SRM VALLIAMMAI ENGINEERING COLLEGE

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[An Autonomous Institution]

DEPARTMENT OF AGRICULTURE ENGINEERING
ACADEMIC YEAR: 2025-2026

LAB MANUAL

AG3664 CAD FOR AGRICULTURAL MACHINERY

2023 Regulation

VI Semester B.Tech. Agricultural Engineering

LAB MANUAL

(2025-2026 ACADEMIC YEAR)

Prepared by:

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GENERAL INSTRUCTIONS

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

- Students should wear lab coat in CAD lab.

- Students are advised to enter the CAD lab WITH FORMAL SHOES ONLY.

- They are not supposed to move the systems and monitors.

- They should enter in the login name and password assigned to each student.

- Students are advised to complete their record work before the next class.

- Students are asked to logout from their area and switch off the computers before leaving the lab.

- Students can access the printers through lab technician.

- Students have free access to use the computers and software available in the lab.

- During the laboratory hours, accessing the internet is strictly prohibited.

- Computer games are strictly prohibited in the CAD lab.

VISION OF THE INSTITUTE

"Educate to excel in Social Transformation"

To accomplish and maintain international eminence and become a model institution for higher learning through dedicated development of minds, advancement of knowledge and professional application of skills to meet the global demands.

MISSION OF THE INSTITUTE

To contribute to the development of human resources in the form of professional engineers and managers of international excellence and competence with high motivation and dynamism, who besides serving as ideal citizen of our country will contribute substantially to the economic development and advancement in their chosen areas of specialization.

To build the institution with international repute in education in several areas at several levels with specific emphasis to promote higher education and research through strong institute industry interaction and consultancy.

VISION OF THE DEPARTMENT

To produce world class professionals who are equipped to meet the demands of global outfit, have analytical abilities and entrepreneurship for making career of self-employment and as contributors to Livelihood and Food / Nutritional Security.

MISSION OF THE DEPARTMENT

M1: To ensure effective teaching learning process to provide in-depth knowledge of principles and its application pertaining to Agricultural Engineering.

M2: To import practical knowledge to students about the conventional and technology based agricultural systems.

M3: To provide engineering and technology expertise in the field of agriculture for the state and nation.

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

1. To train and educate students with general knowledge and skills in agricultural water management, agricultural production process, farm machinery and farm management.
2. To provide a sound theoretical knowledge in engineering principles applied to agriculture.
3. To prepare students for a successful agricultural engineering career integrating all aspects of engineering in agriculture.
4. To develop innovative capacity of students for increasing agricultural production with scarce water resources available.

2. PROGRAMME OUTCOMES (POs):

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

Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering Problems.

Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of Mathematics, natural sciences, and engineering sciences.

Design / Development of solutions: Design solutions for complex 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.

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.

Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

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 professional engineering practice.

Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

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.

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.

Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

3. PROGRAM SPECIFIC OUTCOMES (PSOs):

Establish an Agricultural Engineering career in industry, government or academic field and achieve professional expertise as appropriate.

Execute innovation and excellence in Agricultural engineering problem solving and design in global and societal contexts.

Commit to lifelong learning and professional development in the agriculture engineering field to stay updated in technology, research topics and contemporary issues.

Understand the fundamentals of Agriculture engineering in commercial contexts and in expediting irrigation projects.

4. **PEO / PO Mapping:**

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES												PROGRAM SPECIFIC OUTCOMES			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
1.	3	1	1	1	3	3	3	3	3	3	1	3	3	3	2	3
2.	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
3.	1			3	3	3	1	1	3		3	1	3	3	3	2
4.	3			1	3	3	3		3	3	3	3	3	3	3	3

Contribution: 1.Reasonable 2.Significant 3. Strong

AG3664   **CAD FOR AGRICULTURAL MACHINERY**   **L   T   P   C**

                                                                0   0   3   1.5

OBJECTIVES:

- To design and draft various ploughs.

- To design and draft Cultivators.

- To design and draft various harrows.

- To design and draft mower and weeder.

- To introduce the student's various 3D modeling Software's.

LIST OF EXPERIMENTS:

1. Design and Drawing of Mould board plough
2. Design and Drawing of Disk plough.
3. Design and Drawing of Cultivator.
4. Design and Drawing of Disc Harrow
5. Design and Drawing of Mower
6. Design and Drawing of Weeder
7. Introduction & demonstration on 3D modeling softwares like Pro/E, Creo, Solidworks, Solid Edge etc.,

TOTAL:30 PERIODS

COURSE OUTCOMES:

At the end of the course, the student should be able:

1. Learning about the design and draw the various ploughs.

2. Understanding design and draw the cultivators.

3. Design and draw the various harrows.

4. Studying about design and draw the mower and weeder.

5. learn about the 3D modelling software.

TEXTBOOKS:

1. Sharma D.N. &Mukesh, "Farm Machinery Design Principles & Problems",Jain Bros; 4th edition, December 2012.

2. Massimiliano Varani, Design, Optimization and Analysis of Agricultural Machinery, MDPI Books, 2024.

3. Hijam Jiten Singh, Mukesh Kumar Singh, N. S. Chandel, K. P. Singh, Development and Production of Agricultural Machinery Using Computer-Aided Design, Indian Farming, Vol. 66 No. 1, 2016.

4. Basavaraj, Srigiri, & Jayan, A Textbook of Farm Machinery & Power Engineering, New India Publishing Agency- Nipa,2019.

5. Seung-Kyum Choi, Recep M. Gorguluarslan, and Qi Zhou, Computer-Aided Manufacturing and Design, MDPI Books, 2020.

REFERENCE BOOKS:

1. Karthik, Ravi Natrajan, Design of Agricultural Machinery and Equipment, Agri Horti Press, 2024.

2. Guangnan Chen, Advances in Agricultural Machinery and Technologies, CRC Press, 2018.

3. Mustafa Ucgul and Chung-Liang Chang, Design and Application of Agricultural Equipment in Tillage System, MDPI Books, 2023.

4. Han Zhongzhi, Computer Vision-Based Agriculture Engineering, CRC Press, 2020.

5. Zhuming Bi and Xiaoqin Wang, Computer-Aided Design and Manufacturing, Wiley- ASME Press,2020.

AG3664	PO												PSO			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**
CO1	2	-	-	1	-	3	-	1	3	2	1	3	2	1	3	1
CO2	1	-	3	1	-	1	2	-	1	1	-	3	1	1	3	2
CO3	-	1	-	1	-	2	1	-	-	-	-	1	1	2	3	2
CO4	-	3	2	1	-	1	1	-	1	-	-	2	2	1	2	3
CO5	-	-	3	1	2	1	3	-	1	-	-	3	2	1	3	1
Average	1.5	2.0	2.7	1.0	2.0	1.6	1.8	1.0	1.5	1.5	1.0	2.4	1.6	1.2	2.8	1.8

1. INTRODUCTION

Computer Aided Drafting is a process of preparing a drawing of an object on the screen of a computer. There are various types of drawings in different fields of engineering and sciences. In the fields of mechanical or aeronautical engineering, the drawings of machine components and the layouts of them are prepared. In the field of civil engineering, plans and layouts of the buildings are prepared. In the field of electrical engineering, the layouts of power distribution system are prepared. In all fields of engineering use of computer is made for drawing and drafting.

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

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

REASONS FOR IMPLEMENTING A CAD SYSTEM

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

APPLICATION OF CAD:

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

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

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

computer and the human designer.

BENEFITS OF CAD:

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

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

LIMITATIONS OF CAD

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

CAD SOFTWARES

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

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

- HYPERMESH
- FLUENT – GAMBIT

The above software is used depending upon their application.

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

## 2. <u>AutoCAD – BASICS</u>

<u>STARTING WITH ACAD</u>
CAD uses four basic elements for preparation of any drawing:
1. Line
2. Curves
3. Text
4. Filling point.

   Computer aided drafting id done by the operator by placing the mouse pointer by placing the mouse pointer at the desired location and then executing the command to draw the graphic elements using different methods.

   Advanced computer aided drafting packages utilize four areas on the screen.
1. Drawing area
2. Command area
3. Menu area
4. Tool boxes.
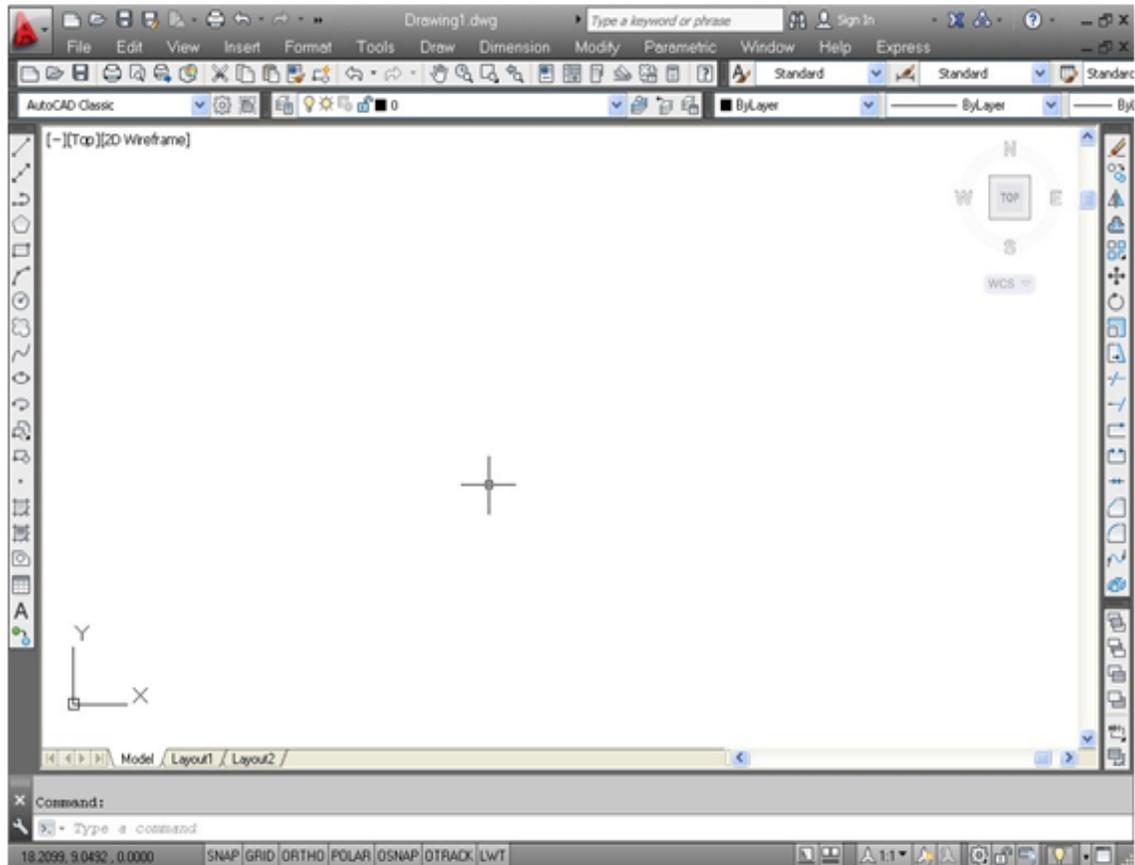
LAYOUT AND SKETCHING

The package provides various facilities for layout, sketching and borders for preparing a drawing. It provides facilities for display co-ordinates and measurement units.

Units: The format for display co – ordinates and measurement can be selected according to the requirement. Several measurement styles are available in ACAD. The main methods are engineering and architectural, having specific base unit assigned to them.

- Decimal: select to enter and display measurements in decimal notation
- Engineering: Display measurements in feet and decimal inches.
- Architectural: Display measurements in feet, inches and fractional inches
- Fractional: Display measurements in mixed numbers notation
- Scientific: Display measurements in scientific notation.

The precision that is specified controls the number of decimal places or fractional size to which we want linear measurements displayed.

Angles: Select the format in which we want to enter and display angles.

- Decimal Degrees: Display partial degrees as decimals
- Deg/Min/Sec: Display partial degrees as minutes and seconds.
- Grades: Display Angles as grades

- Radians: Display angles as radians.
- Surveyor: Displays angles in surveyor units.

Angle measure: Select the direction of the zero angle for the entry of angles:
- East: Select to specify the compass direction east as the zero angle.
- North: Select to specify the compass direction north as the zero angle.
- West: Select to specify the compass direction west as the zero angle.
- South: Select to specify the compass direction south as the zero angle.
- Other: Select to specify a direction different from the points of the compass as the zero angles.

Area: Enter the approximate width and length which is planned to draw in full scale units. This limits the area of the drawing covered by grid dots when the grid is turned on. It also adjusts several default settings, such as text height, line type scaling and snap distance to convenient values. It is possible to adjust these settings.

Title block: Select the description of an ACAD drawing file of a title block to insert as a symbol in the new drawing. It can add or remove drawing files of title blocks from the list with the Add or Remove buttons

Layout: Paper space is often used to create complex multiple view drawings. There are three types of paper spaces:
- Work on the drawing while viewing the layout.
- Work on the drawing without the layout visible
- Work on the layout of the drawing.

The following procedure is used for this purpose

- From the File menu or from the standard tool bar, choose New
- In the startup dialog box, choose Use a wizard, and select Advanced wizard
- Choose OK
- In the Advanced Setup Dialog box, Select Title Block.
- Select Title Block Description and Title Block file Name from the lists and then choose Add.
- In the Select Title Block File dialog box, Select a title block, then choose open
- In the Advanced Setup dialog box, a sample of that title is displayed.
- Choose Done.

DRAWING ENVIRONMENT

ACAD provides two drawing environments for creating and laying out the drawing.

- Model Space
- Layout Space.

ACAD allows creating drawing, called a model, in full scale in an area known as model space without

regard to the final layout or size when the drawing is plotted on the paper.

In the space opened for the first time, it is possible to create floating viewports to contain different views of the model. In the paper space, floating viewports are treated as objects which can be moved and resized in order to create a suitable layout.

1. LIMITS

This sets and controls the drawing boundaries. At the command prompt, enter **limits**
ON/OFF/<LOWER LEFT CORNER> <current>: Specify a point, enter on or off, or press enter.
2. LTSCALE
This sets the line type scale factor. Use LTSCALE to change the relative length of the dash –dot line types per drawing unit

At the Command prompt, enter **ltscale**

New scale factor <current> : Enter a positive real value or press enter Changing the line type scale factor causes the drawing to regenerate. MEASURE
This places point objects or blocks at measured intervals on an object. At the command prompt, enter **measure**
Select object to measure: Use an object selection method / Block: Specify a distance.

3. PAN

This moves the drawing display in the current viewport. At the command prompt , enter **pan**
Displacement: Specify a point (1)

The point which specify indicates the amount to move the drawing or the location of the drawing to be moved.
Second point: Press or specify a point (2)

If pressed, ACAD moves the drawing by the amount which is specified in the Displacement prompt. If we specify a point, ACAD moves the location of the drawing to that point.

ELEMENTS OF DRAWING

1. DRAW COMMANDSLINE:
A line is specified by giving its two end points or first point and the distance of line along with its angle of inclination. A line can be drawn by using two commands.

Command: **line**

Specify first point: Specify a point (1)

Specify next point or [Undo]: Specify a point (2)The second point can be indicated by **@d<a**
Where **d** is the distance of line and **a is** the angle of inclination in degrees.

2. PLINE:

This is a poly line which allows continuous segment of the line and it is drawn similar to the line
command. The polyline allows changing the thickness of the line according to the requirement.

From the Draw tool bar choose the Polyline fly out.Draw pull down menu: **Polyline**
At the command prompt, enter **pline Syntax**
Specify start point: Specify a point (1)

Current line-width is <current>

Specify next point or [Arc/Close/Half width/Length/Undo/Width]: Specify a point (2) or enter an
option
3. LINETYPE

Creates, loads, and sets line types. The LINETYPE command defines line characteristicsconsisting of
dashes, dots, and spaces.

