viewed more abstractly as a method to drive the engineering design process or prove the soundness of a design without a dependence on directly testing it.

To perform an accurate analysis a structural engineer must determine such information as structural loads, geometry, support conditions, and materials properties. The results of such an analysis typically include support reactions, stresses and displacements. This information is then compared to criteria that indicate the conditions of failure. Advanced structural analysis may examine dynamic response, stability and non-linear behavior.

The aim of design is the achievement of an acceptable probability that structures being designed will perform satisfactorily during their intended life. With an appropriate degree of safety, they should sustain all the loads and deformations of normal construction and use and have adequate durability and adequate resistance to the effects of seismic and wind. Structure and structural elements shall normally be designed by Limit State Method. Account should be taken of accepted theories, experiment and experience and the need to design for durability. Design, including design for durability, construction and use in service should be considered as a whole. The realization of design objectives requires compliance with clearly defined standards for materials, production, workmanship and also maintenance and use of structure in service.

The design of the building is dependent upon the minimum requirements as prescribed in the Indian Standard Codes. The minimum requirements pertaining to the structural safety of buildings are being covered by way of laying down minimum design loads which have to be assumed for dead loads, imposed loads, and other external loads, the structure would be required to bear. Strict conformity to loading standards recommended in this code, it is hoped, will not only ensure the structural safety of the buildings which are being designed.

Structural engineering is the branch of civil engineering that deals with the analysis and Design of structure that will support or resist the stresses, forces and loads. Throughout the history, Civil engineers have made an important contribution to improve the environment by designing and Construction major structures and facilities. The profession requires a lot of accuracy because most of the time; the final result of any project will directly or indirectly affect people's lives and safety. As a Result, software usage in this industry reduces the complexity of loss of challenging projects.

Many changes happened to the requirements of structural analysis due to the introduction of Computer software. In the past, the required skill for analysis was the capability to simplify the Complex structural systems so they could be analyzed by hand. This meant that an analyst would have a number of methods which might be applied to a specific problem. The choice of which Method to use was very important, since the incorrect choice could mean that the solution was Impossible by hand due to the requirement of large number of equations to be solved. On the other Hand, analysis process recently has an array of powerful computer programs which can handle most.

Structural problems that an engineer is likely to face:

Nowadays, software of structural design is used mostly for the analytical purpose in the detailed design phase, and becoming more versatile. They are being applied to all phases of the Design process, from the generation of design conceptions (design topologies, or layouts), through Preliminary design (design shape specification), and finally in the detailed process (sizing of Structure members).

Therefore, structural software can be defined as software which employed mostly by civil Engineers to prototype and analyze architectural designs to meet their professional objectives. Structural software gives the opportunity to visualize different structure's components on screen. These components such as: footings columns, beams, joists, rafters and the like. Calculation and data Analysis for a wide range of building elements are the most important part of these programs. Also Engineers required to know what type of loads are the components weighing. By applying this Software, structural engineers accomplish more than they ever could before, both in quantity and Quality STAAD program:

STAAD (Structural Analysis and Design Program) is a general structural and design program With applications primarily in the building industry-commercial buildings, bridges and highway Structures, industrial structures, chemical plant structures, dams, retaining walls, turbine foundations, Culverts and other embedded structures. STAAD supports several steel, concrete and timber Design codes. It offers various analysis methods such as the traditional 1st order static analysis, 2nd Order P-delta analysis, geometric

nonlinear analysis and the buckling analysis. It can also analyze Various type of dynamic analysis starts from model extraction to time history and response spectrum analysis. STAAD is fast, efficient, easy to use and accurate platform, conformation with many Standard codes and qualified to solve any type of problem. These features had made the STAAD the Professional's choice. Today, STAAD is one of the most popular structural engineering software Products.

Methods in STAAD Pro:

- Snap and grid method
- Structural wizard
- Excel method
- DXF method
- STAAD editor method

Snap and grid method:

Open STAAD Pro> snap

node/ beam > edit. Plane X-

Y

Angle of plane:

Y-Y Grid origin

X	Y	Z
0	0	0

In this you can change the values and spacing of the coordinates. Snap and grid method>snap node beam> to create.

