STAAD.PRO BASED RCC BOX CULVERT DESIGN – PRACTICAL WORKSHOP

WORKSHOP OBJECTIVES

- Understand basics of structural engineering concepts
- Learn what STAAD.Pro is and its role in structural design
- Get clear knowledge about RCC box culverts and their applications
- Perform complete RCC box culvert analysis & design using STAAD.Pro
- Interpret results and understand real-time design workflow

STADD.PRO

- ST – Structural
- A - Analysis
- A - And
- D - Design

CONNECT EDITION

PRO – PROGRAM

HISTORY OF STAAD.PRO

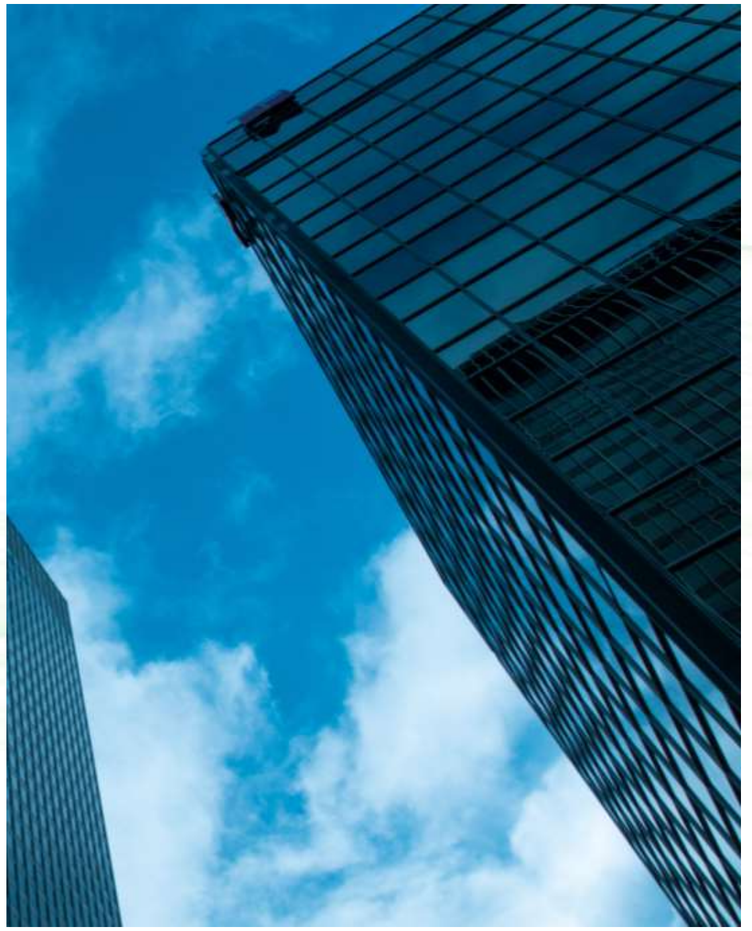
STAAD Pro was originally developed by Research Engineers International in Yorba Linda, CA

