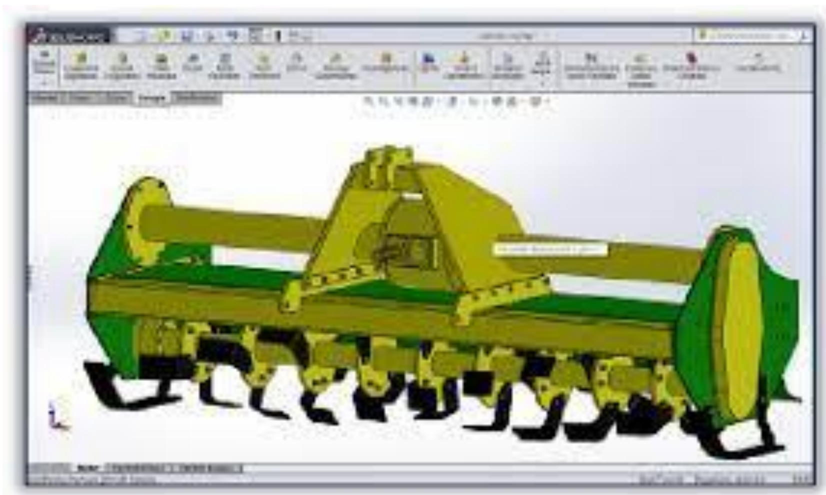
DEPARTMENT OF AGRICULTURE ENGINEERING

CAD FOR AGRICULTURAL ENGINEERING



LABORATORY MANUAL

Vision of the Department

The Agriculture Engineering department aims to produce well informed technocrats, who will be able to integrate engineering and technology inventions with farming and contribute towards sustainable growth in agriculture production across the globe.

Mission of the Department

M1: To prepare the students with in depth Engineering knowledge and skills so as to face the challenges in Agriculture namely Farm Mechanization, Soil and Water Conservation, Agricultural Processing and Post harvest value addition, Bio Energy utilization and Precision farming and prove their prowess and expertise as Agriculture Engineers.

M2: To equip the graduates to meet global challenges in agricultural growth.

M3: To create ample opportunity to interact with industries and institutions and sign MOUs for mutual benefits.

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.

CAD FOR AGRICULTURAL ENGINEERING

OBJECTIVES:

- To design and draft the underground pipeline system
- To design and draft various ploughs.
- To design and draft post-harvest technology units and bio gas plant.
- To introduce the students various 3D modeling Software.
- To design and draft Check dam.

COURSE OUTCOMES (COs)

After completion of the course, Students are able to,

COs	Knowledge level	Course out comes
CO 1	K4	The student will be able to understand the plan and layout of underground pipes.
CO 2	K4	The students also will be able to design and draw the check dams, 3d modelling.
CO 3	K4	The students also will be able to design and draw the various ploughs.
CO 4	K4	The students also will be able to design and draw the post harvest units.
CO5	K4	The students also will be able to design and draw the bio gas plant.

List of Experiments Mapping with COs, POs &PSOs

Exp. No.	Name of the Experiment	COs	POs	PSOs
1	Design and Drawing of Underground pipeline system.	CO1	1,4,8,9,10,12	1
2	Design and Drawing of Check dam.	CO2	1,2,3, 8,9,10,12	2
3	Design and Drawing of Mould board plough.	CO3	4,5,6,9,11	2
4	Design and Drawing of Disk plough.	CO3	4,5,6,9,11	2
5	Design and Drawing of Post harvest technology units (threshers and winnowers).	CO4	1,2,3, 8,9,10,12	2
6	Design and Drawing of Biogas plant.	CO5	1,2,3, 8,9,10,12	2
7	Introduction & demonstration on 3D modeling software like Pro/E, Creo, Solid works, Solid Edge etc.	CO2	1,2,3, 8,9,10,12	2
Content Beyond Syllabus				
8	Study on Retaining Wall	CO2	1,2,3, 8,9,10,12	2

1. *INTRODUCTION TO AUTOCAD*

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
- 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 memoryand 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 specifictype 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.

0. **AutoCAD – BASICS**

STARTING WITH ACAD

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.

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 toconvenient values. It is possible to adjust these settings.

Title block: Select the description of an ACAD drawing file of a title block to insertas 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 <segment length> / 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 thedrawing 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)

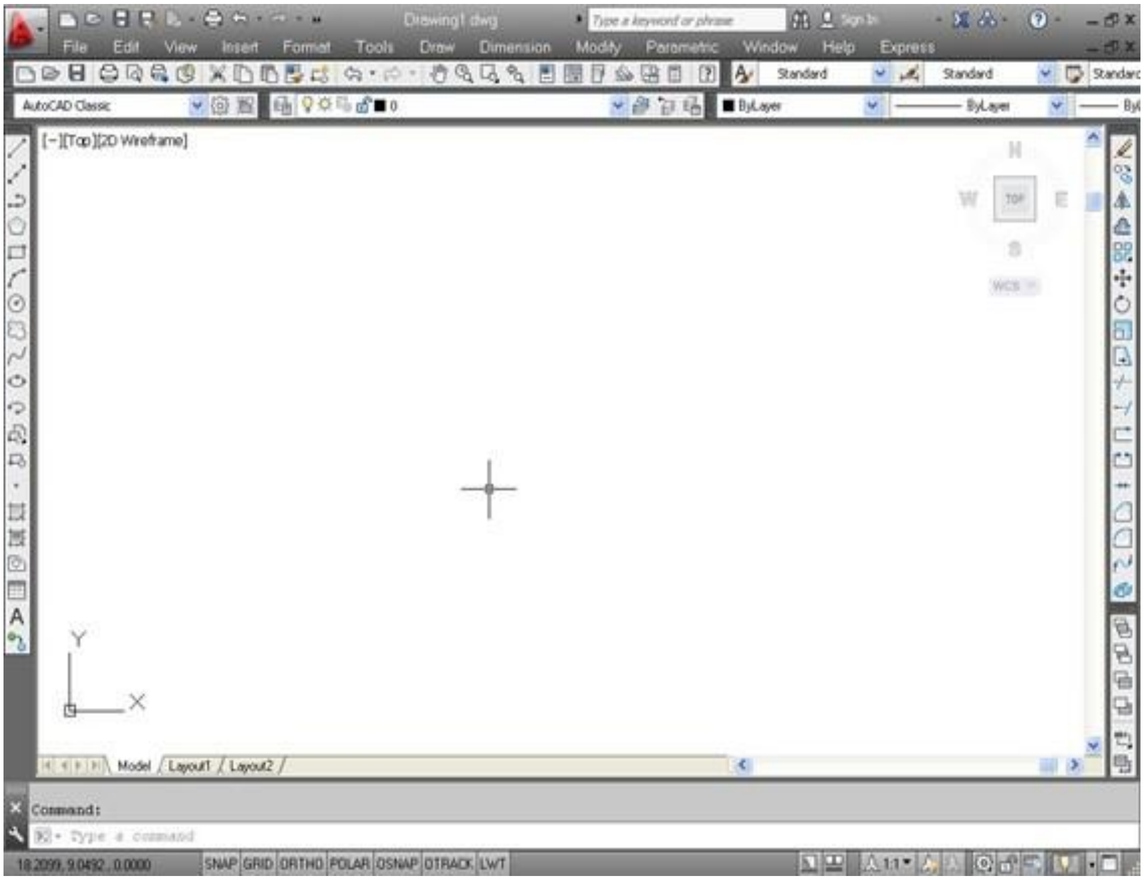
Specify next point or [Undo]: Specify a point (2) The second point can be indicated by

