



Estd: 2008

METHODIST

COLLEGE OF ENGINEERING & TECHNOLOGY

Approved by AICTE New Delhi | Affiliated to Osmania University, Hyderabad
Abids, Hyderabad, Telangana, 500001

DEPARTMENT OF CIVIL ENGINEERING

LABORATORY MANUAL

**Computer Aided Civil Engineering Drafting,
Analysis & Design Lab**

(PC459CE)

BE VI Semester (AICTE/N): 2022-23

Name:

Roll No:

Branch:.....SEM:.....

Academic Year:

Empower youth- Architects of Future World



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DEPARTMENT OF CIVIL ENGINEERING

LABORATORY MANUAL

Computer Applications Laboratory

Prepared by

**Shaista Begum
Associate Professor**

VISION

To evolve into a centre of excellence for imparting holistic civil engineering education contributing towards sustainable development of the society.

MISSION

- To impart quality civil engineering education blended with contemporary and interdisciplinary skills.
- To provide enhanced learning facilities and professional collaborations to impart a culture of continuous learning.
- To involve in trainings and activities on communication skills, teamwork, professional ethics, environmental protection and sustainable development.

PROGRAM EDUCATIONAL OBJECTIVES

The Graduates of the programme shall be able to:

- **PEO1.** Engage in planning, analysis, design, construction, operation and maintenance of built environment.
- **PEO2.** Apply the knowledge of civil engineering to pursue research or to engage in professional practice.
- **PEO3.** Work effectively as individuals and as team members in multi disciplinary projects with organizational and communication skills.
- **PEO4.** Demonstrate the spirit of lifelong learning and career enhancement aligned to professional and societal needs.

PROGRAM OUTCOMES

Engineering Graduates will be able to:

- **PO1. Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and civil engineering specialization to the solution of complex civil engineering problems.
- **PO2. Problem analysis:** Identify, formulate, review research literature, and analyze complex civil engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- **PO3. Design/development of solutions:** Design solutions for complex civil engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

- **PO4. Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
- **PO5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex civil engineering activities with an understanding of the limitations.
- **PO6. The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional civil engineering practice.
- **PO7. Environment and sustainability:** Understand the impact of the professional civil engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
- **PO8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the civil engineering practice.
- **PO9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **PO10. Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
- **PO11. Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
- **PO12. Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Civil Engineering Graduates will be able to:

- PSO 1.** Investigate properties of traditional and latest construction materials using standard testing methods.
- PSO 2.** Use AutoCAD, STAAD Pro, ETABS, Revit Architecture and ANSYS software for computer aided structural analysis and design.
- PSO 3.** Describe the principles of sustainable development and green buildings for environmental preservation.

INDEX

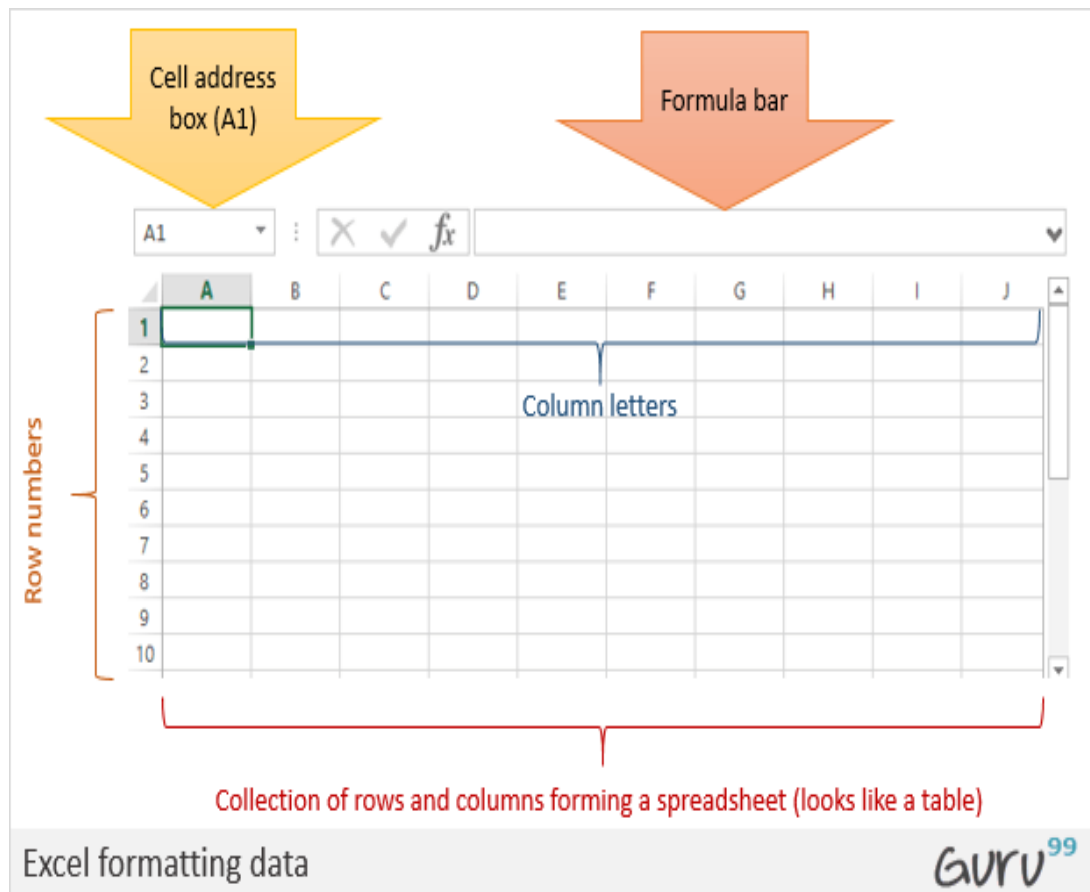
S.No	Name of the Experiment	Page No
	A-EXCEL Introduction to Excel	2 - 5
1	Structural design of an RCC beam section using limit state method, given are the grade of concrete, grade of steel, BM and SF.	6-8
2	Determination of pressure bulb underneath a footing using Boussinesq 's equation	9-10
3	Determination of Direct & Bending stresses of a rectangular section	11-13
4	Computation of discharge over a rectangular notch using velocity of approach	14-16
5	Determination of critical depth in a trapezoidal channel	17-19
6.	Determination of optimum diameter of a hydraulic pipe	20-21
7	Calculation of normal depth in a trapezoidal channel	22-25
8	Design of circular sewer	26-28
	B. STAAD PRO	
9.	Introduction to STAAD-PRO & Analysis and design of a flexural member using STAAD Pro	27-30
10.	Analysis of Continuous Beam	34-42
11	Analysis of single storey frame using STAAD Pro	43-47
12.	Analysis and design of a simple RCC frame one-bay two storey using STAAD PRO	40-44

INTRODUCTION TO MS-EXCEL

Microsoft Excel is a spreadsheet, developed by Microsoft for Windows, Mac OS, Android and iOS. Microsoft Excel is a spreadsheet program that is used to record and analyse numerical data. Think of a spreadsheet as a collection of columns and row that form a table. Alphabetical letters are usually assigned to columns and numbers are usually assigned to rows. The point where a column and a row meet is called a cell. A workbook is a collection of worksheets. By default, a workbook has three cells in Excel. You can delete or add more sheets to suit your requirements. By default, the sheets are named Sheet1, Sheet2 and so on and so forth. You can rename the sheet names to more meaningful names It features calculation, graphic tools, pivot tables and macro programming language called visual basic for application. It has a programming aspect, Visual Basic for Applications, allowing the user to employ a wide variety of numerical methods, for example, for solving differential equations of mathematical physics, and then reporting the results back to the spreadsheet. It also has a variety of interactive features allowing user interfaces that can completely hide the spreadsheet from the user, so the spreadsheet presents itself as a so-called application, or decision support system (DSS), via a custom-designed user interface, for example, a stock analyzer, or in general, as a design tool that asks the user questions and provides answers and reports. In a more elaborate realization, an Excel application can automatically poll external databases and measuring instruments using an update schedule, analyze the results, make a Word report or PowerPoint slide show, and e-mail these presentations on a regular basis to a list of participants. Excel was not designed to be used as a database.

It has been the most widely used spread sheet application available for these platforms since version 5 in 1993. Excel is included as part of Microsoft Office.

1. Microsoft Excel is a powerful spreadsheet program used to record, manipulate, store numeric data.
2. The ribbon is used to access various commands in Excel.
3. The options dialogue window allows you to customize a number of items i.e. the ribbon, formulas, proofing, save, etc.



Microsoft Excel Basic Functions

Functions are one of the most important features of Excel. It helps you to perform the basic calculations as well complex. Below I have listed 10 Basic Excel Functions which you need to learn.

SUM: It returns the sum of numeric values in a cell. You can refer to the cells where you have values or simply insert the values into the function.

COUNT: It returns the count of numeric values in a cell. You can refer to the cells where you have values or simply insert the values into the function.

AVERAGE: It returns the average of numeric values in a cell. You can refer to the cells where you have values or simply insert the values into the function.

TIME: It returns a valid time serial number as per Excel's time format. You need to specify hours, minutes and seconds.

DATE: It returns a valid date serial number as per Excel's time format. You need to specify day, month and year.

LEFT: This function extracts specific characters from a cell/string starting from the left (start). You need to specify the text and number of characters to extract.

RIGHT: This function extracts specific characters from the a cell/string starting from the right (last). You need to specify the text and number of characters to extract.

VOOKUP It looks up for a value in a column and can return that value or a value from the correspondent columns using same row number.

IF: This function returns a value when the specific condition is TRUE and returns another value if condition is FALSE.

NOW: It returns the current date and time in the cell where you insert it using your system's settings.

Use of MS excel spreadsheet

Spreadsheets are an essential business and accounting tool. They can vary in complexity and can be used for various reasons, but their primary purpose is to organize and categorize data into a logical format. Once this data is entered into the spreadsheet, you can use it to help organize and grow your business.

Some important shortcuts in MS excel

Ctrl + P used to open the print dialogue window.

Ctrl + N creates a new workbook.

Ctrl + S saves the current workbook.

Ctrl + C copy contents of current select.

Ctrl + V paste data from the clipboard.

SHIFT + F3 displays the function insert dialog window.

SHIFT + F11 Creates a new worksheet.