Format menu: Line type or Command line: line type
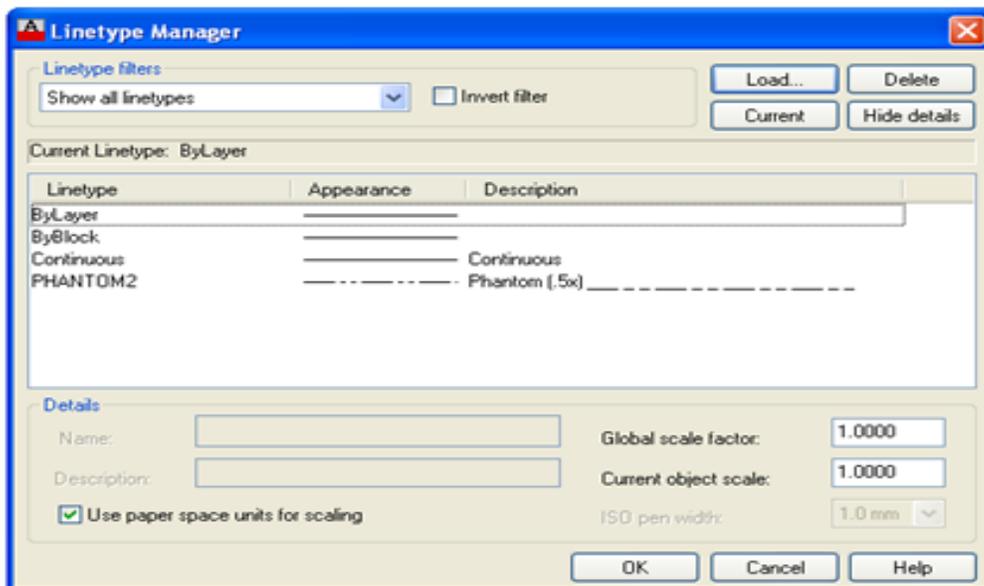
4. CURVES

Following are the various types of curves used in the drawings:

      i.   Circle

      ii.   Ellipse

      iii.   Arc

      iv.   Regular or any other type.

Circle: The circle can be drawn by using two types of commands

      a.   **Circle**

      b.   **Donut**

i. CIRCLE: This command draws the circle by using four methods:

- Center point and radius

- Two point circle

- Three point circle

- Tangent circle

At the command prompt, enter **circle**

Specify center point for circle or [3P (Three Points)/2P (Two Points)/Ttr]: Specify a point or enter an option

ii. DONUT: This draws filled circles and rings.

Donuts are constructed of a closed polyline composed of wide arc segments. At the command prompt, enter **donut**

Specify inside diameter of donut <current>: Specify a distance or press ENTER

If you specify an inside diameter of 0, the donut is a filled circle.

Specify outside diameter of donut <current>: Specify a distance or press ENTER

Specify center of donut or <exit>: Specify a point (1) or press ENTER to end the command

iii. ELLIPSE: It is a curve having major and minor axis with a center.

The ellipse can be prepared by four methods.

Axis endpoint
Arc
Centre
Iso circle
iv. ELLIPSE

 Creates an ellipse or an elliptic arc.

Axis end point: Defines the first axis by two specified endpoints. The angle of the first axis determines the angle of the ellipse. The first axis can define either the major or the minor axisof the ellipse.

Arc: Creates an elliptical arc. The angle of the first axis determines the angle of the ellipticalarc. The first axis can define either the major or the minor axis of the elliptical arc.

Center: Creates the ellipse by a specified center point.

Isocircle: Creates an isometric circle in the current isometric drawing plane.

At the command prompt, enter **ellipse**

Arc: The arc is a curve specified by center and radius as well as the start angle andend angle . There are seven method used for drawing an arc.

- Three point method

- Start point-center point –end point

- Start point-center point-length of chord

- Start point-end point –angle of inclusion

- Start point-end point-direction

- Start point-center point-angle of inclusion

- Start point-end point-radius

These methods can be used by executing the arc command

5. ARC: creates an arc.

At the command prompt, enter arc

Center/<start point>: specify a point, enter c, or press enter

Polyarc: the second method of the drawing the arc is poly arc by use of pline command. This command allows drawing of filled arc of any width .it also allows fordrawing of a regular or irregular curve.

Drawing of Rectangle: A rectangle can be drawn by LINE command or by Rectanglecommand. The **PLINE** command also allows for drawing of hollow or filled rectangle .A **SOLID** command is also used for drawing of filled rectangles.

1. RECTANGLES: draws a rectangular polylineAt the command prompt, enter **rectangle**
First corner: specify point (1)Other corner: specify point (2)
2. SOLID: creates solid –filled polygons .solids are filled only when fill system variableis set to on view is set to plan.

At the command prompt, enter **solid**

First corner: specify point (1)Other corner: specify point (2)
The first two points define one edge of the polygon.

Third point: specify a point (3) diagonally opposite the secondForth point: specify a point (4) or press enter
3. DRAWING OF POLYGON

Creates an equilateral closed polyline .A polygon is a polyline object. AUTOCAD drawspolyline with zero width and no tangent information.

At the command prompt enter **polygon**

Number of sides <**current**>: enter a value between **3 and 1024** or press enter Edge/<center of polygon>: **specify a point (1) or enter**.
4. POINT

Creates a point object .points can act as nodes to which you can snap objects .you can specifya full 3D location for a point.

At the command prompt, enter **point**

Point: specify a point

5. ERASING OF OBJECT:

The object can be removed or erased by use of erase commandERASE
This removes object from drawing at the command prompt, enter **erase**
Select objects: use an object selection method.

6. COLOURING OF OBJECT:

The object can be drawn with any variety of colour which ranges from 0 to 256.The setting of colour can be done by color command
COLOR
Sets the colour for new objects.

At the command prompt, enter color <current>: enter a value (1-255), color name, by block, orby layer

7. FILLING OF OBJECT: the object can be filled with different colors and patternsby use of hatch command

This command allows selection of various patterns, scale of pattern and angle of pattern.

i.   Style: these are four types: normal, bold, italic, underline
ii.   Size: this is the size of characters
iii.   Colour: there are facilities to colour the characters selecting layer.
iv.   Type: different types of fonts may be used:
Mono text: COMPUTER AIDED DESIGN Romans: COMPUTER AIDED DESIGN Romand: **COMPUTER AIDED DESIGN**
Dtext: This displays text on the screen as it is entered .AutoCAD can create text with a variety of character patterns, or fonts. These fonts can be stretched, compressed, oblique, mirrored, or aligned in a vertical column by applying a style to the font .text can be rotated, justified, and made any size.

At the command prompt, enter text

Justify/style/<start point>: specify a point or enter an option

TEXT: This creates a single line of text .AutoCAD can create text with a variety of character patterns, or fonts. These fonts can be stretched, compressed, oblique, mirrored, or aligned in a vertical column by applying a style to the font.

At the command prompt, enter text

Justify/style/<start point>: specify a point or enter an option

QTEXT: This controls the display and plotting of text and attribute of objects. At the command prompt, enter text

ON/OFF <current>: enter on or off, or press enter

TRANSFORMATIONS: These are the modifications in the drawn objects.

There are different types of transformations used

1. MOVE: This allows to move or displace objects a specified distance in a specified direction.
At the command prompt, enter move

Select objects: use an object selection method

Base point or displacement: specify a base point (1)

Second point of displacement: specify a point (2) or press enter

2. COPY: This is used for producing a duplicate copy of the drawing.

At the command prompt, enter copy

Select objects: use an object selection method

<Base point or displacement >/multiple: specify a base point (1) for a single copy or enter m for multiple copies
3. ROTATE: It moves objects about a base point At the command prompt, enter rotate
Select objects: use an object selection method

<Rotate angle >/reference: specify an angle or enter r

4. STRETCH: This moves or stretches objects .AutoCAD stretches lines, arcs, elliptical arcs, splines, rays and polyline segments that cross the selection window.

At the command prompt, enter stretch

Select objects: use the CPOLYGON or cross object selection method (1, 2) Base point or displacement: specify a point (3) or press
Second point of displacement: specify a point ($) or press

5. EXTEND: This extends an object to meet another object. Objects that can be extended include arcs, elliptical arcs, lines, open 2D, and 3Dpolylines and rays.

At command prompt, enter extend.
Select boundary edges

(projmode=UCS, edge mode=no extend) Select objects: use an object selection method

6. SCALE: This enlarges or reduces selected objects equally in X and Y directions At the command prompt, enter scale

Select objects: use an object selection method Base point: specify a point (1)

<Scale factor>/reference: specify a scale or enter r

7. TRACE: This creates solid lines.

From the miscellaneous tool bar choose At the command prompt, enter trace

Trace width<current>: specify a distance, enter a value ,or press enter From point: specify point (1)

To point: specify a point (2)

To point: specify a point (3) or press to end the command

8. EXTRUDE: This creates unique solid primitives by extruding existing two- dimensional objects extrudes also creates solids by extruding two-dimensional objects along a specified path .we can extrude multiple objects with extrude

At the command prompt enter, extrude

Select objects: use an object selection method Path/<height of extrusion>: specify a distance or enter p

9. MIRROR: This is used to producing mirror image of the object

At the command prompt enter, mirror

Select objects: use an object selection method First point of the mirror line: specify a point (1) Second point: specify a point (2)

10. OFFSET: This creates concentric circles, parallel lines and parallel curves, offset creates a creates a new object at a specified distance from an existing object or through a specified point

At the command prompt enter, offset

Offset distance: specify a distance, enter t or press enter

11. ARRAY: This creates multiple copies of objects in pattern. Arrays are three types.

a)   Rectangular Array

b)   Path Array

c)   Polar Array

Rectangular Array: In this, the object is arranged in an array of rows and columns.

At the command prompt: type ARRAYRECT or select the option from MODIFY toolbar. It asks you to select objects. Select the object and press enter. By default it shows an array of 3 rows and 4 columns. The no. of rows and columns can be changed by selecting the Count.

Option (OR) by selecting COLUMNS and ROWS options separately

Path Array: In this, an object is arranged in a specified path.

At the command prompt: type ARRAYPATH or select the option from MODIFY toolbar. Then select

object to be arrayed. Then select the path through which the object is made to be arrayed.

12. CUTTING OF OBJECTS
The drawn objects can be cut or trimmed by using following commands

1. TRIM: Trims objects at a cutting object defined by other objects. Objects that can be trimmed include arcs, circles, elliptical arcs, lines, open 2D and 3Dpolylines,rays and splines
At the command prompt, enter trim
Select cutting edges:
Select objects: use object selection method
<Select object to trim>/project/edge/undo: select an object, enter an option, or press enter

2. BREAK: This erases an object or splits the object in to two parts From the modify toolbar select break flyout
At the command prompt, enter break
Select objects: use an object selection method
First point of the mirror line: specify a point (1) on an object Enter second point: specify the second break point (2) or enter F

13. DIMENSIONING IN DRAWINGS:
The dimensions are inserted in the drawing by use of DIM command. There are various types of dimensions used in AutoCAD.

1. Linear dimensions:
Horizontal- this allows horizontal dimensions Vertical- this allows vertical dimensions Aligned- this allows inclined dimensions Rotated- this allows inclined dimensions

2. Angular dimensions:
This allows angular dimensioning of objects

3. Radial dimensions:
This allows radial dimensioning of arc or circle

4. Diametric dimensions:
This allows diameter dimensions of the circle

For dimensioning of objects, the first point and second point has to be specified. The dimension text must be written and then the position of dimension must be specified at the command prompt, enter dim

Dim: Enter a dimensioning mode command

14. AREA:
This allows calculation of the area and perimeter of objects or of defined areas From the object properties toolbar, choose the inquiry flyout, then
At the command prompt, enter area
<First point>/object/add/subtract: specify a point or enter option

15. FILLET
Rounds and fillets the edges of the object At the command prompt enter fillet
Polyline / Radius / Trim / <Select first object>: use an object selection method or enter an option
Select first object

Select second object: use an object selection method

Enter radius <current>: specify a distance or press

Chain / Radius <Select edge>: Select edges or enter c or r their intersection

16. CO-ORDINATE SYSTEM

The co-ordinate system can be modified in the AutoCAD. There are two types of co-ordinate systems used. The WCS (World co-ordinate system) is a universal system in which its origin is at the fixed position. The UCS (User co-ordinate system) is a system in which user can fix his origin at any point.

1. UCS: This manages user co-ordinate systems At the command prompt enter ucs

Origin / z axis/ 3 point/ object/ view/ X/Y/Z / Prev/ Restore/Save/ Del/?/< world>: enter an option or press enter

2. WCS: This manages world co-ordinate system

17. EXPLODE:

This breaks a compound object into its component objects At the command prompt enter explode

Select objects: use an object selection method.

18. UNION:

This measures the distance and angle between two points. At the command prompt, enter union

Select object: Use an object selection method

19. DIST: This measures the distance and the angle between two points .

At the command prompt area enter dist

First point: Specify a point (1)

Second point: Specify a point (2) Distance = calculated distance

Angle in XY plane = angle from XY plane = angle

Delta X = change in X Delta Y = change in Y Delta Z = change in Z.

20. REGENERATION OF DRAWING:

ACAD provides a facility of regenerating a drawing to clear the cross points or marks on the screen.

- REDRAW
- REGEN
- REGENALL
- REGENAUTO

21. TOLERANCE

This creates geometric tolerances. Geometric tolerances define the maximum allowable variations of form or profile, orientation, location and run out from the exact geometry in a drawing. They specify the required accuracy for proper function and fit the objects drawn in AutoCAD

22. SKETCH

This creates a series of free hand line segments. From the miscellaneous toolbar, choose

At the command prompt enter sketch

Follow the prompting

<div align="center">3D FUNCTIONS</div>

1. BOX

This creates a three dimensional solid box. At the command prompt enter box Center/<corner of the

box><0,0,0> :

Specify a point (1), enter c, or press enter Corner of a box

Specifying a point or pressing defines the first corner of the box. Cube/length /<other corner>: specify a point (2) or enter an option center Creates the box by a specified center point

2. CONE

This creates a 3D solid cone. A cone is solid primitive with a circular or elliptical based tapering symmetrically to a point perpendicular to its base.

At the command prompt enter cone

Elliptical /<center point> <0,0,0> : specify a point , enter e or press enter

3. CYLINDER

This creates a 3D solid cylinder. A cylinder is solid primitive with a circular or elliptical based to a point perpendicular to its base without a taper.

At the command prompt enter cylinder

Elliptical /<center point> <0,0,0> : specify a point , enter e or press enter

4. SPHERE

This creates a 3D solid sphere. A sphere is positioned so that its central axis is parallel to the Z-axis of the current UCS. Latitudinal lines are parallel to the XY plane.

At the command prompt enter sphere

Center of the sphere <0,0,0> : specify a point , enter e or press enter

5. WEDGE

This creates a three dimensional solid with a sloped face tapering along X axis. At the command prompt enter wedge

Center <corner of the wedge> <0,0,0> : specify a point , enter e or press enter Follow the prompting

6. ELEV

This sets an elevation and extrusion thickness of new objects. The current elevation is the Z value that is used whenever a 3D point is expected but only X and y values are supplied.

At the command prompt enter elev

Follow the prompting

7. SHADE

This displays a flat shaded image of the drawing in the current view port. SHADE removes hidden lines and displays a shaded picture of the drawing.

From the render toolbar, choose

At the command prompt, enter shade

8. REGION

This creates a region object from a selection set of existing objects. Regions are 2Dimensional areas you create from closed shapes.

9. REINIT

This reinitializes the input/output ports, digitizer, display and program parameters file.

10. REPLAY

This displays a GIF, TGA or TIFF image. From the tools menu, choose image, then view.

11. REVOLVE

This creates a solid by revolving a two – dimensional object about an axis. From the solids toolbar, choose

At the command prompt, enter revolve

12. SHAPE

This inserts a shape. Before inserting a shape, you must load the file containing the desired shape.