@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



LAYOUT AND SKETCHING

The package provides various facilities for layout, sketching and borders for preparing adrawing. 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.

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)

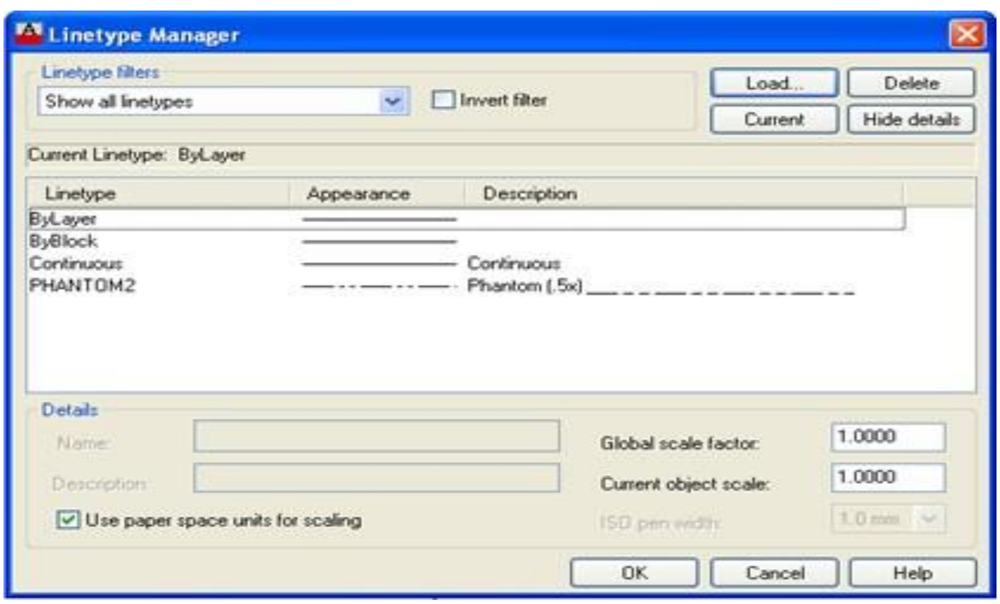
Current line-width is <current>

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 characteristics consisting 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 anarc.

- 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 anarc.

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 for drawing of a regular or irregular curve.

Drawing of Rectangle: A rectangle can be drawn by LINE command or by Rectangle command. 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 variable is 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 second Forth point: specify a point

(4) or press enter

3. DRAWING OF POLYGON

Creates an equilateral closed polyline .A polygon is a polyline object. AUTOCAD draws polyline 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 enterEdge/<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 pecify 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

0. **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.

1. BOX

3D FUNCTIONS

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.

Ex. No: Date:

DESIGN AND DRAWING OF UNDERGROUND PIPELING SYSTEM

Aim: To study the pipeline system which buried under the ground.

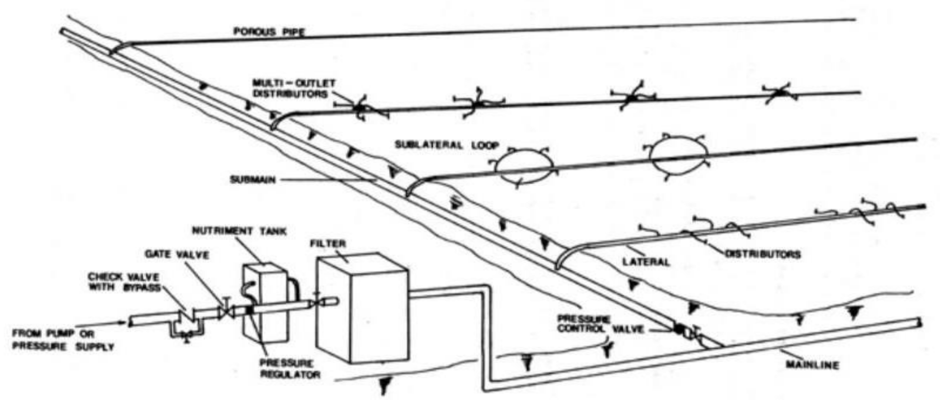
The design of underground pipe line system requires information on land topography, location of water source and water discharge. Pump stands must be of high elevation to allow sufficient operating head for the pipeline. However, stands higher than necessary may permits high heads of water to build up, leading to executive line pressures. The working pressures in the pipeline are kept within one-fourth the internal bursting pressures of the pipe. When it is necessary to design pipeline with higher heads, reinforced concrete pressure pipes are used. The sizes of the outlets are selected to suit the flow required at diversion points. The PVC and HDPE are also used for water distribution at low and moderate pressure. The components of the systems such as pipeline size and height of pump stands and control stands must be designed so as to obtain a balanced water distribution and provide trouble free operation.

The underground pipeline may fail due to i) lack of inspection or maintenance, ii) improper construction, iii) improper design and iv) wrong manufacturing processes and poor quality materials used.The underground pipelines operate without trouble when it is properly designed and correctly installed. Inadequate procedures in design and installation and unforeseen situations give rise to the following troubles.