Viva Questions

1. What is Microsoft Excel?
2. What are cells?
3. Does each cell have unique address?
4. How can you add cells, rows or columns in Excel?
5. How would you format a cell? What are the options?
6. What does the IF function in Excel?
7. What are the advantages of using formula in Excel sheet?
8. What is the syntax of IF statement?
9. What are the 5 functions in Excel?
10. Explain MS Excel in brief.

Experiment- 1

Design of Doubly reinforced RCC section

Aim: - To design a doubly reinforced beam according to the given data

Software: -Microsoft Excel

Theory: - A Beam section consists of two zones compression zone and tension zone. If the reinforcing bars of are provided on both compression and tension side in the beam section, it is called as doubly reinforced beam

Procedure: -

Given the factored moment M_u , grade of concrete, grade of steel, dimension of the section, the procedure for limit state design is as follows: -

- Limiting moment of resistance $M_{u-lim.} = Q \cdot f_{ck} \cdot b d^2$

Where $Q = 0.148$ for Fe 250 grade of steel.

$= 0.138$ for Fe 415 grade of steel.

$= 0.133$ for Fe 500 grade of steel

b = breadth of beam

d = effective depth of beam

- Area of steel corresponding to M_{u-lim} ,

$$A_{st1} = 0.36 \cdot f_{ck} \cdot b \cdot x_{u,max} \cdot (d - 0.42 \cdot x_{u,max})$$

- Compression reinforcement, $A_{sc} = M_{u1} / (f_{sc} \cdot (d - d'))$

Where $M_{u1} = (M_u - M_{u-lim})$

$$f_{sc} = 0.85 \cdot f_y$$

f_y = yield strength of steel.

- Additional tensile steel $A_{st2} = f_{sc} A_{sc} / (0.87 f_y)$

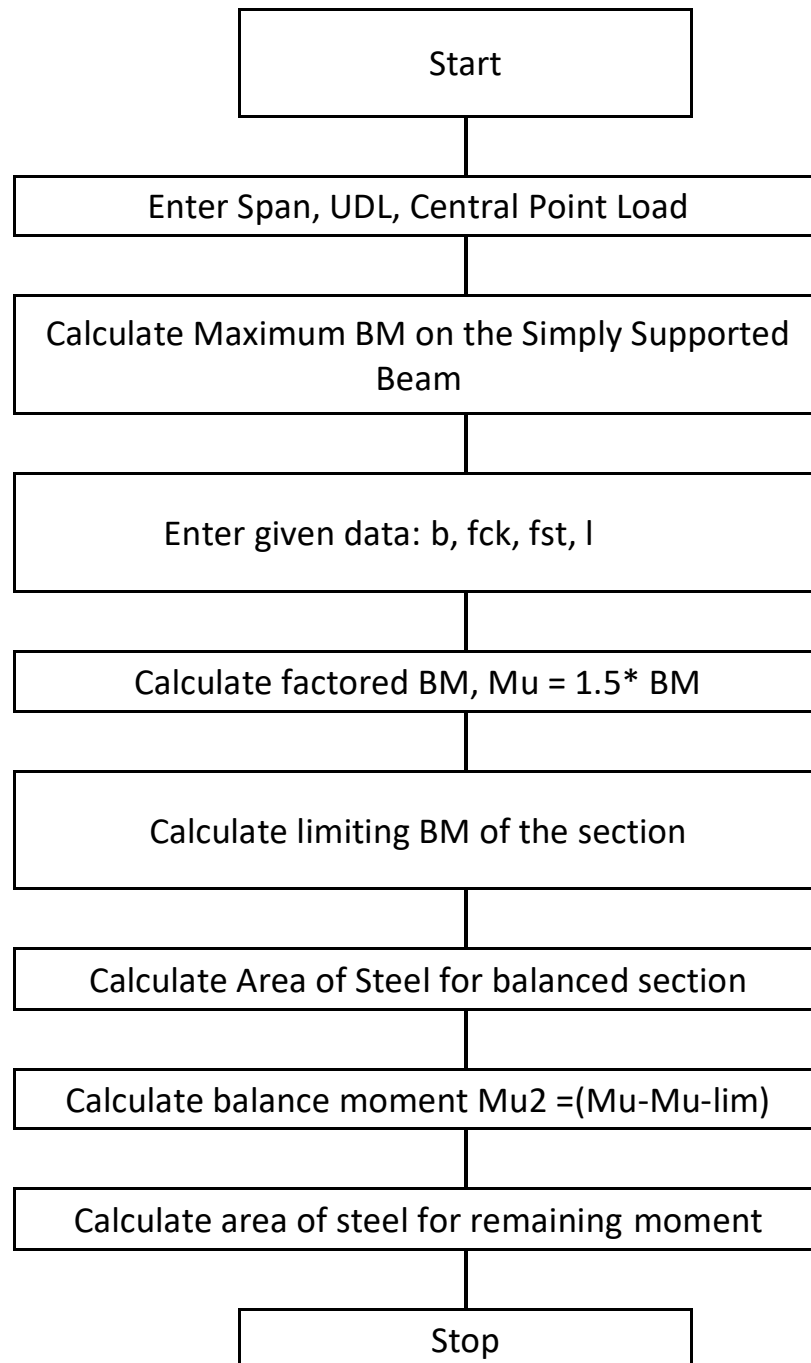
- Total tensile steel $A_{st} = A_{st1} + A_{st2}$

- No. of bars in tension = $A_{st} / (a_1)$

Where a_1 = area of tension bars

- No. of bars in compression = $A_{sc} / (a_2)$

Where a_2 = area of compression bars



Viva Questions

1. What is a doubly reinforced beam?
2. What is meant by f_{sc} ?
3. When will we design Doubly reinforced section?
4. What is M_{ulimit} ?
5. How do find number of bars?
6. What is the difference between round and round up in Excel?
7. Name the excel built in functions used in solving this problem
8. Write the format of IF statement in Excel.
9. What do you mean by Fe500 grade steel?

Experiment - 2

Determination of pressure under a footing under a concentric load

Aim: - To determine the pressure bulb under a footing using Boussinesq's equation

Software: -Microsoft Excel

Theory: -

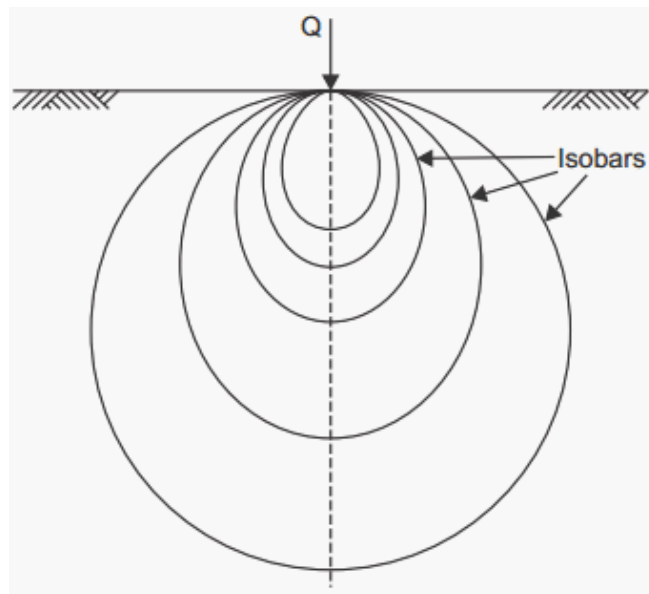
Boussinesq's has given the solution for the stresses caused by the application of a point load at the surface of a homogeneous, elastic, isotropic and semi-infinite medium, with the aid of mathematical theory of elasticity.

An isobar is a stress contour (or) a line which connects all points below the ground surface at which the vertical pressure is the same. In fact, an isobar is a spatial curved surface and resembles a bulb in shape. This is because the vertical at all points in horizontal plane at equal radial distances from the load is the same. Thus, the streams isobar is called the "bulb of pressure" (or) "pressure bulb". The vertical pressure at each point of the pressure bulb is the same

Pressures at points inside the bulb are greater than that of a point on the surface of the bulb; pressures at points outside the bulb are smaller than the value. Any number of pressure bulbs may be drawn for any applied load, since each one corresponds to an arbitrary chosen value of stresses.

A system of isobars indicates the decreases in stresses intensity from the inner to the outer ones.

An isobar diagram, consisting of a system of isobars is shown in the figure



Formulae used: -

$$I_B = \frac{3}{2\pi} * [1/(1+(r/z)^2)]^{5/2}$$

Where I_B = Boussinesq's influence factor.

r = radial distance.

Z = depth of point from ground surface

Problem: A concentrated load of ...kn is applied at a point on the ground surface. Compute the vertical pressure at a depth of 0m, 1.0m, 1.5m, 2m, 2.5m, 3m, 3.5m & 4m for various radii

Viva Questions

1. What is the aim of this exercise?
2. Explain pressure bulb?
3. Define Isobars?
4. In a pressure bulb where will be the maximum pressure?
5. What is Boussinesq's influence factor?
6. What is the difference between round and round up in Excel?
7. Explain what is a spread sheet?
8. What do you mean by cell address?

Experiment- 3

Determination of Direct & Bending stresses of a rectangular section

Aim: - To determine the Direct and bending stresses of a rectangular section subjected to non - central force acting parallel to the access of the member

Software: -Microsoft Excel

Theory: -

A rectangular cross – section is subjected to as non – central force ‘P’ parallel to the access of the member. The load is acting eccentrically about two axes. Considering a column ABCD subjected to a load with eccentricity about two axes as shown.

Procedure: -

Let a column ABCD subjected to a load ‘P’ with eccentricity about two axes.

Let P → Load acting on the column ABCD

A → Cross – sectional area of the column.

e_x → Eccentricity of the load about X-X axis.

e_y → Eccentricity of the load about Y –Y axis.

∴ Moment of the load about X-X axis, $M_x = P \cdot e_x$

Let

I_{xx} = Moment of inertia of the column section about X-X axis

I_{yy} = Moment of inertia of the column section about Y-Y axis

The effect of such a load may be split up into the following three parts.

