



DEPARTMENT OF CIVIL ENGINEERING

**CE6711 - COMPUTER AIDED DESIGN AND DRAFTING LABORATORY
VII SEMESTER
R 2013**

LABORATORY MANUAL

Name : _____

Register No. : _____

Class : _____

VISION

is committed to provide highly disciplined , conscientious and enterprising professionals conforming to global standards through value based quality education and training.

MISSION

- To provide competent technical manpower capable of meeting requirements of the industry
- To contribute to the promotion of academic excellence in pursuit of Technical Education at different levels
- To train the students to sell his brawn and brain to the highest bidder but to never put a price tag on heart and soul

DEPARTMENT OF CIVIL ENGINEERING**VISION**

To impart professional education integrated with human values to the younger generation, so as to shape them as proficient and dedicated engineers, capable of providing comprehensive solutions to the challenges in deploying technology for the service of humanity

MISSION

- To educate the students with the state-of-art technologies to meet the growing challenges of the civil industry
- To carry out research through continuous interaction with research institutes and industry, on advances in structural systems
- To provide the students with strong ground rules to facilitate them for systematic learning, innovation and ethical practices

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

1. FUNDAMENTALS

To provide students with a solid foundation in Mathematics, Science and fundamentals of engineering, enabling them to apply, to find solutions for engineering problems and use this knowledge to acquire higher education

2. CORE COMPETENCE

To train the students in Electronics and Communication technologies so that they apply their knowledge and training to compare, and to analyze various engineering industrial problems to find solutions

3. BREADTH

To provide relevant training and experience to bridge the gap between theories and practice this enables them to find solutions for the real time problems in industry, and to design products.

4. PROFESSIONALISM

To inculcate professional and effective communication skills, leadership qualities and team spirit in the students to make them multi-faceted personalities and develop their ability to relate engineering issues to broader social context

5. LIFELONG LEARNING/ETHICS

To demonstrate and practice ethical and professional responsibilities in the industry and society in the large, through commitment and lifelong learning needed for successful professional career

PROGRAMME OUTCOMES (POs)

- a) To demonstrate and apply knowledge of mathematics, science and engineering fundamentals in civil engineering field
- b) To design a component, a system or a process to meet the specific needs within the realistic constraints such as economics, environment, ethics, health, safety and manufacturability
- c) To demonstrate the competency to use software tools for analysis and design of structures
- d) To identify, constructional errors and solve civil engineering problems
- e) To inculcate an ability to visualize and work on laboratory and multidisciplinary tasks
- f) To function as a member or a leader in multidisciplinary activities
- g) To communicate in verbal and written form with fellow engineers and society at large scale
- h) To understand the impact of civil engineering in the society and demonstrate awareness of contemporary issues and commitment to give solutions exhibiting social responsibility
- i) To demonstrate professional and ethical responsibilities
- j) To exhibit confidence in self-education and ability for lifelong learning
- k) To participate and succeed in competitive exams

CE6711 - COMPUTER AIDED DESIGN AND DRAFTING

SYLLABUS

COURSE OBJECTIVES

- To acquire hands on experience in design
- To prepare structural drawings for concrete / steel structures normally encountered in civil engineering practice

LIST OF EXPERIMENTS

- Analysis and design of cantilever and counterfort retaining wall
- Analysis and design of multistorey building
- Analysis and design of flat slab
- Analysis and design of circular slab
- Analysis and design of tee- beam bridge
- Analysis and design of rectangular water tank
- Analysis and design of circular water tank
- Analysis and design of truss
- Analysis and design of deck type plate girder bridges

COURSE OUTCOMES

- To acquire hands on experience in design for the students
- To acquire knowledge in preparation of structural drawings for concrete / steel structures normally encountered in civil engineering practice

COMPUTER AIDED DESIGN AND DRAFTING**CONTENTS**

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6	Analysis and design of flat slab	
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9	Design of Tee- beam bridge	

Cycle 2 – Experiments

10	Analysis of rectangular water tank	
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12	Analysis and design of circular water tank	
13	Circular water tank with restrained base	
14	Analysis and design of truss	
15	Analysis and design of deck type plate girder bridges	

Expt.No. 01**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 the completion of 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 use, 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, 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 are also recommended in this code, which will 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 of 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 of the design.

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 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
- DXFmethod
- 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 360^0 >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.

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Result:

Thus the introduction about STAAD Pro is studied successfully.

Outcome:

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

Viva – voce

1. What is meant by STAAD Pro?
2. List out the methods of STAAD Pro?
3. What are the applications of STAAD Pro?
4. What is meant by circular repeat?
5. What is meant by translation repeat?
6. What is meant by angular dimension?
7. What is meant by Snap and grid method?
8. What is Structural Wizard?
9. What is meant by Excel Method?
10. What is DXF method?

Applications

In Staad pro we will design RCC, Steel as well, it is not meant for only buildings, can analyze and design water tanks and staircases, retaining walls, steel towers etc..

Expt. No. 2 ANALYSIS AND DESIGN OF CANTILEVER AND COUNTERFORT RETAINING WALL

Aim:

To create and analyze the cantilever or counterfort retaining wall by using STAAD Pro

Software Required:

STAAD PRO V8i

Procedure:

Preprocessing:

1. Create model

- New project> plane> length units as m> force units as kN>type the file name as cantilever or counter fort retaining wall> next> add beam.
- Snap node/ beam > edit> X in right, X spacing, Y in right, Y spacing> ok.
- Now draw the retaining wall model by using snap node/ beam.

2. Property

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

3. Support

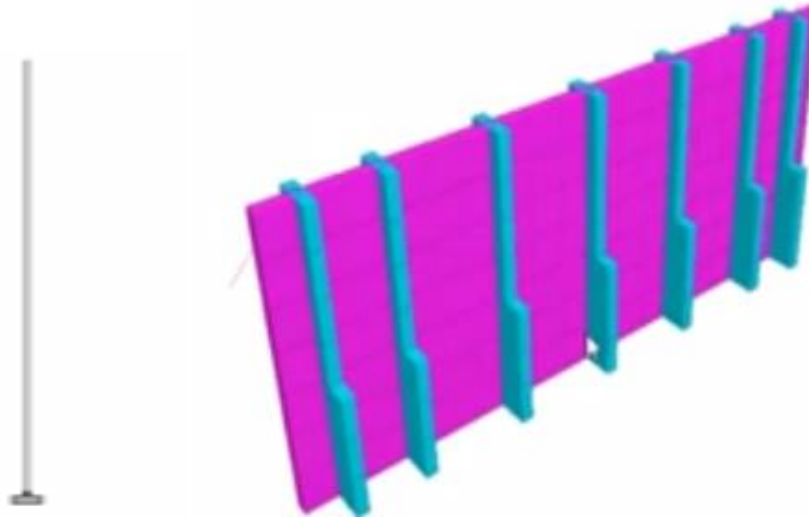
Support> fixed support> select the bottom nodes> assign selected nodes.

4. Loads

- Load and definition> load case detail> add>change the title as DL>add> then change LL> add> WL> add> close.
- Select DL> add> member load> uniform load> type W1 as -40kN/m> add.
- Select LL> add> give the soil pressure acting on the retaining wall.
- Assign the given loads on the retaining wall.
- 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.

5. Design parameters

- Design concrete> IS 456>define parameter> give F_c as 20000 kN/m² for M₂₀ concrete > F_c as 30000 kN/m² for M₃₀ concrete>add> F_y as 415000 kN/m²> add> select> ratio as 3>add.
- Then go to commands>design beam> add>design column> add>take off > close.



Retaining wall model

- 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.

Analysis:

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

Post-processing:

- 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.
- Results> view value> beam results> maximum displacement> activate.
- You can also see the animations of displacement in it.

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Result:

Thus the retaining wall is created and analyzed by using STAAD Pro.

Outcome:

At the end of this experiment, student acquires knowledge to create and analyze the cantilever or counterfort retaining wall by using STAAD Pro.

Viva-Voce

1. What is meant by retaining walls?
2. What is meant by cantilever retaining walls?
3. What are preprocessing and post processing?
4. Where do you recommend cantilever retaining wall?
5. What are the various types of retaining wall?
6. What is meant by active pressure?
7. What is meant by passive pressure?
8. What is meant by counterfort retaining walls?
9. What is meant by slip friction?
10. What is angle of repose?

Applications

It is designed and analyzed, to resist the pressure of the material that it is holding back the structure.

Expt.No. 03**CANTILEVER RETAININGWALL**

Design a reinforced concrete cantilever type retaining wall having a 5 m tall stem. The wall retains soil level with its top. The soil weighs 18000 N/m^3 and has an angle of response of 30° . The safe bearing capacity of the soil is 200 kN/m^2 . Use M 20 concrete and Fe 415 steel.

Solutions:**Wall Proportions:**

Thickness of the stem at the top

Thickness of the stem at the bottom

Consider one meter run of the wall

Effective cover of stem reinforcement = 40 mm

Total thickness of stem = 301 mm

The thickness may be increased by 30% to 35% for an economical design.

Provide a thickness of 400 mm at the bottom of the stem.

The base slab also will be made 400 mm thick

Total height of the wall = $H = 5 + 0.40 = 5.40 \text{ m}$

Width of the base slab

$$b = 0.5H \text{ to } 0.6H$$

$$0.5H = 0.5 \times 5.4 = 2.70 \text{ m}$$

$$0.6H = 0.6 \times 5.4 = 3.24 \text{ m}$$

Provide a base width of 3 m

Toe project may be made about one – third the base width

Provide a toe projection of 1 m

Stability Calculation:

Load due to	Magnitude of the load (N)	Distance from (m)	Moment about (Nm)
$W_1 = 0.2 \times 5 \times 25000$	25000	1.7	42500
$W_1 = \frac{0.2 \times 5}{2} \times 25000$	12500	$\frac{28}{15}$	23333.33
$W_2 = 3 \times 0.40 \times 25000$	30000	1.5	45000
$W_b = 1.6 \times 5 \times 18000$	144000	0.8	115200
Moment of lateral pressure $C_p w \frac{H^3}{6} = \frac{1}{3} \times 18000 \times \frac{5.4^3}{6}$			157464
Total	211500		383497.83

Distance of the point of application of the resultant force from the heel end a,

$$= Z = \frac{383497.33}{211500} = 1.813 \text{ m}$$

$$\text{Eccentricity } e = Z - \frac{b}{2} = 1.813 - 1.50 = 0.313 \text{ m}$$

$$= \frac{b}{6} = \frac{3}{6} = 0.5 \quad \therefore e < \frac{b}{6}$$

Extreme pressure intensity at the base

$$= \frac{W}{b} \left[1 \pm \frac{6e}{b} \right]$$

$$= \frac{211500}{3} \left[1 \pm \frac{6 \times 0.313}{3} \right] \text{ N/m}^2$$

$$P_{\max} = 114633 \text{ N/m}^2 \text{ and } P_{\min} = 26367 \text{ N/m}^2$$

Safe bearing capacity of the soil = 200 KN/m³

Design of the stem:

$$\text{Maximum B.M. } M = 125000 \text{ Nm}$$

$$\text{Ultimate moment, } M_u = 1.5 \times 125000 = 187500 \text{ Nm}$$

$$\text{Effective Depth } d = 400 - 40 = 360 \text{ mm}$$

$$\frac{M_u}{bd^2} = \frac{18750 \times 10^3}{1000 \times 360^2} = 1.447$$

Percentage of steel $P_t = 50 \left[\frac{1 - \sqrt{1 - \frac{4.6 \times 1.447}{20}}}{\frac{415}{20}} \right] = 0.441\%$

Spacing of 16 mm diameter bars

$$A_{st} = \frac{201 \times 1000}{1588} = 126 \text{ mm}$$

Provide 16 mm Ø bars @ 120 mm c/c

$$\text{Distribution steel} = \frac{0.12}{100} (1000 \times 400) = 480 \text{ mm}^2$$

Spacing of 8 mm diameter bars

$$= \frac{50 \times 1000}{480} = 104 \text{ mm say } 100 \text{ mm c/c}$$

If the distribution steel is provided near both the faces, the spacing of 8 mm diameter bars will be 200 mm near each face.

Design of the toe slab:

The bending moment calculations for a 1 m wide strip of the toe slab are shown in the table below.