Bentley®

In late 2005 , Research Engineer International was bought by Bentley Systems

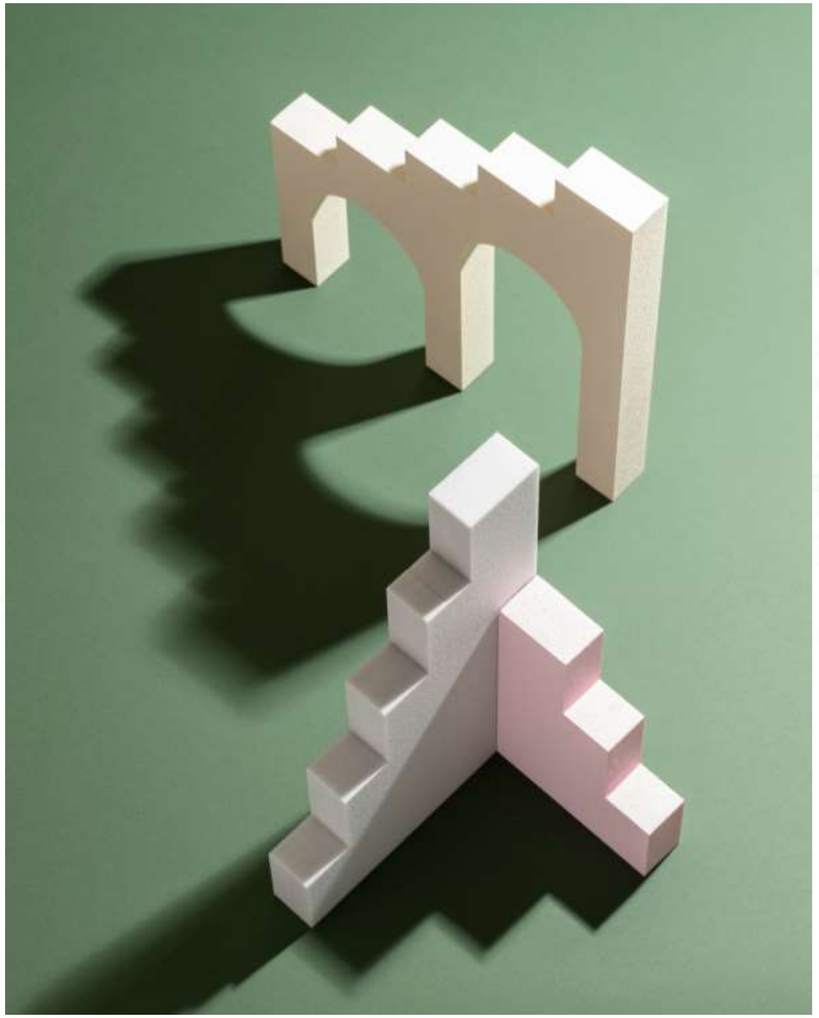
What is Structural Engineering

- Branch of civil engineering dealing with analysis and design of structures
- Ensures strength, stability, serviceability, and safety
- Structures resist loads such as:
- Dead load
- Live load
- Earth pressure
- Water pressure
- Vehicle loads

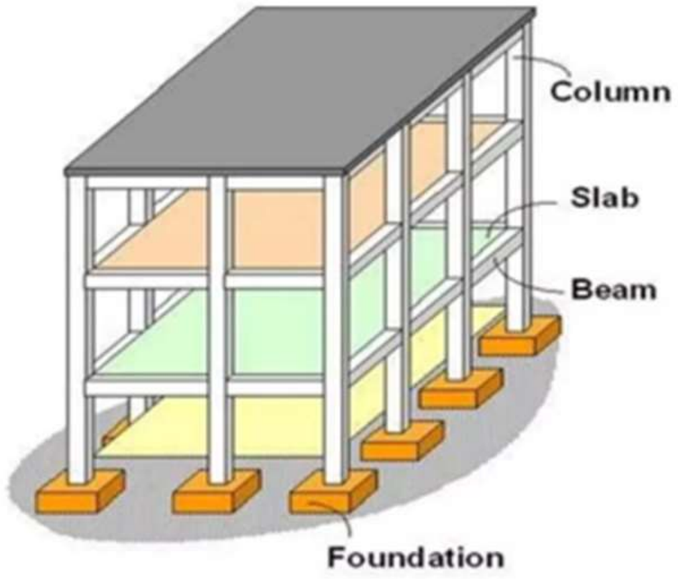


Basic Structural Concepts

- Load types and load combinations
- Stress, strain, and material behavior
- Bending moment, shear force, axial force
- Support conditions and boundary restraints
- Limit state design concept



STRUCTURE



Typical RC Frame Building

It’s combination of Structural Element

- **Slab**
- **Beam**
- **Column**
- **Footing**

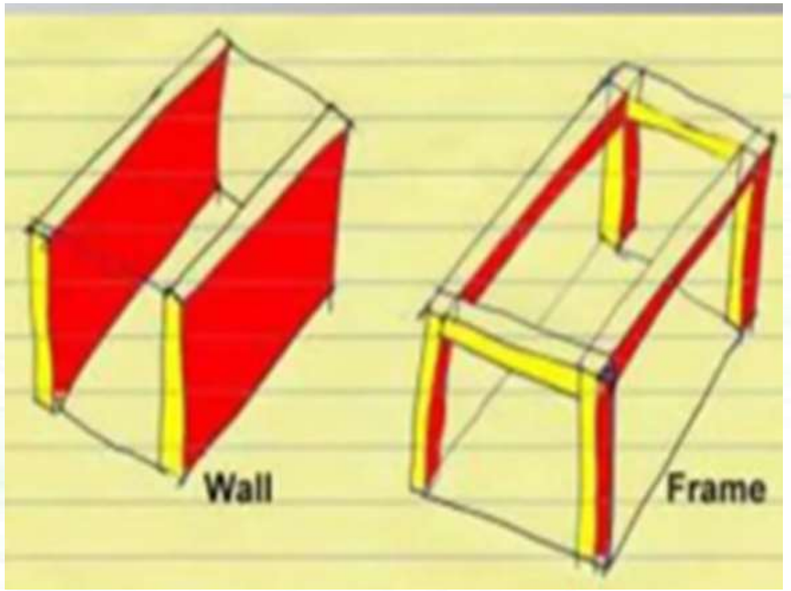
STAAD.PRO BASED ON LOADING

Load Bearing Structure :

- (G+ 2)> This Structure instead of column andBeam, it has walls taking the load .

Framed Structure :

- (G+2 & above)> This Structure having the combination of Beam,column and slab to resist the lateral and gravity loads“wall



TYPE OF STRUCTURE

Concrete

Steel

Timber

Aluminium

DESIGN

Architectural Design

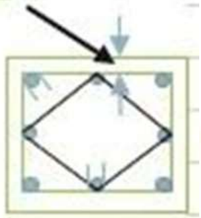
Structural Design

NUMBER OF ROD

8, 10, 12,16,18,20,22,25,28,32,36,40,45,50 MM

CONCRETE COVER

1	FOOTING	: 50mm
2	RAFT FOUNDATION TOP	: 50mm
3	RAFT FOUNDATION BOTTOM/SIDES	: 50-75mm
4	STRAP BEAM	: 50mm
5	GRADE SLAB	: 20mm
6	COLUMN	: 40mm
7	SHEAR WALL	: 25mm
8	BEAMS	: 25mm
9	SLABS	: 15mm
10	FLAT SLAB	: 20mm
11	STAIRCASE	: 15mm
12	RET. WALL	: 20/25mm
13	WATER RETAINING STRUCTURES	: 20/30mm