- Development of longitudinal cracks in the pipe, usually at the top or both at top and bottom
- Telescoping of sections
- Pushing of the pipe into the stands
- Development of circumferential cracks
- Surging or intermittent flow of water

Leak Testing and Repair

All buried low pressure irrigation pipelines should be tested for leaks before the trench is filled. The pipeline should be filled with water and slowly brought up to operating pressure with all turnouts closed. Any length of pipe section or joints showing leakage should be replaced and the line retested. The water should remain in pipelines throughout the backfilling of trenches, because the internal pressure helps to prevent pipe deformation from soil loading and equipment crossings. Underground pipeline should be inspected for leakage at least once a year. Leaks may be spotted from wet soil areas above the line that are otherwise unexplained. Small leaks in concrete pipeline can be repairs by carefully cleaning the pipe exterior surrounding the leak, then applying a patch of cement mortar grout. For larger leaks, one or more pipe sections may have to a be replaced. Longevity of concrete pipelines can be increased by capping all opening during cold winter months to prevent air circulation. Small leaks in plastic pipe, expect at the joints, can sometimes be repaired by pressing a gasket-like material tightly against the pipe wall around the leak and clamping it with a saddle. Where water is supplied from a canal to portable surface pipe, sediment often accumulates in the pipe. This sediment should be flushed out before the pipe is moved. Otherwise, the pipe will be too heavy to be moved but hand and may be damaged if it is moved mechanically. Buried plastic pipelines can be expected to have a usable life of about 15 years, if it is moved mechanically. Buried plastic pipelines can be expected to have a usable life of about 15 years, if well maintained. The annual cost of maintenance can be estimated as approximately 1% of the installation cost.



Underground piping system

15

Result

Thus the pipeline system which buried under the ground.

Ex. No: Date:

DESIGN AND DRAWING OF CHECK DAMS

Aim: To study the design aspects of check dams

A check dam is a small, sometimes temporary, dam constructed across a swale, drainage ditch, or waterway to counteract erosion by reducing water flow velocity. Check dams themselves are not a type of new technology; rather, they are an ancient technique dating all the way back to the second century A.D. Check dams are typically, though not always, implemented as a system of several check dams situated at regular intervals across the area of interest.

Grade control mechanism

Check dams have traditionally been implemented in two main environments: across channel bottoms and on hilly slopes. Check dams are used primarily to control water velocity, conserve soil, and improve land. They are used when other flow-control practices, such as lining the channel or creating bios wales is impractical.

DESIGN CONSIDERATIONS

Site

Before installing a check dam, careful inspection of the site must be undertaken. The drainage area should be ten acres or less. The waterway should e on a slope of no more than 50% and should have a minimum depth to bedrock of 2ft. Check dams are often used in natural or constructed channels or swales. They should never be placed in live streams unless approved but appropriate local, State and /or federal authorites.

Materails

Check dams are made of a variety of materials. Because they are typically used as temporary structures, they are often made of cheap and accessible materials such as rocks, gravel, logs, hay bales, and sandbags. Of these, logs and rock check dams are usually permanent or semi-permanent; and the sandbag check dam is implemented primarily for temporary purposes. Also, there are check dams that are constructed with rock fill or wooden boards. These dams are usually implemented only in small, open channels that drain 10 acres ($0.04km^2$) or less; and usually do not exceed 2 ft.(0.6m) high. [14] woven-wire can be used to construct check dams in order to hold fine material in a gully. They are typically utilized in environments where the fully has a moderate slope (less than 10%), small drainage area, and in region where flood flows for not typically carry large rocks or boulders. In nearly all instances, erosion control blankets, which are biodegradable open – weave blankets, are used in conjunction with check dams. These blankets help enforce vegetation growth on the slopes, shorelines and ditch bottoms.

Size

A check dam should not be more than 2ft (0.61m) to 3ft (0.91 m) high. And the center of the dam should be at least 6 in (0.15 m) lower than its edges. They may kill grass linings in channels if water stays high or sediment load is great. This criteria induces a weir effect, resulting in increased water surface level upstream for some, if not all flow conditions.

Spacing

In order to effectively slow down water velocity to counter the effects of erosion and protect the channel between dams in a larger system, the spacing must be designed properly. The check dams should be spaced such that the toe of the upstream check dam is equal to the elevation of the downstream check dam's crest. By doing so, the water can pond between check dams and thus slow the flow's velocity down substantially as the water progresses downslope.

DESIGN EXAMPLE OF CHECK DAM

Data

Catchment area = 15.68 sq. km (6.127 sq. miles) Nature of Catchment = Good

Average annual rainfall = 825 mm

65 percent dependable rainfall = 717 mm

Gauge-Discharge Table

Discharge	Water Level
50	89.98
60	91.59
70	93.21
80	94.83
90	96.45
110	99.69
115	100.50

Yield from Catchment

From Strange's Table

Yield/sq. km for 717 mm rainfall is 26.08 percent of rainfall = 0.187 MCM Yield from the catchment = 15.68 X 0.187

= 2.93 MCM

Design Flood

Where a formula applicable to a given situation is available viz. Dicken's or Ryve's formula.

Assuming that following Dicken's formula is available

$Q = 1000\ A^{3/4}$

$Q = 1000\ (6.127)^{3/4}$

$= 3894$ cusecs

$= 110.37$ cumecs

Design of Sharp Crested Weir

Discharge, $Q = 1.84\ (L – KnH)$

$H^{3/2}$ Where,

L = Length of weir

K = Coefficient of end contraction (adopted 0.1)

n = Number of end contractions (in this case = 2)

H = Total head over spillway crest

Q = Discharge

Providing a total head (including velocity head of 0.05) = 1.05 m

$110.37 = 1.84\ (L – 0.1 \times 2 \times 1.05)\ 1.05^{3/2}$

$= 1.84\ (L – 0.21) \times 1.076$

L = 55.95 m

Say 56 m

Discharge intensity, q = 110.37/56

= 1.97 cumecs

Normal Scour depth, $R = 1.35\ (q^2/f)^{1/3}$

Assuming, f = 1

$= 1.35\ (1.972^2/f)^{1/3}$

R = 2.12 m below the maximum flood level

Computed flood level at weir site corresponding to the design discharge of 110.37 cumecs is 99.75 m