Direct stress on the column, due to the load,

$$P_o = P/A$$

Bending stress due to eccentricity ‘ e_x ’

$$P_{bx} = M_x \cdot y / (I_{xx}) = P \cdot e_x \cdot y / (I_{xx})$$

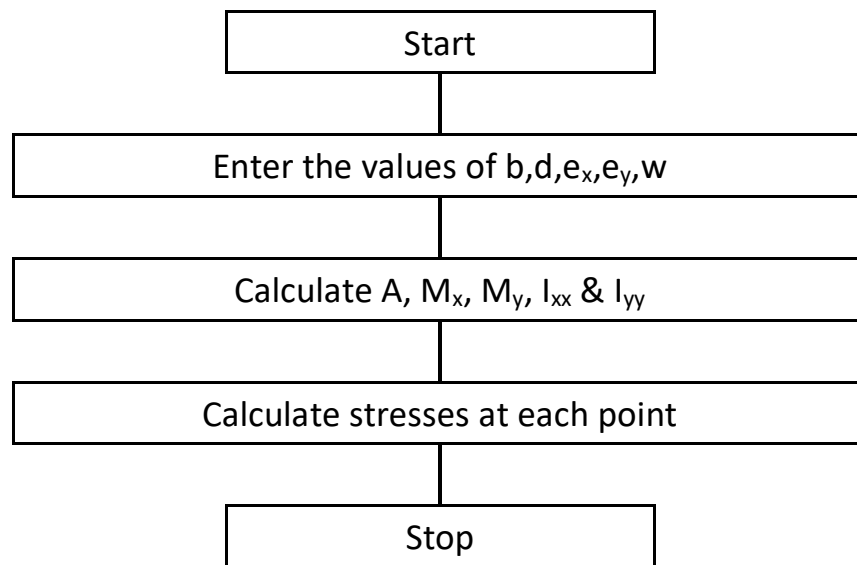
Bending stress due to eccentricity ‘ e_y ’

$$P_{by} = M_y \cdot x / (I_{yy}) = P \cdot e_y \cdot x / (I_{yy})$$

∴ Total stresses at the extreme fiber = $P_o + P_{bx} + P_{by}$.

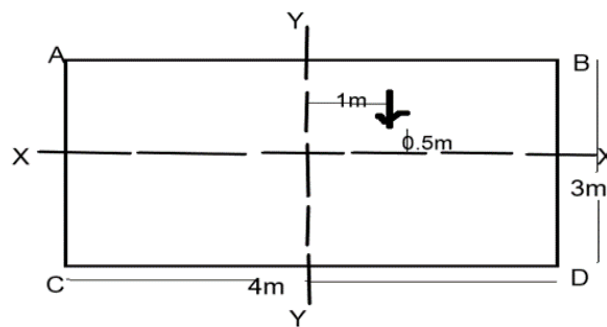
$$= P/A + M_x \cdot y / (I_{xx}) + M_y \cdot x / (I_{yy})$$

The +ve (or) -ve sign depends on the position of the fibre w.r.t the load. A little consideration will show, that the stresses will be maximum at 'B'. when both the +ve signs are to be adopted. The stress will be minimum at 'D', where both the -ve sign are to be adopted. The stress will be minimum at 'A', the value of ' M_x ' is to taken as +ve, whereas the value of ' M_y ' as -ve. Similarly, for the stress at 'C', the value of ' M_x ' as '-ve' and ' M_y ' as +ve to be taken.



Problem:

A masonry pier of 3m x 3m supports a vertical load ofKN as shown in figure. Find the stresses developed on each corner of the pier.



Viva Questions

1. What is direct and bending stress?
2. What is the maximum bending stress?
3. Define Moment of Inertia?
4. Every material is elastic in nature, Explain.
5. What is bending stress formula?
6. How do you calculate allowable bending stress?
7. Name the macro programming language used in Excel.
8. Name some functions that are present in Excel.

Experiment - 4

Determination of discharge over a rectangular notch

Aim: - To compute a discharge over a rectangular notch using velocity of approach

Software: -Microsoft Excel

Theory: - Area of rectangular notch (A) = width * depth.

Discharge without velocity approach $Q = \frac{2}{3} C_d L \sqrt{2g} H_1^{3/2}$

$C_d \rightarrow$ coefficient of discharge.

$L \rightarrow$ length of the notch.

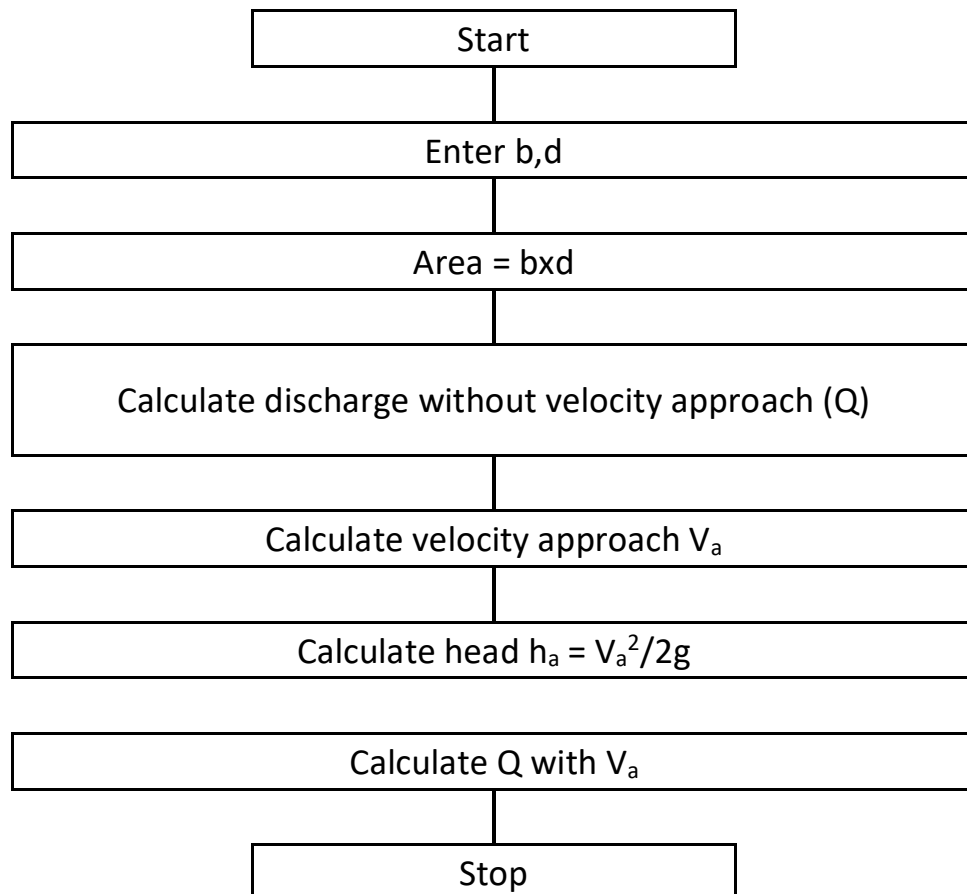
$H_1 \rightarrow$ head of water

Velocity of approach $V_a = Q/A$.

Additional head $h_a = V_a^2 / (2g)$.

Discharge with velocity of approach is given by

$Q = \frac{2}{3} * C_d * L * \sqrt{2g} * [[H_1 + h_a]^{3/2} - h_a^{3/2}]$



Problem:

Compute the discharge over a Rectangular notch of length of head H_1 m with width of channel 0.6m and depth 0.45m using velocity of approach; take $C_d = \dots\dots$ & $g = 9.81 \text{ m/sec}^2$

Viva Questions

1. What is a rectangular notch?
2. Name the other types of notches available.
3. Which formula is used to measure the discharge through a rectangular notch?
4. A flow in which the quantity of liquid flowing per second is constant, is called _____ flow.
5. The formula for calculating discharge over a rectangular notch is?
6. What is the difference between notch and a weir?
7. Explain what is a spread sheet?
8. What do you mean by cell address?

Experiment-5 Determination of critical depth in a trapezoidal channel

Aim: - To calculate critical depth in a trapezoidal channel

Theory: -

The depth of flow at which the specific energy is minimum is called critical depth 'y', and the velocity of flow at the critical depth of the flow greater than the critical depth of the flow, the velocity of the flow is less than the critical velocity for a given discharge. When the depth of the flow is less than the critical depth, the specific energy increases and velocity of flow is greater than the critical velocity.

$$\text{Area (A)} = (B + z*y) * y$$

B → Bottom width

z → slope

y → depth of slope

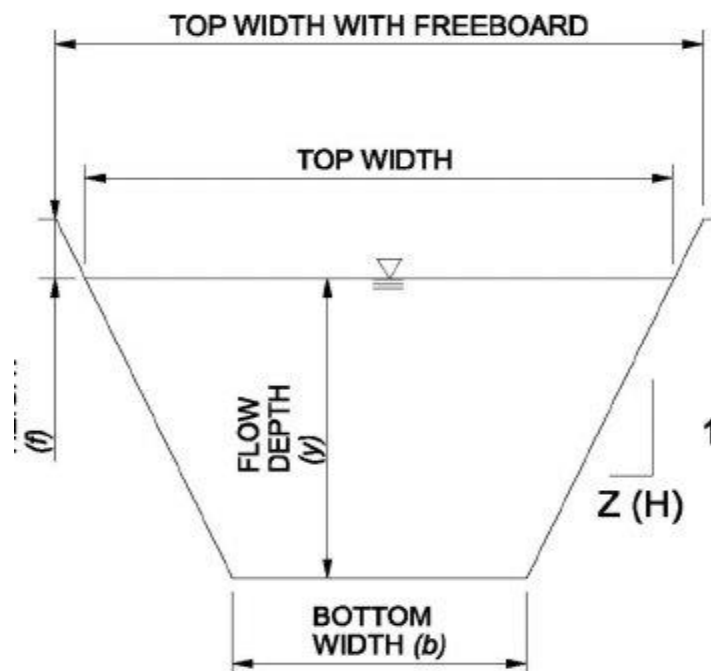
$$\text{Critical flow } Q^2/g = A^3/T$$

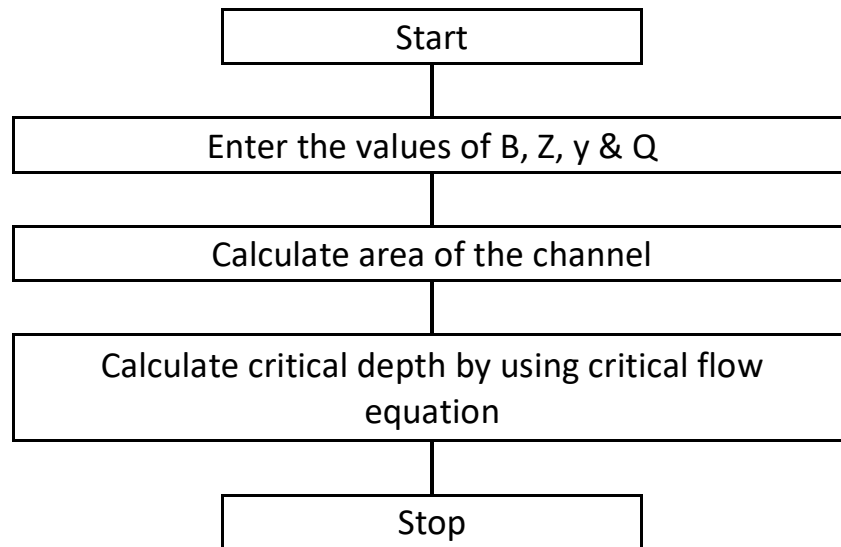
Q → Discharge

A → Area

T → Top width = (B + z y_c)

y_c → critical depth





Problem:

A trapezoidal channel has a bottom width of 6m and side slopes of 2 Horizontal to a 1 vertical (2H:1V). If the depth of flow is 1.2m at a discharge of $10\text{m}^3/\text{sec}$. Compute the critical depth.