13. ROTATE 3D

This moves objects about a three dimensional axis From the modify toolbar, choose the rotate flyout then Follow the prompting

14. SECTION

This uses the intersection of a plane and solids to create a region.

AutoCAD creates regions on the current layer and inserts them at the location of the cross – section. Selecting several solids creates separate regions for each solid.

15. SLICE

This slices a set of solids with a plane.

16. SHELL

This accesses operating system commands.

17. REVOLVE

This creates a solid by revolving a two dimensional object about an axis.

18. RENDER

This creates a realistically shaded image of a three dimensional wireframe or solid model. RENDER produces an image using information from a scene, the current selection set, or the current view.

Starting the drawing

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

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

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

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

DESIGN AND DRAWING OF MOULD BOARD PLOUGH

Aim: To study the design aspects of mould board plough

Mould Board plough is the most important plough for primary tillage in canal irrigated or heavy rain areas where too much weeds grow. The objective for ploughing with a Mould Board is to completely invert and pulverize the soil, up-root all weeds, trash and crop residues and bury them under the soil. The shape of mould board is designed to cut down the soil and invent it to right side, completely burying the undesired growth which is subsequently turned into manure after decomposition.

Benefits:
- It can handle the toughest ploughing job with outstanding penetration performance.
- It is designed to work in all types of soil for basic functions such as soil breaking, soil raising and soil turning.
- It can be used in stony & rooted soils.

Features
- The under frame and unit-to-unit clearance are adequate to copy with trashy condition.
- Adding an extra furrow or repositioning units to allow for extra clearance is quick and easy.
- The plough has special wear-resistant steel bottoms with bar points for toughest ploughing jobs.
- Bar point bottoms ensure longer life as they can be extended or reversed and re used fill the last possible length.

DESIGN PROCEDURE FOR MOULD BOARD PLOUGH

It is a primary tillage equipment used primarily in areas with sufficient rainfall for better inversion, green maturing, burying the heavy weed growth underneath the soil for proper decay.

Tractor mounted mould board plough [Fig. 4.1 (a)] consists of share point, share, mould board, Landslide, frog, shank, frame and hitch system. The share point is of bar type and is made from high carbon steel or low alloy steel. The share is also made from high carbon steel or low alloy steel. Both are hardened and tempered to suitable hardness (about 45 HRC). The working of the plough is controlled by hydraulic system lever and three point linkage. Its bar point makes it suitable to break hard pan of the soil. Various terminology related with the mould board plough is discussed in detail.

Implement draft (D): The implement draft is given by

$$D = K + MR$$

Where   D = implement draft, kg or N

K = soil and crop resistance, kg or N

MR = total implement motion resistance, kg or N

Also,

$$DBHP = (0.65 \text{ to } 0.70) \text{ BHP}$$

Alternatively, $DBHP = D.S/75$

Where, D = draft, kg

S = tractor speed, m/s

Or $P_{db} = D.S/3.6$

Where, P_{db} = draw-bar power, kW

D = implement draft, kN

S = tractor speed, km/h

Alternatively,

D = DBHP x 75/S

D = P_{db} x 3.6/S

Or

  Also

  Draft *(D)* = Unit draft x Cross sectional area

$$D = K..n..a..b$$

Where,   K = unit draft, kg/mm2 or N/mm2

      n = number of bottoms

      a = depth of ploughing, mm

        b = width of furrow slice, mm

Using eqn. 4.5 or 4.6 and 4.7, select the size of plough bottom and number of bottoms to. Match Power source.

Tractive effort of a plough: The tractive effort of a plough is given by

$$P = f.G + K.a.b + \varepsilon \, abv^2$$

where,   P = tractive effort of plough, N

    f = coefficient of resistance, 0.5 for stubble and 1.0 for clover bottoms respectively

    G = plough weight, N

    a = depth of ploughing, cm

    b = width of furrow slice, cm

    v = velocity of plough, m/s

            ε = constant depending on mould board surface = 150-200 kgf-s^2/m^4

      K = unit draft of plough, N/cm^2. The unit draft of plough for different types   of soil is given in Table:

Table: Unit draft of plough (K) for different types of soil

Soil Type	K, N/cm^2
Light soil	2.1 – 4.1
Medium soil	3.4 -6.2
Heavy soil	5.88 – 9.7
Very heavy soil	8.82 – 14.71

Components of plough draft (R_x): Plough draft along vertical plane (R_y) and lateral plane (R_z) are as given by

$$R_z = 0.2 \, R_x$$
$$R_y = (0.27\text{-}0.47) \, R_x$$

Where,   Rx = draft of plough, *N*

Design Procedure for Mould Board Ploughs

1. Establish following points:

- Type and kind of mould board
- Tillage depth, a
- Furrow slice width, b
- b/a ratio (1.1 to 1.5)

2. Decide the angles of share Refer Fig. 4.1 (b) B
- Load angle = 14-18 degrees
- Share angle = 35-45 degrees
- Cutting angle = 22-28 degrees

α = Load angle
ψ = Cutting angle
θ$_s$ = Share setting angle
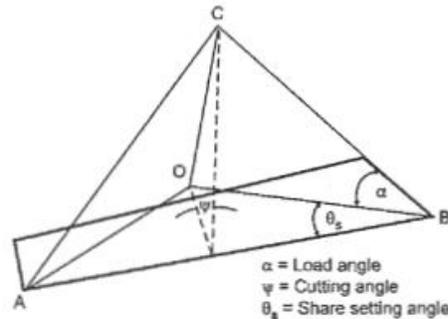
3. Calculate drawbar horse power (DBHP) of tractor
$$DBHP = 60\% \text{ of BHP}$$

4. Calculate drawbar pull

Drawbar pull available from tractor is given by

$$DBHP = \frac{pull(kg)x\ speed(m/min)}{4500}$$

$$\text{Pull (kg)} = \frac{DBHP}{speed(m/min)}$$

5. Calculation of width of implement (Wi)

The width of an implement (W_i) can be calculated from the following formula:

$$W_1 = \frac{D1}{ndpR} \text{ in cm}$$

Where, D_1 = draft requirement of implement, kg

n = number of bottoms in M B plough

d_p= depth of plowing, cm

R = specific resistance of soil, kg/cm^2

6. Forces acting on M.B plough bottom

Various forces acting on plough bottom are shown in Fig.
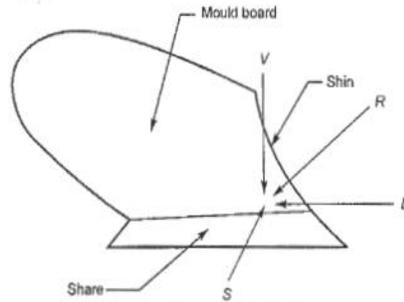
Fig. 4.2: Forces acting on mould board plough bottom

Draft (D) $= P \cos \theta \cos \alpha$.
Side draft (S) $= P \cos \theta \cos \alpha$.
Vertical component (V) $= P \cos \theta \cos \alpha$.
Where, P = Pull of plough, kg or N
                      θ = Angle of pull with horizontal plane, **degrees**
                      α = Angle of pull with vertical plane, degrees

7. Design of share of M.B plough
(i) The best throat angle (share angle) of the share should be an angle along which soil rupture
Takes place.
Soil shear angle $(\theta_3) = 45° - \phi$
        Where, ϕ = angle of friction between metal and soil.

(ii) Now, the share may be assumed like a rectangular plate of area (Δ ABC+ Δ BCD) subjected to bending. Refer Fig.
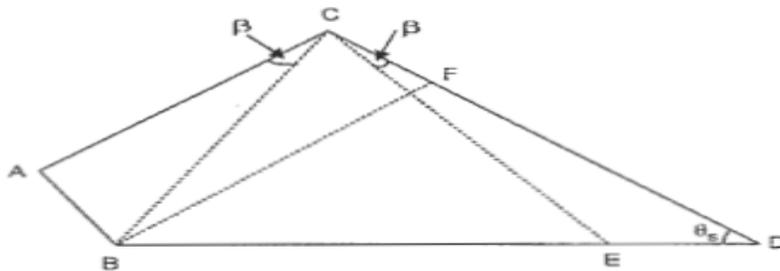
The equivalent rectangular dimensions of share can e taken as CE and BF and calculated as:
From the similar triangles ABC and BCF
                    $AC/BC = BC/BF$ or $BF = BC^2/AC$
Also in triangle ABC, $AB/BC = \sin \beta$. Therefore, find angle β.
Also from triangle CED, $\angle\beta + \angle\theta_5 + \angle CED = 180^0$
                        $\angle CED = 180^0 - \angle\beta + \theta_5$
Or,
 (iii) Find value of CE by using sine theorem.
                    $CD/\sin \angle CED = CE/\sin \angle\theta5$

(iv) Calculate the total soil pressure on the share.
Unit draft of medium soil = 0.5 kg/cm2 and factor of safety as 2.0.
Therefore, unit draft of share = 0.5 kg/cm2 x F.O.S = 0.5 x 2.0 = 1.0 kg/cm^2

(v) Total design draft of plough bottom = width x depth x unit draft
The total draft force will act on entire area of share. It is assumed that the soil pressure is uniformly distributed on the share.
Total area of share = area of BCD + area of ABC

(vi) Therefore, soil pressure on share= total load, kg/ area of share cm^2
This load is acting on the share at $\psi = 20°$

(vii) Calculate length breadth ratio of share = *Lib*
(viii) Calculate share thickness (*t*)
In the design of plough share law of bending of rectangular plate with one side fixed and three sides freely supported may be applied. For uniformly distributed loads on rectangular plate.
S_{max} = B. F. b^2/t^2
Where, S_{max} = max. Stress developed in share, kg/cm^2
F = uniformly distributed load, kg/cm^2
b = width of shank, cm
t = thickness of share, cm
B = a constant, depends on length-breadth ratio of share
Determine thickness of share by putting values in eqn. 4.12.

8. Design of land side of M.B. Plough

Landside is a long flat metal piece bolted to the side of frog and acts as one side of the wedge formed with the share of mould board plough as given in Fig. 4.4 (a) and (b). It takes side thrust of plough bottom caused during turning of furrow slice. Usually force encountered by the landside is about 25-50% of longitudinal force (Pull) acting on the plough bottom.
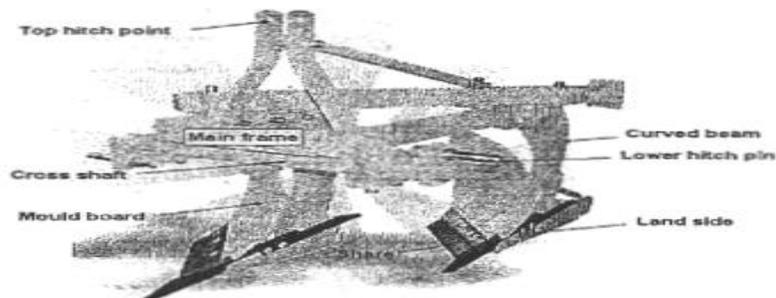
Fig. 4.4 (a): Components of two bottom mould board plough
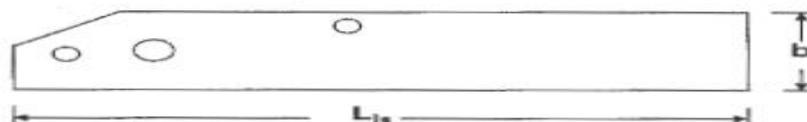
Fig. 4.4 (b): Landside of mould board plough

Length of landside (L$_{ls}$)
Length of landside (L$_{1s}$) is calculated by using following expression:

$$L_{1s} = \frac{1}{2} X \frac{b \cos \phi}{\sin \alpha \cos (\phi + \alpha)}$$

Where, L$_{1s}$ = length of landside from the point of share to heel of landside, cm
B = width of landside, cm
ϕ = angle of soil granular friction, degrees
α = inclination of pull with vertical plane, degrees

Width of landside (b)
Usually width of landside is taken as one third of throat width of share of plough bottom.

Thickness of landside (t)
For determination of thickness of landside, it is assumed that the side is fixed on one end and the
Other ends are free and side thrust is uniformly distributed over entire area of landside. Now permissible
stress in the landside is given by
$$f_t = W. L_e^2 / 13\ t^2$$
Where, f$_t$ = permissible stress in the landside, kg/cm^2 or N/mm^2
W = uniformly distributed load on landside surface. kg/cm^2 or N/mm^2
T = thickness of landside, cm or mm

9. Design of Beam of M.B plough:
The M.B plough bottom of tractor drawn plough is attached to a curved beam As the beam is curved
therefore, theory of bending of curved beams is applied. According to theory of curved beams of
rectangular section, the bending stress is given by
$$f = \frac{M.y}{A.e(Ro+y)}$$

Where, f = bending stress at any point at 'y' distance from neutral axis= 500 kg /cm^2
M = maximum bending moment induced in the beam = Maximum draft x distance
R$_e$ = the initial radius of neutral surface, cm = R - e
e= distance between the neutral axis and the principal axis through centroid, cm
A = area of cross section of beam, cm2
   There will be tension on the inner side and compression on the outer side of the beam. If the beam
is assumed to be of square section, each side measuring X cm, then· the value of 'e' can be determined
by using the relationship

$$e = R - \frac{X}{\log\left[\left(R + \frac{X}{2}\right) \div \left(R - \frac{X}{2}\right)\right]}$$

The stress produced the beam can be calculated by using equation and the value of X can be determined
by hit and trail method by using allowable stress in the based on material of the beam.
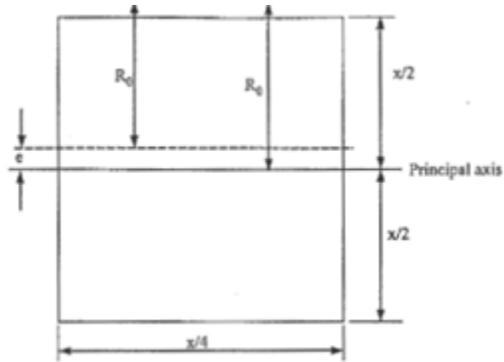
Cross section of beam of M.B plough

1O. Design of frog:

The frog is one solid piece to suit fitting of share mould board and landside with considerable strength. It is usually made from pressed steel sheet, cast steel or welded steel. The hardness of frog made from steel casting should be 130·201 HB and for heavy duty cast iron the hardness should be of 160-260 HB.