Keeping the crest level = 99.00 m

Maximum water level = 99.00 + 1.05

= 100.05 m

Thus, there will be a net flood lift of (100.05 – 99.75) i.e. 0.3 m at the weir site Depth of downstream cutoff = 1.5 R

= 1.5 X 2.12

= 3.18 m

Desired R.L. of cut off = 100.05 – 3.18 = 96.87

m Average bed level of deep channel is 97.30 m

Providing a minimum depth of 1 m for cutoff

Actual R.L. of cutoff = 97.30 – 1.0

Design of Weir Floor

Design flood = 110.37 cumecs

Length of weir = 56 m

Height of weir above the bed = 99.00 – 97.30

= 1.7 m

Bottom width of weir = 1.6 m

Total maximum head, H = 1.7 m

Total creep length required, $L = C \times H$

Adopting C = 4

$L = 4 \times 1.7$

= 7.22 m

Say 7.25 m

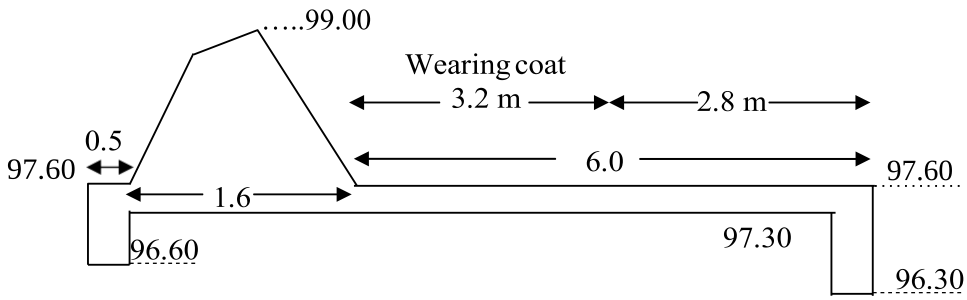
Length of downstream floor, $L_d = 2.21\, C\sqrt{(H/13)}$

$= 2.21 \times 4\sqrt{(1.7/13}$

= 3.19 m

Say 3.20 m

Provide a length of 6.0 m and provide wearing coat for 3.20 m.



Bottom level of downstream cutoff = 96.30

Assuming bottom level of U/S cut off = 96.60

Provide floor thickness = 0.3 m

Actual creep length = 1.0 + 0.5 + 1.6 + 3.2 + 2.8 + 1.3 = 10.4 m against 7.25 m required. Hence O.k.

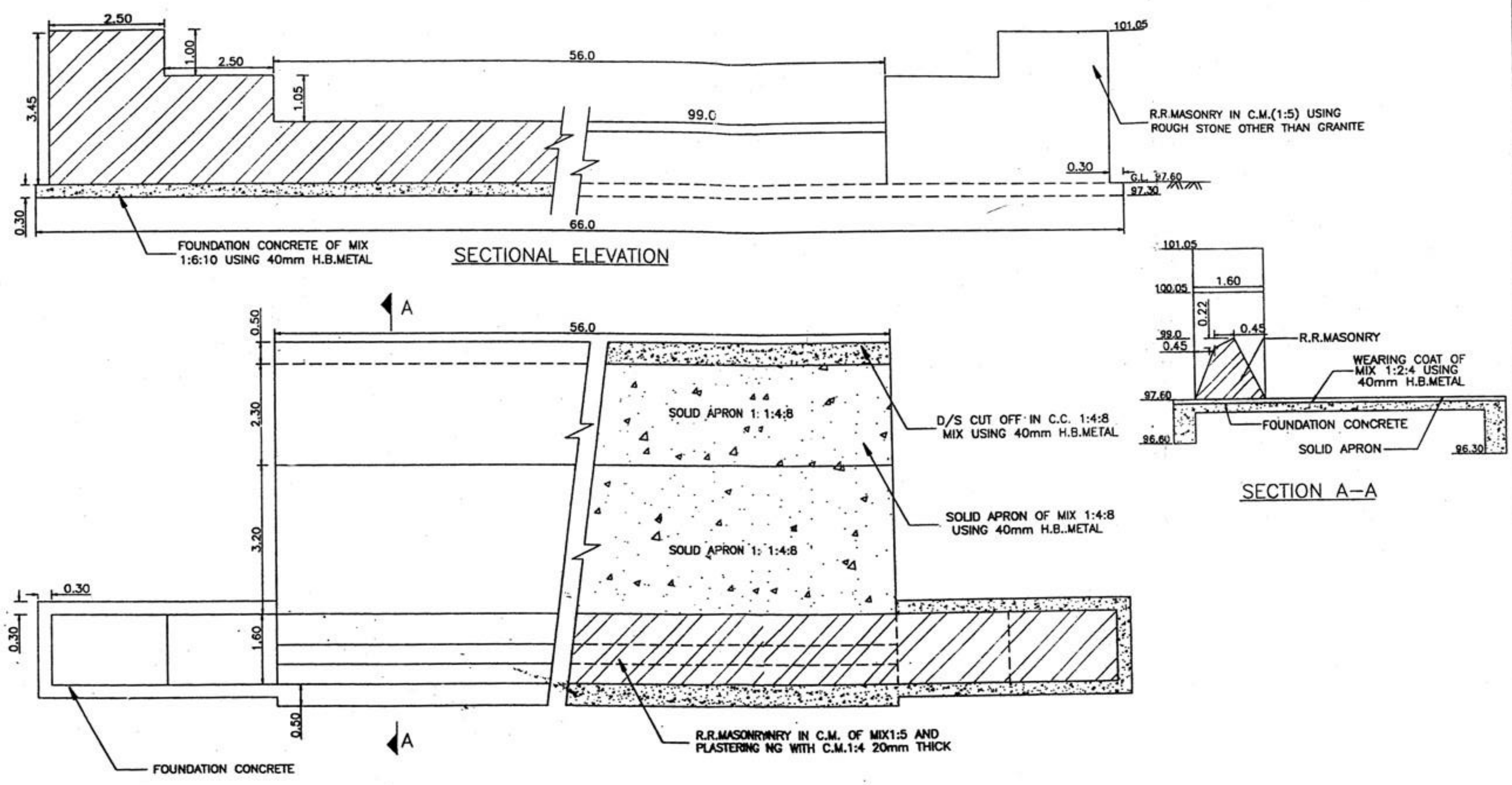
The sample drawings for Check Dam are shown in Figure.