Viva Questions

1. How do you find the critical depth of a trapezoidal channel?
2. What is critical depth in open channel?
3. Why is critical depth important?
4. What is meant by critical flow?
5. What does Froude number tell you?
6. Why do we use Reynolds number?
7. Name the macro programming language used in Excel.
8. Name some functions that are present in Excel.
9. What is the use of Round function in Excel?

Experiment-6

Determination of optimum diameter of hydraulic pipe

Aim: - To determine optimum diameter of pipe for turbulent flow.

Theory: -

A pipe is a closed conduit through which a fluid flows pipes can be large. The water pipes supplying water in the house, pipes can transport both liquid and gases. The nature of the streak line formed by injecting the dye depends on the fluid velocity.

When the fluid is moving slowest, get a well-defined streak line. The fluid flow situation is called laminar flow. When the fluid is moving fast get an irregular streak-line also which blurs and spread the dye out. The streak line also fluctuates randomly with time. This is called turbulent flow.

When the fluid is moving at an intermediate velocity, there are irregularities in the streak-line but the streak-line is still well defined. This is called transitional flow.

Reynolds's number: -

whether a flow will result in laminar (or) turbulent flow is primarily determined by the Reynolds's number.

$$R_e = \rho v D / \mu$$

When $\rho \rightarrow$ density

$D \rightarrow$ diameter of pipe fluid.

$V \rightarrow$ velocity

$\mu \rightarrow$ viscosity

The flow is laminar flow $R_e < 2000$

The flow is turbulent flow for $R_e > 4000$

The flow is transitional flow for $2000 < R_e < 4000$

Procedure: -

To determine the diameter that is optional for a turbulent flow two equations can be used that is Blaciars eq² and Swami jain eqn.

Reynolds number, $R_e = \rho v D / \mu$

$$\rho = 1000 \text{ kg/m}^3 \quad V = Q/A \quad \mu = 0.01$$

$$A = \pi D^2 / 4$$

Head loss can be calculated with $h_f = flv^2/2gD$

Where $h_f \rightarrow$ the head loss due to friction (m)

$l \rightarrow$ the length of the pipe (m)

$D \rightarrow$ the diameter of hydraulic pipe (m)

$V \rightarrow$ the average velocity of the fluid flow (m/sec)

$g \rightarrow$ the local acceleration due to gravity (m/sec^2)

$f \rightarrow$ a dimension less coefficient called the Darcy frictional factor.

'f' can be found out using either Blacier's equation (or) Swami jain equation.

In absence of data f can be assumed as 0.001.

Formulae: - Blacier's Equation $\rightarrow f = 0.136/R_e^{0.25}$

Swami jain equation $\rightarrow f = 0.25/[\log_{10}(e/3.70 + 5.7v/R_e^{0.9})]$

Problem:

A smooth pipe carries water at the rate of 300litre/sec at 20⁰C. density(ρ)=1000kg/m³ and kinematic viscosity(V)= 10⁻⁶m/sec with a head loss of 3m in 100m length of pipe. Determine the optimum pipe diameter.

Use $f=0.0031+(0.221/R_e^{0.237})$.

Viva Questions

1. What is optimum pipe diameter?
2. What is meant by head loss?
3. What is Reynold's number?
4. What is meant by laminar flow?
5. What is kinematic viscosity?
6. At what Reynolds number is turbulent flow?
7. Is Turbulent Flow bad?
8. Syntax of Π
9. Common examples of turbulent flow
10. Name some functions that are present in Excel.

Experiment-7

Calculation of normal depth in a trapezoidal channel

Aim: - To determine normal depth in a trapezoidal channel

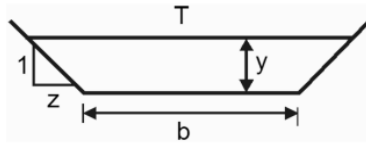
Theory: -Trapezoidal Channels allow the collection and transportation of surface water while protecting the area from erosion. A trapezoidal section is the most economical if half the top width is equal to one of the sloping sides of the channel or the hydraulic radius is equal to half the depth of flow.

A channel section is said to be economical when the cost of construction of the channel is minimum. The cost of construction of a channel depends on depth of excavation and construction for lining. The cost of construction of channel is minimum when it passes maximum discharge for its given cross sectional area. It is evident from the continuity equation and uniform flow formulae that for a given value of slope and surface roughness, the velocity of flow is maximum when hydraulic radius is maximum. The hydraulic radius is maximum for given area if wetted perimeter is minimum. Hence the wetted perimeter, for a given discharge should be minimum to keep the cost down or minimum. This condition is utilized for determining the dimensions of economical sections of different forms of channels. Most economical section is also called the best section or hydraulic efficient section as the discharge passing through a most economical section of channel for a given cross-sectional area (A), slope of the bed (S₀) and a roughness coefficient (n), is maximum.

The conditions for the most economical section of channel

1. A rectangular channel section is the most economical when either the depth of flow is equal to half the bottom width or hydraulic radius is equal to half the depth of flow.
2. A trapezoidal section is the most economical if half the top width is equal to one of the sloping sides of the channel or the hydraulic radius is equal to half the depth of flow.
3. A triangular channel section is the most economical when each of its sloping side makes an angle of 45° with vertical or is half square described on a diagonal and having equal sloping sides.

Trapezoidal Channel



$$A = (b + zy)y \quad ; \quad P = b + 2y\sqrt{1 + z^2} \quad ; \quad T = b + 2zy$$

Problem:

The discharge in a channel with bottom width 3 m is $12 \text{ m}^3/\text{s}$. If Manning's n is $0.013 \text{ m}^{-1/3} \text{ s}$ and the streamwise slope is 1 in 200, find the normal depth if:

- the channel has vertical sides (i.e. rectangular channel);
- the channel is trapezoidal with side slopes 2H:1V.

Solution:

$b = 3 \text{ m}$ (base width) $Q = 12 \text{ m}^3/\text{s}$; $n = 0.013 \text{ m}^{-1/3} \text{ s}$; $S = 0.005$

(a) Discharge:

$$Q = VA$$

Where V in normal flow

$$V = (1/n) R_h^{2/3} S^{1/2} ,$$

$$A = bh,$$

$$R_h = bh/(b + 2h) = h/(1 + 2h/b)$$

Hence,

$$Q = ((1/n) * (bh^{5/3}) / (1 + 2h/b)^{2/3}) * S^{1/2}$$

Rearranging as an iterative formula for h :

$$h = \left(\frac{nQ}{b\sqrt{S}} \right)^{3/5} (1 + 2h/b)^{2/5}$$

Here, with lengths in metres,

$$h = 0.8316 (1 + 2h/3)^{2/5}$$

Iteration (from, e.g., $h = 0.8316$) gives

$$h_n = 1.024 \text{ m}$$

Answer: 1.02 m.

(b) Geometry: Trapezoidal cross-section with base width b , surface width $b + 2 \times (2h)$ and two sloping side lengths $\sqrt{h^2 + (2h)^2} = h\sqrt{5}$.

Area and wetted perimeter: $A = (1/2) * (b + b + 4h)h = h(b + 2h) = hb(1 + 2h/b)$

$$P = b + 2h\sqrt{5}$$

Hydraulic radius: $R_h \equiv (A/P) = h(b + 2h) / (b + 2h\sqrt{5}) = h * ((1 + 2h/b) / (1 + 2\sqrt{5}h/b))$

Discharge:

$$Q = VA = \frac{1}{n} R_h^{2/3} S^{1/2} A$$

Hence,

$$Q = \frac{1}{n} h^{2/3} \left(\frac{1 + 2h/b}{1 + 2\sqrt{5}h/b} \right)^{2/3} S^{1/2} hb(1 + 2h/b)$$

$$\Rightarrow \frac{nQ}{b\sqrt{S}} = h^{5/3} \frac{(1 + 2h/b)^{5/3}}{(1 + 2\sqrt{5}h/b)^{2/3}}$$

$$\Rightarrow h = \left(\frac{nQ}{b\sqrt{S}} \right)^{3/5} \frac{(1 + 2\sqrt{5}h/b)^{2/5}}{1 + 2h/b}$$

Here, with lengths in metres,

$$h = 0.8316 \frac{(1 + 1.491h)^{2/5}}{1 + 2h/3}$$

Iteration (from, e.g., $h = 0.8316$) gives

$$h_n = 0.7487 \text{ m}$$

Answer: 0.749 m.

Viva Questions

1. What is meant by economical section of a channel?
2. What is the condition for the most economical section of a trapezoidal channel?
3. Write the Manning's Equation
4. What is the area of trapezoidal channel?
5. Syntax of square root
6. What is meant by wetted parameter?
7. Name some functions that are present in Excel.