Design a mould board plough for 30 hp tractor
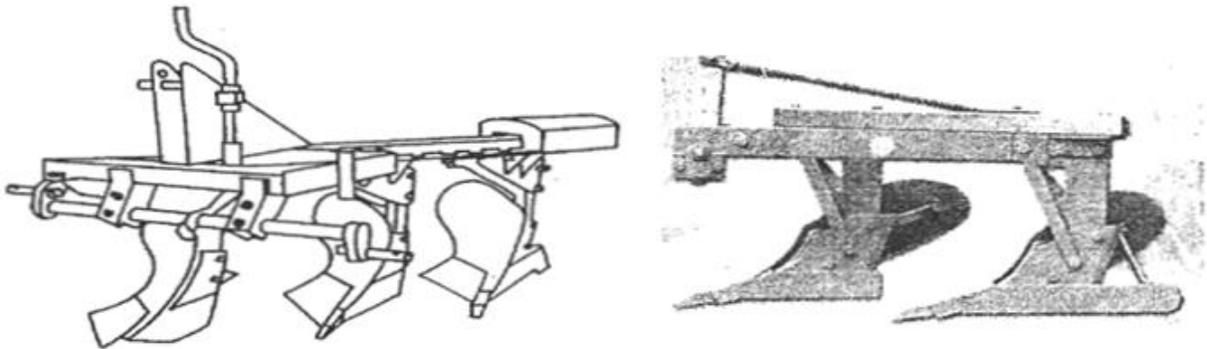
Tractor drawn mould board plough

Solution: Given brake horse power (BHP) of tractor = 30 hp
1. **Calculating drawbar horse power (DBHP)**: Drawbar horse power (DBHP) is given by
    DBHP = 60% of BHP
    DBHP = 0.60 x 30 = 18 hp

2. **Calculating draw bar pull**: Drawbar pull available from tractor is given by

$$DBHP = \frac{Pull\ (kg) \times speed\ (m/min)}{4500}$$

$$Pull\ (kg) = \frac{DBHP \times 4500}{speed\ (m/min)}$$

For proper ploughing with M.B. Plough, the speed of operation should be 4-6 km/hr. Hence, let the speed of ploughing be 5 km /hr. Therefore, the pull is given by

$$\text{Pull (kg)} = \frac{18 \times 4500}{5000/60} = 972 \text{ kg}$$

3. Calculation of width of implement: The width of an implement (W_i) can be calculated from the following formula

$$W_i = \frac{D_i}{nd_pR} \text{ in cm}$$

Where, D_i = draft requirement of implement, kg
n = number of bottoms in M B plough
dp = depth of ploughing, cm
R = specific resistance of soil, kg/cm^2
Draft is the horizontal component of pull. Here, in this example let us assume that the draft is equal to pull, the number of bottoms in the MB plough is two, maximum depth of ploughing is 20 cm and the type of soil is medium soil whose specific resistance is 0.5 kg/cm^2
Putting values in the eqn. we get,

$$W_i = \frac{972}{2 \times 20 \times 0.5} = 48.6 \text{ cm}$$

Therefore, the width of one bottom of MB plough is 45 cm.
So, the details of designed MB plough would be
Size of plough   : 2 x 45 cm
Depth of ploughing   : 20 cm
Speed of operation   : 5 km/hr

4. Forces acting on M.B plough:
        Now, for a medium size MB plough, the weight= 250 kg.
Also assume that line of pull makes an angle of 20° with the horizontal and lies in vertical plane which is at an angle of 15° with direction of motion.
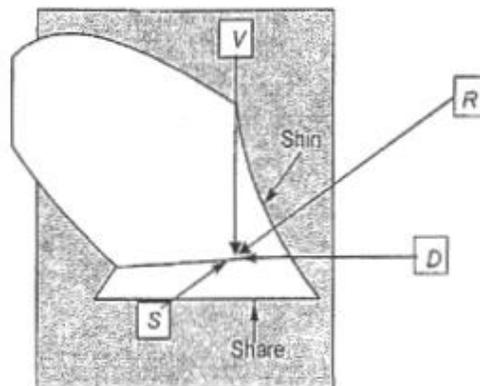
Forces action on mould board plough bottom

Therefore, various forces acting on plough bottom are:
- Draft (D) $\qquad = P \cos 20° \cos 15° = 972 \times 0.9397 \times 0.9659 = 882.24$ kg.
- Side draft (S) $\qquad = P \cos 20° \sin 15° = 972 \times 0.9397 \times 0.2588 = 236.38$ kg.
- Vertical component (V) $\qquad = P \sin 20° \cos 15° = 972 \times 0.3420 \times 0.9659 = 321.09$ kg.

5. Design of share of mould board plough: Since the size of bottom is 45 cm, therefore, throat   width of share will be 45 cm. The best throat angle of the share should be an angle along which soil rupture takes place.

We know that
Soil shear angle $(\theta_s) = 45° - (\phi/2)$
Where, ϕ = angle of friction between metal and soil (for medium soil we may assume $\phi = 20°$)
Therefore, $\theta_s = 45° - 20°/2 = 35°$.

Share of mould board plough

$BF = b$ = breadth of share
$CE = L$ = length of share
$CE = 47\text{-}79$ cm
$BF = 46.60$ cm
$CD = 64.26$ cm
$BC = 45$ cm
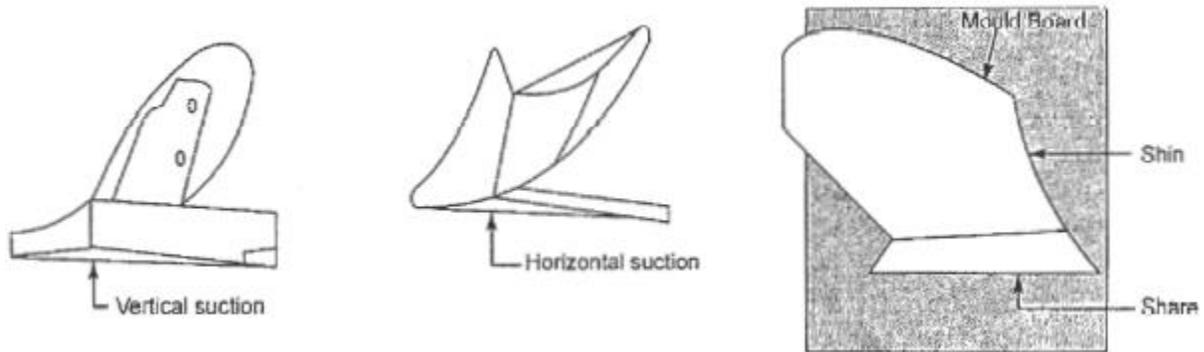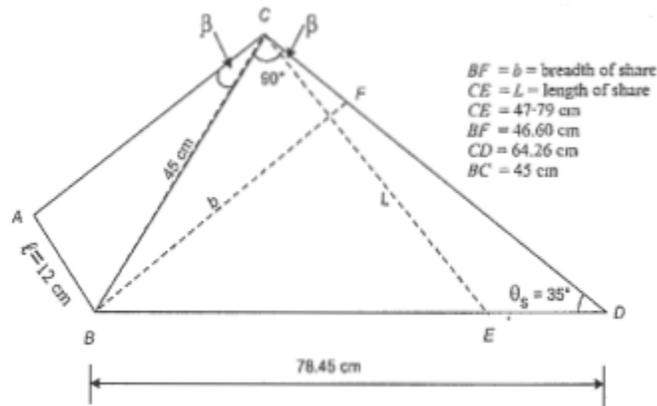
Dimension of share of mould board plough

Referring to Fig.
We see from right angled triangle *BCD* that,
$\qquad\qquad$ Tan 35° = BC/CD
or $\qquad\qquad\qquad$ CD = BC/ tan 35°

$= 45 \times 1.428 = 64.26$ cm

Also, $\qquad BD = (BC^2 + CD^2)\ 112$

$= \{(45)^2 + (64.26)^2\}^{1/2}$

$= 78.45$ cm.

, may be taken from I 2-15 cm (say 12 cm in the present case).

Therefore, in right angled triangle ABC

$AC = (BC^2 - AB^2)^{1/2}$

$= \{(45)_2 - (12)^2\}^{1/2} = 43.37$ cm.

Now, the share may be assumed like a rectangular plate subjected to bending. The equivalent dimensions of share can be taken as CE and BF.

Now, from the similar triangles *ABC* and *BCF*.

AC/BC = BC/BF

or $\qquad BF = BC^2/AC = (45)^2/43.37 = 46.69$ cm.

Also in triangle *ABC*,

AB/BC $= \sin \beta = 12/45$

or, $\qquad \beta = 15.47°$.

Also from triangle *CED*,

$\qquad \angle\beta + \angle\theta_5 + \angle CED = 180^0$

$\qquad \angle CED = 180° - 15.47° - 35° = 129.53°$.

Find value of *CE* by using sine theorem

$CD/ \sin \angle CED = CE/\sin \angle\theta_5$

$64.26/ \sin 129.53° = CE/ \sin 35°$

$CE = 64.26 \times 0.5736/0.7712 = 47.79$ cm.

Therefore, $\qquad BF = = 46.6$ cm and $CE = 47.79$ cm.

We know that unit draft of medium soil $= 0.5$ kg/cm^2.

Also take factor of safety as 2.0.

Therefore, unit draft of share $= = 0.5$ kg/cm^2 x f.o.s $= 0.5 \times 2.0 = 1.0$ kg/cm^2

Total design draft of plough bottom = width x depth x unit draft

$= 45$ cm x 20 cm x 1 kg/cm^2

$= 900$ kg.

The total draft force will act on entire area of share. It is assumed that the soil pressure is uniformly distributed on the share.

Now, total area of share = Area of *BCD* + area of *ABC*

$\quad = 1/2$ (BC x CD+ AB x AC).

$\quad = 1/2$ (45 X 64.26 + 12 X 43.37)

$\quad = 1706.07$ cm^2

Therefore, soil pressure on share = Total load, kg/ Area of share, cm^2

$= 900$ kg/ 1706.07 kg/cm^2

$= 0.528$ kg/cm^2.

This load is acting on the share at $\backslash\psi = 20°$

Therefore, unit load normal to share $= 0.528 \times \sin 20° = 0.181$ kg/cm^2

Now, length breadth ratio of share= *L/b* $= 47.79/46.69 = 1.023$

In the design of plough share law of bending of rectangular plate with one side fixed and three sides freely supported may be applied.

Therefore, for uniformly distributed loads on rectangular plate.

$S_{max} = B. F. b^2/ t^2$

Where, S_{max} = max. Stress developed in share, kg/cm^2

F = uniformly distributed load, kg/cm^2

b = width of share, cm

t ·= thickness of share, cm

B = a constant, depends on length-breadth ratio of share

Now, in the present case L/b = 1.023 and value of B = 0.520 (from hand book)

Therefore, S_{max} = 0.520 x 0.179 kg/cm^2 x $(45)^2/t^2$

Take S_{max} - 800 kg/cm^2

or $\quad\quad\quad\quad$ t^2 = 0.520 x 0.179 x (45)^2/ 800

or $\quad\quad\quad\quad$ t = 0.485 cm say 5 mm size

6. Design of landside of mould board plough: The throat width of plough share is 45 cm and angle of friction between metal and medium soil is assumed as 20°. The material of construction of landside is taken as mild steel which has permissible tensile stress of 800 kg/cm^2, bending stress of 1400 kg/cm^2 and shear stress of 700 kg/cm^2• Let us assume that the force encountered by landside is 40% of longitudinal draft force.

Now, Pull developed by 30 hp tractor = 972 kg

α= 15° (Practically measured) and

φ = 20°

Therefore,

Side draft of plough (S) = P cos 20° sin 15° = 972 x 0.9397 x 0.2588 = 236.38 kg

Since, the plough has two bottoms, so, side draft on each bottom of plough= 236.38 kg/cm^2
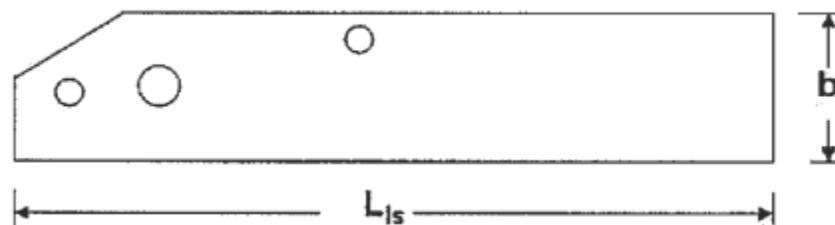
Side draft= 118.19 kg

Alternatively,

Draft = Width of bottom (cm) x depth of ploughing (cm) x unit draft (kg/cm^2)

= 45 cm x 20 cm x 0.5 kg/cm^2 = 450 kg

Also, side draft = 40% of total draft = (40/100) x 450 kg = 180 kg

So, we can take higher value of side draft for design of landside

Landside of mould board plough

Now,

Take width of landside as one third of share width. = 45 crn/3 = 15 cm

Length of landside is determined by using eqn.

$$L_{ls} = \frac{1}{2} \times \frac{b\cos\phi}{\sin\alpha\cos(\phi+\alpha)}$$

Where, L_{ls} = length of landside from the point of share to heel of landside, cm

b = width of landside, cm

ϕ = angle of soil granular friction, degrees

α= inclination of pull with vertical plane, degrees

Putting values in equation .we get

L_{is} = (l/2) 15 cos 20°/(sin 15° cos (20° + 15°)

Or L_{is} = (1/2) 15 x 0.9397 / (0.2588 x 0.819) = 33.25 cm

So, provide landside of 33 cm long & 15 cm wide.

Now, area of landside = Length x width = 33 cm x 15 cm = 495 cm^2

Maximum side draft (S) taken by the landside = 180 kg

So, uniformly distributed load over the landside surface (W) is= Side draft/ Area of landside

W = 180 kg/ 495 cm^2

   = 0.3636 kg/cm^2

Let us take factor of safety as 4.0

Yield strength of mild steel = 2000 kg/cm^2

Therefore, permissible stress in landside (f_t) = 2000/4.0 = 500 kg/cm^2

Since the landside is fixed from one end other ends are free. Therefore we can take effective length of landside 15 cm which is subjected to bending.

For landside supported on one end the stress is given by

f_t = W.L_e^2/3 t^2

Where, f_t = permissible stress in the landside, kg/cm^2 or N/mm^2

W = uniformly distributed load on landside surface, kg/cm^2 or N/mm^2

t = thickness of landside, cm or mm

L_e = effective length of landside, cm or mm

Putting values in eqn. we get,

500 = 0.3636 X (15)^2 / 3 x t^2

 Or,   t^2 = 0.3636 x 225 / 3 x 500 = 0.05454

 Or,   t = 0.2335 cm   say 0.25 cm or 25 mm

Hence designed dimensions of landside are:

Length (L_{is}) = 33.0 cm

Width (b) = 15.0 cm

Thickness (t) = 25 mm

7. Design of beam:

 The beam of plough bottom is designed based on maximum draft under extreme soil

Conditions which is given by

Total draft of bottom = W (share width) x depth of ploughing x specific resistance of soil (kg/cm^2)

Assume Unit draft of heavy soil encountered = 1.25 kg/cm^2

Throat width of share of plough bottom = 45 cm

Assume radius. of curvature of beam = 20 cm

Ground clearance of beam = 40 cm

Therefore, total draft of bottom= 45 cm x 20 cm x 1.25 kg/cm^2 = 1125 kg

Now, bending moment in the beam, M = Draft x ground clearance

M = 1125 kg x 40 cm = 45000 kg-cm

Take factor of safety as 4.0 considering impact forces while the plough encounters an obstruction.
Mild steel is taken as material of the beam
Ultimate strength of mild steel = 2000 kg/cm^2
Since, curved beam will be provided in the M.B plough. So, from theory of bending of curved beam:

$$f = \frac{M.y}{A.e.(R_0 + y)}$$

Where, f = Bending stress at any point at 'y' distance from neutral axis= 571.5 kg /cm^2.
M = Maximum bending moment induced in the beam = Maximum draft x distance
R_0 = the initial radius of neutral surface, cm= R - e
e = Distance between the neutral axis and the principal axis through centroid, cm
A = Area of cross section of beam, cm^2
There will be tension on the inner side and compression on the outer side of the beam. If the beam
is assumed to be of square section, each side measuring X cm, then the value of ' e' can be determined by
using the relationship.

$$e = R - \frac{X}{\log\left[\left(R + \frac{X}{2}\right) \div \left(R - \frac{X}{2}\right)\right]}$$

Y = X / 2 ± e

Now, substituting values in equation we get
f = 45000 x (X/2 ± e) I {X^2 e (20 + X/2 ± e)}
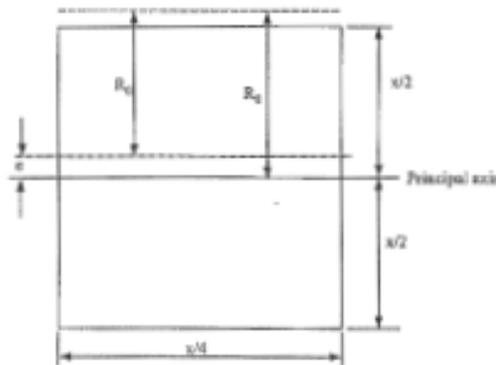
Cross section of beam of M.B plough

The eqn. will give relationship between f and X; and there is no direct solution of this equation. Thus by
hit and trial method we can find out value of X with permissible bending stress with a factor of safety of
3.5 and +ve value of e.
Permissible stress in beam = 2000 kg/cm^2 / 3.50 = 571.5 kg/cm^2
Assume X = 5.0 cm
e = R - XI Log {(R + X/2)/ (R - X/2)}
e = 20-5/ Log {(20 + 5/2)/ (20 - 5/2)}
e = 0.08 cm
Putting value of 'e' in eqn. 4.22 we get.

f = 45000 x (2.5 + 0.08) / 25 x 0.08 x (20 +2.5 + 0.08)

  = 2050 kg/cm^2

 As the value of 'f' is very much higher than 571.5 kg/cm^2 hence it is not within the safe limits.