UNIT WEIGHTS

- R.C.C - 2500KN / M * 3
- P.C.C - 2400KN / M * 3
- BRICK - 1800KN / M * 3
- WOOD - (400 - 700) * KN / M * 3
- SOIL - 1600KG / M * 3
- CEMENT - 1440KG / M * 3
- STONE - 2300KG / M * 3
- STEEL - 7850KG / M * 3
- GLASS - 2560KG / M * 3
- CORSE AGGREGATE - 2300KG / M * 3
- FINE AGGREGATE - 2350KG / M * 3
- 1000 LITERS = 1 M3

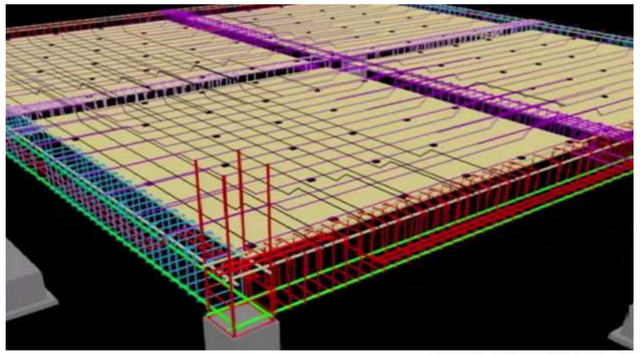
SLAB

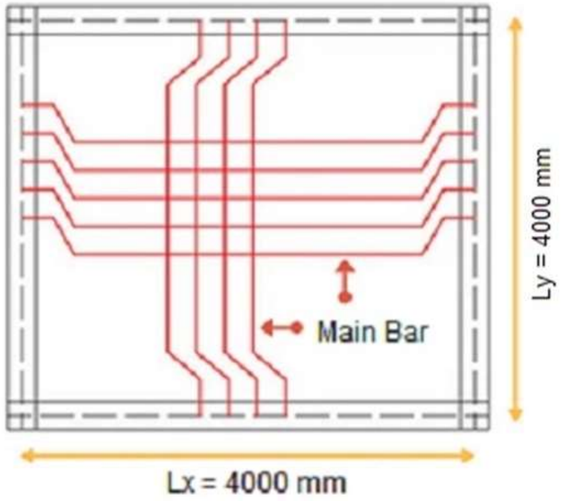
1.One Way Slab

$l_y/l_x > 2$

2. Two Way Slab

$l_y/l_x < 2$

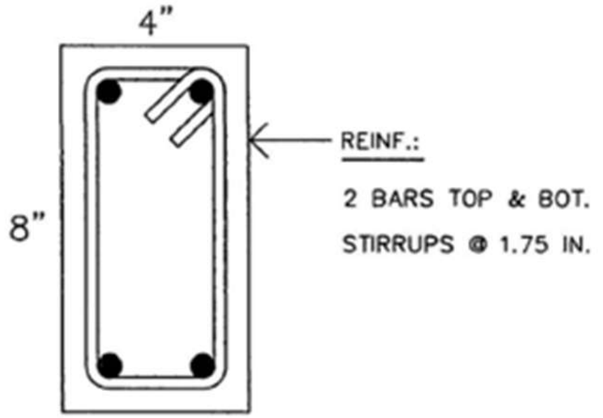




STAAD.PRO

BEAM

Horizontal Member & Tension Member



Basic Value of Span to effective depth ratios for spans up to 10m

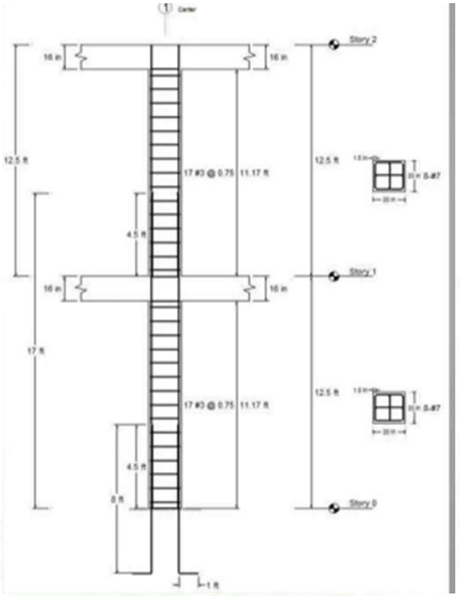
- ✓Cantilever 7
- ✓Simple Supported 20
- ✓Continuous 26

above 10 m

le/10 to le/15

Ref: IS 456 :2000
Page No: 37
Class No: 23.2.1

COLUM VERTICAL MEMBER & COMPRESSION MEMBER



Short Column

| eff/LLD>12

Long Column

| eff/LLD<12

Minimum Eccentricity

IS456, Clause 25.4 gives an expression for the possible min. eccentricity

emin = (L/500)+(D/30)