Experiment-8 Design of circular sewer

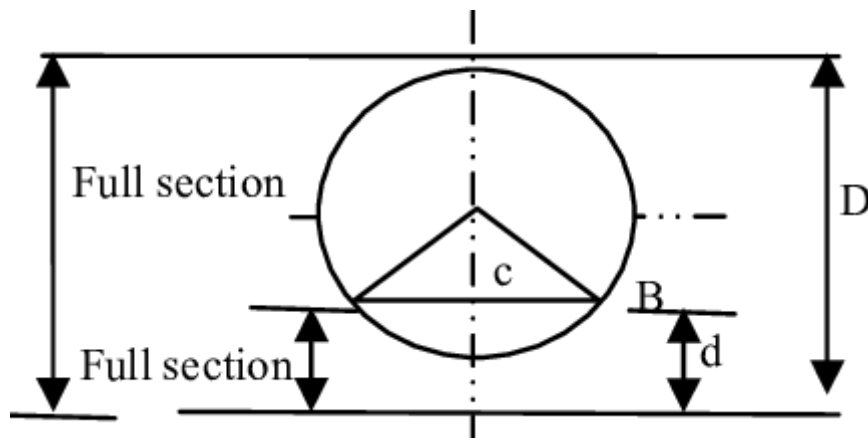
Aim: - To design a Circular Sewer

Theory: The three types of sewers are sanitary sewers, storm sewers, and combined sewers. All three of these sewer systems play important roles in ensuring that the waste we produce is transported and treated properly.

Sewers are generally circular in shape. The advantages of circular sewers are:

- The perimeter of circular sewer is the least with respect to the sewer of other shape.
- The inner surface is smooth hence the flow of sewage is uniform and there is no chance of deposition of suspended particles.
- The circular sewers are easy to construct.

In this type of sewer, the outer surface is circular. The inner surface is divided into two portions. The upper portion resembles a basket-handle and the lower portion is like a channel. During dry season, the sewage flows through the lower portion and during monsoon, the combined sewage flows through the full section.



Problem:

Design a sanitary sewer to serve a population of 5,000 people, if the average consumption is 400 liters per capita per day (lpcd). How many extra persons can be served if the slope is doubled? Using "n" value of 0.013 in the Manning's formula & the return flow as 70%. Check the minimum self-cleaning velocity. Neglect infiltration & inflow?

Given Data:

Population (P)	= 5000 Persons
Average water consumption (q)	= 400 lpcd
Manning Coefficient (n)	= 0.013
Return Flow	= 70 %
Assume Slop (s)	= 0.005
Average waste water flow (qw)	= P * Return flow (%) * q = 5000 * 0.7 * 400 = 1,400,000 lpcd = 0.0162 m ³ /sec
Let take peaking factor (P.F)	= 3
Peak Hourly Waste Water Flow	= 3 * 0.0162 = 0.0486 m ³ /sec

Now finding the diameter of sewer pipe line

Using discharge formula;

$$Q = AV$$

$$0.0162 = (\pi * D^2 / 4) ((1/n) * R^{2/3} S^{1/2})$$

$$D = 0.264 \text{ m (264mm or 10.40")}$$

Use 12" Dia pipe

Checking the minimum self cleaning velocity

$$V = ((1/n) * R^{2/3} S^{1/2})$$

Where $R = (D/4)^{2/3}$ for circular pipe

$$V = 0.96 \text{ m/sec}$$

$$V_{\min} = 0.6 \text{ m/sec} < V = 0.96 \text{ m/sec} <$$

$$V_{\max} = 2.5 \text{ m/sec}$$

Viva Questions

1. What are the three types of sewers?
2. What are advantages and disadvantages using circular sewer section?
3. What are the 2 main types of sewer systems?
4. Which sewer section is most efficient?

Experiment-9

Introduction to STAAD-PRO

Aim: To study the introduction about STAAD Pro

Overview: STAAD- Standard Analyze and Design

Company name – Bentley Version- STAADV8i.

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

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

Advantages:

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

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

STAAD Pro consists of the following:

The STAAD Pro Graphical User Interface:

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

The STAAD analysis and design engine:

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

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

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

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

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

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

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

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, 2ndOrder P-delta analysis, geometric nonlinear analysis and the buckling analysis. It can also analyze various type of dynamic analysis starts from model extraction to time history and response spectrum analysis. STAAD is fast, efficient, easy to use and accurate platform, conformation with many Standard codes and qualified to solve any type of problem. These features had made the STAAD the Professional's choice. Today, STAAD is one of the most popular structural engineering software Products.

Methods in STAAD Pro:

- Snap and grid method
- Structural wizard
- Excel method
- 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.
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. Result: X Y Z 0 0 0

Viva Questions:

1. Explain the use of AutoCAD in staad.pro
 2. Explain the difference between global and local axis
 3. Explain different types of loads that acts on structure
 4. Explain different types of supports
 5. What is code book for RCC design?
 6. Define Staad.Pro
 8. What is difference between AutoCAD and Staad.Pro?
 9. Explain the abbreviation for Staad.pro
 10. How to select nodes in staad.pro
-

Experiment-10 ANALYSIS OF CONTINUOUS BEAM

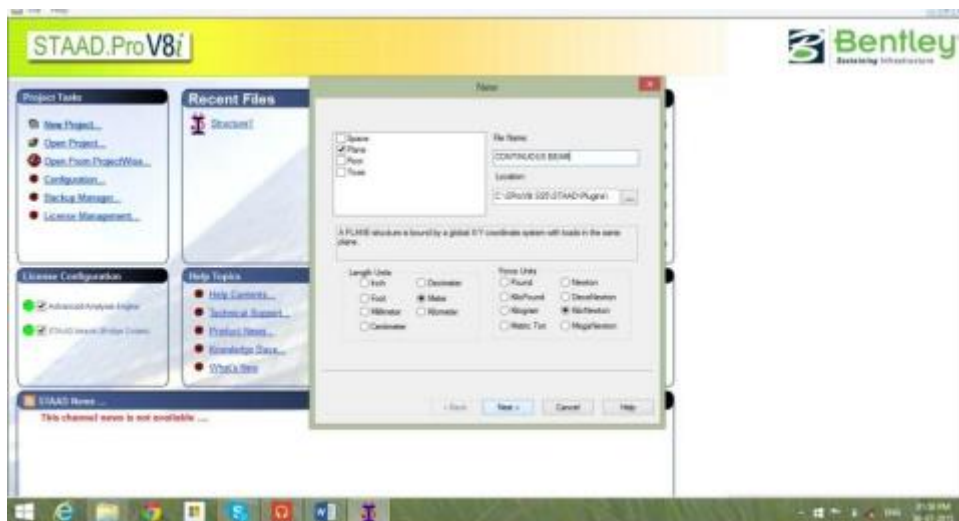
Aim: To analyze the continuous beam using staad.pro

Software: STAAD Pro.

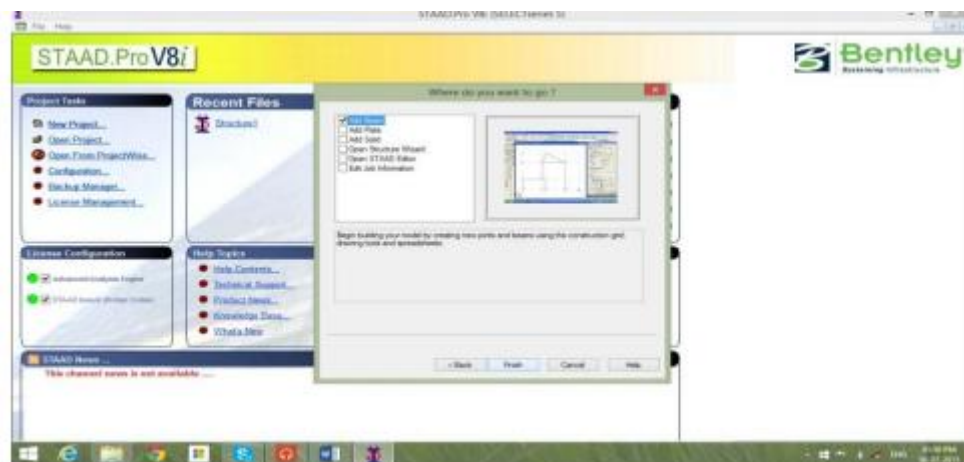
Procedure:

Following are the step wise procedures for Staad Pro Problems (CONTINUOUS BEAM)

1. Double click the Staad Pro Icon on Desk top
2. Select Plane , Meter, Kilo Newton and write File Name & click Next

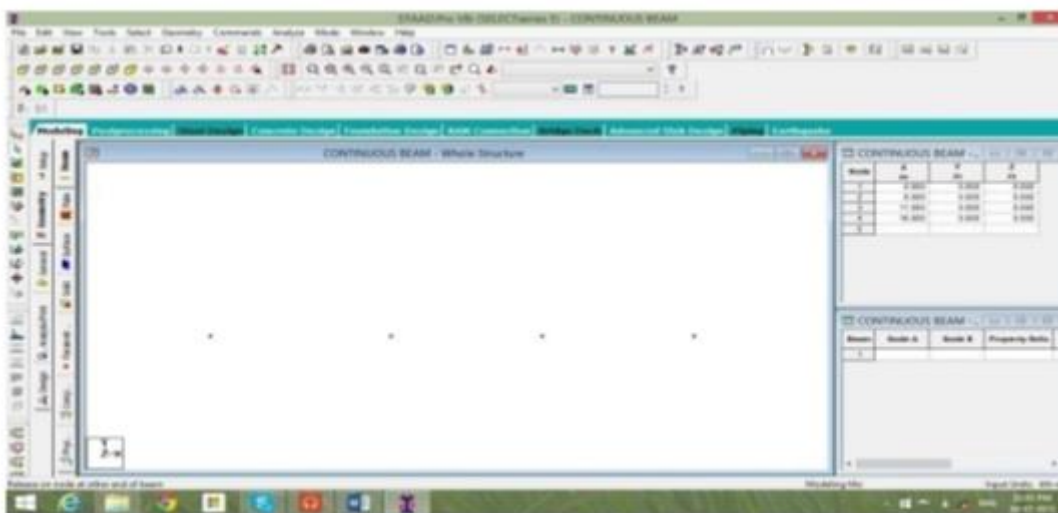


3. Add beam , Finish

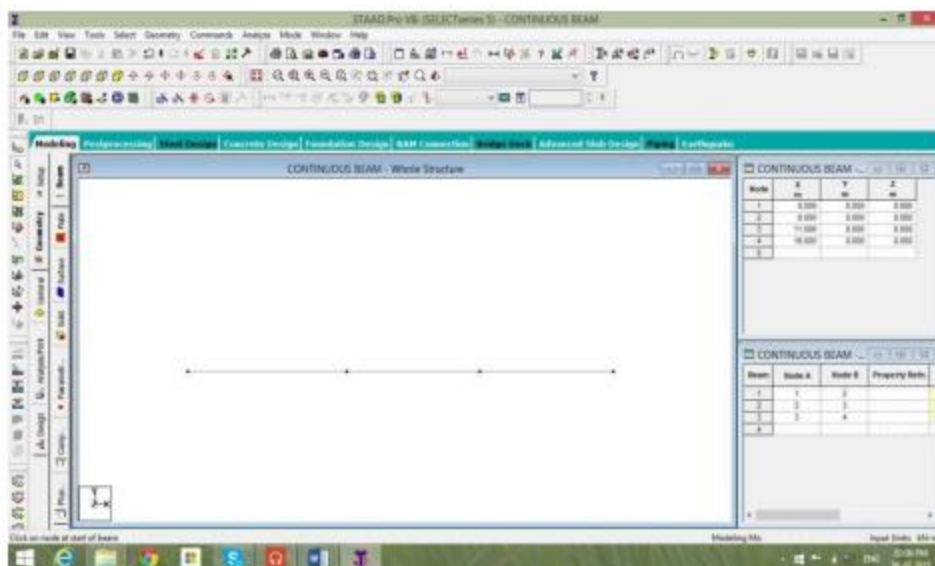


4. Click on XY plane and cut Screen (Snap node/beam) screen by clicking at right top corner.

5. Enter Coordinates of each joint of above beam



6. Connect all joints by beam element, join nodes by nodes individually Now the screen should appear like a 3-span beam with nodes clearly seen at the end of each span This step is very important.