Therefore, take X = 8.0 cm

Again

e = 20 - 8/Log { (20 + 8/2) / (20 - 8/2)}

e = 0.25 cm

Putting values again in equation we get

f = 45000 x (8/2 + 0.25)/ 64 X 0.25 X (20 +8/2 + 0.25)

f = 45000 x 4.25 / (64 x 0.25 x 24.25) = 493.00 kg/cm^2

Stress produced due to direct bending

45 x 20 x 1.25 / 8 x 8 = 17.58 kg/cm^2

Total stress developed = Bending stress + direct stress = 493.00 + 17 .58 = 510.78 kg/cm^2

Since, the stress developed in the beam is less than permissible stress, therefore, the design is safe.

Therefore, a curved beam of 20 cm radius with ground clearance of 40.0 cm of square section of 8.0 cm is suitable for the required plough.

8. Design of frame of M.B plough:

Main frame of tractor drawn mould board plough is also designed for maximum draft under extreme soil conditions. Draft of M.B plough is estimated by following equation.

Draft (D) = Unit draft x Cross sectional area

D = K.n.a.b

Where,   K = Unit draft, kg/cm^2 or N/mm^2

n = Number of bottoms

a = Depth of ploughing, cm

b = Width of furrow slice, cm

For heavy soils, K = 0.75 - 0.85 kg/cm^2 (Say 0.8 kg/cm^2)

Width of cut (furrow slice), b = 45 cm

Depth of ploughing, a = 15 cm

Number of bottoms, n = 2

Putting values in eqn. we get,

D = 0.8 kg/cm^2 x 2 x 15 cm x 45 cm =1080 kg

Also for clay soils vertical component of pull is 25% of draft force

So, Vertical component (V) = (25/100) x 1080 kg =270 kg

Assume weight of two bottom M.B plough as 200 kg

So, weight of soil over M.B surface = V - W = 270 kg - 200 kg= 70 kg

Therefore total pull exerted by the tractor is given by

p = {(D^2 + (V - W)^2}$^{0.5}$

or,   P = (1080^2 + 70^2)$^{0.5}$

P = (1166400 + 4900)$^{0.5}$

P = 1082.27 kg

Horizontal component of soil reaction force (R$_H$):

R$_H$ = P$_h$ = 1080 kg

Vertical component of pull (P$_y$) :

P$_v$ =270 kg

Vertical component of soil reaction (R_y):

$R_y = P_v - W$

Where W = weight of plough, kg
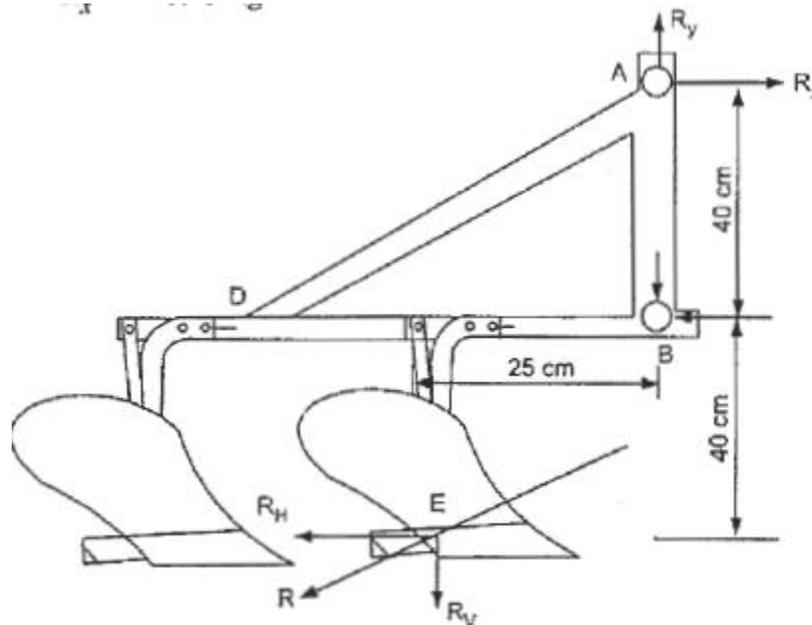
So, $\qquad R_y = 270$ kg $- 200$ kg$= 70$ kg

Now referring to fig Let R_x and R_y, are the components of reactions at upper hitch point in horizontal and vertical direction. Neglecting rolling resistance of tractor and taking moment about 'B' in Fig. we get

$\qquad R_v \times 45 - R_H \times 40 + R_x \times 40 = 0$ (Let R_v act at 45 cm)

Or $\qquad 270 \times 45 - 1080.0 \times 40 + R_x \times 40 = 0$

Or, $\qquad R_x \times 40 = 43200 - 12150 = 31050$

$\qquad R_x = 776.25$ kg

Forces on M.B.Plough in vertical plane

Assume angle of inclination in top link is 10° with horizontal.

$\qquad R_y = R_x \tan 10^0 = 776.25 \times 0.18229 = 141.50$ kg

Total force in top link = $\sqrt{R_x^2 + R_y^2} = \sqrt{776.25^2 + 141.50^2} = 779.04 kg$

Now, assume that line of pull is situated midway and reactions will be equally distributed in lower hitch points.

So,

Horizontal components in each lower link

$$R_{Hl} = \frac{R_H + R_x}{2} = \frac{1080.0 + 776.25}{2} = 928 \text{ kg}$$

Vertical component in each lower link

$$R_{vl} = \frac{R_v + (-R_y)}{2} = \frac{70.0 - 141.50}{2} = -71.50 \text{ kg}$$

Assume that length of member AD = 50 cm

Then, $\qquad$ BD = $(50^2 - 40^2)^{0.5}$ = 30 cm

Now, taking the case when the M.B plough is in lifted position. The direction of reactions at hitch point will be changed because here weight of plough only is acting. And these reactions are determined by taking moments about A & B respectively. Assume that angle of top link in complete lifted position is about 30° with the horizontal

Therefore, the reactions are:

$\qquad$ R_x in top link = 125 kg

And $\qquad$ R_y = R_x tan 30° = 72.50 kg

Similarly, reactions at each lower hitch points

$\qquad$ R_x = 125.0/2 = 62.50 kg

& $\qquad$ R_y = 72.50 kg + 200 kg = 272.50 kg

Let us now design the frame of M.B plough for critical loading. Therefore, it should be designed Based on loads when the plough is in operation.

Design of member AB

Since the load taken by the member is very small, therefore, we may use two mild steel flat plates of 4.0 cm x 1.5 cm size for making upper hitch point (Refer Fig.).

Design of member BD

Now, length of member *BD* is 50 cm (Refer Fig).

Maximum bending moment taken by BD = - 71.50 kg x 50 cm = - 3575 kg-cm

So, bending moment taken by each member *BD* = 3575 kg-cm/2 = 1787.50 kg-cm

Let us assume that a mild steel flat is used with b:t = 3:1

Or, $\qquad$ b = 3 *t*

Therefore, $\qquad$ I = *t* $(3t)^3$/12 = 9 $t^4$14

Also,

$\qquad$ f_b ='MY/I

$\qquad$ 1650 = 1787.50 x (3/2) *t*/ (9/4) t^4

Or, $\qquad$ t^3 = 1787.50 x 3 x 4/ (2 x 9 x 650) = 0.720

Or, $\qquad$ *t* = 0.9 cm

and $\qquad$ b = 3 *t* = 3 x 0.9 = 2.7 cm

Take $\qquad$ b = 3.0cm & *t* = 1.0 cm

Now, check in tension. Total tensile force in member *BD* = 928 kg

Area of cross section of member *BD* = *t* x *b* = 1.0 x 3.0 = 3.0 cm²

Therefore,

$\qquad$ f_t = F/A = 928 kg/ 3.0 cm² = 307 kg/cm²

As 307 kg/cm² < Allowable stress of mild steel. Hence, the design is safe.

Design of compression member AD:

Now, from Fig. we know that

$\qquad$ tanθ =40/30= 53.130

Now,

Maximum compression force in member *AD* = R_x/Cosθ + = R_y/ Sinθ

$\qquad$ = 776.25/0.600 + 141.50/0.799

$\qquad$ = 1293.75 + 177.10 =1470.85 kg

Let us assume that mild steel flat is used for this purpose

And   b:t=3:1

Or,   b .= 3t

Take allowable compressive stress in mild steel as 700 kg/cm^2

Therefore,

$$A = F/allowable\ stress = 1470.85\ kg/\ 700\ kg/cm^2$$
$$= 2.101\ cm^2$$

Now, for the proposed flat $A = 3t \times t = 3\ t^2$

Or, $3t^2 = 2.101$

Or,   = 0.8369 cm say 0.85 cm

&   b = 3 x 0.85 = 2.55 cm

Therefore, designed cross section of member *BD* is 2.55 x 0.85 cm mild steel flat.

Design of spacing member:
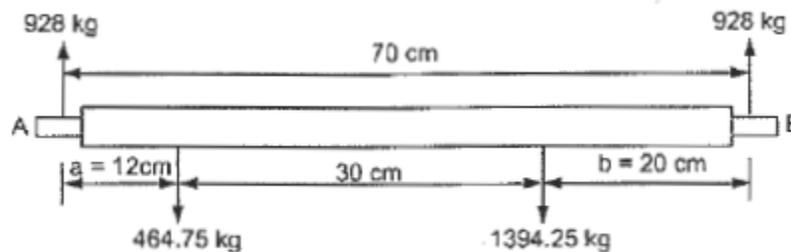
Distance between two bottoms = 45 cm

Since bending moment, taken by this member is equal to bending moment taken by member *BD*.

Therefore, we may provide 'a mild steel flat of same size as in *BD*. So, cross section, of this member should be

$$b = 3.0\ cm\ and\ t = 1.0\ cm$$

Design of cross shaft

Refer to Fig. for location of various forces on cross shaft.

Forces in horizontal plane in cross shaft of frame

Length of shaft = 70 cm

Taking bending moment about 'A' we get:

$$464.75 \times 12 + 1394.25\ x\ (70 - 20) = 928\ x\ 70$$

Or, solving

$$b = 28.0\ cm$$

Now based on bending moment diagram, maximum bending moment in the member is

$$= 1394.25 \times b$$
$$= 1394.25 \times 28 = 39039\ kg\text{-}cm$$

Let us take circular cross section of cross shaft whose diameter is d and material is mild steel.

Therefore,

$$I = (\pi/64)\ d^4\ \&\ y = d/2$$

We know that,

$$f_b = MY/I$$

Or, $1650 = 39039\ x\ d/2\ /(n/64)\ d4$

Or, $d^3 = 39039\ x\ 64\ /\ (2\ \pi\ x\ 16500)$

Or, $d = 6.24$ cm

Therefore, take diameter of cross shaft as 6.25 cm. The ends of shaft are made according to the Points of hitches of lower links of the tractor.

The specifications of designed mould board plough are summarized below:

I. Number of bottoms   : Two
2. Size of plough   : 45 cm
3. Total draft of plough   : 900 kg
4. Thickness of share   : 5 mm

Result

Thus the mould plough design and that was modelled.

Ex.No: **Date:**

DESIGN AND DRAWING OF DISC PLOUGH

Aim: To study the design aspects of disc plough

        Disc plough used for deep ploughing in root-infested, sticky, stony, and hard soils, Mixes remains of crops and weeds throughout the depth of ploughing, hence it is ideal for rain fed areas for checking soil erosion by water and wind. Spring loaded floating rear furrow wheel control the side draft to ensure straight work and ease of handling by smaller tractor. Other features include Re-graspable taper roller bearing in disc hubs, Disc angle adjustable to vary the penetration with varying soil conditions, Cat I and II linkage and the Disc scrapers are also adjustable to ensure that the discs remain clean in all conditions.

Benefits:

- The disc plough is designed to work in all types of soil for basic functions such as soil breaking, soil raising, soil turning and soil mixing.
- It is used open the new fields and to processes the stony areas.
- It can be used easily at rocky and rooted areas.
- It is especially useful in hard and trashy land conditions and in soils where souring is a major problem.

 Features:

- In conformity with the soil conditions it is produced with 2-3 and 4 bottoms version with an option for extra kit for converting it to extra-bottom plough
- It is directly mounted to tractors
- Extra heavy-duty pipe frame has high trash clearance allowing the plough to operate under heavy crop residue.

DESIGN PROCEDURE FOR DISC PLOUGH

The disc plough consists of a series of individually mounted, inclined disc blades on a frame which may be supported by wheels. It is most suitable for conditions under which mould board plough does not work satisfactorily i.e. dry hard ground, rough, stony or Rooty ground, sticky, waxy, non-scouring soils .or soils having a hard pan or sole. Disc plough does not cover trash as thoroughly as a mould board plough. Under usual plough conditions, it leaves the field rough and cloddy, thus requiring more operations to obtain a good seed bed. The components of tractor drawn two bottom and three bottom disc ploughs are shown in Fig. respectively.
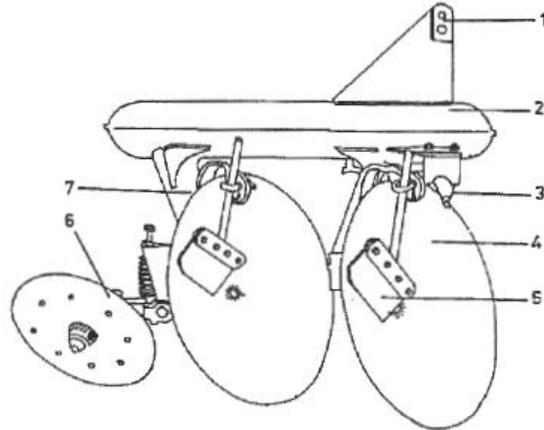
1. Top hitch   2. Frame   3. Side hitch   4. Disc bottom
5. Scraper   6. Rear furrow wheel   7. Standard

Components of tractor drawn two bottom disc plough
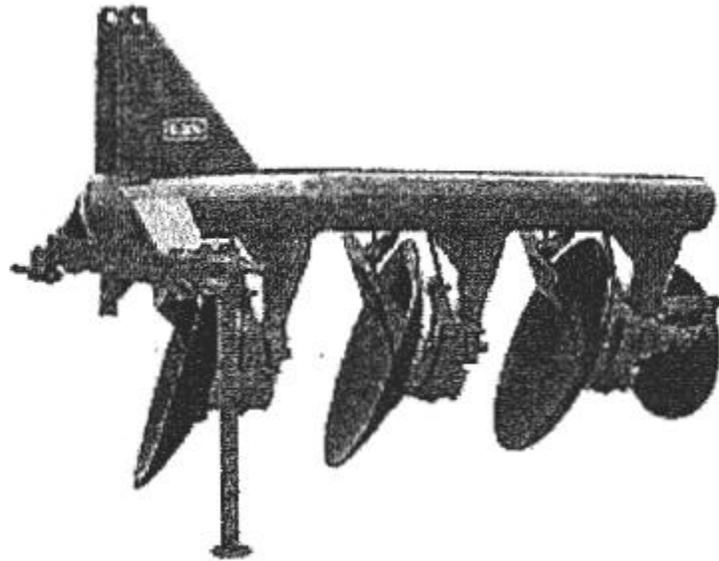
The plough consists of common main frame, disc beam assembly, rockshaft (category-I or 11), a heavy spring loaded furrow wheel and a gauge wheel. In some models disc plough is designed to operate as 2, 3 or 4 bottom, by adding or removing the sub beam assembly according to requirement. The disc angle ranges from 40 to 45° to obtain the desired width of cut and the tilt angle ranges from 15° to 25° for penetration. The discs of the plough are made of high carbon steel or alloy steel and the edges are hardened and sharpened:· The discs are mounted on tapered roller bearings. Scrapers prevent soil build up on the discs in sticky soils. The furrow slice rides along the curvature and is pulverized to some extent before being thrown.