but not less then 20 mm

Ref: IS 456 :2000
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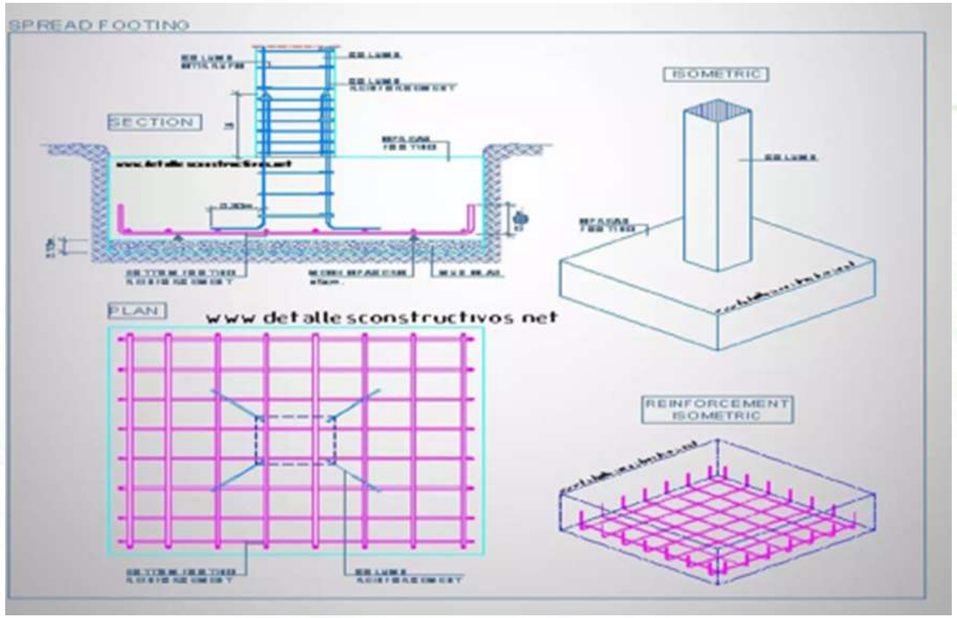
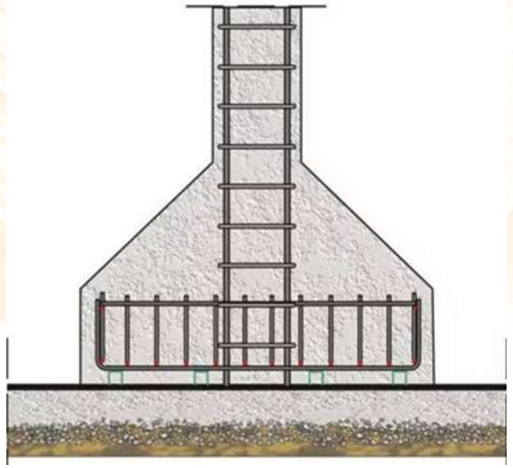
FOUNDATION

A concrete support under a foundation that rested in solid ground and is wider than the structure supported. Footing distribute the weight of the structure over the ground. Spread footing