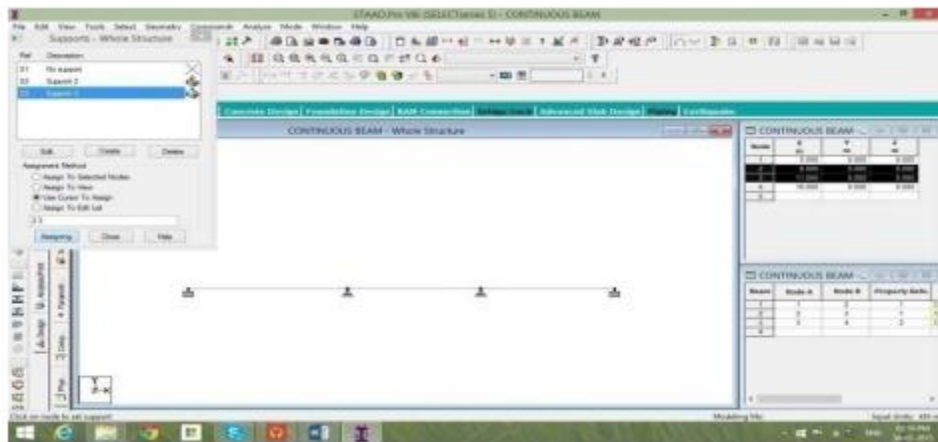


7. Now select Commands. Under this select Member Property\Prismatic and click Rectangle. Enter following details

YD = 0.45

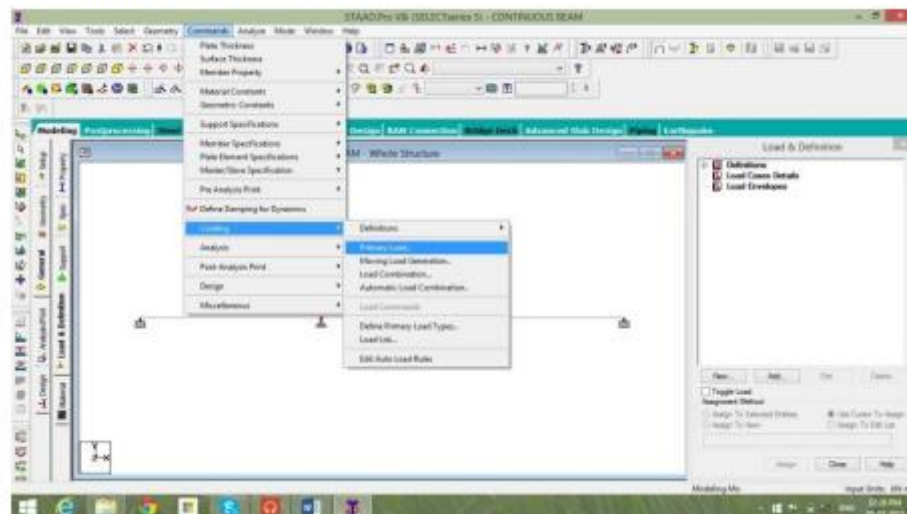
ZD= 0.30

8. Now repeat above steps and assign Pin support to remaining two central supports.

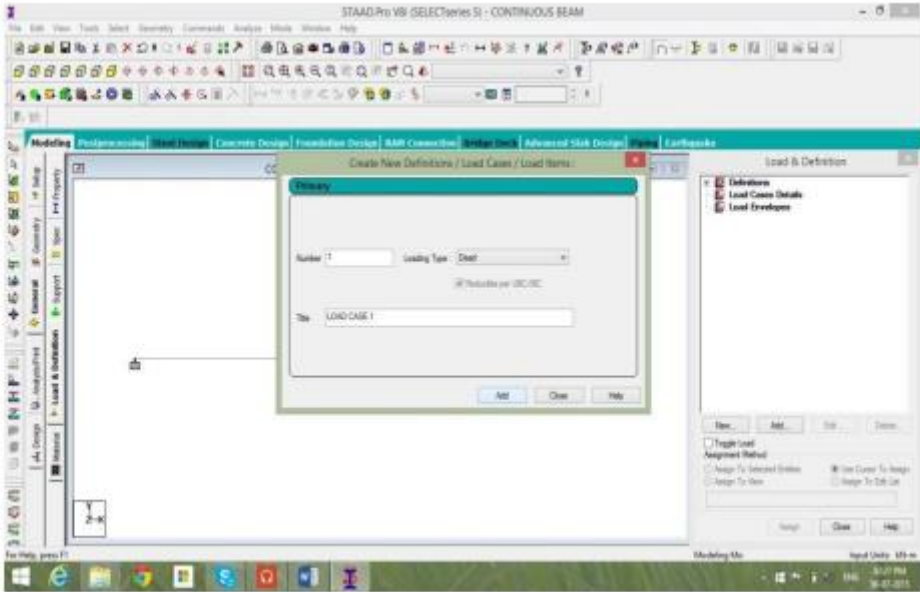


9. Select Commands\Loading\Primary Load

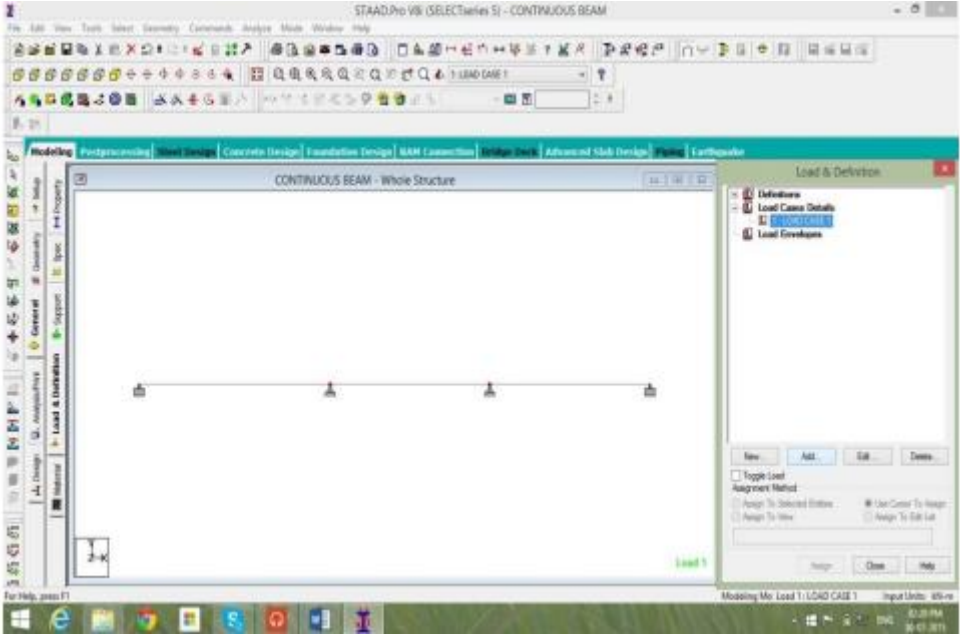
***** Loading Primary Load *****

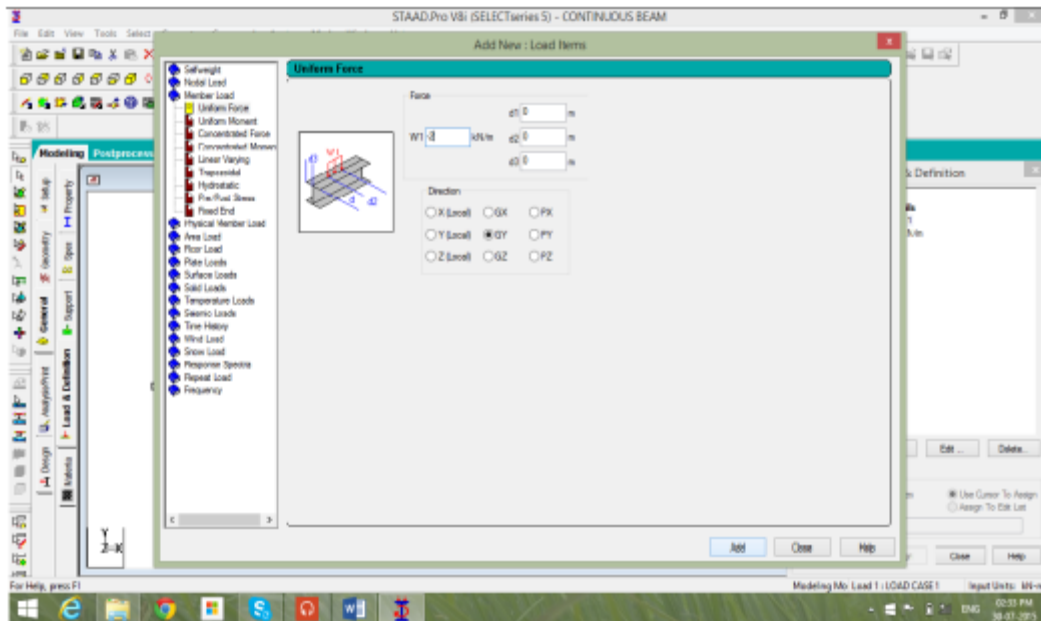


Number 1 , Loading type DEAD , Title Load Case 1 , Add , Close

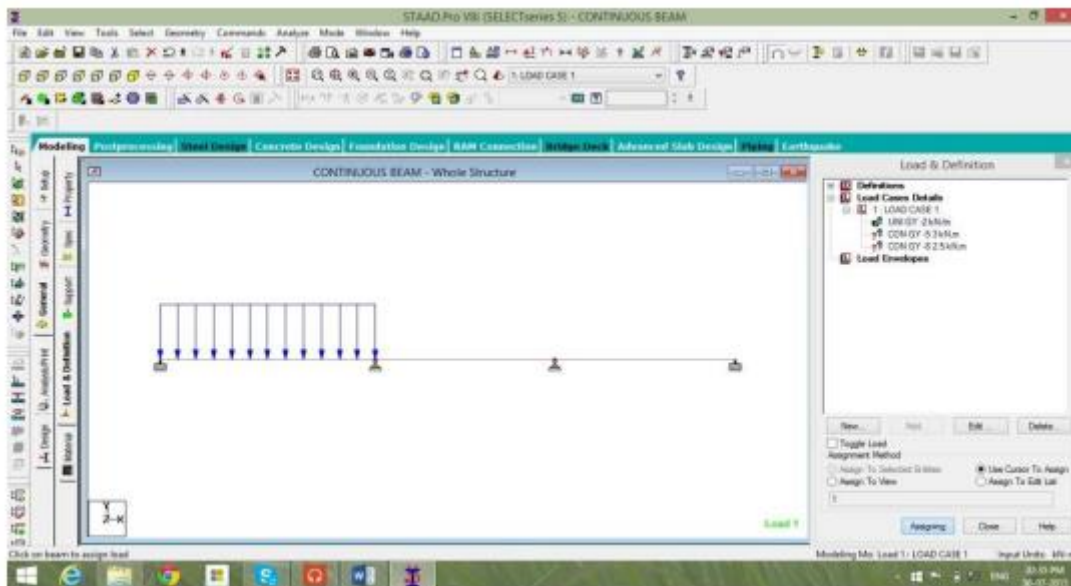


Now click on Load case 1 , New , Load Items , Member load , Uniform Load , W1 , -2 kn m Add

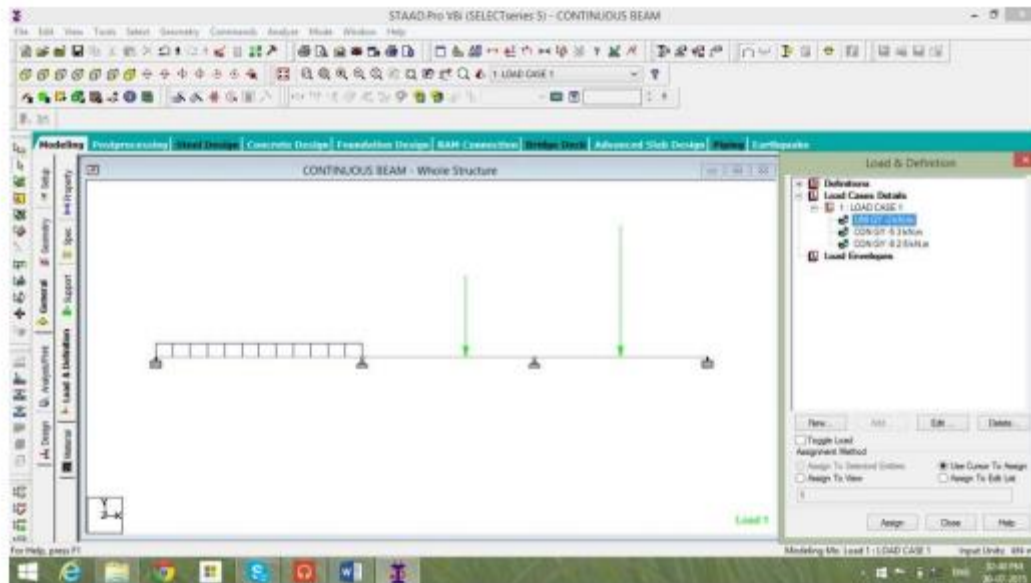