Step-by-step procedure for the design of disc plough is as follows:
1. Calculate drawbar horse power (DBHP). Drawbar horse power (DBHP) is given by
$$DBHP = 60\% \, of \, BHP \quad (4.26)$$
2. Calculate diameter of disc (D_d). The diameter of disc is given hr (D_d)

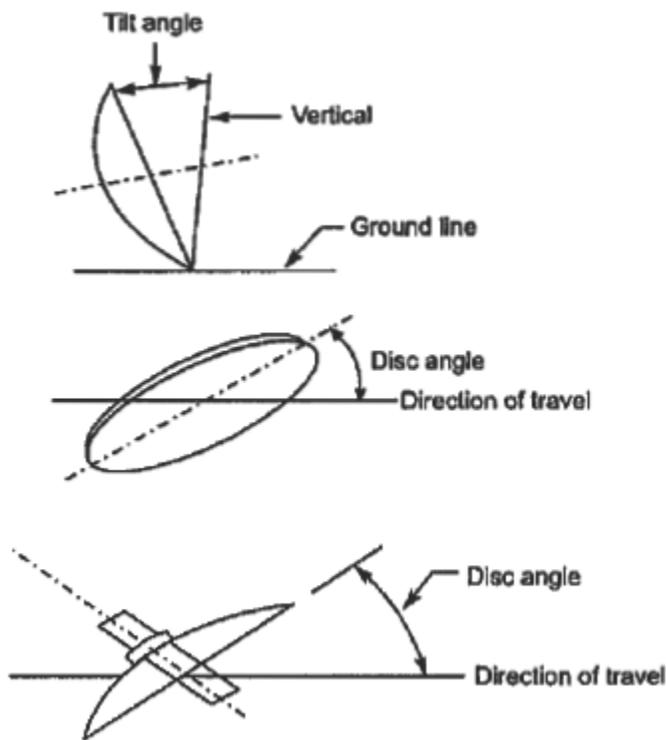$$D_d = \frac{K.d_p}{\cos\beta} \text{ in cm}$$

where, K = a coefficient which varies from 2.5 - 3 for deep tillage.

d_p = depth of ploughing, cm

β = tilt angle of disc which is I 5°-25°- with vertical.

Also, the width of cut of disc plough (W) is given by
$$W = D_d / 3$$

Disc and tilt angles

3. Radius of curvature of disc (R). The radius of curvature of disc is given by

$$R = \frac{D_d}{2\sin\phi} \text{ in cm}$$

where, D_d = diameter of disc, in cm

φ = half of center angle of the arc of circle formed by the cutting disc on equatorial plane
which is given by the formula

where,   α = disc angle, 45°

ε = back cleaning angle, 3-5°

i = sharpness / taper angle of disc, 15-25°

4. Calculate disc spacing (Sd) in plough. The spacing between the discs (S_d) is given by

$$S_d = 2 \tan \alpha \sqrt{\left[\frac{R_h}{\cos\beta}\left(D_d - \frac{R_h}{\cos\beta} \right) + e \right]}. \text{ in cm}$$

where, R_h, = ridge height, cm which is= 0.3 d_P for plough

d_p = depth of plugging, in cm

D_d = diameter of disc, in cm

α = disc angle, 45°

β = tilt angle of disc which is 15° - 25° with vertical.

e = eccentricity of disc. Let e = 2

Moreover, $S_d > 2d_p$ s

5. Width of cut (W_e)· The width of cut (W_e) of one disc is given by

$$W_c = 2(\sin\alpha)\sqrt{R_h(D_d - R_h)}. \text{ in cm}$$

6. Thickness of disc (T_d). The thickness of disc (T_d) for heavy soils is given by

$T_d = 0.008 \, D_d + 1$ in mm

7. Number of bottoms or discs in plough (n)

$$\text{DBHP} = \frac{\text{Speed (m/s)} \times \text{Draft (kg)}}{75}$$

Also.

Draft of plough = $n.W_c.d_p.k.F$

where,   n = number of bottoms or discs in plough

W_ε = width of cut, in cm

d_P = depth of ploughing, in cm
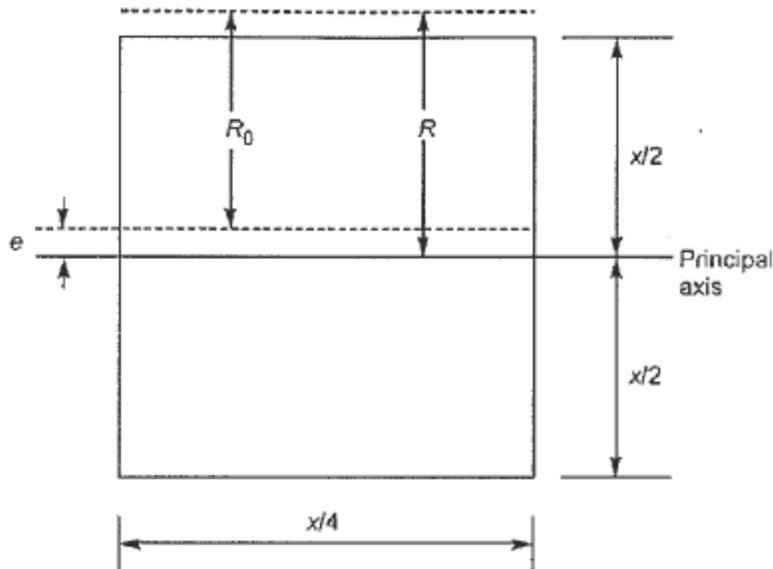
k = a constant. For heavy soils K = 0.75 - 0.85 kglcm^2.

F = factor of safety. (FOS = 1.5)

8. Design of main frame (tubular section). For rectangular section

$$f = \frac{M.y}{A.e.(R_0 + y)}$$

Where, f = bending stress at any point at y distance from neutral axis = 500 kg /cm^2

M = Maximum bending moment = max draft x distance.

Cross - section of tubular section

Solved Problem

Design a disc plough/or 35 hp tractor.

Solution: Given brake horse power (BHP) of tractor= 35 hp.

I. Calculating drawbar horse power (DBHP): Drawbar horse power \DBHP) is given by

$$DBHP = 60\% \text{ of BHP}$$
$$DBHP = 0.60 \times 35 = 21 \text{ hp}$$

2. Calculate diameter of disc (D_d): The diameter of disc is given by (D_d)

$$D_d = \frac{K.d_p}{\cos\beta} \text{ in cm}$$

Where, K = a coefficient which varies from 2.5-3 for deep tillage.

d_p = depth of ploughing, cm

β = tilt angle of disc which is 15°-25° with vertical.

$$D_d = \frac{3 \times 20}{\cos 25°} = 66.2 \text{ cm}$$

Also, the width of cut of disc plough (W) is given by

$$W = \frac{D_d}{3} = \frac{66.2}{3} = 22.1 \text{ cm}$$

3. Radius of curvature of disc (R): The radius of curvature of disc (R) is given by

$$R = \frac{D_d}{2\sin\phi} \text{ in cm}$$

Where, D_d = diameter of disc, in cm

ϕ = half of centre angle of the arc of circle formed by the cutting disc on equatorial plane

Which is given by the formula

$$\phi = \alpha - i - \varepsilon$$

Where, α = disc angle, 45°

ε = back cleaning angle, 3-5°

i = sharpness/taper angle of disc, 15-25°

Thus, $\phi = 45° - 15° - 5° = 25°$

$$R = \frac{66.2}{2\sin 25°} = 78.325 \text{ cm.}$$

4. Calculate disc spacing (S_d) in plough: The spacing between the discs (S_d) is given by

$$S_d = 2\tan\alpha \sqrt{\left[\frac{R_h}{\cos\beta}\left(D_d - \frac{R_h}{\cos\beta}\right) + e\right]}, \text{ in cm}$$

Where, R_h = ridge height, cm which is = 0.3 d_P for plough

Where, d_p = depth of ploughing, in cm

R_h, = 0.3 x 20 cm = 6 cm.

D_d = diameter of disc, in cm

α = disc angle, 45°

β = tilt angle of disc which is I 5°- 25° with vertical.

e = eccentricity of disc. Let e = 2

Moreover, $S_d > 2d_p$

Putting the values in the eqn we get

$$S_d = 2\tan 45° \sqrt{\left[\frac{6}{\cos 25°}\left(66.2 - \frac{6}{\cos 25°}\right) + 2\right]} = 40.38 cm$$

The condition $S_d > 2d_p$ = 2 x 20 cm = 40 cm is satisfied.

5. Width of cut (W_c): The width of cut (W_c) of one disc is given by

$$W_c = 2(\sin\alpha)\sqrt{R_h(D_d - R_h)}, \text{ in cm}$$

Putting the values in the eqn.we get,

$$W_c = 2(\sin 45°)\sqrt{6(66.2 - 6)} = 26.87 \text{ cm}$$

6. Thickness of disc (T_d): The thickness of disc (T_d) for heavy soils is given by

$$T_d = 0.008D_d + I \qquad \text{in mm}$$
$$T_d = 0.008 \times 66.2 + I = 5.4 \text{ mm}$$

7. Number of bottoms or discs in plough (n):

$$DBHP = \frac{\text{Speed (m/s)} \times \text{Draft (kg)}}{75}$$

Putting values in the eqn. we get

$$21 = \frac{1.38 \times \text{Draft}}{75}$$

$$\text{Draft} = \frac{21 \times 75}{1.38} = 1141.3 \text{ kg}$$

Also,

Draft of plough= $n.W_c.d_p.k.F$

Where, n = number of bottoms or discs in plough

W_c = width of cut, in cm

d_p = depth of ploughing, in cm

k = a constant. For heavy soils $K = 0.75 - 0.85$ kg/cm^2.

F = factor of safety. (FOS = 1.5)

Putting the values in the eqn.we get,

I 141.3 kg= n x 26.87 x 20 x 0.75 x 1.5

n= 2.

Number of bottoms = 2

Now,

$$\theta = \tan^{-1}\frac{55}{65} = 40.24°$$

Now, draft of plough,

$P_h = P.\cos\theta$

$P = 1141.3/\cos 40.24° = 1495.1$ kg

$P_v = P \sin 40.24°$

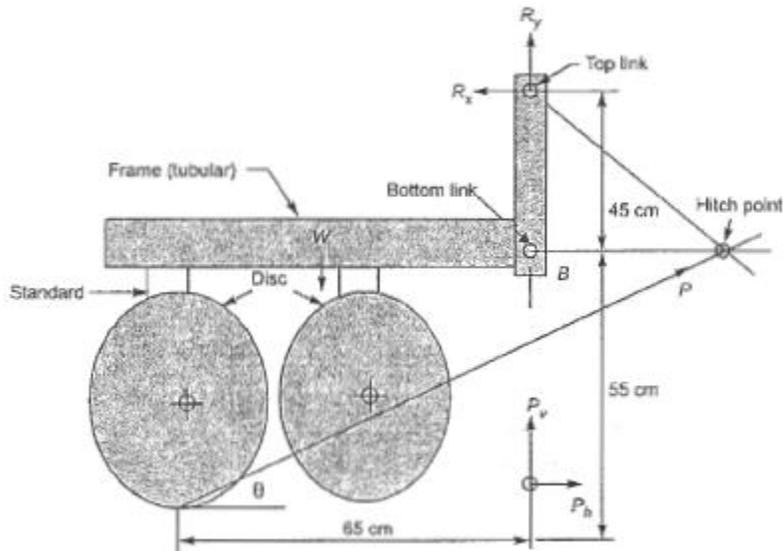$= 1495.1 \times 0.64599 = 965.82$ kg

Assume weight of plough = 200 kg

Now, from Fig.

Vertical component of soil reaction (R_v):

$R_v = P_v - W.$

Where, W = weight of plough, kg.

$R_v = 965.82 - 200 = 765.82$ kg.

Various forces acting on tractor drawn disc plough

Horizontal component of soil reaction force (R_H):

$R_H = P_h = 1141.3$ kg

Now, taking moment about 'B' in figure.

$$R_x \times 45 - R_H \times 55 + R_v \times 65 = -0$$

$$R_x \times 45 - 1141.3 \times 55 + 765.82 \times 65 = 0$$

$$R_x = 288.76 \text{ kg}$$

Assume angle of inclination in top link is 10° with horizontal.

$$R_Y -= R_x . \tan 10° = 288.76 \times 0.18229 = 52.64 \text{ kg}$$

Total force in-top link = $\sqrt{R_x^2 + R_y^2} = \sqrt{288.76^2 + 52.64^2} = 293.52 \text{ kg}$

Horizontal components in each lower link

$$R_{HI} = \frac{R_H + R_x}{2} = \frac{1141.3 + 288.76}{2} = 715.03 \text{ kg}$$

Vertical component in each lower link

$$R_{vl} = \frac{R_v + (-R_y)}{2} = \frac{765.82 - 52.64}{2} = 356.59 \text{ kg}$$

8. Design of main frame (tubular section): For rectangular section

$$f = \frac{M.y}{A.e.(R_0 + y)}$$

Where, f = bending stress at any point at y distance from neutral axis = 500 kg /cm^2.

M = maximum bending moment= Maximum draft x distance

Maximum draft of plough = $n.W_c.d_p.k. F$

Where, n = no. of bottoms or discs in plough

W_c = width of cut, in cm

d_p = depth of ploughing, in cm

k = a constant. For heavy soils K = 0.75 - 0.85 kg/cm^2.

F = factor of safety. (FOS = 1.5)
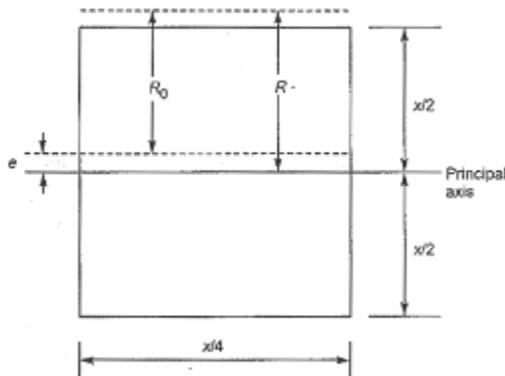
.   **Cross section of tubular frame**

Putting the values in the eqn.we get,

Max. Draft   = 2 x 26.87 x 20 x 0.85 x 1.5

               = 1400 kgf.

M = 1400 x 55cm = 77000kg-cm.

R_0 = initial radius of neutral axis= R-e

R = radius of curvature of beam= 20 cm

$$e = R - \cfrac{x}{\log \dfrac{R + x/2}{R - x/2}}$$

A = area of cross-section of beam = $x^2/4$

$$y = \frac{x}{2} \pm e$$

$$f = \cfrac{77000(x/2 \pm e)}{\dfrac{1}{4}x^2 e\left[(R - e) + (\dfrac{x}{2} \pm e)\right]}$$

Choose value of x such that value of 'f' is not greater than 500 kg/cm² say by taking x = 5 cm. We get f = 510 kg/cm² which is nearly equal to 500 kg/ cm².

Ans. The specifications of the designed disc plough is summarized as given below:

1. Diameter of disc   = 66.2 cm
2. Width of cut   = 27 cm
3. Radius of curvature of disc   = 78.325 cm
4. Disc spacing   = 40 cm
5. Thickness of disc   =5.4 mm
6. Number of bottoms   =2
7. Maximum draft of the plough   = 1400 kgf.