B.M. Calculations for a 1 meter wide strip of the toe slab

Load due to	Magnitude of the load (N)	Distance from (m)	Moment about (Nm)
Upward Pressure	85211	0.5	42605.50
85211 x 1	14711	2/3	9807.33
0.5 x 1 x 29422			
			52412.83
Deduct for self-weight of toe slab			
1 x 0.40 x 25000	10000	0.5	5000
B.M. for toe slab			47412.83

B.M. for toe slab $M = 47412.83 \text{ Nm}$

Ultimate moment $M_u = 1.5 \times 47412.83 = 71119.245 \text{ Nm}$

Effective Depth $d = 400 - 60 = 340 \text{ mm}$ (For base slab effective cover = 60 mm)

$$\frac{M_u}{bd^2} = \frac{71119.245 \times 10^3}{1000 \times 340^2} = 0.615$$

Percentage of steel $P_t = 50 \left[\frac{1 - \sqrt{1 - \frac{4.6 \times 0.615}{20}}}{\frac{415}{20}} \right] = 0.177\%$

Minimum percentage of steel when Fe 415 is used = 0.2%

Spacing of 12 mm diameter bars

$$A_{st} = \frac{113 \times 1000}{680} = 166 \text{ mm}$$

Provide 12 mm Ø bars @ 160 mm c/c

Design of the heel slab:

The bending moment calculations for a 1 m wide strip of the heel slab are shown in the table below.

B.M. Calculations for a 1 meter wide strip of the heel slab

Load due to	Magnitude of the load (N)	Distance from (m)	Moment about (Nm)
Backing 1.6 x 5 x 18000	144000	0.8	115200
DL of heel slab 1.6 x 0.4 x 25000	16000	0.8	12800
			128000
Deduction for Upward Pressure 26367 x 1.6	42187.2	0.8	33749.76
0.5 x 1.6 x 47075.2	37660.16	1.6/3	20085.42
Total deduction			53835.18
B.M. for heel slab			74164.82

B.M. for heel slab $M = 74164.82 \text{ Nm}$

Ultimate moment $M_u = 1.5 \times 74164.82 = 111197.245 \text{ Nm}$

Effective Depth $d = 400 - 40 = 360 \text{ mm}$ (For base slab effective cover = 40mm)

$$\frac{M_u}{bd^2} = \frac{111247.23 \times 10^3}{1000 \times 360^2} = 0.858$$

Percentage of steel $P_t = 50 \left[\frac{1 - \sqrt{1 - \frac{4.6 \times 0.858}{20}}}{\frac{415}{20}} \right] = 0.251\%$

Spacing of 16 mm diameter bars

$$A_{st} = \frac{201 \times 1000}{904} = 222 \text{ mm}$$

Provide 16 mm Ø bars @ 220 mm c/c

It is convenient to match the spacing of reinforcements of stem and heel slab.

Accordingly, we will provide,

16mm Ø bars @ 220 mm c/c for the heel slab, and

16mm Ø bars @ 110 mm c/c for the stem.

Check for Sliding:

Total horizontal pressure force per meter run of the wall

$$= P = C_p \frac{wH^2}{2} = \frac{1}{3} \times 18000 \times \frac{5.4^2}{2} = 87840 \text{ N}$$

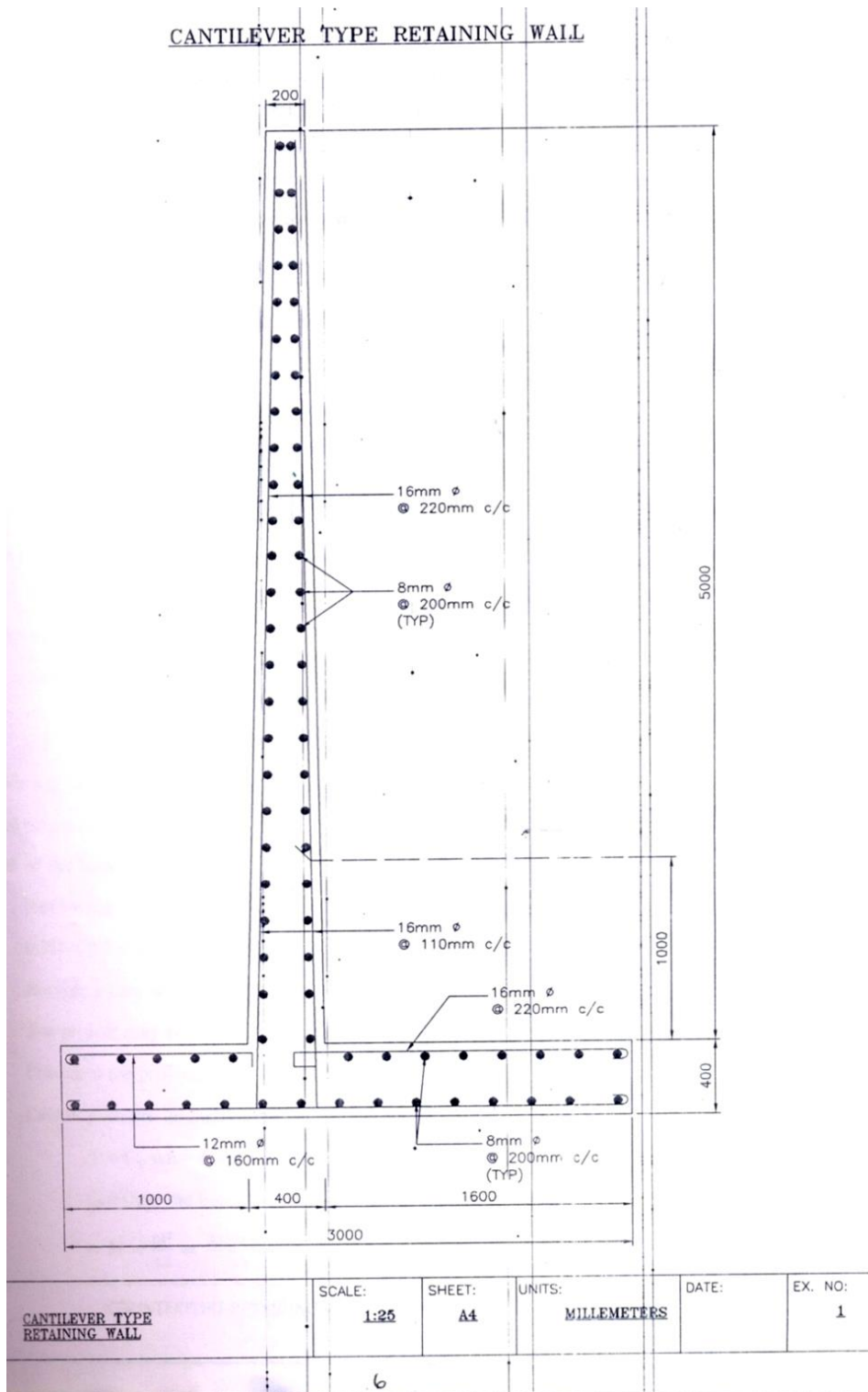
Taking $\mu = 0.65$,

Limiting friction = $\mu W = 0.65 \times 211500 = 137475 \text{ N}$

Factor of Safety against sliding = $\frac{\mu W}{P} = \frac{137475}{87480} = 1.57$

The design of cantilever retaining wall to be completed.

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Result:

Thus the Cantilever retaining wall is designed successfully.

Outcome:

At the end of this experiment, student acquires knowledge in designing the cantilever retaining wall manually.

Viva-Voce

1. What is meant by the toe slab?
2. What is meant by factor of safety?
3. What is meant by heel slab?
4. What is safe bearing capacity of soil?
5. What is meant by bearing capacity?
6. What is cantilever retaining wall?
7. Draw the cross section of cantilever retaining wall.
8. What is poisson's ratio?
9. What is meant by upward pressure?
10. Write the formulas for sliding factor.

Applications

To retain the soil at a slope that is greater than it would naturally assume, usually at a vertical or near vertical position

Expt. No. 4 COUNTERFORT RETAINING WALL

Aim:

To design a reinforced concrete counterfort type retaining wall to the following particulars:

- a) Height of the wall above the general ground level = 5.50m
- b) Safe bearing capacity of the soil = 30°
- c) Weight of Soil = 16000 N/m^3
- d) Spacing of counterforts = 3m centers
- e) Use M 20 concrete and Fe 415 steel.

Solution:

$$\text{Depth of foundation} = \frac{P}{W} \left[\frac{1 - \sin \phi}{1 + \sin \phi} \right]^2 \quad \text{Taking } P = \text{Safe bearing capacity of soil.}$$

$$\text{Depth of foundation} = \frac{160000}{16000} \left[\frac{1}{3} \right]^2 = 1.1 \text{ m}$$

Let us provide a foundation depth of 1.2m

$$\text{Overall height of the wall} = H = 5.50 + 1.20 = 6.70 \text{ m}$$

Thickness of the base slab:

This may be taken nearly

$$(i) 47.1\sqrt{H} = 41.7 \times \sqrt{6.7} = 324 \text{ mm}$$

$$(ii) 20 LH = 20 \times 3 \times 6.7 = 402 \text{ mm}$$

Provide a thickness of 400 mm for the base slab

Width of the base slab: This may be taken from 0.6H to 0.7H

$$0.6H = 0.6 \times 6.7 = 4.02 \text{ m}$$

$$0.7H = 0.7 \times 6.7 = 4.69 \text{ m}$$

Provide a base width of 4.50 m

Toe project may be made about one – fourth the base width

Provide a toe projection of 1.125 m

Lateral pressure intensity at the bottom of the upright slab

$$P = C_p wh = \left(\frac{1}{3} \right) \times 16000 \times 6.3 = 33600 \text{ N/m}^2$$

Consider the bottom 1 m deep strip of the upright slab.

$$= M = \frac{pl^2}{12} = \frac{33600 \times 3^2}{12} = 25200 \text{ Nm}$$

Ultimate moment

$$M_u = 1.50 \times 25200 = 37800 \text{ Nm}$$

$$0.138f_{ck}bd^2 = 0.138 \times 20 \times 1000 d^2 = 37800 \text{ E3}$$

$$d = 117 \text{ mm}$$

$$\text{Thickness of slab} = 117 + 40 = 157 \text{ mm}$$

Provide a thickness of 200 mm

$$\text{Actual effective depth} = d = 200 - 40 = 160 \text{ mm}$$

Stability Calculations per meter run of the wall:

Load due to	Magnitude of the load (N)	Distance from (m)	Moment about (Nm)
$W_1 \ 0.2 \times 6.30 \times 25000$	31500	3.4	107100
$W_2 \ 4.5 \times 0.40 \times 25000$	45000	2.25	101250
$W_b \ 3.30 \times 6.30 \times 16000$	332640	1.65	548856
Moment of lateral pressure $C_p \frac{wH^3}{6} = \frac{1}{3} \times 18000 \times \frac{6.7^3}{6}$			267345
Total	409140		1024551

Distance of the point of application of the resultant force from the heel end a,

$$= Z = \frac{1024551}{409140} = 2.50 \text{ m}$$

$$\text{Eccentricity } e = Z - \frac{b}{2} = 2.50 - 2.25 = 0.25 \text{ m}$$

$$= \frac{b}{6} = \frac{4.5}{6} = 0.75 \text{ m} \quad \therefore e < \frac{b}{6}$$

Extreme pressure intensity at the base

$$= \frac{W}{b} \left[1 \pm \frac{6e}{b} \right] = \frac{409140}{4.50} \left[1 \pm \frac{6 \times 0.25}{4.50} \right] \text{ N/m}^2$$

$$P_{\max} = 121225 \text{ N/m}^2 \text{ and } P_{\min} = 60613 \text{ N/m}^2$$

Design of the upright slab:

Maximum B.M. $M = 25200 \text{ Nm}$

Ultimate moment $M_u = 1.5 \times 25200 = 37800 \text{ Nm}$

Effective Depth $d = 200 - 40 = 160 \text{ mm}$

$$\frac{M_u}{bd^2} = \frac{37800 \times 10^3}{1000 \times 160^2} = 1.476$$

$$\text{Percentage of steel } P_t = 50 \left[\frac{1 - \sqrt{1 - \frac{4.6 \times 1.476}{20}}}{\frac{415}{20}} \right] = 0.451\%$$

Spacing of 12 mm diameter bars

$$A_{st} = \frac{113 \times 1000}{721.6} = 156 \text{ mm}$$

Provide 12 mm \emptyset bars @ 150 mm c/c

$$\text{Distribution steel} = \frac{0.12}{100} (1000 \times 200) = 240 \text{ mm}^2$$

Spacing of 8 mm diameter bars

$$= \frac{50 \times 1000}{240} = 208 \text{ mm say } 200 \text{ mm c/c}$$

If the distribution steel is provided near both the faces, the spacing of 8 mm diameter bars will be 300 mm near each face.