Result

Thus the design aspects of check dams was studied

Figure A-5.1

PLAN SHOWING CHECK DAM



HALF PLAN AT TOP AND HALF PLAN AT BOTTOM

NOTE:– ALL DIMENSIONS ARE IN METRES.

Ex No: **Date:**

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,

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

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

$$P = f\,.G + K.a.b + \mathcal{E}\,abv^2$$

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

$\mathcal{E}$ = 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

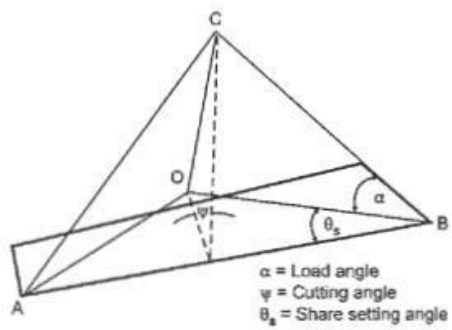
Design Procedure for Mould Board Ploughs

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



3. Calculate drawbar horse power (DBHP) of tractor

DBHP = 60% 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:

W1=D1/ndpR 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.

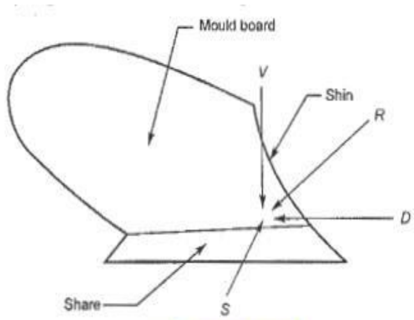


Fig. 4.2: Forces acting on mould board plough bottom

Draft (D) = P cos θ cos α.

Side draft (S) = P cos θ cos α.

Vertical component (V) = P cos θ cos α.

Where, P = Pull of plough, kg or N

θ = Angle of pull with horizontal plane, **degrees**

α = Angle of pull with vertical plane, degrees

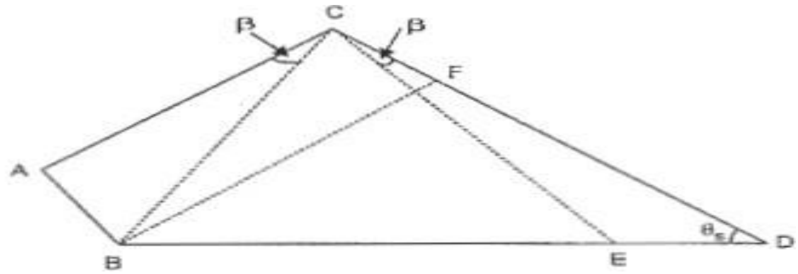
7. Design of share of M.B plough

(i) The best throat angle (share angle) of the share should be an angle along which soil rupture Takes place.

Soil shear angle (θ_3) = 45° - ϕ

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

$$AC/BC = BC/BF \text{ or } BF = BC^2/AC$$

Also in triangle ABC, AB/BC = sin β. 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.

$$CD/\sin\angle CED = CE/\sin\angle\theta 5$$

(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 ψ= 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.

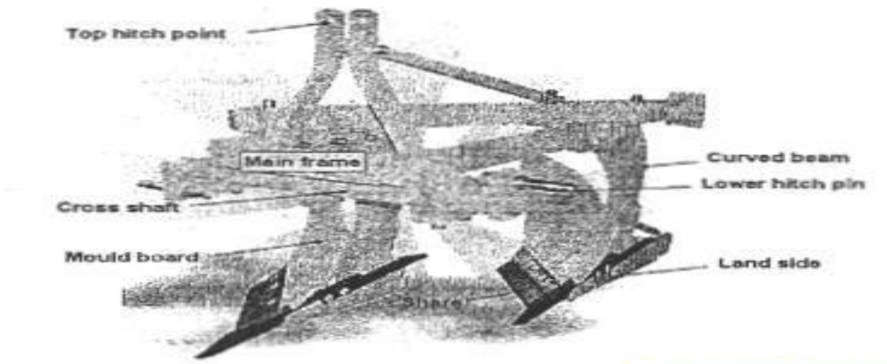


Fig. 4.4 (a): Components of two bottom mould board plough

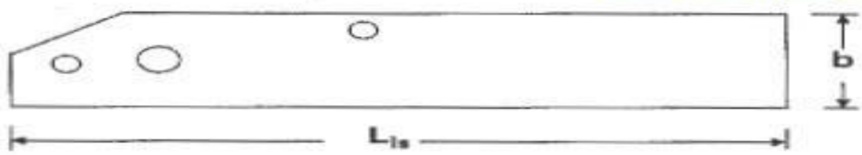


Fig. 4.4 (b): Landside of mould board plough

Length of landside (L_{ls})

Length of landside (L_{1s}) is calculated by using following expression:

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

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

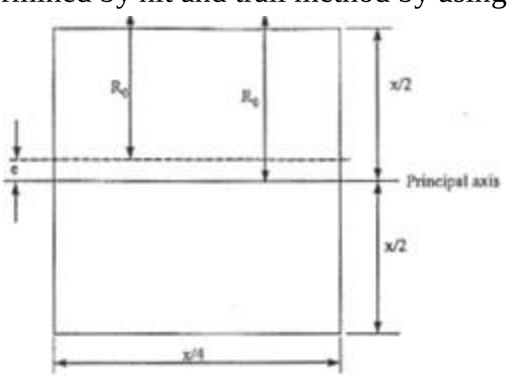
$$f = \frac{\square.\square}{\square.\square(\square\square+\square)}$$

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.