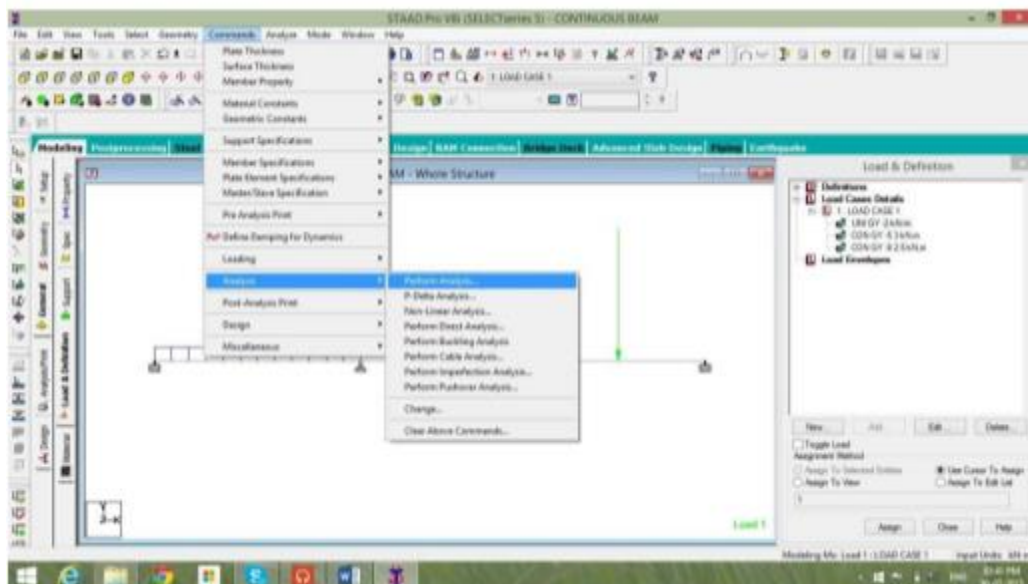
Then Concentrated force P -5 d1 3 Add , then P -8 d1 2.5 Add close Now click on UNI GY -2 kn/m
 use cursor to Assign, Click on first Span.



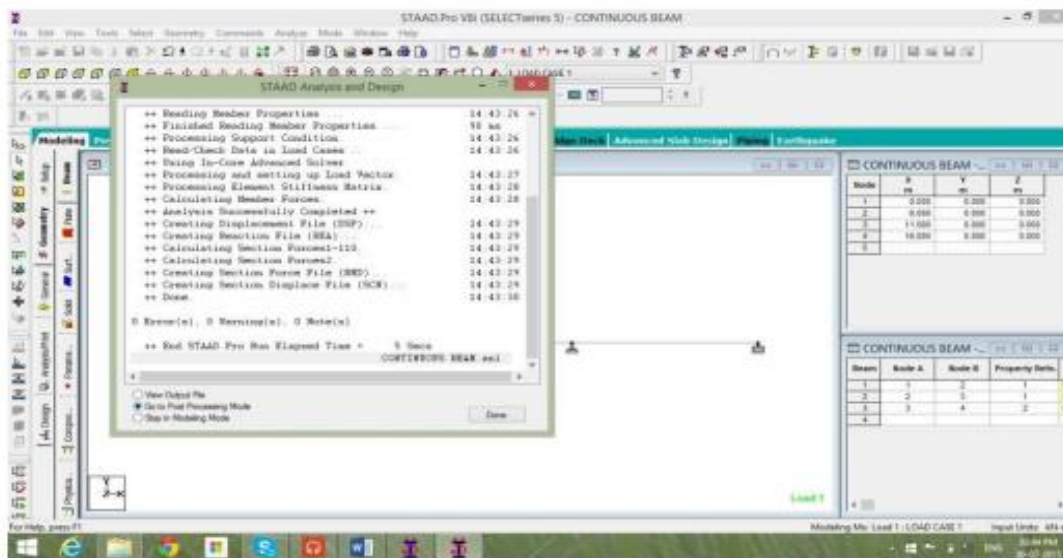
Similarly assign 5kn and 8Kn on remaining two spans and then click close To verify whether all loads are assigned correctly or not Click on Load details menu on menu bar And click load view, now load diagram with values should be seen on main diagram



10. Now Commands\Analysis\Perform Analysis, select all, ok.



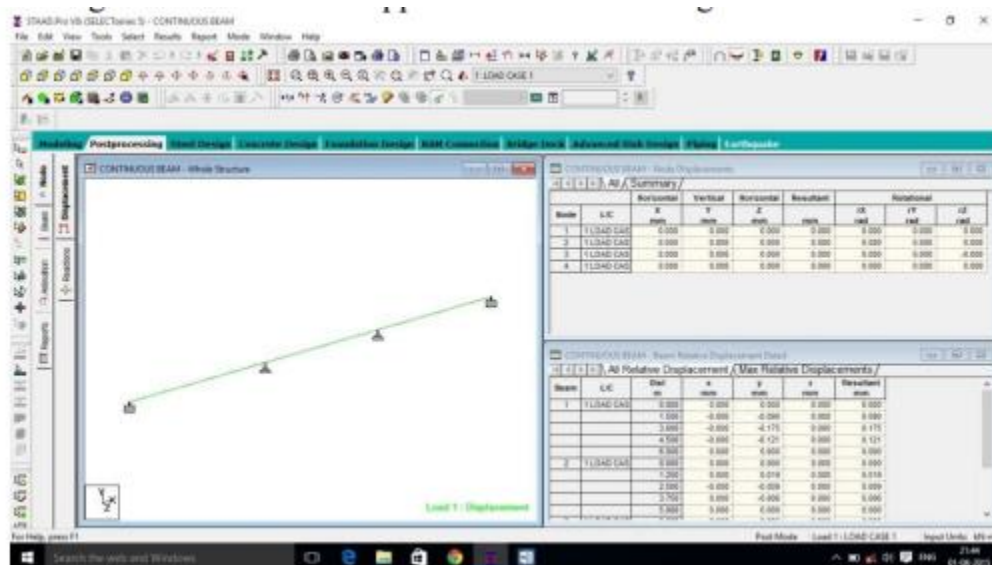
11. Now Click Analysis\Run analysis Click Staad Analysis After a time, display will show number of errors & warning messages if any then