Design of the toe slab:

The bending moment calculations for a 1 m wide strip of the toe slab are shown in the table below.

B.M. Calculations for a 1 meter wide strip of the toe slab

Load due to	Magnitude of the load (N)	Distance from a (m)	Moment about a (Nm)
Upward Pressure	107755	0.5	53877.5
107755 x 1	6735	2/3	4490
0.5 x 1 x 13470			
		Total	58367.5
Deduct for self-weight of toe slab			
1 x 0.40 x 25000	10000	0.5	5000
B.M. for toe slab			53367.5

B.M. for toe slab $M = 53367.5 \text{ Nm}$

Ultimate moment $M_u = 1.5 \times 53367.5 = 80051.25 \text{ Nm}$

Effective Depth $d = 400 - 60 = 340$ mm (For base slab effective cover = 60mm)

$$\frac{M_u}{bd^2} = \frac{80051.25 \times 10^3}{1000 \times 340^2} = 0.692$$

Percentage of steel $P_t = 50 \left[\frac{1 - \sqrt{1 - \frac{4.6 \times 0.692}{20}}}{\frac{415}{20}} \right] = 0.2\%$

$$A_{st} = \frac{0.2}{100} (1000 \times 340) = 680 \text{ mm}^2$$

Spacing of 12 mm diameter bars

$$A_{st} = \frac{113 \times 1000}{680} = 166 \text{ mm}$$

Provide 12 mm Ø bars @ 160 mm c/c

$$\text{Distribution steel} = \frac{0.12}{100} (1000 \times 400) = 480 \text{ mm}^2$$

If the distribution steel is provided near both the faces, the spacing of 8 mm diameter bars will be 200 mm near each face.

Design of the heel slab:

The heel slab is designed as a continuous slab spanning horizontally between the counterforts. Consider a 1 meter wide strip of the heel slab near the heel end.

$$\text{Weight of soil } 16000 \times 6.3 = 100800 \text{ N/m}^2$$

$$\text{DL. of the strip } 1 \times 0.4 \times 25000 = 10000 \text{ N/m}^2$$

$$\text{Deduct for upward pressure} = 60613 \text{ N/m}^2$$

$$\text{Net downward loading} = 50187 \text{ N/m}^2$$

Maximum B.M. for a 1 m wide strip

$$M = \frac{wl^2}{12} = \frac{50187 \times 3^2}{12} = 37640.25 \text{ Nm}$$

$$\text{B.M. for heel slab } M = 37640.25 \text{ Nm}$$

$$\text{Ultimate moment } M_u = 1.5 \times 37640.25 = 56460.4 \text{ Nm}$$

Effective Depth $d = 400 - 60 = 340$ mm (For base slab effective cover = 60mm)

$$\frac{M_u}{bd^2} = \frac{56460.4 \times 10^3}{1000 \times 340^2} = 0.488$$

Percentage of steel $P_t = 50 \left[\frac{1 - \sqrt{1 - \frac{4.6 \times 0.488}{20}}}{\frac{415}{20}} \right] = 0.14\%$

Minimum percentage of steel when Fe 415 is used = 0.2%

$$A_{st} = \frac{0.2}{100} (1000 \times 340) = 680 \text{ mm}^2$$

Spacing of 12 mm diameter bars

$$A_{st} = \frac{113 \times 1000}{680} = 166 \text{ mm}$$

Provide 12 mm Ø bars @ 160 mm c/c

Design of the counterfort:

Let the top width of the counterfort be 0.40m

The thickness of the counterfort may also be made 0.40m

Total later pressure transferred to one counterfort

$$= C_p \frac{wh^2}{2} l = \frac{1}{3} \times 16000 \times \frac{6.3^2}{2} \times 3 = 3137520 \text{ N}$$

Maximum B.M. for the counterfort

$$M = 3137520 \times \frac{6.3}{3} = 666792 \text{ Nm}$$

B.M. for heel slab $M = 666792 \text{ Nm}$

Ultimate moment $M_u = 1.5 \times 666792 = 1000188 \text{ Nm}$

Effective Depth $d = 3500 - 60 = 3440 \text{ mm}$

Let the inclination of the reinforcement with the vertical be β

$$\tan \beta = (3.1/6.3) = 0.4921, \beta = 26^\circ 12', \cos \beta = 0.8972$$

$$\frac{M_u}{bd^2 \cos^2 \beta} = \frac{1000188 \times 10^3}{400 \times 3440^2 \times (0.8972)^2} = 0.262$$

$$\text{Percentage of steel } P_t = 50 \left[\frac{1 - \sqrt{1 - \frac{4.6 \times 0.262}{20}}}{\frac{415}{20}} \right] = 0.074\%$$

Minimum percentage of steel when Fe 415 is used = 0.2%

$$A_{st} = \frac{0.2}{100} (1000 \times 3440 \cos \beta)$$

$$A_{st} = \frac{0.2}{100} (1000 \times 3440 \times 0.8972) = 2469 \text{ mm}^2$$

Provide 10 bars of 18mmØ

Curtailment of bars:

Let 5 bars be curtailed at a depth Y from the top

$$\frac{A'_{st}}{A_{st}} = \frac{1}{2} = \frac{y^2}{6.3^2} \quad y = 4.45 \text{ m say } 4.4 \text{ m from the top.}$$

Connection between the counterfort and the upright slab:

Consider the bottom 1 m deep strip of the upright slab.

Tension transmitted to the counterfort by the strip

$$= 33600 (3 - 0.40) = 87360 \text{ N}$$

Factored tension $= 1.5 \times 87360 = 131040 \text{ N}$

$$A_{st} = \frac{\text{Factored tension}}{0.87f_y} = \frac{131040}{0.87 \times 415} = 363 \text{ mm}^2$$

Provide 2 – legged 8mm diameter horizontal links @ 260mm c/c.

Connection between the counterfort and the heel slab:

Consider the bottom 1 m wide strip of the heel slab near the heel end.

Net downward loading on the strip $= 50187 \text{ N/m}^2$

Tension transmitted to the counterfort by the strip, $= 50187 (3 - 0.40) = 130486 \text{ N}$

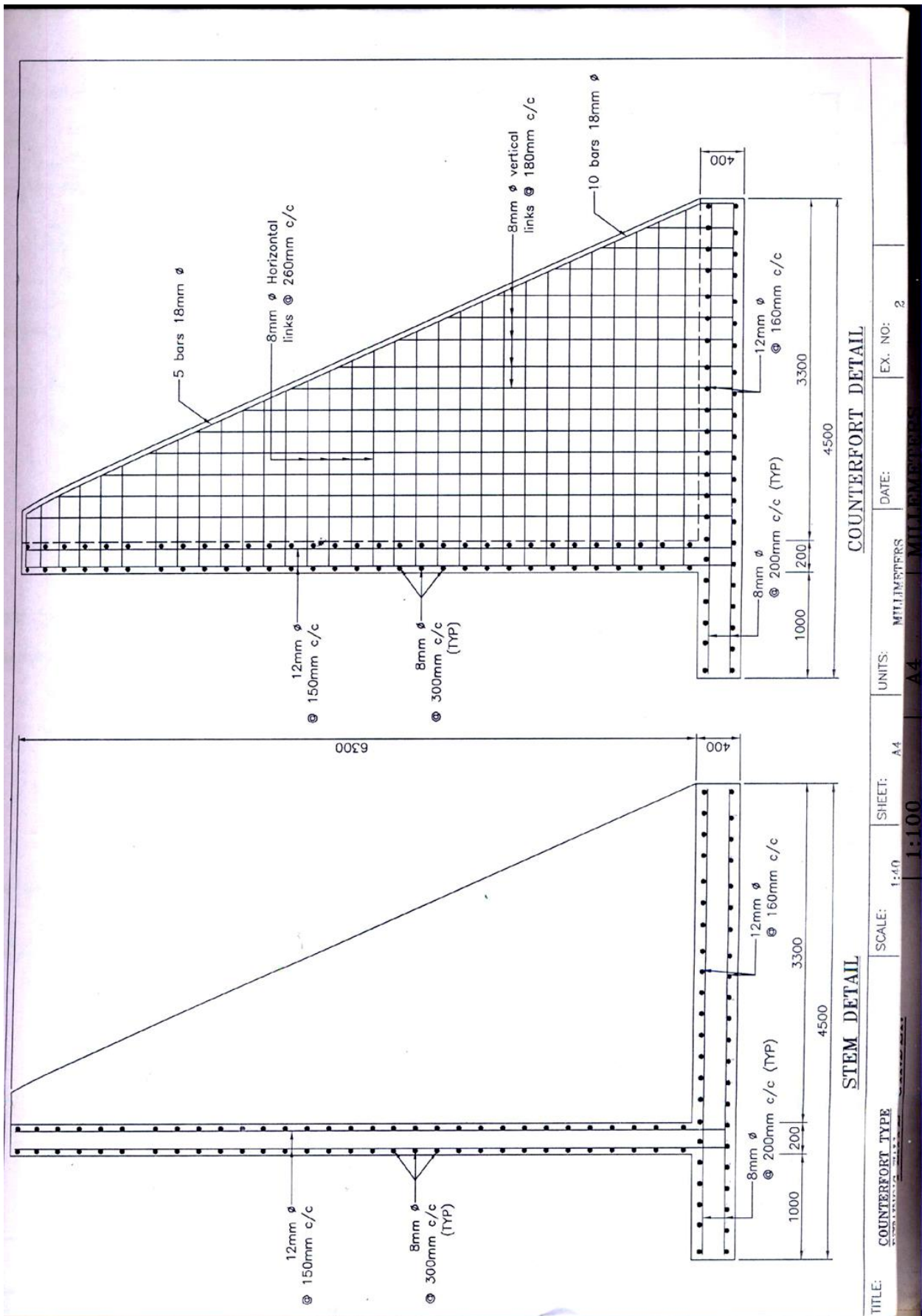
Factored tension $= 1.5 \times 130486 = 195729 \text{ N}$

$$A_{st} = \frac{\text{Factored tension}}{0.87f_y} = \frac{195729}{0.87 \times 415} = 543 \text{ mm}^2$$

Spacing of 8 mm diameter bars $= A_{st} = \frac{50 \times 1000}{543} = 92 \text{ mm}$

Provide 2 – legged 8mm diameter horizontal links @ 180 mm c/c.

The design procedure completed.



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Result:

Thus the Counterfort retaining wall is designed successfully.

Outcome:

At the end of this experiment, student acquires knowledge in designing the Counterfort retaining wall manually.

Viva-Voce

1. What is sliding?
2. What do you understand by curtailment of bars?
3. When do you prefer counterfort retaining wall?
4. What is meant by active pressure and passive pressure?
5. What is Bending moment?
6. What is Shear force
7. What is counterfort retaining wall?
8. What are the various loads on retaining wall
9. What is meant by curtailment?
10. What is meant by contra flexure?

Applications

A counterfort retaining wall is a cantilever wall with counter forts or buttresses, attached to the inner face of the wall to further resist lateral thrust.