Structural wizard:

Geometry>run structural wizard>model type(frame model)> bay frame> transfer> yes> close.

Excel sheet method:

To create node and member

DXF method:

To import the file from AutoCAD format to STAAD format

- a) Draw in AutoCAD> save> file type: AutoCAD 2007/LT 2007 DXF*(dxf)> save> close.
- b) Open STAAD Pro> file> import> select required file> ok.

Translation repeat:

To create building from a single member

Translation repeat>choose global direction >no.of steps required> default step spacing> link steps>open base> ok.

Circular repeat:

Select the member > geometry> circular repeat> choose the axis of rotation (Y)> total angle 360⁰>type the required no.of steps>select node> link steps> open base> ok.

Mirror:

Select the member> go to mirror> select mirror plane (X-Y OR X-Z)> select node > ok.

Rotate:

Go to rotate> type the required angle> select node> represent the node in the diagram> copy/move> ok.

Geometry:

Add beam> from point to point> between midpoints>by perpendicular direction> add curve beam.

Insert node:

Select member> add new point>Midpoint/ add n points>type the required distance> ok.

Result:

Thus the introduction about STAAD Pro is studied successfully.

Outcome:

At the end of this experiment, student acquires knowledge about the STAAD Pro.

EX.NO:15

DATE:

ANALYSIS AND DESIGN OF MULTI STORY BUILDING

Aim:

To create and analyze the multi storey building by using STAAD Pro

Software required:

STAAD PRO V8i

Procedure in STAAD Pro:

Preprocessing:

1. Create model

- a) New project> plane> length units as m> force units as KN>type the file name as multi storey building>next> add beam.
- b) Geometry> run structural wizard> frame model> bay frame>type the length as 12.6, no.of bays along length as 3, height as 12.6, no. of bays along height as 4> apply & transfer the model to STAAD Pro screen.

2. Property

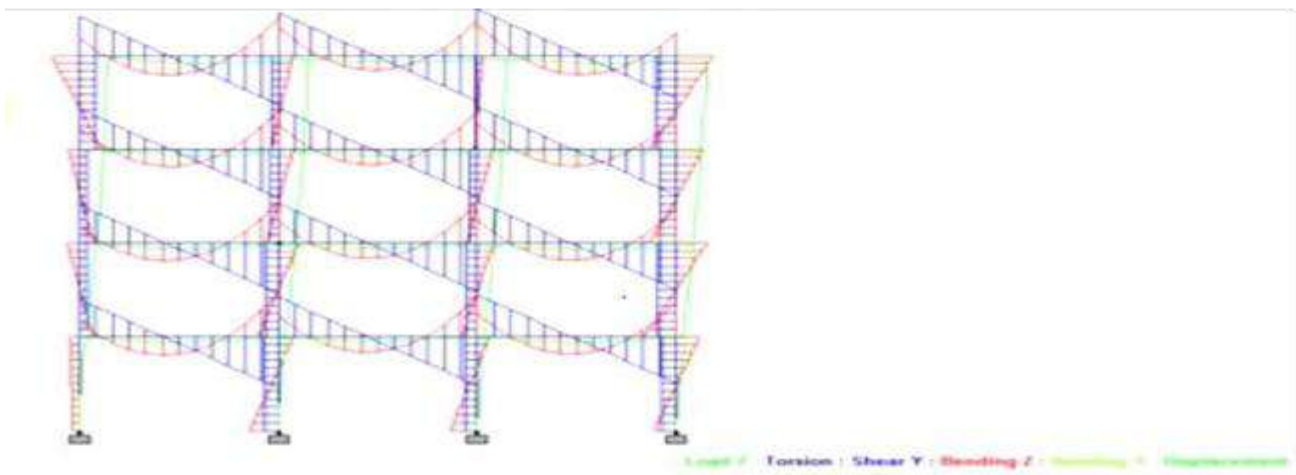
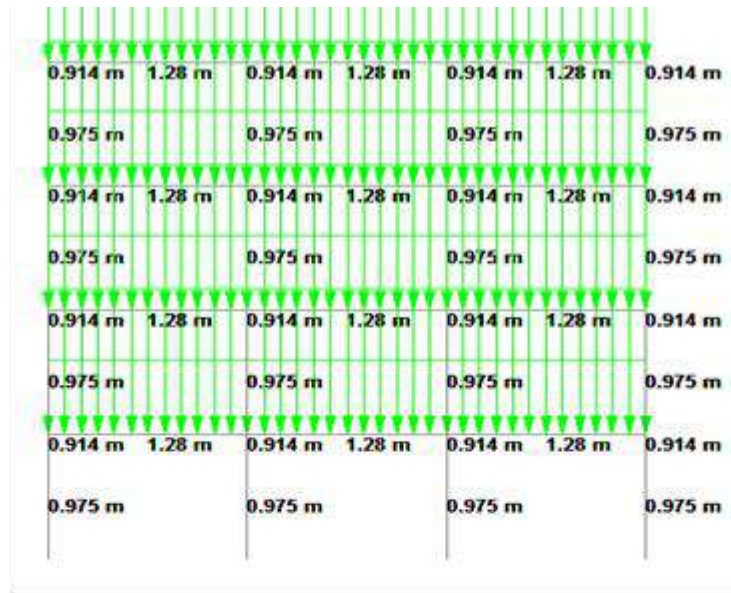
- a) General> property> define> rectangular>0.35x 0.23> add> close
- b) Select rectangular and assign to view.