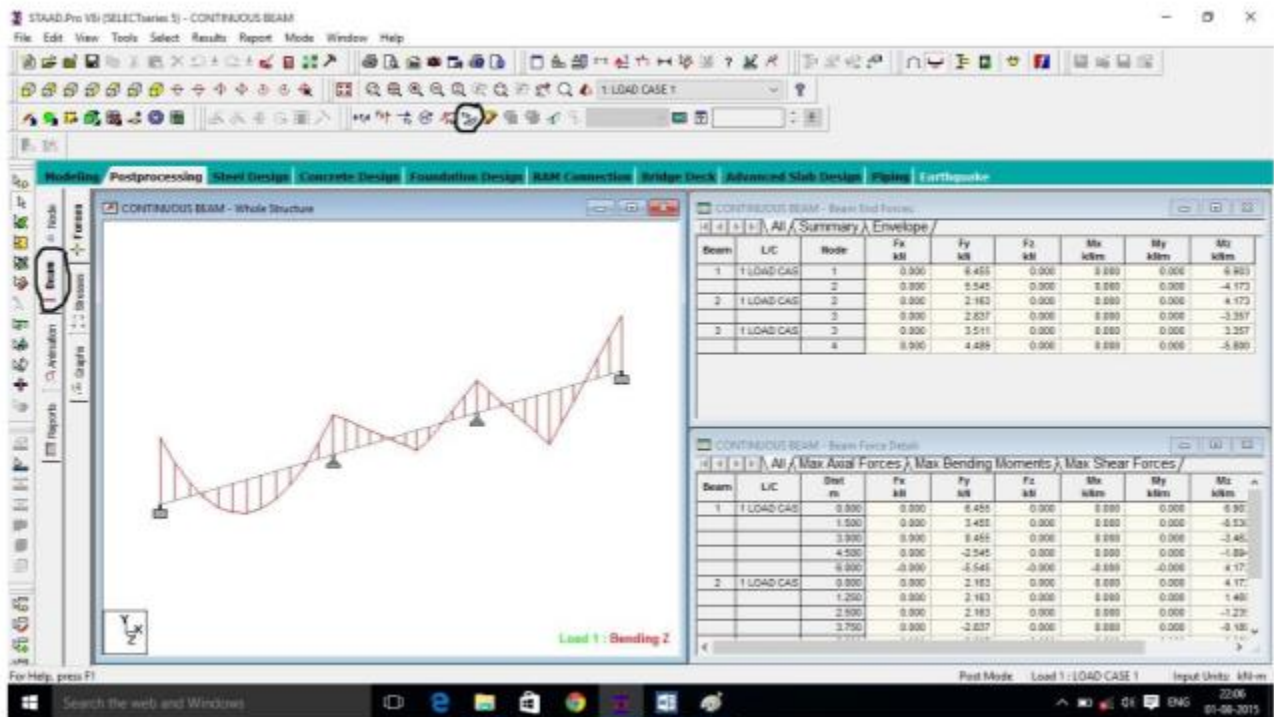
12. Now Staad pro has executed analysis of continuous beam and the results of the analysis are to be seen on Post processing mode.

Click _Go to Post Processing mode_ Similarly 'Done ' 'Apply ' 'OK'

The post processing mode window will appear as shown in the fig. Below.



13. To see the bending moment diagram of the analysed beam click on the **beam** tab at left side of the working window. Click on **Mz** button on the menu bar at top of the working window. You should see the BMD as shown in the figure below (Holding down the ctrl button scroll the **mouse wheel** to adjust the scale to your convenience). Go to **reactions** menu >> **view value** >> **beam results** and check the boxes **ends, maximum and midpoint** under **bending** to see the value of **BMD** at respective locations.
14. To see the shear force diagram click on the **beam** tab at left side of the working window. Click on **Fy** button on the menu bar at top of the working window. You should see the SFD as shown in the figure below (Holding down the ctrl button scroll the **mouse wheel** to adjust the scale to your convenience). Go to **reactions** menu >> **view value** >> **beam results** and check the boxes **ends, maximum and midpoint** under **shear** to see the value of **SFD** at respective locations.



Result:

Viva Questions:

1. Define a Continuous beam.
2. What are the different types of supports used in Continuous beam?
3. What type of loads used on continuous beam?
4. What is the bending moment at hinge support?
5. How to create the supports?
6. How to see B.M.D in Continuous beam?
7. How to see S.F.D in Continuous beam?
8. Where to see the Results?
9. How many types of loads are there?
10. What is Self-weight of beam?

Experiment-11

Analysis of single storey frame using STAAD Pro

Aim: To analyze the single storeyed space frame using STAAD pro

Hardware & software required: Computer with specified configuration with installed STAAD Pro Software

PROCEDURE AND ANALYSIS STEPS:

Staad foundation:

Staad foundation is a powerful tool used to calculate different types of foundations. It is also licensed by Bentley software's. All Bentley software's cost about 10 lakhs and so all engineers can't use it due to heavy cost.

Analysis and design carried in Staad and post processing in staad gives the load at various supports. These supports are to be imported into this software to calculate the footing details i.e., regarding the geometry and reinforcement details.

This software can deal different types of foundations

SHALLOW ($D < B$)

1. Isolated (Spread) Footing
2. Combined (Strip) Footing
3. Mat (Raft) Foundation

DEEP ($D > B$)

1. Pile Cap
2. Drilled Pier

1. Isolated footing is spread footing which is common type of footing.
2. Combined Footing or Strap footing is generally laid when two columns are very near to each other.
3. Mat foundation is generally laid at places where soil has less soil bearing capacity.
4. pile foundation is laid at places with very loose soils and where deep excavations are required.

So depending on the soil at type we has to decide the type of foundation required. Also, lot of input data is required regarding safety factors, soil, materials used should begiven in respective units. After input data is give software design the details for each and every footing and gives the details regarding

1. Geometry of footing
2. Reinforcement
3. Column layout
4. Graphs
5. Manual calculations
6. These details will be given in detail for each and every column.
7. Another advantage of foundations is even after the design; properties of the
8. members can beupdated if required.
9. The following properties can be updated
10. Column Position
11. Column Shape
12. Column Size
13. Load Cases
14. Support List

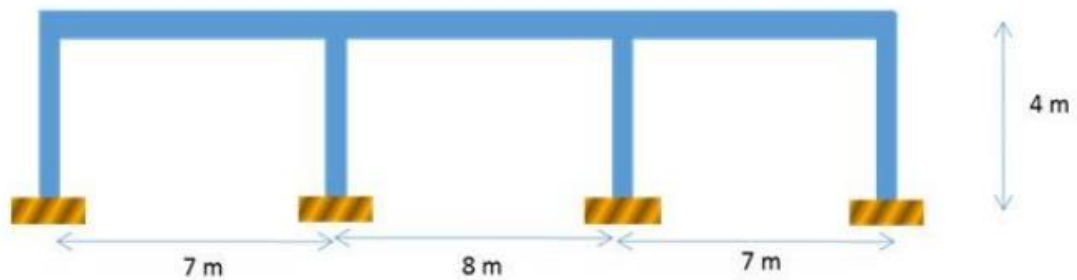
The multistoried frame represents the center line diagram of the building in staad pro.

Each support represents the location of different columns in the structure. This structure is used in generating the entire structure using a tool called transitional repeat and link steps.

After using the tool the structure that is created can be analyzed in staad pro under various loading cases.

Below figure represents the skeletal structure of the building which is used to carry out the analysis of our building. All the loadings are acted on this skeletal structure to carry out the analysis of our building .This is not the actual structure but just represents the outline of the building in staad pro.

A mesh is automatically created for the analysis of these building.



Load Conditions and Structural System Response :

The concepts presented in this section provide an overview of building loads and their effect on the structural response of typical wood-framed homes. As shown in Table, building loads can be divided into types based on the orientation of the structural action or forces that they induce: vertical and horizontal (i.e., lateral) loads. Classification of loads are described in the following sections.

Building Loads Categorized by Orientation:

Types of loads on an hypothetical building are as follows.

Vertical Loads

Dead (gravity)

Live (gravity)

Snow(gravity)

Wind(uplift on roof)

Seismic and wind (overturning)

Seismic(vertical ground motion)

Horizontal (Lateral) Loads:

Direction of loads is horizontal w.r.t to the building.

Wind

Seismic(horizontal ground motion)

Flood(static and dynamic hydraulic forces)

Soil(active lateral pressure)

Dead load calculation

Weight=Volume x Density

Self-weight floor finish= $0.12 \times 25 + 1 = 3 \text{ kn/m}^2$

The above example shows a sample calculation of dead load.

Dead load is calculated as per IS 875 part 1

Generally, for any structure live load is taken as 25 N/mm for design.

Live loads are calculated as per IS 875 part 2

Wind loads:

In the list of loads we can see wind load is present both in vertical and horizontal loads. This is because wind load causes uplift of the roof by creating a negative(suction) pressure on the top of the roof. After designing wind load can be assigned in two ways

1. Collecting the standard values of load intensities for a particular height and assigning of the loads for respective height.
2. Calculation of wind load as per IS 875 part 3.

We designed our structure using second method which involves the calculation of wind load using wind speed. In Hyderabad we have a wind speed of 45 kmph for 10 m height and this value is used in Calculation.

Floor load:

Floor load is calculated based on the load on the slabs. Assignment of floor load is done by creating a load case for floor load. After the assignment of floor load our structure looks as shown in the below figure.

The intensity of the floor load taken is: 0.0035 N/mm²

-ve sign indicates that floor load is acting downwards

Load combinations:

All the load cases are tested by taking load factors and analyzing the building in different load combination as per IS456 and analyzed the building for all the load combinations and results are taken and maximum load combination is selected for the design Load factors as per IS456-2000

When the building is designed for both wind and seismic loads maximum of both is taken.

Live load	dead load	wind load
1.5	1.5	0
1.2	1.2	1.2
0.9	0.9	0.9

Because wind and seismic do not come at same time as per code. Structure is analyzed by taking all the above combinations.

Result:

Viva Questions:

1. How many types of models are available in structure wizard?
2. How can you import the AUTO CAD drawings into STAAD pro?
3. What are the different types of analysis in STAAD pro?
4. In how many ways can we assign support to nodes?
5. In STAAD pro we have only add beam tool but not add column then how can we add columns?
6. What is the name of extension file of STAAD pro ?
7. How many types of meshing we have in STAAD pro?
8. How to select beams in staad.pro?
9. STAAD pro perform analysis is?
10. Who invented STAAD pro?