Expt. No. 05 ANALYSIS AND DESIGN OF MULTISTOREY 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

- New project> plane> length units as m> force units as kN>type the file name as multi storey building>next> add beam.
- 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

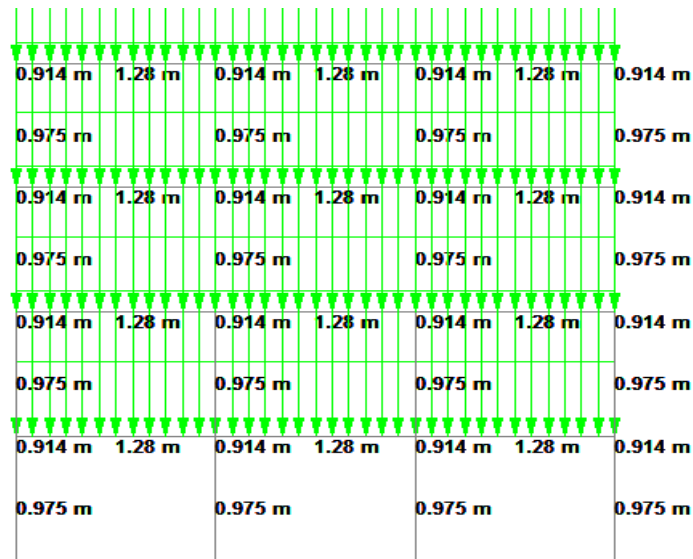
- General> property> define> rectangular>0.35x 0.23> add> close
- Select rectangular and assign to view.

3. Support

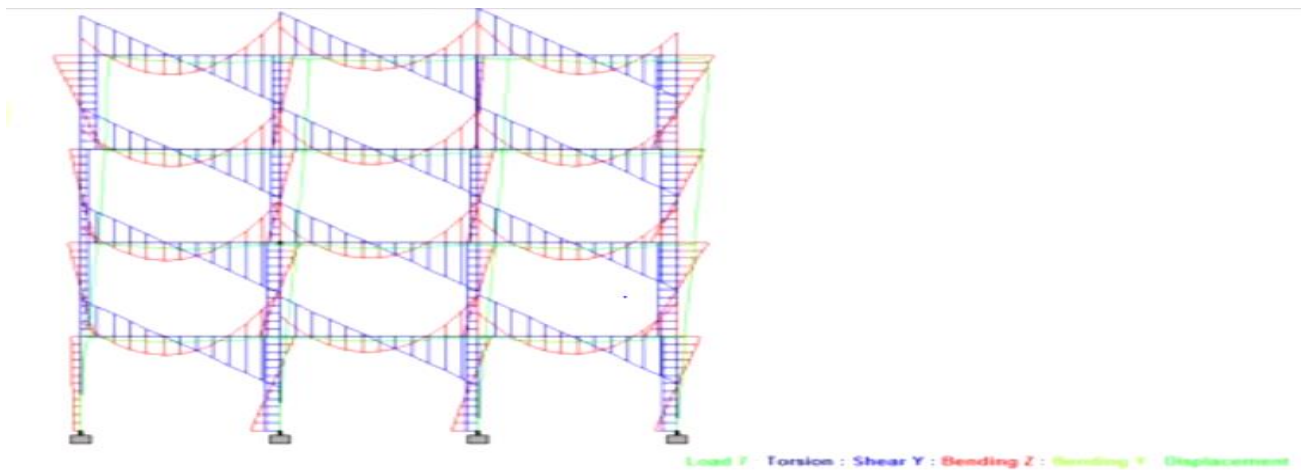
Support> fixed support> select the bottom nodes> assign selected nodes.

4. Loads

- Load and definition> load case detail> add>change the title as DL>add> then change LL> add> WL> add> close.
- Select DL> add> member load> uniform load> type W1 as -40 kN/m < add.
- Select LL > add> member load> uniform load> type W1 as -20 kN/m < add.
- 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.
- Similarly, click select > member parallel to x direction> assign selected beams.
- WL> select node cursor> select the particular node> assign selected node.
- 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.



Loads and Dimensions



Post Processing

- h) 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.
- i) 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.
- j) 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

- a) Design concrete> IS 456>define parameter> give F_c as 20000 kN/m² for M₂₀ concrete > F_c as 30000 kN/m² for M₃₀ concrete>add> F_y as 415000 kN/m²> add> select> ratio as 3>add.

- b) 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 and 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.

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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.

Viva-Voce

1. What are the load combinations taken for multistory building?
2. What do you analyze in preprocessing of the building?
3. What is meant by continuous beam?
4. List the various types of supports.
5. List the various types of loads.
6. What is meant by theorem of moments?
7. What is castigliano's theorem?
8. What is Maxwell's theorem?
9. What are the different types of concrete?
10. What is SCC?

Applications

1. To perform an accurate analysis a structural engineer must determine such information as structural loads, geometry, support conditions, and materials properties
2. The results of such an analysis typically include support reactions, stresses and displacements.
3. Then information can be compared to criteria that indicate the conditions of failure.

Expt. No. 6 ANALYSIS AND DESIGN OF FLAT SLAB

Aim:

To create and analyze the flat slab by using STAAD Pro

Software required:

STAAD PRO V8i

Procedure in STAAD Pro

Preprocessing:

1. Create model

- New project> plane> length units as m> force units as kN>type the file name as flat slab>next> add beam.
- By using coordinates system create the nodes as per the design.

X	Y	Z
0	0	0
3	0	0
12	0	0

- Then select the nodes> choose the global direction as Y>no. of steps as 1 and the default spacing as 3.5m>ok.
- Then add the beam between the nodes and complete the model.

2. Property

- Go to property>thickness> plate element thickness> 0.2.
- Select plate thickness> assign to view> assign > ok.

3. Support

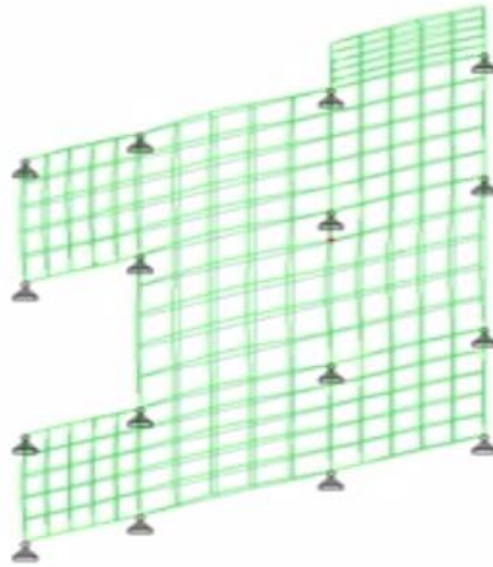
- Support> fixed support> ok>
- Select the support>use cursor to assign> assign > ok.

4. Loads

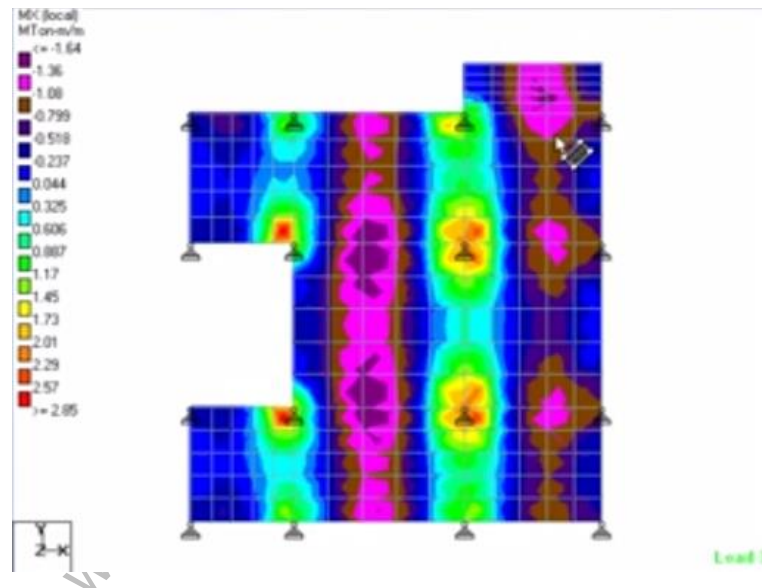
- Load and definition> load case detail> add>change the title as DL> add.
- Again change the title as plate load> add> close.
- Select DL> add> plate load as -1kN/m < add. Select the plate by using plate cursor>assign to selected plate> yes.

5. Design parameters

- Design concrete> IS 456>define parameter> give F_c as 20000 kN/m² for M₂₀ concrete > F_y as 415000 kN/m²> add> select> ratio as 3>add.



Preprocessing: Slab model with support



Post processing: Stresses acting on the slab

- b) 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.

6. Analysis

Analysis and 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 M_x > apply> close.
- c) You can also see the animations of displacement in it.

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Result:

Thus the flat slab is created and analyzed by using STAAD Pro.

Outcome:

At the end of this experiment, student acquires knowledge in creating and analyzing the flat slab using STAAD Pro.

Viva-Voce

1. What is shear?
2. What support is being taken for analysis?
3. Where do you use flat slab?
4. What is Shear force?
5. What is counterfort retaining wall?
6. What are the various loads on retaining wall?
7. What is curtailment?
8. What is contra flexure?

Applications

1. Flat slab is a reinforced concrete slab supported directly by concrete columns without the use of beams.
2. Flat Slabs are considered suitable for most of the construction and for asymmetrical column layouts like floors with curved shapes and ramps etc.

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Expt.No.07 ANALYSIS AND DESIGN OF CIRCULAR SLAB

Aim:

To create and analyze the circular slab by using STAAD Pro

Software required

STAAD PRO V8i

Procedure in STAAD Pro:

Preprocessing:

1. Create model

- New project> plane> length units as m> force units as kN>type the file name as circular slab >next> add beam.
- Geometry> run structural wizard> frame model> reverse cylindrical model >type the length as 7m, no.of bays along length as 2, radius as 5, no.of bays along periphery as 16> apply & transfer the model to STAAD Pro screen.
- Remove the bottom member by selecting and deleting it.

2. Create plate

- Select the top horizontal member of the model> right click the cursor> new view> isometric view.
- Select the surface mesh and create the mesh by connecting all nodes. Give the division as 3 (i.e., along the periphery you will get $16 \times 3 + 48$ elements).
- Then display the whole structure by using the specified icon.

3. Property

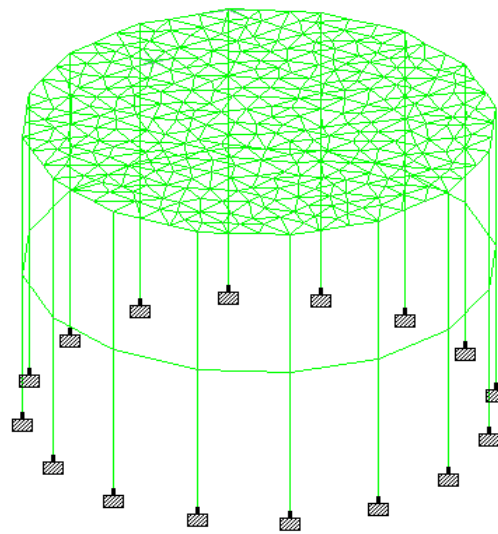
- General> property> define> rectangular>0.38 x 0.23> add> close.
- Circular>0.45> add> close.
- Go to thickness> plate element thickness> 0.15.
- Select rectangular and assign the horizontal beams, Select circular and assign the vertical columns, select the plate by using plate cursor and assign it.

4. Support

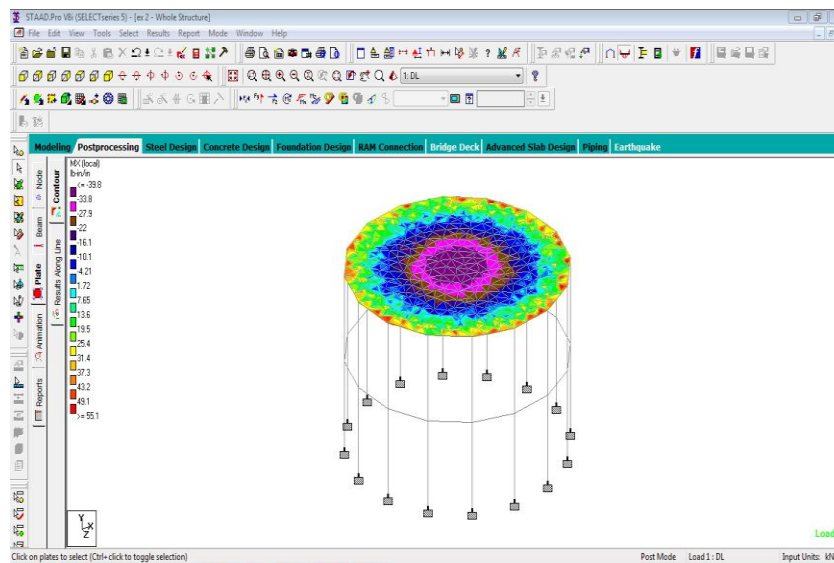
Support> fixed support> select the bottom nodes> assign selected nodes.