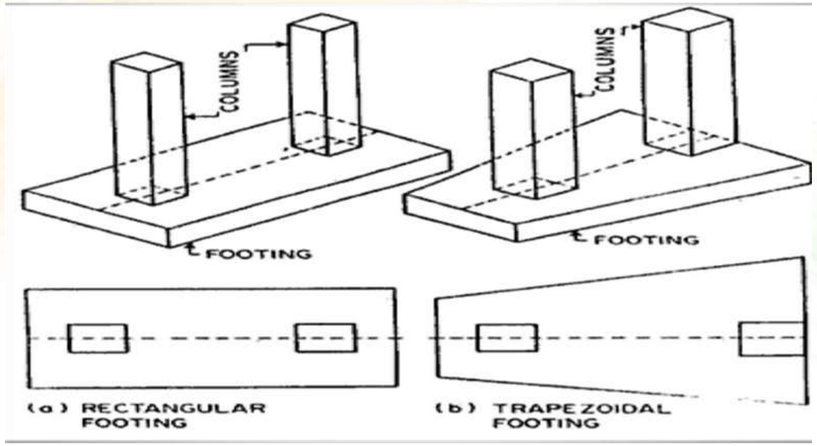


STAAD.PRO FOUNATION

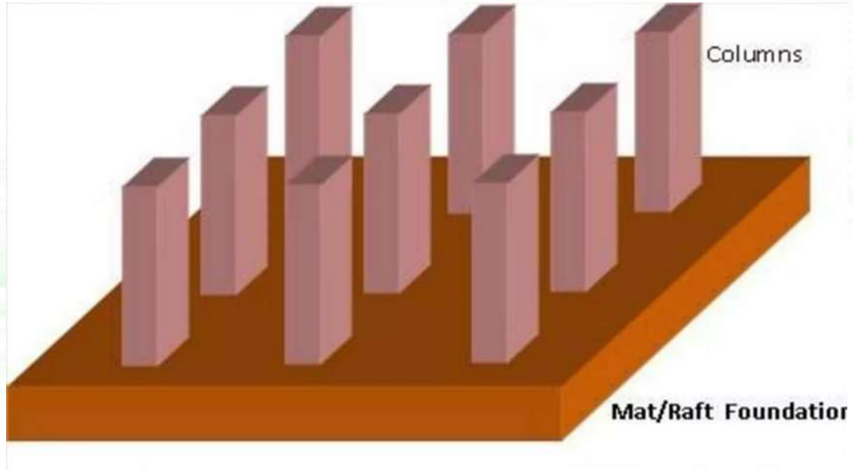
ISOLATED FOOTING



COMBINED FOOTING



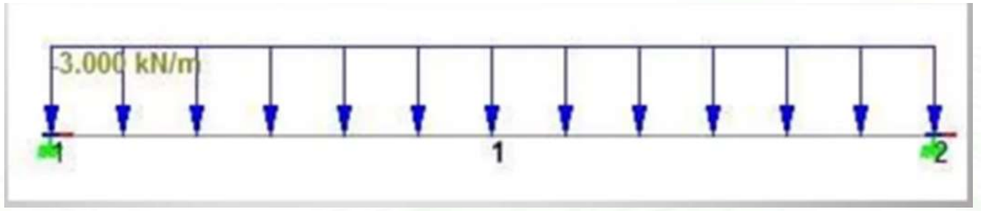
MAT FOOTING



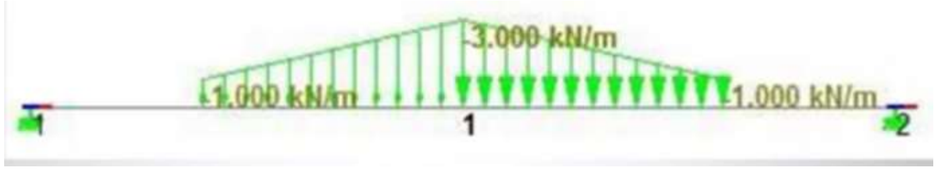
LOADINGS

POINT LOAD

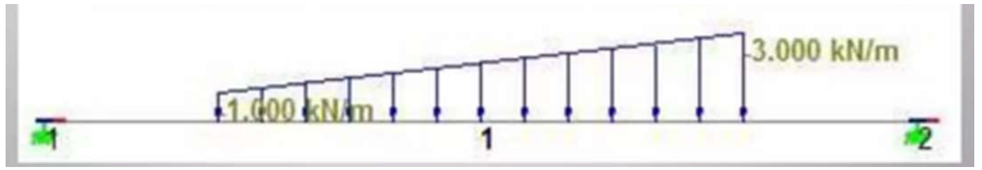
UDL (UNIFORM DISTRIBUTION LOAD)



TRIANGLE LOAD

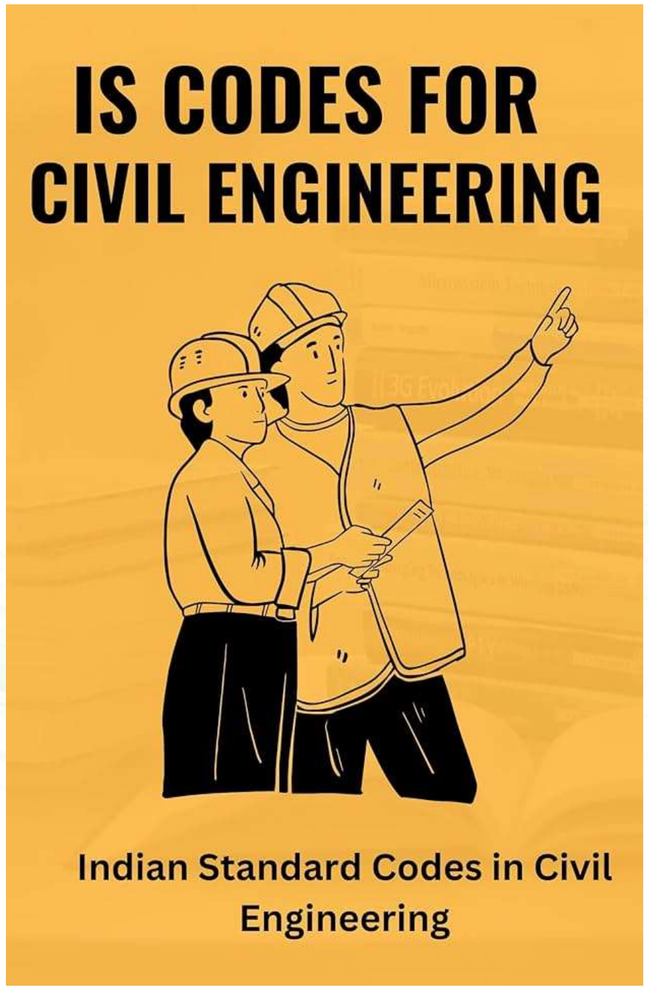


TRAPEZOIDA L LOAD



INDIAN STANDARD CODE BOOK

- IS 456 - REINFORCED CONCRETE DESIGN
- IS 800 - STEEL DESIGN
- IS 802 - TRANSMISSION TOWER (I TO III)
- IS 875 - DEAD LOAD (PART I)
- IS 875 - LIVE LOAD (PART II)
- IS 875 - WIND LOAD (PART III)
- IS 875 - SNOW LOAD (PART IV)
- IS 875 - SPECIAL LOAD (PART V)
- IRC 6,18,21 - BRIDGE DESIGN