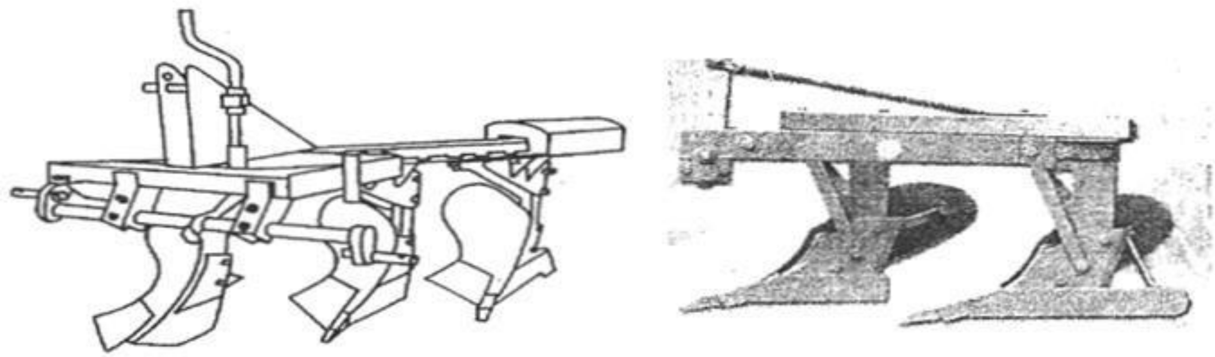


Cross section of beam of M.B plough

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

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

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

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

$$W_i = \frac{D_i}{n d_p R} \text{ in cm}$$

Where, D_i = draft requirement of implement, kg

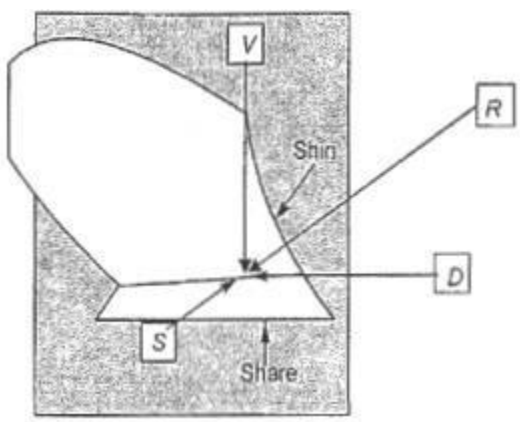
n = number of bottoms in M B plough
dp = depth of ploughing, cm
R = specific resistance of soil, kg/cm^2
Draft is the horizontal component of pull. Here, in this example let us assume that the draft is equal to pull, the number of bottoms in the MB plough is two, maximum depth of ploughing is 20 cm and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

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

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) = *P* cos 20° cos l5° = 972 x 0.9397 x 0.9659 = 882.24 kg.
- Side draft (S) = *P* cos 20° sin 15° = 972 x 0.9397 x 0.2588 = 236.38 kg.
- Vertical component (V) = *P* sin 20° cos l5º = 972 x 0.3420 x 0.9659 = 321.09 kg.

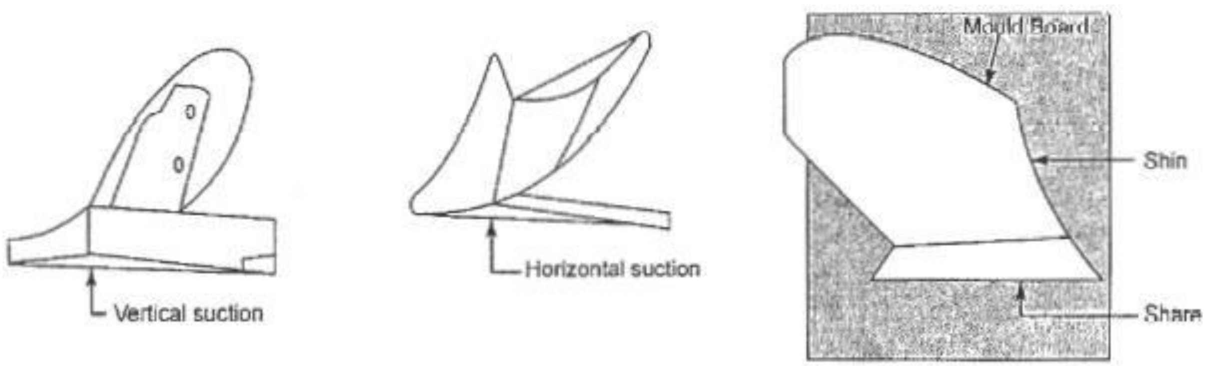
5. **Design of share of mould board plough:** Since the size of bottom is 45 cm, therefore, throat width of share will be 45 cm. The best throat angle of the share should be an angle along which soil rupture takes place.

We know that

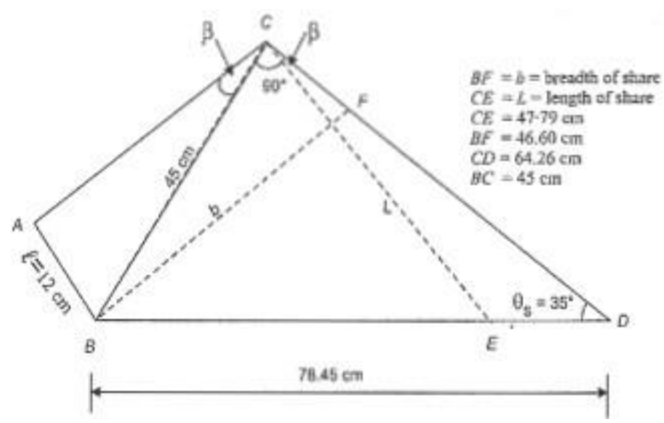
Soil shear angle (θ_s) = 45° - (ϕ/2)

Where, ϕ = angle of friction between metal and soil (for medium soil we may assume ϕ = 20°)

Therefore, θ_s = 45° - 20°/2 =35°.



Share of mould board plough



Dimension of share of mould board plough

Referring to Fig.

We see from right angled triangle *BCD* that,

Tan 35° = BC/CD

or CD = BC/ tan 35°

= 45 x 1.428 = 64.26 cm

Also, 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 $BF = BC^2/AC = (45)^2/43.37 = 46.69$ cm.

Also in triangle *ABC*,

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

or, $\beta = 15.47°$.

Also from triangle *CED*,

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

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

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 x 0.5736/0.7712 = 47.79 cm.