5. Loads

- Load and definition> load case detail> add>change the title as DL> add.
- Again change the title as plate load> add> close.
- Select DL> add>plate load as -1kN/m > add.



Load 1 : Displacement



d) Select the plate by using plate cursor>assign to selected plate> yes.

6. Design parameters

- Design concrete> IS 456>define parameter> give F_c as 20000 kN/m² for M₂₀ concrete > F_y as 415000 kN/m²> add> select> ratio as 3>add.
- 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.

- d) For beams > select the beams parallel to x direction and for columns column parallel to y direction and then assign it.

7. Analysis

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

Post-processing:

- 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.
- Results> plate rest contour> stress type M_x > apply> close.
- You can also see the animations of displacement in it

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Result:

Thus the circular slab is created and analyzed by using STAAD Pro.

Outcome:

At the end of this experiment, student acquires knowledge in creating and analyzing the circular slab using STAAD Pro

Viva-Voce

1. What is the difference between flat and circular slab?
2. Where do you recommend circular slab?
3. What do you mean by axial forces?
4. What is active pressure?
5. What is passive pressure?
6. What is counter fort retaining wall?
7. What is slip friction?
8. What is angle of repose?

Applications

1. It is used to design the roof of the room
2. Floor of circular water tank or towers can be constructed
3. Roof of traffic can be controlled by the post at the intersection of road

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Expt. No. 08 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

- New project> space > length units as m> force units as KN>type the file name as tee beam bridge >next> add beam.
- 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
- Translation repeat> global direction Z, no.of steps=3, spacing = 25 m, 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

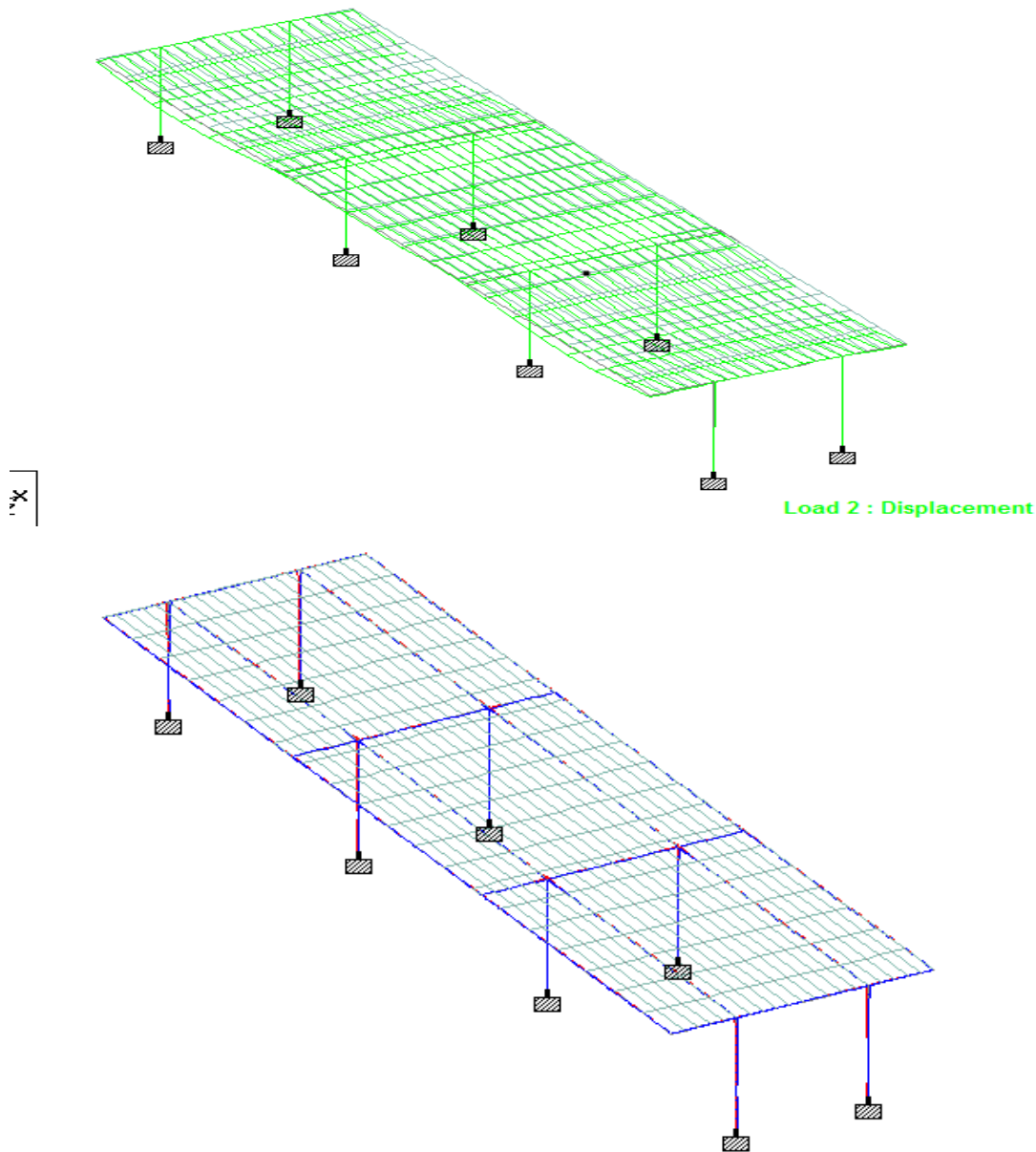
- General> property> define> rectangular>0.3 x 0.23> add> close
- Circular>0.3> add> close
- Go to thickness> plate element thickness> 0.15.
- Select rectangular and assign the horizontal beams, Select circular and assign the vertical columns, select the plate by using plate cursor and assign it.

4. Support

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

5. Loads

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



Bending stresses

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

6. Design parameters

- a) Design concrete> IS 456>define parameter> give F_c as 20000 kN/m² for M₂₀ concrete > F_y as 415000 kN/m²> add> close.
- b) 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.

7. Analysis

Analysis and 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 M_x > apply > close.
- c) You can also see the animations of displacement in it.

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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

1. Where do you use Tee beam girder?
2. What is the method used to find shear force and bending moment in Tee beam girder?
3. What are the different types of bridges?
4. What is arch bridge?
5. What are the loads acting on bridges?

Applications

1. A T-beam or tee beam used in construction is a load-bearing structure of reinforced concrete, wood or metal, with a t-shaped cross section
2. The vertical force on the bridge becomes a shear and flexural load on the beam which is transferred down its length to the substructures on either side.

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Expt.No.09**DESIGN OF T – BEAM BRIDGE**

A reinforced concrete (single span) T beam bridge is to consist of 5 beams 1.75 meters apart. The span of the bridge is 12 meters apart. The span of the bridge is 12 meters clear width end bearings of 600 mm. the live load on the bridge 17000 N per sqm including impact. The carriage way over the bridge is to be 7 meters wide with a footpath of 1.5 meters width on other side. The loading on the footpath may be taken as 3900 N per a square meter. Design the bridge. Use M 20 concrete and Fe 415 steel.

Solutions:

A parapet 100 mm thick and 1.25 meters high is provided at each side.

Design of footpath slab:

The bending moment for the footpath slab will consist of the following:

Consider one meter run of the bridge.

$$\text{B.M. due to self-weight of parapet} = 0.1 \times 1.25 \times 25000 \times 1.55 = 4844 \text{ Nm}$$

$$\text{B.M. due to weight of wearing coat (75 mm)} = 1.5 \times 0.075 \times 24000 \times (1.5/2) = 2025 \text{ Nm}$$

$$\text{B.M. due to wt. of footpath (150 mm)} = 1.6 \times 0.15 \times 25000 \times 0.8 = 4800 \text{ Nm}$$

$$\text{B.M. due to live load } 3900 \times 1.5 \times (1.5/2) = 4388 \text{ Nm}$$

$$\text{Max. B.M. for the footpath slab} = 16057 \text{ Nm.}$$

Taking $c = 7 \text{ N/mm}^2$, $t = 230 \text{ N/mm}^2$ and $m = 13.33$ and equating the moment of resistance to the bending moment,

$$d = 133 \text{ mm.}$$

With a effective cover of 15 mm and providing 10 mm \varnothing bars the overall depth required

$$= 5 + 15 = 20 \text{ mm.}$$

$$\text{Actual effective depth} = 150 - 20 = 130 \text{ mm}$$

$$A_{st} = \frac{16057 \times 1000}{230 \times 0.90 \times 130} = 597 \text{ mm}^2$$

$$\text{Spacing of 12mm } \varnothing \text{ bars} = \frac{79 \times 1000}{597} = 132 \text{ say } 130 \text{ mm c/c}$$

$$\text{Distribution steel} = 0.12\% \text{ gross area} = (0.12/100) \times 150 \times 1000 = 180 \text{ mm}^2$$

$$\text{Spacing of 8 mm } \varnothing \text{ bars} = \frac{50 \times 1000}{180} = 277 \text{ say } 250 \text{ mm c/c}$$

Design of the deck slab:

$$\text{Dead load of deck slab (150 mm)} = 25 \times 150 = 3750 \text{ N/mm}^2$$

$$\text{Wearing coat (75 mm average)} = 24 \times 75 = 1800 \text{ N/mm}^2$$

$$\text{Live Load} = 1700 \text{ N/mm}^2$$

Consider a one meter wide strip of the deck slab.

$$\text{Max. Bending moment} = \frac{wl^2}{10} = \frac{22550 \times 1.75^2}{10} = 6905.9 \text{ Nm}$$

Providing 25 mm clear cover, the effective depth of the centre of 10mm diameter bars

$$= 150 - 25 - 5 = 120 \text{ mm}$$

$$= A_{st} = \frac{6905.9 \times 1000}{230 \times 0.90 \times 120} = 278 \text{ mm}^2$$

$$\text{Spacing of 12mm } \varnothing \text{ bars} = \frac{75 \times 1000}{278} = 269 \text{ say } 250 \text{ mmc/c}$$

Design of beams:

Loads per meter run on an intermediate T beam:

$$\text{Loads from deck slab} = 22550 \times 1.75 = 39462 \text{ N/m}$$

Dead load of the rib (1120 mm overall, 360 mm wide rib)

$$= 0.97 \times 0.36 \times 25000 = 8730 \text{ N/m}$$

$$\text{Total} = 48192 \text{ N/m}$$

Loads per meter run on the end beam:

From cantilever slab:

$$\text{Weight of parapet} = 0.10 \times 1.25 \times 25000 = 3125 \text{ N/m}$$

$$\text{Wearing coat (75 mm)} = 0.075 \times 1.5 \times 24000 = 2700 \text{ N/m}$$

$$\text{Footpath slab} = 0.15 \times 1.6 \times 25000 = 6000 \text{ N/m}$$

$$\text{Live load on the footpath slab} = 3900 \times 1.5 = 5180 \text{ N/m}$$

$$\text{Loads from the deck slab} = (39462/2) = 19731 \text{ N/m}$$

$$\text{Dead load of the rib} = 8730 \text{ N/m}$$

$$\text{But load on an intermediate beam} = 48192 \text{ N/m}$$

Hence the intermediate beams carry heavier loads than the end beams. We shall therefore design an intermediate beam.

$$\text{Maximum B.M.} = ((48192 \times 12.6 \times 12.6)/8) = 956370 \text{ Nm}$$

Assuming 20 mm diameter bars are likely to be provided in two rows and providing a clear cover of 40 mm to the outer layer of bars, the effective depth to the centroid of the tensile reinforcement.

$$d = \text{overall depth} - \text{cover} - \text{dia. of bar} - \text{half the spacing between layers}$$

$$= 1120 - 40 - 25 - 10 = 1045 \text{ mm}$$

$$\text{Approximate lever arm} = d - \frac{d_s}{2} = 1045 - \frac{150}{2} = 970 \text{ mm}$$

$$\text{Approximate steel requirement} = \frac{956370 \times 1000}{230 \times 970} = 4287 \text{ mm}^2$$

Let us provided 14 bars of 20mm diameter arranged in two layers with 7 bars in each layer. Width of flange of the T beam:

$$B = (1/6) + b_r + 6d_s = ((12.6 \times 1000)/6) + 360 + (6 \times 150) \\ = 2100 + 360 + 900 = 3360 \text{ mm.}$$

B shall not be taken greater than the breadth of web + half the sum of the clear distance to the adjacent beams on either side.