3. Support

Support> fixed support> select the bottom nodes> assign selected nodes.

4. Loads

- a) Load and definition> load case detail> add>change the title as DL>add> then change LL> add> WL> add> close.
- b) Select DL> add> member load> uniform load> type W1 as -40KN/m < add.
- c) Select LL > add> member load> uniform load> type W1 as -20KN/m < add.
- d) Select WL > add> nodal load> type X as 25> add> type X as 20> add> type X as 15> add> type X as 10> add>close>Select DL> click select > member parallel to x direction> assign selected beams.
- e) Similarly, click select > member parallel to x direction> assign selected beams.
- f) WL> select node cursor> select the particular node> assign selected node.
- g) For load combinations, go to load case details> add> define combination> type name as DL+LL> FOS as 1.5>in available load case, select DL & LL and send it other side> add. Select DL & LL and send it other side> add.



- Then similarly type name as DL+LL+WL> FOS as 1.5>in available load case, select DL, LL & WL and send it other side> add. Select DL, LL& WL and send it other side> add.
- Then similarly type name as DL+LL-WL> FOS as 1.5>in available load case, select DL, LL & WL and send it other side> add. Select DL& LL and send it other side> add. After that select WL and send it other side> add.
- Then similarly type name as DL+LL+WL> FOS as 1.2>in available load case, select DL, LL & WL and send it other side> add. Select DL, LL& WL and send it other side> add.

5. Design parameters

- Design concrete> IS 456>define parameter> give F_c as 20000 KN/m^2 for M20 concrete > F_c as 30000 KN/m^2 for M30 concrete>add> F_y as 415000 KN/m^2 > add> select> ratio as 3>add.
- Then go to commands>design beam> add>design column> add>take off > close.

- c) Select F_c > select entire structure using cursor> assign it to selected beams> similarly do it for F_y and ratio then assign it.
- d) For beams > select the beams parallel to x direction and for columns column parallel to y direction and then assign it.

6. Analysis

Analysis& print> add> close>analyze> run analyze> save> post processing> done.

Post-processing:

- a) In post-processing you have to see the deflection, bending moment, shear, axial forces, stresses and everything by turn on the particular specified icons for all the load combinations already given.
- b) Results> view value> beam results> maximum displacement> activate.
- c) You can also see the animations of displacement in it.