STAAD.PRO

- IS 1893:1984 CRITERIA FOR EARTHQUAKE RESISTANT DESIGN OF STRUCTURES
- PART 1: GENERAL PROVISIONS AND BUILDINGS
- PART 2: LIQUID RETAINING TANKS - ELEVATED AND GROUND SUPPORTED
- PART 3: BRIDGES AND RETAINING WALLS
- PART 4: INDUSTRIAL STRUCTURES INCLUDING STACK LIKE STRUCTURES
- PART 5: DAMS AND EMBANKMENTS
- IS 3370 CODE OF PRACTICE CONCRETE STRUCTURES
- FOR THE STORAGE OF LIQUIDS
- PART 1: GENERAL REQUIREMENTS
- PART 2: REINFORCED CONCRETE STRUCTURES
- PART 3: PRESTRESSED CONCRETE STRUCTURES
- PART 4: DESIGN TABLES

Why STAAD.Pro for Culvert Design?

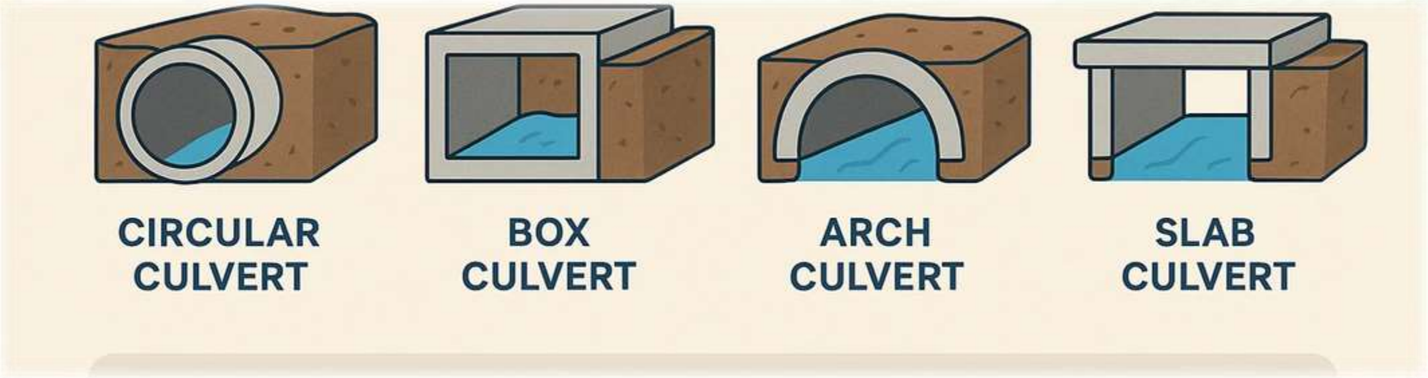
- Accurate load analysis
- Easy modeling of box culvert geometry
- Supports Indian Standard codes (IS 456, IRC)
- Efficient for real-time project-based design
- Industry-accepted software

What is a Culvert?

- Structure that allows water to flow under roads, railways, or embankments
- Used to maintain natural drainage
- Small span bridge-type structure

Types of Culverts

- Pipe culvert
- Slab culvert
- Box culvert (RCC Box Culvert)
- Arch culvert



What is an RCC Box Culvert

- Reinforced Concrete closed frame structure
  Composed of:
  - Top slab
  - Bottom slab
  - Side walls
  - Acts as a rigid frame

Where RCC Box Culverts Are Used

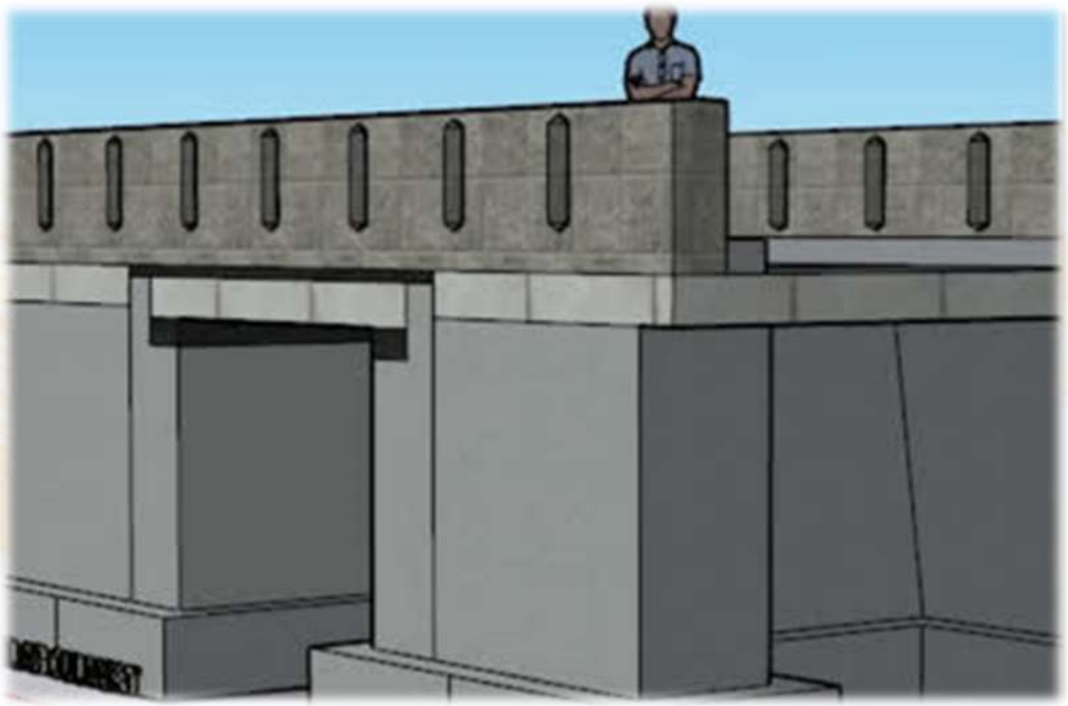
- Highways and expressways
- Railway crossings
- Urban drainage systems
- Irrigation canals
- Industrial infrastructure