Result

Thus the design aspects of disc plough was studied

Ex.No: Date:

EXPERIMENT: DESIGN AND DRAWING OF CULTIVATOR

1. Aim
To study, design and draw the main components of a tractor-mounted cultivator used for secondary tillage operations.

---

2. Introduction
A cultivator is a tractor-mounted implement used for **loosening soil, weed control, seedbed preparation and aeration** after ploughing. It works at shallow depths and consists of tines fitted with shovels or sweeps mounted on a frame.

Cultivators are widely used because of:
- Lower draft requirement
- Better weed control
- Uniform soil pulverization

---

3. Classification of Cultivator
1. Based on mounting:
   o Rigid cultivator
   o Spring-loaded cultivator
2. Based on tines:
   o Rigid tine cultivator
   o Spring tine cultivator

---

4. Main Parts of Cultivator
1. Main frame
2. Tines (rigid/spring loaded)
3. Shovels or sweeps
4. Hitching system (3-point linkage)
5. Clamps and fasteners

Problem Statement
Design a **tractor-mounted rigid tine cultivator** suitable for operation with a **35 HP tractor** for secondary tillage in medium soil. The cultivator should work at a depth of **120 mm** with a working width of about **1.8 m**.

Given Data

Parameter	Value
Tractor power	35 HP
Type of soil	Medium
Working depth	120 mm
Operating speed	5 km/h

Parameter	Value
Type of cultivator	Rigid tine
Shovel type	Reversible
Hitching	3-point linkage

Assumptions
1. Draft requirement per tine in medium soil = **900 N**
2. Efficiency of power transmission = **75%**
3. Maximum allowable draft per HP ≈ **700–800 N/HP**
4. Material used:
   - Frame: Mild steel
   - Tines: Medium carbon steel
   - Shovels: High carbon steel

Step 1: Available Draft from Tractor
$$\text{Available Power} = 35 \times 0.75 = 26.25\ HP$$

Convert HP to kW:
$$26.25 \times 0.746 = 19.58\ kW$$

Draft force:
$$D = \frac{P}{V}$$
$$V = \frac{5 \times 1000}{3600} = 1.39\ m/s$$
$$D = \frac{19.58 \times 1000}{1.39} = 14{,}080\ N$$

Step 2: Number of Tines
Draft per tine = **900 N**
$$\text{Number of tines} = \frac{14080}{900} = 15.6$$

Considering field conditions and spacing:
Adopt number of tines = 9

Step 3: Spacing Between Tines
Recommended spacing for rigid cultivator:
$$\text{Spacing} = 180\text{–}220\ mm$$

Adopt spacing = 200 mm

Step 4: Working Width of Cultivator

$$\text{Working width} = (9 - 1) \times 0.2 = 1.6 \, m$$

Considering end clearance:
Adopt working width = 1.8 m

Step 5: Design of Tine
- Type: Rigid tine
- Length below frame: **450 mm**
- Cross-section: **25 × 12 mm**
- Material: Medium carbon steel

This section is sufficient to withstand bending stresses due to soil resistance.

Step 6: Design of Shovel
- Type: Reversible
- Width: **150 mm**
- Thickness: **6 mm**
- Material: High carbon steel

Shovel width is selected to ensure full soil coverage without excessive draft.

Step 7: Design of Frame
- Material: Mild steel
- Angle section: **50 × 50 × 6 mm**
- Length: **1800 mm**
- Width: **600 mm**

The frame supports tines and transmits draft to tractor safely.

Step 8: Hitching System
- Type: Three-point linkage
- Category: I
- Material: Mild steel flats and plates

Ensures easy lifting and depth control.

Final Design Summary

Component	Specification
Tractor power	35 HP
Number of tines	9
Spacing	200 mm
Working width	1.8 m
Working depth	120 mm
Tine size	25 × 12 mm
Shovel size	150 × 6 mm
Frame size	50 × 50 × 6 mm

Side View

Top View Tines

Working Width: 1.8 m
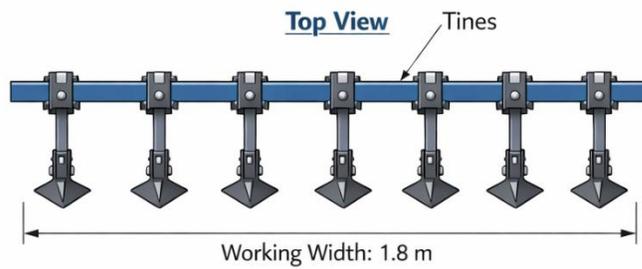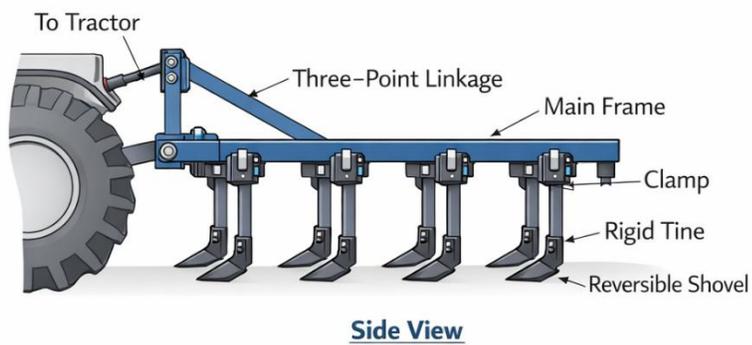
Result

Thus, a **tractor-mounted rigid tine cultivator** suitable for a **35 HP tractor** was designed considering soil condition, draft requirement, and standard design practices.

Ex. No: Date:

DESIGN AND DRAWING OF DISC HARROW

1. Aim

To study, design and draw the main components of a tractor-mounted disc harrow used for primary and secondary tillage operations.

---

2. Introduction

A disc harrow is a tractor-mounted tillage implement used for cutting, pulverizing and mixing soil after ploughing. It consists of a number of concave steel discs mounted on a common axle known as a disc gang. The discs are set at an angle to the direction of travel to achieve soil cutting and inversion.

Disc harrows are widely used because of:

- Effective soil pulverization
- Better residue incorporation
- Suitable for hard and dry soils
- Reduced clogging compared to tine implements

---

3. Classification of Disc Harrow

(a) Based on mounting

- Mounted disc harrow
- Trailed disc harrow

(b) Based on arrangement of discs

- Single action disc harrow
- Double action (tandem) disc harrow

---

4. Main Parts of Disc Harrow

- Main frame
- Disc gangs
- Concave discs
- Gang axle
- Bearings
- Scrapers
- Hitching system (three-point linkage)

---

5. Problem Statement

Design a **tractor-mounted disc harrow** suitable for operation with a **45 HP tractor** for tillage operations in **medium soil**. The disc harrow should work at a depth of **120–150 mm** with adequate soil pulverization.

---

6. Given Data

Parameter	Value
Tractor power	45 HP
Type of soil	Medium
Working depth	120–150 mm

Parameter	Value
Operating speed	5 km/h
Type of harrow	Disc harrow
Mounting	Tractor mounted
Hitching	Three-point linkage

7. Assumptions

- Draft requirement per disc in medium soil = **950 N**
- Efficiency of power transmission = **75%**
- Disc diameter range = **450–550 mm**
- Standard disc spacing = **180–220 mm**

Materials Used

- Discs: High carbon steel
- Frame: Mild steel
- Axle: Medium carbon steel

8. Design Calculations

Step 1: Available Draft from Tractor

Available power:

$$P = 45 \times 0.75 = 33.75 \text{ HP}$$

Convert HP to kW:

$$P = 33.75 \times 0.746 = 25.18 \text{ kW}$$

Forward speed:

$$V = \frac{5 \times 1000}{3600} = 1.39 \text{ m/s}$$

Draft force:

$$D = \frac{P}{V} = \frac{25.18 \times 1000}{1.39} = 18{,}120 \text{ N}$$

Step 2: Number of Discs

Draft per disc = **950 N**

$$\text{Number of discs} = \frac{18{,}120}{950} = 19.07$$

Considering field conditions and standard practice:

Adopt number of discs = 16 (8 per gang)

Step 3: Disc Diameter

Recommended disc diameter for mounted disc harrow:

450 to 550 mm

Adopt disc diameter = 510 mm

Step 4: Disc Spacing

Recommended disc spacing:

180 to 220 mm

Adopt disc spacing = 200 mm

Step 5: Working Width of Disc Harrow

$$\text{Working width} = (8 - 1) \times 0.2 = 1.4 \text{ m}$$

Considering overlap and end clearance:

Adopt working width = 1.6 m

Step 6: Disc Thickness

For a disc diameter of 510 mm:

Disc thickness = 4.5 mm

Material: High carbon steel for good wear resistance.

Step 7: Gang Angle

Recommended gang angle:

15° to 25°

Adopt gang angle = 20°

This angle provides proper penetration and soil throw.

Step 8: Design of Frame
- Material: Mild steel
- Angle section: **65 × 65 × 6 mm**
- Length: **1600 mm**
- Width: **700 mm**

The frame supports disc gangs and safely transmits draft to the tractor.

Step 9: Design of Axle and Bearings
- Axle diameter: **32 mm**
- Bearing type: Taper roller bearing
- Material: Medium carbon steel

Step 10: Hitching System

- Type: Three-point linkage
- Category: I / II
- Material: Mild steel flats and plates

Ensures easy lifting and depth control.

9. Final Design Summary

Component	Specification
Tractor power	45 HP
Number of discs	16
Discs per gang	8
Disc diameter	510 mm
Disc thickness	4.5 mm
Disc spacing	200 mm
Working width	1.6 m
Working depth	120–150 mm
Gang angle	20°
Frame size	65 × 65 × 6 mm

Top View

Side View
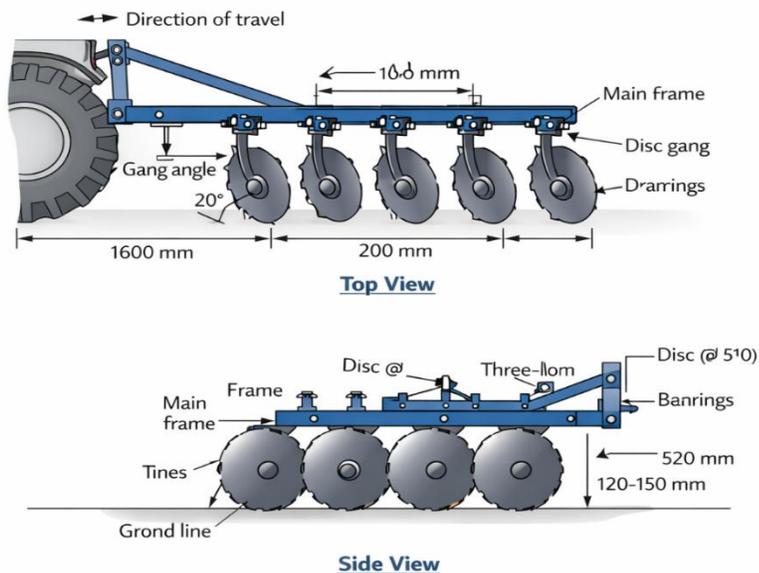
10. Result

Thus, the design and drawing of a **tractor-mounted disc harrow** suitable for a **45 HP tractor** was successfully carried out.

DESIGN AND DRAWING OF TRACTOR-MOUNTED MOWER

1. Aim

To study, design and draw the main components of a tractor-mounted mower used for cutting grasses and forage crops.

---

2. Introduction

A mower is an agricultural implement used for cutting grass, fodder crops and weeds at a uniform height above the ground. Tractor-mounted mowers are widely used in forage harvesting, pasture management and lawn maintenance. The cutting action is achieved using rotating or reciprocating blades driven by the tractor PTO.

Mowers are widely used because of:

- Uniform cutting height
- High field capacity
- Reduced labour requirement
- Better forage quality

---

3. Classification of Mower

(a) Based on cutting mechanism

- Rotary mower
- Reciprocating (sickle bar) mower

(b) Based on mounting

- Mounted mower
- Trailed mower

---

4. Main Parts of Mower

- Main frame
- Cutting unit (blades / cutter bar)
- Power transmission system (PTO shaft, gearbox)
- Blade carrier or cutter bar
- Skids or gauge wheels
- Hitching system (three-point linkage)

---

5. Problem Statement

Design a **tractor-mounted rotary mower** suitable for operation with a **35 HP tractor** for cutting grasses and fodder crops. The mower should have a working width of about **1.5 m** and operate at a cutting height of **50 mm**.

---

6. Given Data

Parameter	Value
Tractor power	35 HP
Type of mower	Rotary mower
Working width	1.5 m

Parameter	Value
Cutting height	50 mm
Operating speed	5 km/h
Power source	PTO
Hitching	Three-point linkage

7. Assumptions

- Power available at PTO = **85% of engine power**
- Efficiency of power transmission = **80%**
- PTO speed = **540 rpm**

Materials Used

- Frame: Mild steel
- Blades: High carbon steel
- Shaft: Medium carbon steel

8. Design Calculations

Step 1: Power Available at PTO

$$P_{PTO} = 35 \times 0.85 = 29.75 \text{ HP}$$

Convert HP to kW:

$$P = 29.75 \times 0.746 = 22.19 \text{ kW}$$

Effective power considering transmission efficiency:

$$P_{eff} = 22.19 \times 0.80 = 17.75 \text{ kW}$$

Step 2: Selection of Working Width

Recommended working width for rotary mower with 35 HP tractor:

$$1.2 \text{ to } 1.8 \text{ m}$$

Adopt working width = 1.5 m

Step 3: Blade Tip Speed

Recommended blade tip speed:

$$50\text{–}70 \text{ m/s}$$

Assuming blade radius = **0.75 m**

$$V = \omega r$$
$$\omega = \frac{2\pi N}{60}$$

For PTO speed = 540 rpm:

$$V = \frac{2\pi \times 540}{60} \times 0.75 = 42.4 \text{ m/s}$$

This speed is sufficient for effective cutting.

Step 4: Design of Blade
- Type: Swinging blade
- Length: **450 mm**
- Width: **50 mm**
- Thickness: **6 mm**
- Material: High carbon steel

Step 5: Design of Cutting Disc / Blade Carrier
- Diameter: **500 mm**
- Thickness: **8 mm**
- Material: Mild steel

Step 6: Design of Frame
- Material: Mild steel
- Frame size: **50 × 50 × 6 mm angle**
- Length: **1500 mm**
- Width: **600 mm**

The frame supports cutting unit and transmission system.

Step 7: Design of PTO Shaft and Gearbox
- PTO speed: **540 rpm**
- Gearbox reduction ratio: **1 : 1.2**
- Shaft diameter: **30 mm**
- Material: Medium carbon steel

Step 8: Hitching System
- Type: Three-point linkage
- Category: I
- Material: Mild steel flats and plates

Provides easy lifting and cutting height control.