On this basis, this is equal to = c to c distance between beams

$$B = 1750 \text{ mm}$$

Assuming the neutral axis, to be situated below the slab, we have

$$1750 \times 150 (n - 75) = 13.33 \times 4396 (1045 - n) = 252 \text{ mm}$$

$$\bar{y} = \frac{3n - 2d_s}{2n - d_s} - \frac{d_s}{3} = \frac{3 \times 252 - 2 \times 150}{2 \times 252 - 150} \times \frac{150}{3} = 64.4 \text{ mm}$$

$$\text{Actual lever arm} = 1045 - 64.40 = 980.60 \text{ mm}$$

Corresponding compressive stress in concrete

$$c = \frac{222}{13.33} \times \frac{252}{1045 - 252} = 5.30 \text{ N/mm}^2$$

Shear:

$$\text{Maximum S.F. } S = \frac{48192 \times 12}{2} = 289152 \text{ N}$$

$$\text{For 0.91 \% steel, } \tau_c = 0.33 \text{ N/mm}^2$$

Shear resistance of concrete

$$\tau_{cb} d = 0.33 \times 360 \times 1045 = 124146 \text{ N}$$

Shear to be resisted by reinforcement

$$V_s = 289152 - 124146 = 165006 \text{ N}$$

Shear resistance of four bars

$$0.707 A_{wtw} = 0.707 \times 4 \times 314 \times 230 = 204238 \text{ N.}$$

Let 3 more bars be bent up at a further distance of 1380 mm.

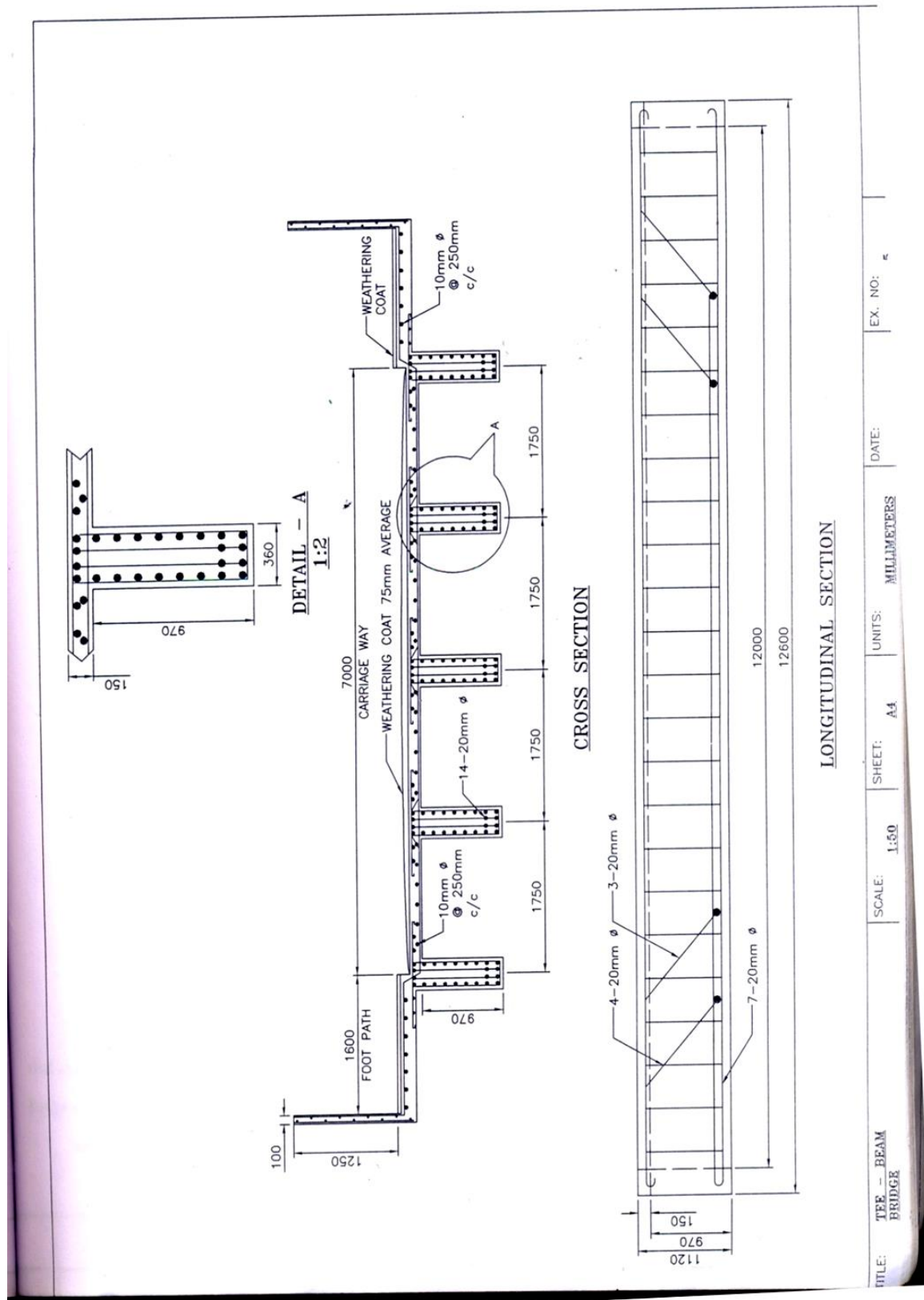
Maximum S.F. at centre when the live load covers half the span

$$= \frac{(17000 \times 1.75) \times 6}{2 \times 12} = 44525 \text{ N}$$

Nominal shear stress due to this shear force

$$= \frac{44525}{360 \times 1045} = 0.12 \text{ N/mm}^2$$

The Design procedure is completed.



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Result:

Thus the design of T Beam Bridge is designed successfully.

Outcome:

At the end of this experiment, student acquires knowledge in designing the T beam bridge manually.

Viva-Voce

1. What are the IRC codes available in design of bridges?
2. What do you mean by suspension bridge?
3. What is deck slab?
4. What is meant by abutment?
5. What is meant by culvert?
6. What is the difference between culvert and bridge?

Applications

1. A T-beam or tee beam, used in construction, is a load-bearing structure of reinforced concrete, wood or metal, with a T-shaped cross section
2. The vertical force on the bridge becomes a shear and flexural load on the beam which is transferred down its length to the substructures on either side.

Expt. No. 10**ANALYSIS OF RECTANGULAR WATER TANK****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 rectangular water tank>next> add beam.
- b) Geometry> run structural wizard> frame model> bay frame>type the length as 4, no.of bays along length as 1, height as 10, no.of bays along height as 3>width as 4m >no.of bays along width ad 1 apply & transfer the model to STAAD Pro screen.
- c) Then change the characteristics bay along height as 4,4, 2
- d) Now apply and transfer the model to STAAD screen.

2. Create plate

- a) Mesh> create mesh for plates> quadrilateral meshing> ok > apply.
- b) Similarly create mesh for all side walls.
- c) Then delete all the beam element in the water tank.

3. Property

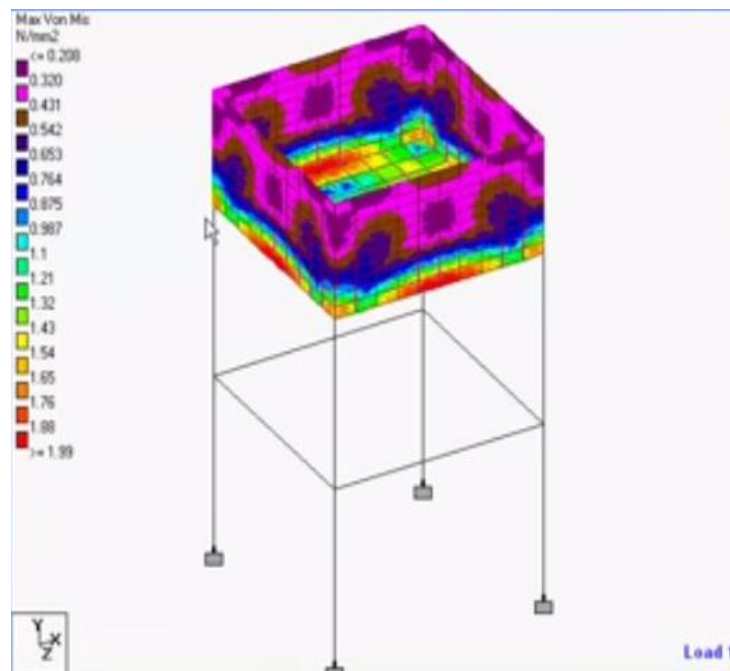
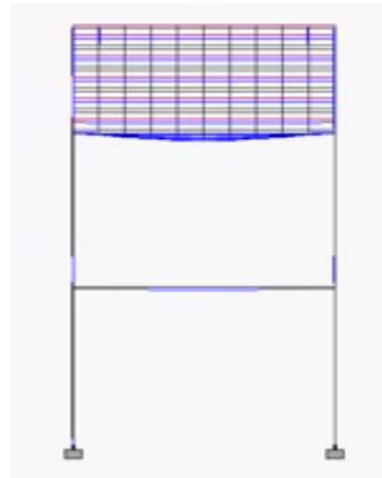
- a) General> property> define> rectangular>0.23 x 0.23> add> close
- b) Go to thickness> plate element thickness> 0.15.
- c) Select rectangular and assign to view, Select the plate by using plate cursor and assign it.

4. Support

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

5. Loads

- a) Load case detail> add>DL>add> close.
- b) DL> add> pressure on full plate> global direction y>W1 = -20 kN/m²> add> close.



- c) Select the bottom plate using plate cursor and assign it.
- d) DL> add> plate load> hydrostatic >select plate > select the specified plate by using cursor>done> $W_1 = -20$ kN/m²(depending on the z- axis direction) and $W_2 = 0.001$ >global y axis and local Z axis> close.
- e) Similarly give the load on the basis of z axis direction for all the side walls of the tanks.

6. Design parameters

- a) Design concrete> IS 456>define parameter> give F_c as 20000 kN/m² for M₂₀ concrete > F_y as 415000 kN/m²> add> close.
- b) 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.

7. Analysis

Analysis and 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 M_x > apply> close.
- c) Deflection and stresses acting in the water tank
- d) You can also see the animations of displacement in it.

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Result:

Thus the rectangular water tank is created and analyzed by using STAAD Pro.

Outcome:

At the end of this experiment, student acquires knowledge in creating and analyzing the rectangular water by using STAAD Pro.

Viva-Voce

1. What are the types of tanks?
2. How can you calculate the capacity of tank?
3. What are the uses of water tank?
4. What is the difference between rectangular and circular water tank?
5. What is steel water tank?

Applications

A water tank is a container for storing water. Water tanks are used to provide storage of water for use in many applications, drinking water, irrigation agriculture, fire suppression, agricultural farming, both for plants and livestock, chemical manufacturing, food preparation as well as many other uses.