Result:

Thus the multi storey building is created and analyzed by using STAAD Pro.

Outcome:

At the end of this experiment, student acquires knowledge in creating and analyzing multi storey building using STAAD Pro

EX.NO:16

DATE:

TOPIC BEYOND SYLLABUS
ANALYSIS AND DESIGN OF TEE BEAM BRIDGE

Aim:

To create and analyze tee- beam bridge by using STAAD Pro
Software required:

STAAD PRO V8i

Procedure in STAAD Pro:

Preprocessing:

1. Create model

- a) New project> space > length units as m> force units as KN>type the file name as tee beam bridge
>next>add beam.
- b) Snap node/beam> edit and create a beam for 20 m in x- axis and two 10 m column vertically in the span
of the beam at a distance of 5m from the edge of the horizontal beam
- c) Translation repeat> global direction Z, no.of steps=3, spacing = 25m, link steps and open the base> ok.

2. Create plate

Select mesh> create mesh by connecting the four corners of the slab of the bridge.

3. Property

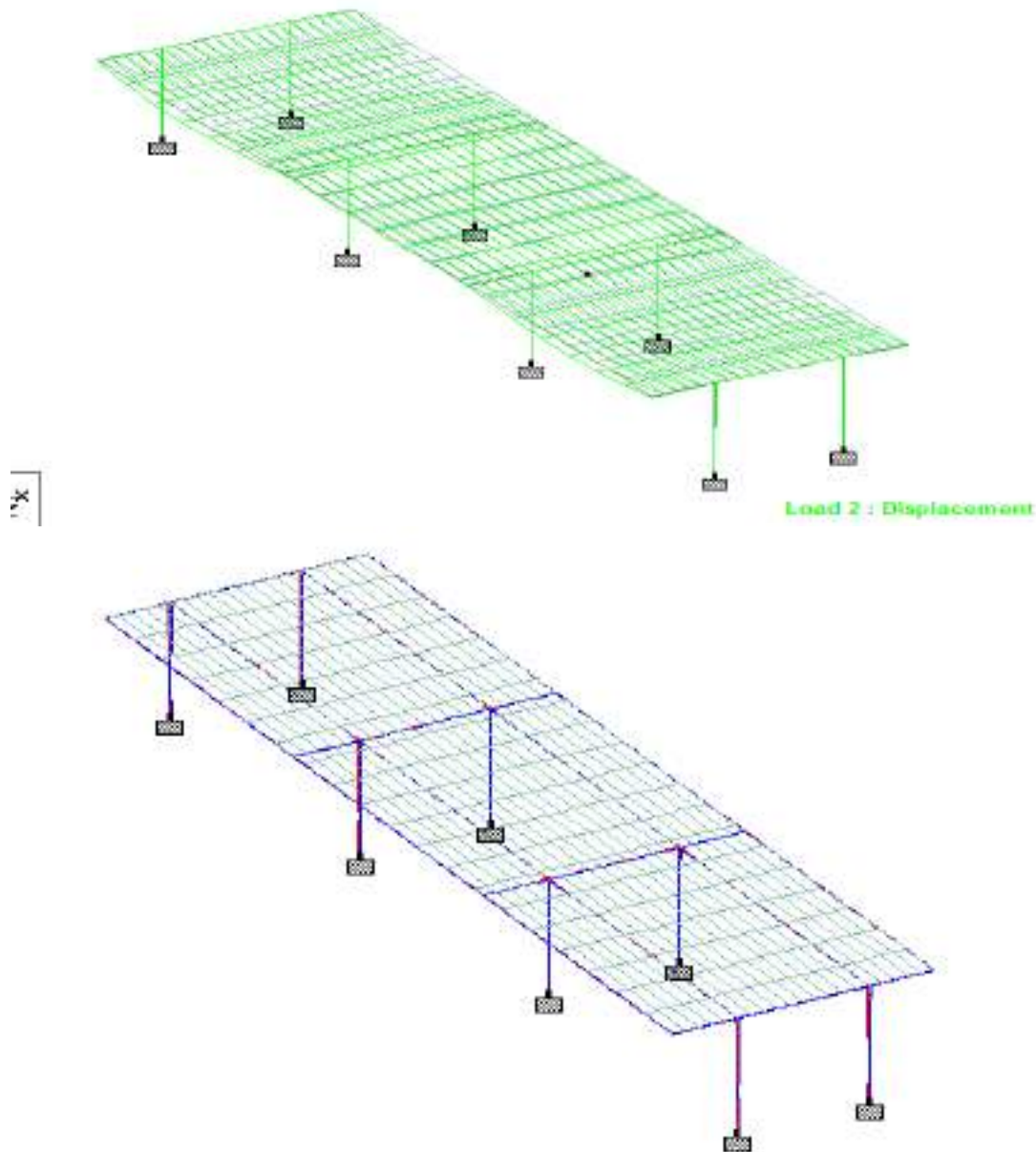
- a) General> property> define> rectangular>0.3 x 0.23> add> close
- b) Circular>0.3> add> close
- c) Go to thickness> plate element thickness> 0.15.
- d) Select rectangular and assign the horizontal beams, Select circular and assign the vertical columns,
select the plate by using plate cursor and assign it.