---

9. Final Design Summary

Component	Specification
Tractor power	35 HP
Type of mower	Rotary mower
Working width	1.5 m
Cutting height	50 mm
Blade size	450 × 50 × 6 mm

| Component	Specification
Blade carrier dia	500 mm
Frame size	50 × 50 × 6 mm
PTO speed	540 rpm

10. Working Principle

Power from the tractor PTO is transmitted to the mower gearbox. The gearbox drives the blade carrier, causing the blades to rotate at high speed. The rotating blades cut grass and fodder crops at the desired height.
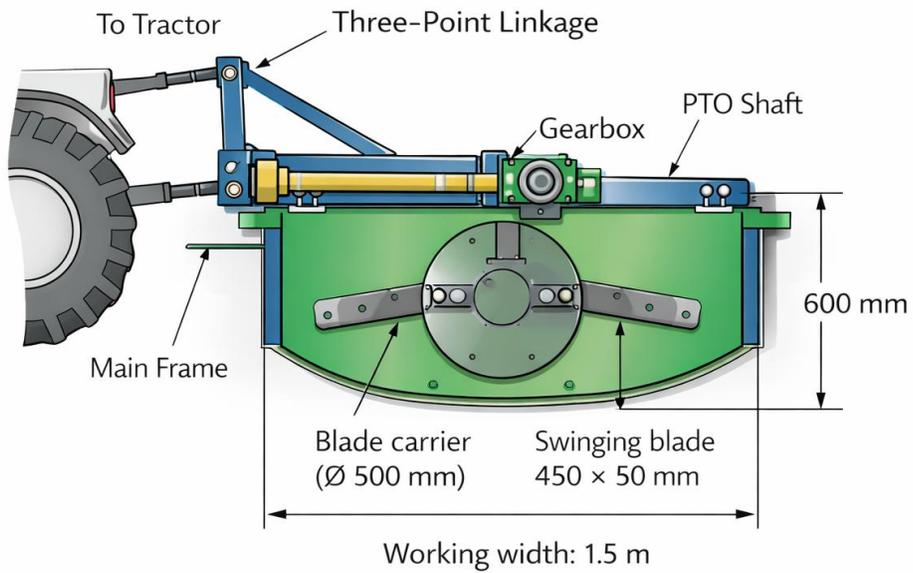
11. Advantages of Mower

- Uniform cutting
- High field efficiency
- Reduced labour requirement
- Simple operation

12. Result

Thus, the design and drawing of a **tractor-mounted rotary mower** suitable for a **35 HP tractor** was successfully carried out.
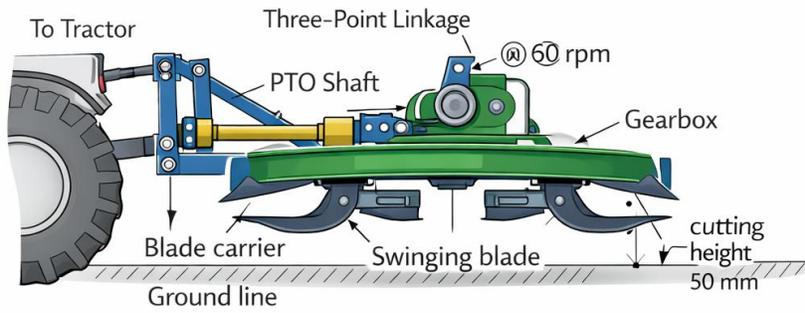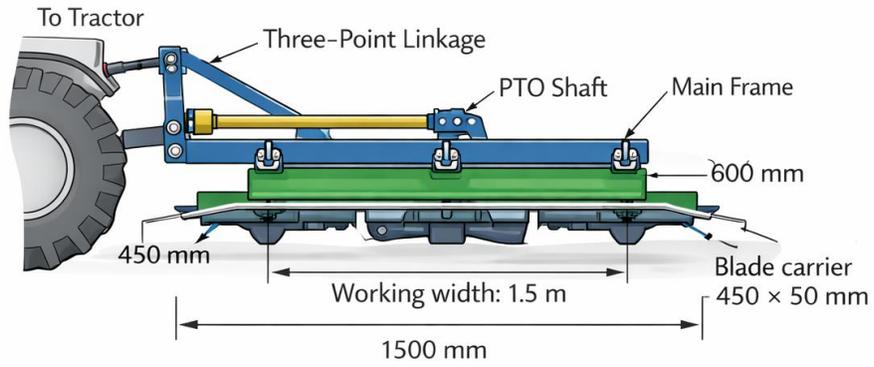
Side View

Top View

DESIGN AND DRAWING OF TRACTOR-MOUNTED MOWER

1. Aim
To study, design and draw the main components of a tractor-mounted weeder used for inter-row weed control in row crops.

2. Introduction
A weeder is a farm implement used to remove weeds growing between crop rows without disturbing the crop plants. Tractor-mounted weeders are commonly used in row crops such as cotton, maize, sugarcane and vegetables. They work at shallow depths and reduce manual labour while improving soil aeration.

Advantages of weeder:
- Effective weed control
- Reduced labour requirement
- Improved soil aeration
- Increased crop yield

3. Classification of Weeder
Based on power source:
- Manual weeder
- Power weeder
- Tractor-mounted weeder

Based on working tool:
- Blade weeder
- Sweep type weeder
- Rotary weeder

4. Main Parts of Weeder
- Main frame
- Weeding tools (sweeps/blades)
- Tines or tool bars
- Gauge wheel / depth control wheel
- Hitching system (3-point linkage)
- Clamps and fasteners

Problem Statement
Design a **tractor-mounted sweep type weeder** suitable for a **35 HP tractor** for inter-row weeding in medium soil conditions. The weeder should operate at a depth of **50 mm** with a working width of **1.6 m**.

Given Data

Parameter	Value
Tractor power	35 HP
Soil type	Medium
Working depth	50 mm

Parameter   **Value**

Operating speed 4 km/h

Type of weeder Sweep type

Hitching   3-point linkage

Assumptions
- Draft requirement per sweep in medium soil = **600 N**
- Power transmission efficiency = **75%**
- Maximum allowable draft ≈ **700 N/HP**
- Materials used:
  - Frame: Mild steel
  - Tines: Medium carbon steel
  - Sweeps: High carbon steel

Step 1: Available Draft from Tractor

Available power:
$$35 \times 0.75 = 26.25 \text{ HP}$$

Convert HP to kW:
$$26.25 \times 0.746 = 19.58 \text{ kW}$$

Operating speed:
$$V = \frac{4 \times 1000}{3600} = 1.11 \text{ m/s}$$

Draft force:
$$D = \frac{19.58 \times 1000}{1.11} = 17{,}640 \text{ N}$$

Step 2: Number of Weeding Tools

Draft per sweep = **600 N**
$$\text{Number of sweeps} = \frac{17640}{600} = 29.4$$

Considering crop spacing and frame limitation:
Adopt number of sweeps = 7

Step 3: Spacing Between Sweeps

Recommended spacing for sweep weeders:
$$200\text{–}250 \text{ mm}$$

Adopt spacing = 225 mm

Step 4: Working Width of Weeder

$$\text{Working width} = (7 - 1) \times 0.225 = 1.35 \text{ m}$$

Considering end clearance:
Adopt working width = 1.6 m

Step 5: Design of Tine
- Type: Rigid tine
- Length below frame: **350 mm**
- Cross-section: **20 × 10 mm**
- Material: Medium carbon steel

This section is adequate to withstand bending stresses due to soil resistance.

Step 6: Design of Sweep
- Type: V-shaped sweep
- Width: **200 mm**
- Thickness: **5 mm**
- Material: High carbon steel

The sweep width ensures complete weed cutting between crop rows.

Step 7: Design of Frame
- Material: Mild steel
- Angle section: **50 × 50 × 6 mm**
- Length: **1600 mm**
- Width: **600 mm**

The frame safely supports all weeding tools and transfers draft to the tractor.

Step 8: Depth Control Wheel
- Type: Adjustable gauge wheel
- Diameter: **300 mm**
- Material: Mild steel

Used to maintain uniform working depth.

Step 9: Hitching System
- Type: Three-point linkage
- Category: **I**
- Material: Mild steel plates and flats
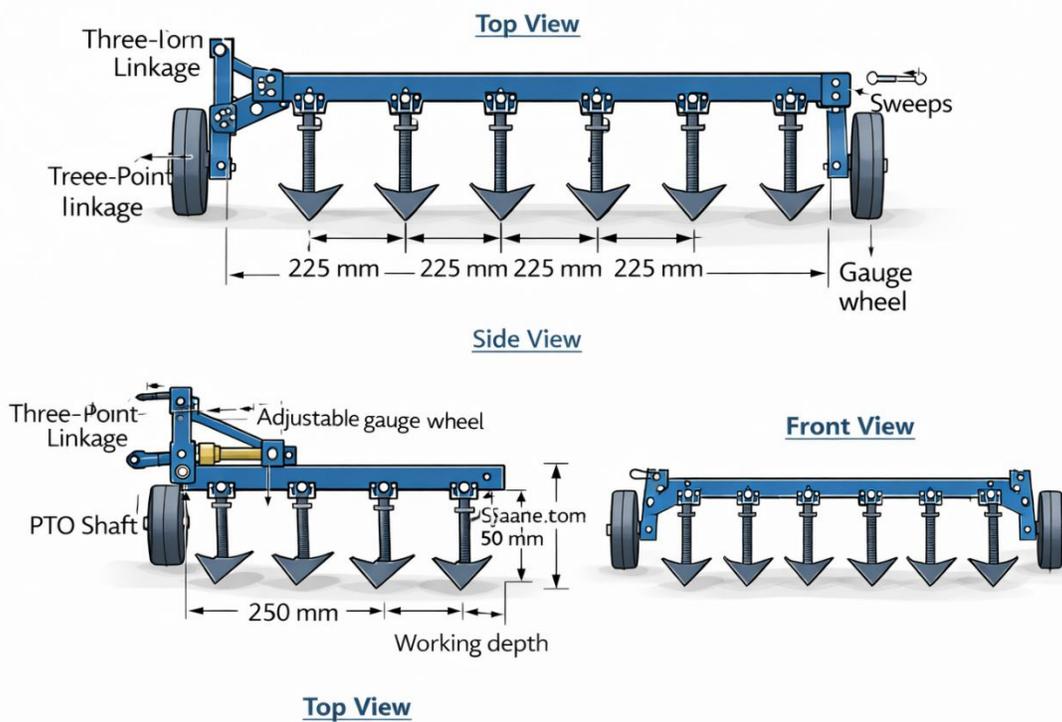
Ensures easy lifting, lowering and depth adjustment.

Final Design Summary

Component	Specification
Tractor power	35 HP
Number of sweeps	7

Component	Specification
Spacing	225 mm
Working width	1.6 m
Working depth	50 mm
Tine size	20 × 10 mm
Sweep size	200 × 5 mm
Frame size	50 × 50 × 6 mm
Hitching	3-point linkage

10. Result

Thus, the design and drawing of a **tractor-mounted sweep type weeder** suitable for a **35 HP tractor** was successfully carried out.

Ex. No: **Date**

INTRODUCTION AND DEMONSTRATION OF 3D MODELING SOFTWARES (PRO/E, CREO, SOLIDWORKS, SOLID EDGE)

---

1. Aim

To study the basic features and demonstrate 3D modeling operations using CAD softwares such as Pro/ENGINEER (Pro/E), Creo, SolidWorks and Solid Edge for modeling agricultural implements.

---

2. Introduction

3D modeling softwares are widely used in engineering design for creating accurate digital representations of components and assemblies. Softwares like Pro/E (Creo Parametric), SolidWorks and Solid Edge enable engineers to design, analyze and visualize mechanical components efficiently. These tools are extensively used in agricultural machinery design for developing implements such as cultivators, weeders, disc harrows and mowers before actual fabrication.

---

3. Objectives of 3D Modeling
- To create accurate 3D models of machine components
- To reduce design errors before manufacturing
- To visualize assemblies and motion
- To generate 2D drawings from 3D models

---

4. List of 3D Modeling Softwares

Software	Developer	Application
Pro/ENGINEER	PTC	Parametric 3D modeling
Creo Parametric	PTC	Advanced CAD & simulation
SolidWorks	Dassault Systems	Mechanical design
Solid Edge	Siemens	Parametric and synchronous modeling

---

5. System Requirements
- Processor: Intel i5 or higher
- RAM: Minimum 8 GB
- Graphics card: Dedicated (2 GB or above)
- Operating system: Windows 10 / 11

---

6. Basic Features of 3D Modeling Softwares
- Sketching (2D profiles)
- Feature-based modeling
- Parametric design
- Assembly modeling
- Drafting (2D drawing creation)

---

7. Demonstration of 3D Modeling Operations

Step 1: Creating a New Part

- Open the software
- Select New → Part
- Set units (mm, kg, sec)

Step 2: Sketch Creation
- Select a reference plane (Front / Top / Right)
- Draw basic geometry using:
  - Line
  - Circle
  - Rectangle
- Apply dimensions and constraints

Step 3: Feature Creation
- Convert sketch into 3D feature using:
  - Extrude
  - Revolve
  - Sweep
  - Loft

Step 4: Editing Features
- Modify dimensions
- Apply fillets and chamfers
- Create holes using Hole Wizard

Step 5: Assembly Modeling
- Create a new Assembly file
- Insert individual parts
- Apply mating constraints

Step 6: Drafting (2D Drawing)
- Generate standard views:
  - Top view
  - Front view
  - Side view
- Add dimensions and annotations

---

8. Application to Agricultural Implement Design

3D modeling softwares are used to design agricultural implements such as:
- Cultivator frames
- Disc harrow gangs
- Weeder tines and sweeps
- Mower blades and frames

These models help in visualization, interference checking and design optimization.

---

9. Advantages of 3D Modeling Softwares
- High accuracy
- Reduced development time
- Easy design modification
- Improved product quality

10. Result

Thus, the introduction and demonstration of 3D modeling softwares such as Pro/E, Creo, SolidWorks and Solid Edge was successfully carried out.

Viva Questions and Answers

1. What is the purpose of design and drawing of farm implements?

Answer:

To determine suitable dimensions, materials and working parameters and to represent the implement clearly before manufacturing.

---

2. Why mild steel is commonly used for frames of farm implements?

Answer:

Because mild steel has good strength, weldability, low cost and easy availability.

---

3. What is draft?

Answer:

Draft is the horizontal pulling force required to move an implement through soil.

---

4. What factors affect draft requirement of an implement?

Answer:

Soil type, working depth, speed of operation, implement width and soil moisture.

---

5. What is three-point linkage?

Answer:

A hitching system having two lower links and one top link used to attach implements to tractors.

MOULD BOARD PLOUGH

6. What is the function of a mould board plough?

Answer:

To cut, lift, invert and pulverize soil for primary tillage.

---

7. Name the main parts of a mould board plough.

Answer:

Share, mould board, landside, frog, beam and hitch.

---

8. Why high carbon steel is used for plough share?

Answer:

Because it has high wear resistance and retains sharp cutting edge.

DISC PLOUGH

9. What is a disc plough?

Answer:

A primary tillage implement consisting of concave discs used to cut and turn soil.

---

10. Why disc plough is preferred in hard and sticky soils?

Answer:

Because it prevents clogging and provides better penetration.

11. What is the usual disc diameter of a disc plough?
Answer:
600–750 mm.

CULTIVATOR
12. What is the function of a cultivator?
Answer:
To loosen soil, control weeds and prepare seedbed after ploughing.

13. Difference between rigid and spring-loaded cultivator?
Answer:
Rigid cultivator has fixed tines, while spring-loaded cultivator absorbs shocks using springs.

14. What is the recommended tine spacing in a cultivator?
Answer:
180–220 mm.

DISC HARROW
15. What is the function of a disc harrow?
Answer:
To pulverize soil, break clods and mix crop residues.

16. What is a disc gang?
Answer:
A set of discs mounted on a common axle is called a disc gang.

17. Why gang angle is provided in disc harrow?
Answer:
To achieve proper soil cutting, penetration and soil throw.

MOWER
18. What is a mower?
Answer:
A machine used to cut grasses and fodder crops at uniform height.

19. Difference between rotary mower and sickle bar mower?
Answer:
Rotary mower uses rotating blades, while sickle bar mower uses reciprocating blades.

20. What is the function of PTO in mower?
Answer:
To transmit power from tractor engine to mower cutting mechanism.

WEEDER

21. What is a weeder?

Answer:

An implement used to remove weeds between crop rows.

---

22. What is a sweep type weeder?

Answer:

A weeder that uses V-shaped sweeps to cut weeds below soil surface.

---

23. Why shallow depth is maintained in weeder operation?

Answer:

To remove weeds without damaging crop roots.

3D MODELING SOFTWARE

24. What is 3D modeling software?

Answer:

Software used to create three-dimensional digital models of components and assemblies.

---

25. Name any two advantages of 3D CAD software.

Answer:

High accuracy and easy modification of designs.