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Expt.No. 11 ANALYSIS AND DESIGN OF CIRCULAR WATER TANK

Aim:

To create and analyze the circular water tank by using STAAD Pro

Software required:

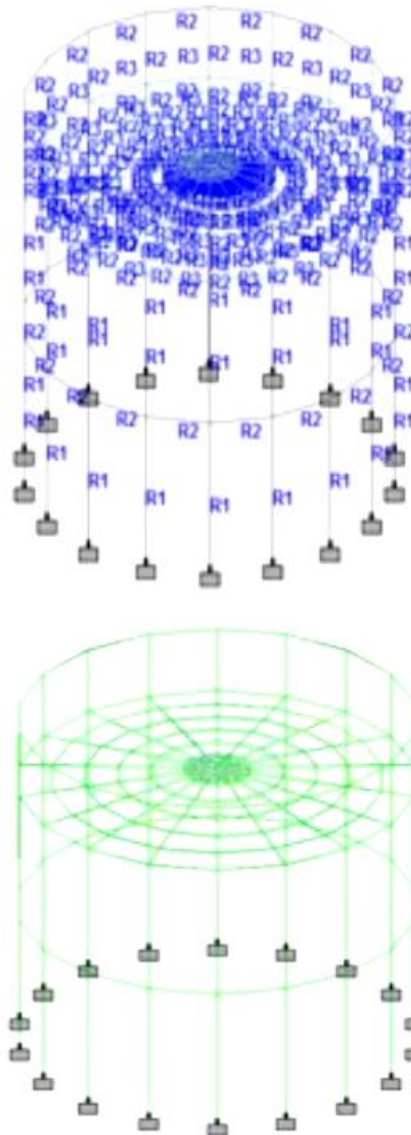
STAAD PRO V8i

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 circular water tank>next> add beam.
- b) Geometry> run structural wizard> frame model> reverse cylindrical model >type the length as 10m, no.of bays along length as 3, change the property in length as 4,4,2>radius as 5m no.of bays along periphery as 18> apply & transfer the model to STAAD Pro screen.
- c) Remove the bottom member by selecting and deleting it.
- d) Select front view and select the top horizontal beams of the tank> right click> new view> ok.
- e) Isometric view> add beam> create beam in its diameter> select beam > insert node> add midpoint> ok.
- f) Select node> copy > paste>change y distance as 0.5m> ok.
- g) Delete the created beam in its diameter
- h) Geometry> add beam> add the beam by cursor in between the centre and edge of circle.
- i) Select beam> select insert node> give n= 5> add n points> ok.
- j) Then select the entire beam>circular repeat>, select direction as Y, no.of steps= 18, link steps, open base>select the center node of the circle> ok.
- k) Top view> select the beams > delete.
- l) Create mesh at the center and give the division as 1> ok.
- m) Select all the beams> select fill floor grid with plates> thus the plates are created>select all beams in that and delete it.
- n) Select 4 node plates, create the plate for the side walls> fill floor grid with plates and make it as plate.



2. Property

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

3. Support

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

4. Loads

- Load case detail> add>DL>add> close.

- b) DL> add> pressure on full plate> global direction y> $W_1 = -20 \text{ kN/m}^2$ > add> close.
- c) Select the bottom plate using plate cursor and assign it.
- d) DL> add> plate load> hydrostatic >select plate < select the specified plate by using cursor>done> $W_1 = -20 \text{ kN/m}^2$ (depending on the z- axis direction) and $W_2 = 0.001$ >global y axis& local Z axis> close.

5. Design parameters

- a) Design concrete> IS 456>define parameter> give F_c as 20000 kN/m^2 for M_{20} concrete > F_y as 415000 kN/m^2 > add> close..
- b) 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 and 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 M_x > apply> close.
- c) You can also see the animations of displacement in it.

Result:

Thus the circular water tank is created and analyzed by using STAAD Pro.

Outcome:

At the end of this experiment, student acquires knowledge in creating and analyzing the circular water by using STAAD Pro.

Viva-Voce

1. What is the difference of application in rectangular and circular tank?
2. What are the types of tanks?
3. How can you calculate the capacity of tank?
4. What are the uses of water tank?
5. What is the difference between rectangular and circular water tank?

Applications

The base of the circular water tank has a flexible joint. The tank rests on the ground. The wall of the tank is designed for hoop tension.

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Expt.No. 13 CIRCULAR WATER TANK WITH RESTRAINED BASE

Design a reinforced concrete circular water tank has an internal diameter of 12 meters, the maximum depth of water being 4 meters. The walls of the tank are restrained at the base. The tank rests on ground. Use M 20 concrete and grade 1 mild steel.

Solutions:

$$H = 4 \text{ m}$$

$$D = 12 \text{ m}$$

Thickness of wall:

This shall not be less than

(i) 150 mm

(ii) 30 mm per metre depth + 50 mm = $30 \times 4 + 50 = 170 \text{ mm}$

Hence let us provided a thickness of 170 mm

$$= \frac{H^2}{Dt} = \frac{4 \times 4}{12 \times 0.17} = 7.8$$

Max. Co – efficient for hoop tension of

$$= \frac{H^2}{Dt} = 6, \text{ is } 0.574 \text{ at } 0.6H \text{ depth}$$

Max. Co – efficient for hoop tension of

$$= \frac{H^2}{Dt} = 8, \text{ is } 0.575 \text{ at } 0.6H \text{ depth}$$

Max. Co – efficient for hoop tension of

$$= \frac{H^2}{Dt} = 7.8, \text{ is } 0.569 \text{ at } 0.6H \text{ depth}$$

Max. hoop tension = $0.569 WH (D/2)$

$$= 0.569 \times 9810 \times 4 \times \frac{12}{2} = 133965 \text{ KN}$$

Hoop steel per metre height

$$= (133965 / 115) = 1165 \text{ mm}^2$$

Spacing of 12 mm Ø bars

$$= (113 \times 1000) / 1165$$

$$= 96 \text{ mm.}$$

Provide 12 mm Ø bars @ 190 mm c/c near each face.

$$\text{Vertical distribution of steel} = (0.3/100) \times 170 \times 1000 = 510 \text{ mm}^2$$

Spacing of 8 mm Ø bars = $(50 \times 1000) / 510 = 98 \text{ mm}$.

Provide 8 mm Ø @ 180 mm c/c near each face.

Horizontal distribution steel = $(0.3/100) \times 170 \times 1000 = 150 \text{ mm}^2$

Spacing of 8 mm Ø bars = $(50 \times 1000) / 510 = 98 \text{ mm}$.

Provide 8 mm Ø @ 180 mm c/c near each face

Max. Co – efficient for hoop tension of

$$= \frac{H^2}{Dt} = 7.8,$$

Max. Cantilever Moment = $0.015 WH^3$

$$= 0.015 \times 9810 \times 4 \times 4 \times 4 = 9417.6 \text{ Nm}.$$

Eff. Depth to the centre of 8 mm Ø.

Vertical bars = $170 - (25 + 12 + 4) = 129 \text{ mm}$.

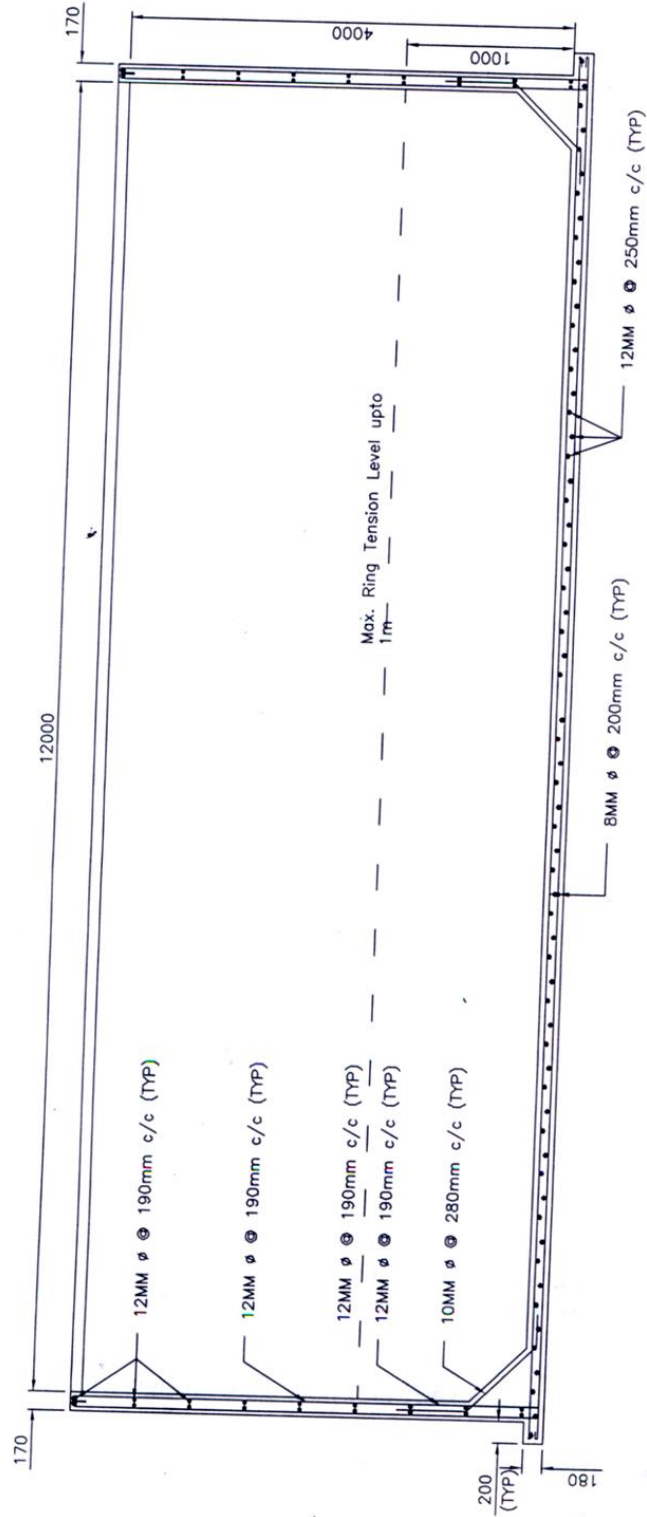
Vertical steel for B.M = $(9417.6 \times 1000) / (115 \times 0.85 \times 129)$
= 747 mm^2

Spacing of 8 mm Ø bars = $(50 \times 1000) / 747$
= 67 mm .

Provide 8 mm Ø bars at 120 mm c/c.

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CIRCULAR TANK WITH MONOLYTHIC EDGE



E: CIRCULAR WATER TANK
WITH RESTRAINED BASE

SCALE: 1:50

SHEET: A1

UNITS: MILLIMETERS

DATE:

EX. NO: 3

TITLE:

Result:

The design procedure completed.

Outcome:

At the end of this experiment, student acquires knowledge in designing the circular water tank with restrained base manually.

Viva-Voce

1. What do you mean by restrained base?
2. What is hoop tension?
3. What is steel water tank?
4. When do you prefer sliding base and rigid base in tank?
5. What is circular tank?
6. What do you mean by restrained base?
7. How will you measure the pressure in water tank?
8. What is pressure gauge?
9. What are the pressure measuring devices?
10. What is density?

Applications

1. Water tank used in Municipal Water
2. The base of the circular water tank has a flexible joint. The tank rests on the ground. The wall of the tank is designed for hoop tension.

Expt.No. 14 ANALYSIS AND DESIGN OF TRUSS

Aim:

To create and analyze the truss by using STAAD Pro

Software required:

STAAD PRO V8i

Procedure in STAAD Pro:

Preprocessing:

1. Create model

- New project> plane> length units as m> force units as kN>type the file name as truss> next> add beam.
- Snap node/ beam > edit> X in right = 4, X spacing 6 m, Y in right=1, Y spacing=3> ok.
- Now draw the truss model by using snap node/ beam.

2. Property

- General> property>section database> Indian> channel> IS MC 125> add
- Select ISMC 125>assign to view> yes.

3. Support

Support> create> fixed> release the displacement in X- axis by selecting F_x , M_x , M_y , M_z > add> use cursor to sign > assign.

4. Load

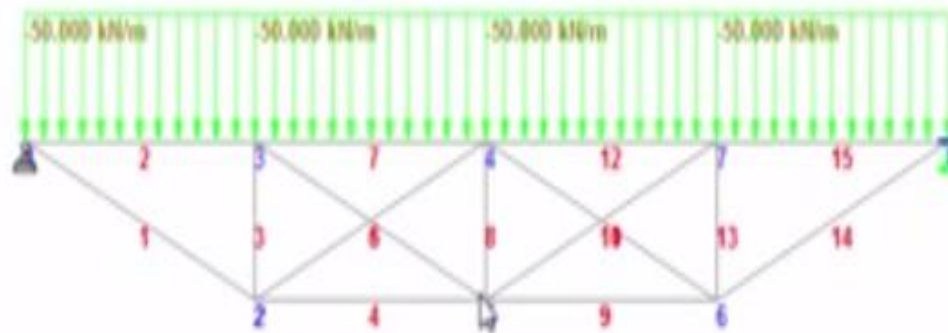
- Load and definition> load case detail> add>change the title as DL> add.
- DL>self-weight> uniform forces> $W1 = -50 \text{ kN/m}$ > add> close.
- Assign the load in the top the beam by using the cursor.