Therefore, 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 x 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*

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

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

= 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 \ψ = 20°

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

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

ln 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 t^2 = 0.520 x 0.179 x $(45)^2$/ 800

or 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

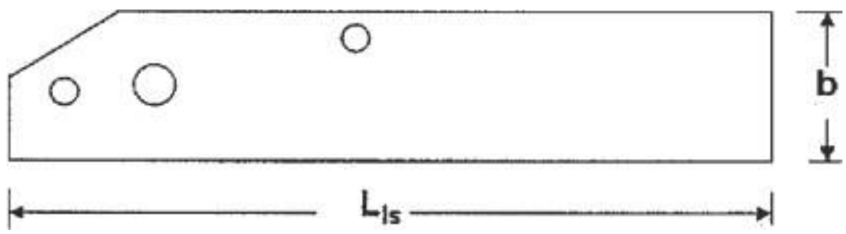
Alternatively,

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

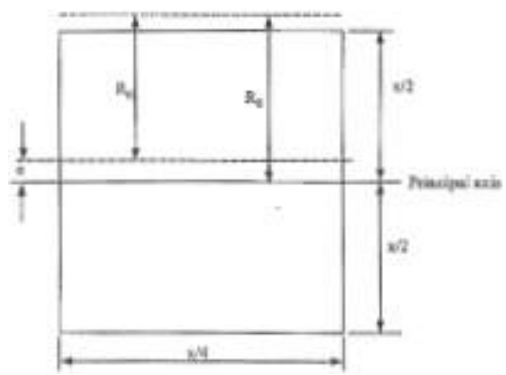
is assumed to be of square section, each side measuring *X* cm, then the value of ‘ e’ can be determined by using the relationship.

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

$$Y = X / 2 \pm e$$

Now, substituting values in equation we get

$f = 45000 \times (X/2 \pm e)\ I\ \{X^2\ e\ (20 + X/2 \pm e)\}$



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 = $(1080^2 + 70^2)^{o.5}$

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, R_y = 270 kg – 200 kg= 70 kg

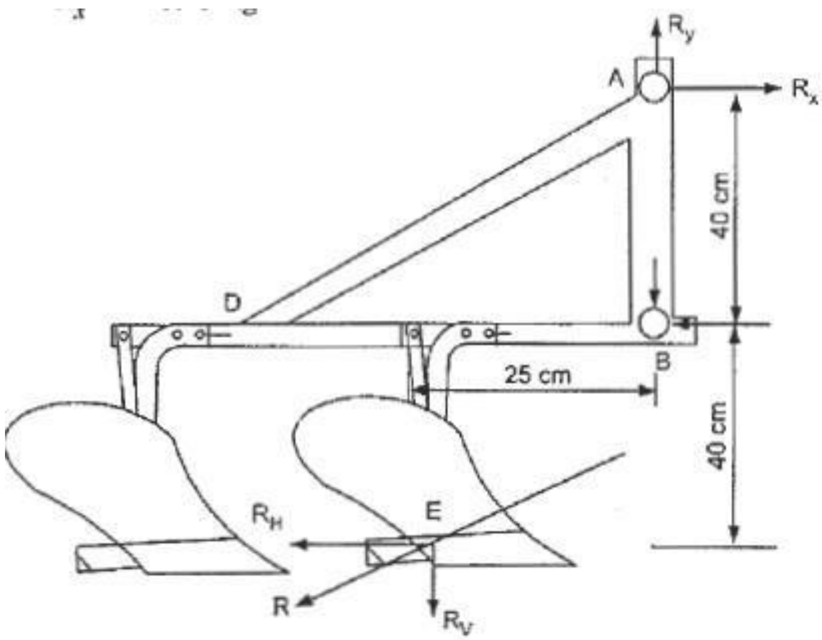
Now referring to fig Let R_x and R,, are the components of reactions at upper hitch point in horizontal and vertical direction. Neglecting rolling resistance of tractor and taking moment about 'B' in Fig. we get

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

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

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

$R_x = 776.25$ kg



Forces on M.B.Plough in vertical plane

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

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

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

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

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

Assume that length of member AD = 50 cm

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

R_x in top link = 125 kg

And $R_y = R_x \tan 30° = 72.50$ kg

Similarly, reactions at each lower hitch points

$R_x = 125.0/2 = 62.50$ kg

& $R_y = 72.50$ 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, $b = 3t$

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

Also,

f_b =’MY/I

$1650 = 1787.50 \times (3/2)\,t/\,(9/4)\,t^4$

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

Or, $t = 0.9$ cm

and $b = 3\,t = 3 \times 0.9 = 2.7$ cm

Take $b = 3.0$cm & $t = 1.0$ cm

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

Area of cross section of member *BD* = $t \times b = 1.0 \times 3.0 = 3.0$ cm^2

Therefore,

$f_t = F/A = 928$ kg/ 3.0 cm^2 = 307 kg/cm^2

As 307 kg/cm^2 < Allowable stress of mild steel. Hence, the design is safe.

Design of compression member AD:

Now, from Fig. we know that

tanθ =40/30= 53.130

Now,

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

= 776.25/0.600 + 141.50/0.799

= 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 .= 3*t*

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

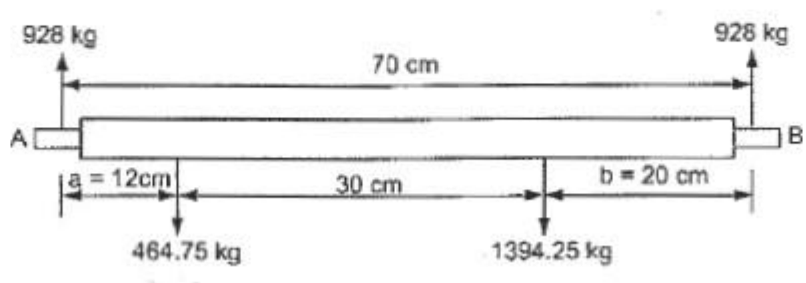
Since bending moment, taken by this member is equal to bending moment taken by member *BD*.