Advantages of RCC Box Culvert

- High load carrying capacity
- Longer service life
- Minimum maintenance
- Suitable for heavy traffic loads
- Can be constructed in limited height areas

Design Philosophy of Box Culvert

- Designed as rigid frame structure
- Consider soil–structure interaction
- Design based on limit state method
- Load combinations govern critical forceS



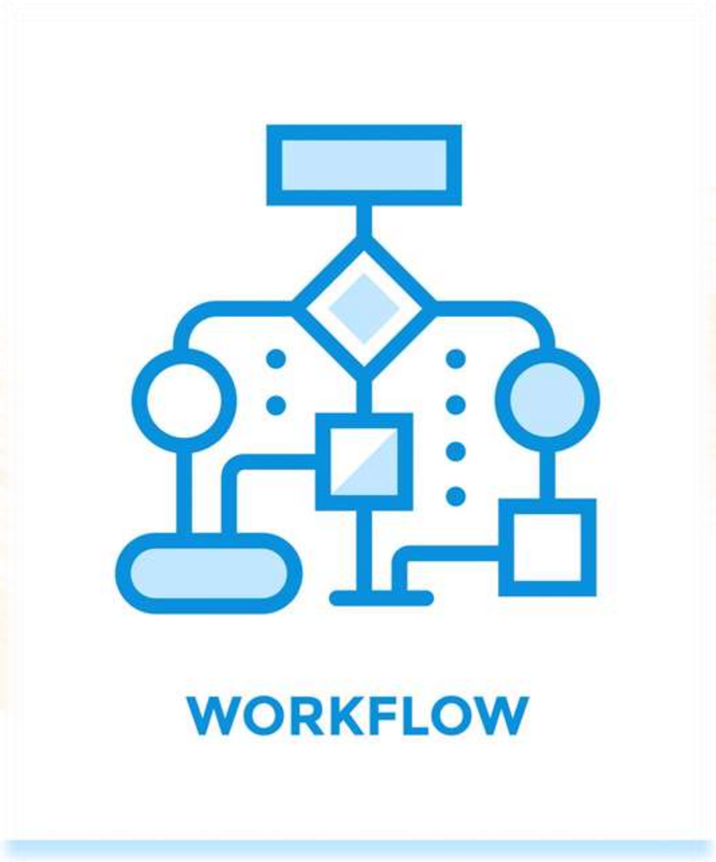
Loads Considered in Box Culvert Design

- Self weight of structure
- Earth pressure
- Water pressure
- Live load (IRC vehicle load)
- Impact load
- Surcharge load