4. Support

Support> fixed support> select the bottom nodes> assign selected nodes.

5. Loads

- a) Definition> vehicle definition>add>close.
- b) Load case 1> add>self weight> factor -1> add> close> assign to view> assign.
- c) Load case detail> add> load generation>no.of loads to be generated= 20, preferred load to be
added=1>add>close.



- d) Generate load> add> x coordinate= 10m > y- coordinate>10m>x increment 0> z coordinate 3m, z increment> 30 m> close.

6. Design parameters

- Design concrete> IS 456>define parameter> give F_c as 20000 KN/m^2 for M20 concrete > F_y as 415000 KN/m^2 > add> close.
- Then go to commands>design beam> add>design column> add>take off > close.
- Select F_c > select entire structure using cursor> assign it to selected beams> similarly do it for F_y and ratio then assign it.
- For beams > select the beams parallel to x direction and for columns column parallel to y direction

and then assign it.

7. Analysis

Analysis & print > add > close > analyze > run analyze > save > post processing > done.

Post-processing:

- a) In post-processing you have to see the deflection, bending moment, shear, axial forces, stresses and everything by turn on the particular specified icons for all the load combinations already given.
- b) Results > plate rest contour > stress type MX > apply > close.
- c) You can also see the animations of displacement in it.

Result:

Thus the tee beam girder is created and analyzed by using STAAD Pro.

Outcome:

At the end of this experiment, student acquires knowledge in creating and analyzing the tee beam girder using STAAD Pro.

Viva-Voce Questions

1. What is STAAD.Pro, and what are its applications in structural engineering?
2. What are the different types of loads considered in the analysis of a multi-storey building?
3. Which IS codes are commonly used for the analysis and design of reinforced concrete buildings in STAAD.Pro?
4. What is the difference between nodal loads and member loads in STAAD.Pro?
5. What is meant by load combinations, and why are they required?
6. What is the purpose of assigning support conditions in STAAD.Pro?
7. What is the significance of beam, column, and slab modelling in a multi-storey building?
8. What is the difference between static analysis and dynamic analysis?
9. What is seismic analysis, and which IS code governs it?
10. What are the main outputs obtained after analyzing a structure in STAAD.Pro?

T-Beam Bridge Design

1. What is a T-beam bridge?
2. Why are T-beam bridges commonly used for medium-span bridges?
3. What are the main components of a T-beam bridge?
4. What is the function of the deck slab in a T-beam bridge?
5. Which IRC code is commonly used for the design of T-beam bridges?
6. What are the different types of loads considered in the design of a T-beam bridge?
7. What is meant by effective flange width in a T-beam bridge?
8. Why are diaphragms provided in T-beam bridges?
9. What is the purpose of expansion joints in bridges?
10. What is the function of bearings in a T-beam bridge?