5. Analysis

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



Truss Model



Loads and supports in truss

Post-processing:

- 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.
- Results> plate rest contour> stress type M_x > apply> close.
- You can also see the animations of displacement in it.

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Result:

Thus the truss is created and analyzed by using STAAD Pro.

Outcome:

At the end of this experiment, student acquires knowledge in creating and analyzing the truss by using STAAD Pro.

Viva-Voce

1. What are the different types of truss?
2. Draw north light truss
3. What is girder?
4. What is purlin?
5. What is stone masonry?
6. What is strain energy?
7. What is neutral axis?
8. What is the difference between stress and pressure?
9. What is Poisson effect?
10. What is shear?

Applications

1. A type of truss used in Roofing
2. Simple truss
3. Planar truss
4. Space frame truss
5. Warren truss
6. Pratt truss
7. King post truss
8. Lenticular truss
9. Vierendeel truss

Expt. No. 15 DECK TYPE PLATE GIRDER BRIDGES

Design a deck type plate girder railway bridge for single tract B.G. main line loading for the following data:

1. Effective span : 24 m.
2. Spacing of plate girder : 1.9 m c/c
3. Weight of stock rails : 440 N/m (90 lb/yard rails)
4. Weight of guard rails : 260 N/m
5. Weight of fastenings etc : 280 N/m of track
6. Timber sleepers : 250 mm x 150 mm x 2.8 m @0.4 m c/c
7. Density of timber : 7.4 kN/m³

Take permissible stresses as per Railway Steel Bridge Code.

Solution:

Step 1. Computation of loads, B.M. and S.F. in Plate girder:

$$\text{Weight of main rails per meter run of track} = 0.44 \times 2 = 0.88 \text{ kN/m}$$

$$\text{Weight of guard rails per meter run of track} = 0.26 \times 2 = 0.52 \text{ kN/m}$$

$$\text{Weight of fastening per meter run of track @ 0.28 kN/m} = 0.25 \text{ kN/m}$$

$$\text{Weight of sleeper per meter run of track} = \frac{2.8 \times 0.25 \times 0.15}{0.4} \times 7.4 = 1.94 \text{ kN/m}$$

$$\text{Total Load} = 3.62 \text{ kN/m}$$

$$\text{Self-weight of girder for B.G. main line loading is } W = 0.78 L = 18.72 \text{ kN/m}$$

$$\text{Total dead load per meter run of track} = 3.62 + 18.72 = 22.34 \text{ kN/m}$$

$$\text{Total Dead Load} = 22.34 \times 24 = 536.2 \text{ kN}$$

$$\text{Dead load per girder} = 0.5 \times 536.2 = 268.1 \text{ kN}$$

EUDL for B.M., for BG (revised) for loaded length $L = \text{span} = 24 \text{ m}$ is 2034 kN

$$\text{Impact load (I.L.) for B.M.,} = 2034 \times 0.417 = 848.2 \text{ kN}$$

$$\text{Hence total load per track} = 536.2 + 2034 + 848.2 = 3418.4$$

$$\text{Hence load per girder, for B.M.} = 0.5 \times 3418.4 = 1709.2 \text{ kN}$$

$$M_{\max} = (WL/8) = (1709.2 \times 24) / 8 = 5127.6 \text{ kN/m}$$

This occurs at the mid span of each girder. B.M. at distance x from the mid span is

$$\text{For end sections, } L = 24 \text{ m}$$

$$\text{Hence EUDL for shear} = 2231 \text{ kN}$$

$$\text{Impact load,} = 2231 \times 0.417 = 930.3 \text{ kN}$$

$$\text{Total (L.L. + I.L.)} = 2231 + 930.3 = 3161.3 \text{ kN per track}$$

$$\text{Hence, (L.L. + I.L.)} = 0.5 \times 3161.3 = 1580.6 \text{ kN}$$

$$\text{S.F. due to (L.L. + I.L.)} = 0.5 \times 1580.6 = 790.3 \text{ kN}$$

$$\text{Dead load per girder, } W_d = 268.1 \text{ kN}$$

$$\text{Dead load shear per girder} = 0.5 \times 268.1 = 134.1 \text{ kN}$$

$$\text{Total S.F. at each end of a girder} = 790.3 + 134.1 = 924.4 \text{ kN}$$

For any section x from one end, $L = l - x$

Let W_e be the total L.L. + I.L. one length L for each girder

$$F_x = R_A = (W_e (l-x))/2l$$

$$\text{For section at 2 m from end, } L = 24 - 2 = 22 \text{ m}$$

$$\text{EUDL for shear} = 2102 \text{ kN}$$

$$\text{(L.L. + I.L.)} = 2102 (1 + 0.436) = 3018.4 \text{ kN}$$

For both girders, (L.L. + I.L.) for each girder

$$W_e = 0.5 \times 3018.4 = 1509.2 \text{ kN}$$

$$F_2 = (1509.2 (24 - 2)) / (2 \times 24) = 691.7 \text{ kN}$$

$$\text{Also, S.F. due to dead load} = ((W_d)/2) - ((W_d)/l)x = (268.1/2) - (268.1/24)x = 134.05 - 11.17x$$

$$\text{At } x = 2 \text{ m, } F = 134.05 - 11.17 \times 2 = 111.7 \text{ kN}$$

$$\text{Total shear} = 691.7 + 111.7 = 803.4 \text{ kN}$$

Step 2. Design of central section of plate girder:

$$M_{\max} = 5127.6 \text{ kN-m.}$$

$$\text{Economical depth } d = 1.1 \sqrt{(M / t_w \sigma_b)} = 1.1 \sqrt{(5127.6 / 10 \times 138)} = 2120 \text{ mm}$$

$$D = 1.1 \sqrt{(5127.6 \text{ E6} / 12 \times 138)} = 1936 \text{ mm}$$

Hence adopt $d = 2000 \text{ mm}$ and $t_w = 12 \text{ mm}$.

$$\text{Area of web } A_w = t_w \times d = 12 \times 2000 = 24000 \text{ mm}^2$$

$$\text{Area of flange } A_f = (M / \sigma_{bt} \times d) = (5127.6 \text{ E6} / 138 \times 2000) = 18578 \text{ mm}^2$$

$$\text{Net area of flange plates } A_p = (2/3)A_f - (1/8)A_w = (2/3) \times 18578 - (1/8) \times 24000 = 9386 \text{ mm}^2$$

$$\text{Keep gross area of plates} = 1.2 \times 9386 = 11263 \text{ mm}^2$$

Provide two plates $500 \times 12 \text{ mm}$ each having

$$A_p = 2 \times 500 \times 12 = 12000 \text{ mm}^2$$

$$\text{Gross area of each angle} = 7740 / 2 = 3870 \text{ mm}^2$$

Choose 2 ISA $200 \times 150 \times 12 \text{ mm}$ @ 13.8 kg/m , each having $A = 4056 \text{ mm}^2$

Step 3. Design of riveted jointing connecting flange angles with the web:

$$(L.L. + I.L.) \text{ per girder, per mm run} = (0.5 \times 224.6) / 1200 (1+1) = 0.187 \text{ kN/mm}$$

$$\text{Dead load of track, per girder} = 0.5 \times 3.62 = 1.81 \text{E-3 kN/mm}$$

$$\text{Total load } w \text{ on compression flange} = 0.187 + 0.00181 = 0.189 \text{ kN/mm}$$

(a) For compression flange:

$$P = 147.2 \text{ mm}$$

(b) For tension flange:

$$P = ((59.86 \times 2000)/924.4) \times ((7080 + 3000)/7080) = 184.4 \text{ mm}$$

$$\text{Max. Permissible pitch} = 16 \times 12 = 192 \text{ mm.}$$

Hence provide uniform pitch of 180 mm throughout the length.

Step 4. Design of riveted joint connecting flange plates to flange angles:

(a) Connection of flange plate to flange angle in compression flange, at ends

$$V = 924.4 \text{ kN and one plate is available in top flange.}$$

$$A_f = 8112 + 1200/2 = 14112 \text{ mm}^2$$

$$\text{Bearing} = 21.5 \times 12 \times 232 \text{E-3} = 59.86 \text{ KN, } R = 36.3 \text{ KN}$$

$$P = ((36.3 \times 2000)/924.4) \times ((14112 + 4000)/6000) = 237 \text{ mm}$$

(b) Connection of flange plate to flange angles in tension flange at 3.66 m ends:

$$A_f = 7080 + 10968 / 2 = 12564 \text{ mm}^2$$

$$(1/8)A_w = 3000 \text{ mm}^2. V = 703 \text{ KN.}$$

$$P = ((36.3 \times 2000)/703) \times ((12564 + 3000)/(10968/2)) = 293 \text{ mm.}$$

Step 5. Design of end stiffener:

$$\text{End reaction} = 924.4 \text{ KN,}$$

$$\text{Permissible bearing stress} = 185 \text{ N/mm}^2$$

$$\text{Bearing area required} = (((3/4) \times 924.4 \text{E3})/185) = 3748 \text{ mm}^2$$

$$4t_a (150 - 10) = 3748, \text{ which gives } t_a = 6.7 \text{ mm}$$

$$\text{However provide } 150 \times 75 \times 8 \text{ mm angles having } A = 1742 \text{ mm}^2$$

$$\text{Actual length of stiffener} = 2000 - 2 \times 12 = 1976 \text{ mm}$$

$$\text{Effective length of stiffener} = (3/4) \times 1976 = 1482 \text{ mm}$$

$$l/r = 1482/69.3 = 21.4$$

$$\text{Hence Load carrying capacity} = 132.65 \times 10568 \text{E-3} = 1402 \text{ kN.}$$

Design of riveted connection for the end stiffener:

Strength of 20mm dia. rivets in double shear = $2 \times (\pi/4) \times 21.5^2 \times 100 \times 10^{-3} = 72.6 \text{ kN}$

Strength of rivets in bearing on web = $21.5 \times 12 \times 233 \times 10^{-3} = 59.68 \text{ kN}$

No. of rivets required = $924.4/59.86 = 16$

Hence provide 8 rivets, in each row, thus making a total of 16 rivets.

Step 6. Design of intermediate stiffeners:

$V = 924.4 \text{ kN}$,

Shear stress, $f_s = (924.4 \times 10^3 / 2000 \times 12) = 38.5 \text{ N/mm}^2$

Hence for $d = 1700 \text{ mm}$, $t_w = 12 \text{ mm}$ and $f_s = 38.5 \text{ N/mm}^2$

For overall depth 2438 mm and depth 2048 mm,

Try 2 ISA 125 x 75 x 8, Outstand face of web = 125 mm

$f_s = (682.6 \times 10^3 / 2000 \times 12) = 28.4 \text{ N/mm}^2$

Hence Max. Spacing = 1900 mm.

Maximum permissible spacing = 1830 mm as per railway bridge code.

Result:

The Design procedure is completed.

Outcome:

At the end of this experiment, student acquires knowledge in designing a deck type plate girder railway bridge for single tract manually.

Viva-Voce

1. What is a plate girder?
2. Where do you find the use of plate girder?
3. What is Rivet connection?
4. What is the use of stiffeners?
5. What is basement?
6. What is flooring?
7. What are the different types of flooring?
8. What is weathering course?
9. What is the nominal size of bricks?
10. What are the types of bricks available?

Applications

1. The deck includes any road lanes, medians, sidewalks, parapets or railings, and miscellaneous items like drainage and lighting.
2. It is used in construction of Box girder bridge
3. It is used to construct Plate girder bridge

PROJECT TITLES

1. Design and analysis of foot over bridge by using staad pro.
2. Design and analysis of earthquake resistant structure.
3. Design and analysis of auditorium building with seismic conditions.
4. Dynamic analysis of flanged shear wall using stadd pro.
5. Design and analysis of Transmission Line Towers using Stadd Pro.
6. Design and analysis deck
7. Design and analysis girder bridge
8. Model making – Bridge
9. Model making – Frame Building
10. Design and analysis Shear wall using Stadd Pro.

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