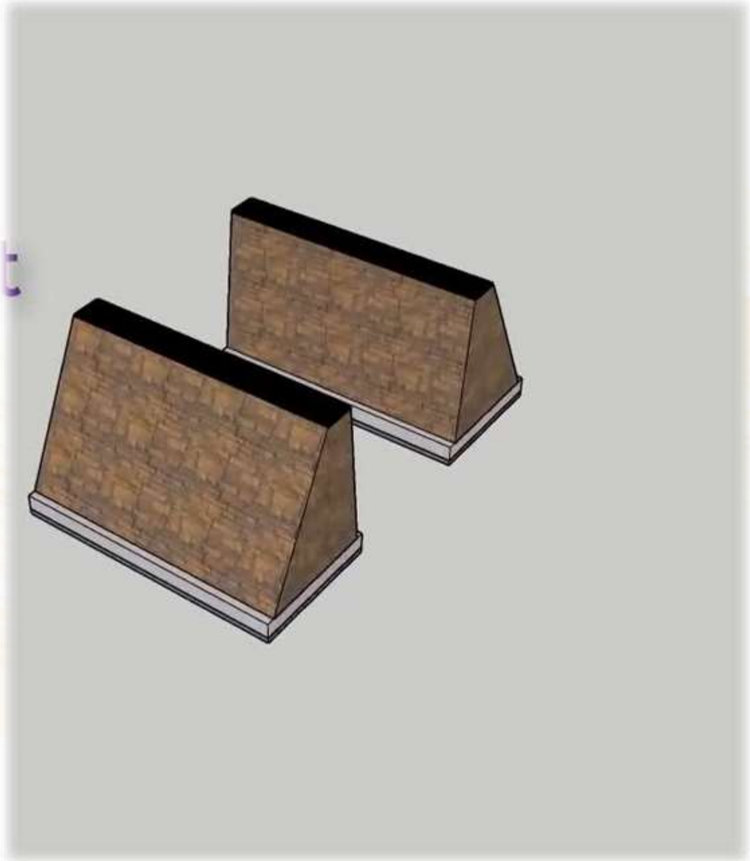
Relevant Codes for Culvert Design

- IS 456 – RCC design
- IRC:6 – Loads and stresses
- IRC:112 – Concrete road bridges
- IS 875 – General loading (reference)

Box Culvert Design Workflow



- Define geometry and span
- Calculate loads
- Apply load combinations
- Structural analysis
- Member force extraction
- RCC design
- Reinforcement detailing



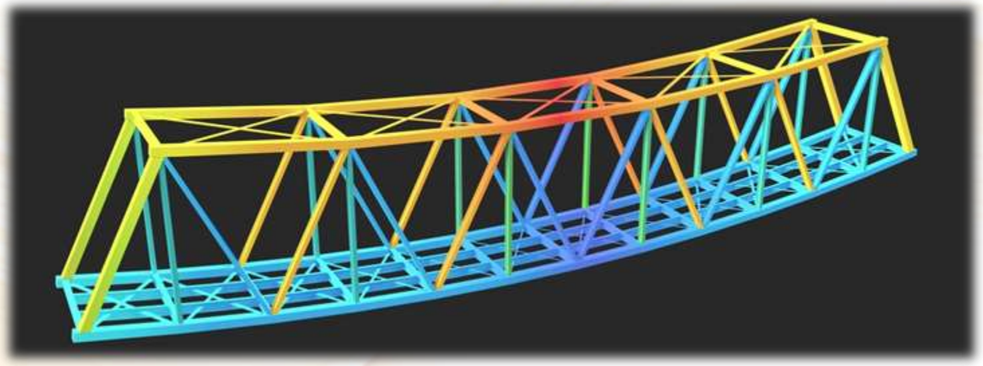
Modeling RCC Box Culvert in STAAD.Pro

- Define nodes and plates
- Create box geometry
- Assign material properties
- Assign plate thickness
- Define supports

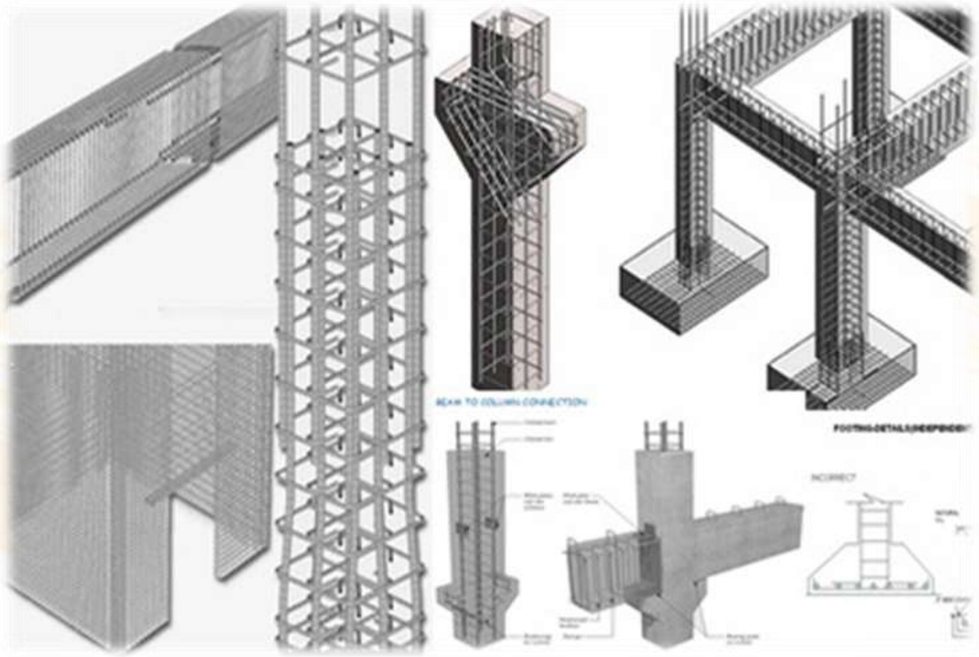
Load Application

- Self weight command
- Earth pressure using plate loads
- Water pressure loads
- Live load as surcharge
- Load combinations as per IRC

Analysis



- Run analysis
- Check for errors
- Review displacements
- Check reactions
- Extract bending moment and shear force



RCC Design

- Design slabs and walls
- Check reinforcement requirement
- Verify deflection and stress limits
- Code-based design checks

TIME TO FEEDBACK

THANK YOU FOR LISTENING!