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:

$$464.75 \text{ X } 12 + 1394.25 \text{ x } (70 – 20) = 928 \text{ x } 70$$

Or, solving

$$b = 28.0 \text{ cm}$$

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

$$= 1394.25 \text{ x } b$$

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

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,

$$f_b = \text{MY}/I$$

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

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

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:

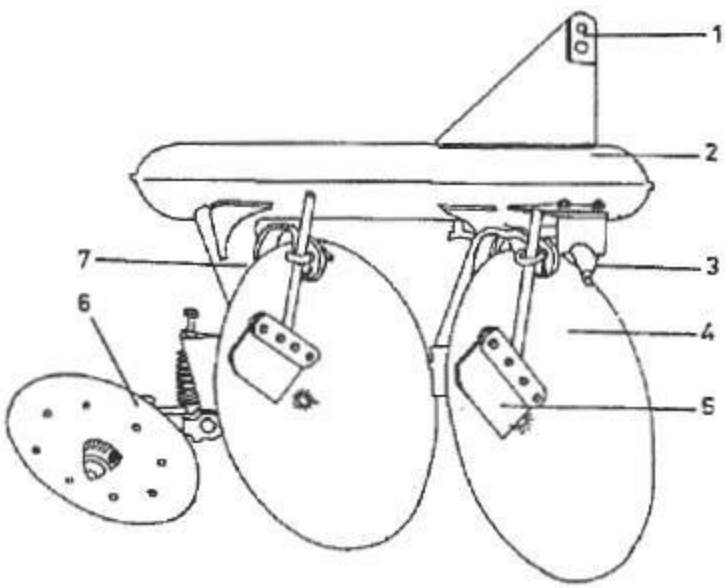
- The disc plough is designed to work in all types of soil for basic functions such as soil breaking, soil raising, soil turning and soil mixing.
- It is used open the new fields and to processes the stony areas.
- It can be used easily at rocky and rooted areas.
- It is especially useful in hard and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

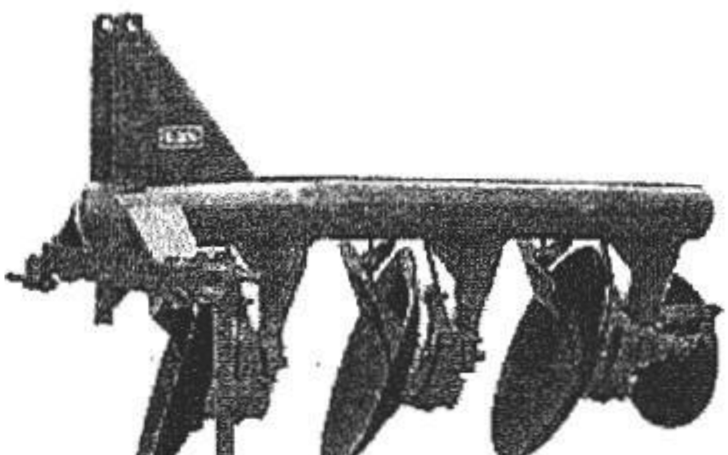
DESIGN PROCEDURE FOR DISC PLOUGH

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)

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

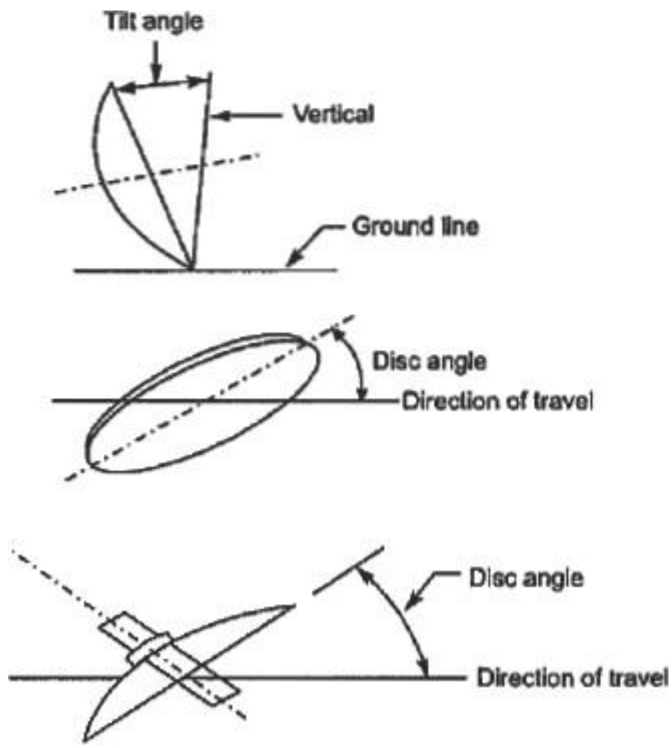
where, K = a coefficient which varies from 2.5 – 3 for deep tillage.

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 I. 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.

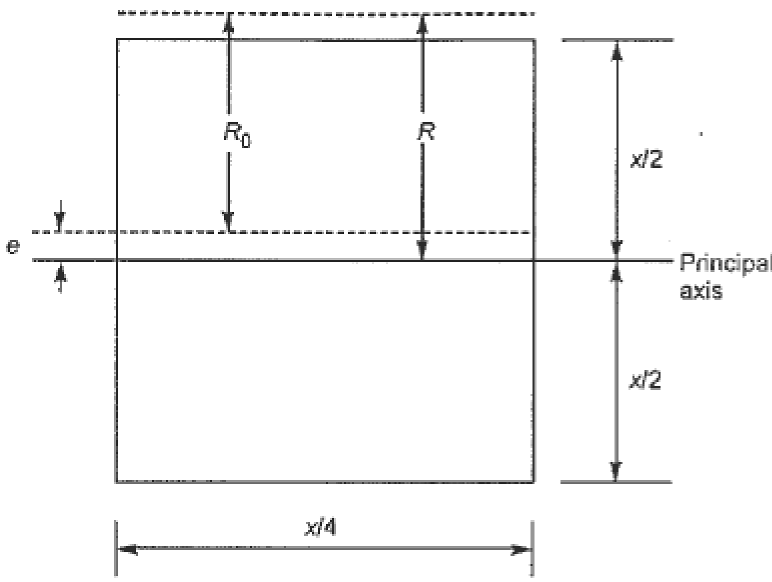
F = factor of safety. (FOS = 1.5)

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% of BHP

DBHP = 0.60 x 35 = 21 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 I: The radius of curvature of disc I 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, ϕ = 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

$$S_d = 2\tan 45^0 \sqrt{\left[\frac{6}{\cos 25^0}\left(66.2 - \frac{6}{\cos 25^0}\right) + 2\right]} = 40.38cm$$

The condition $S_d > 2d_p = 2 \times 20$ 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

$T_d = 0.008D_d + I$ in mm

$T_d = 0.008 \times 66.2 + I = 5.4$ mm

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

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

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

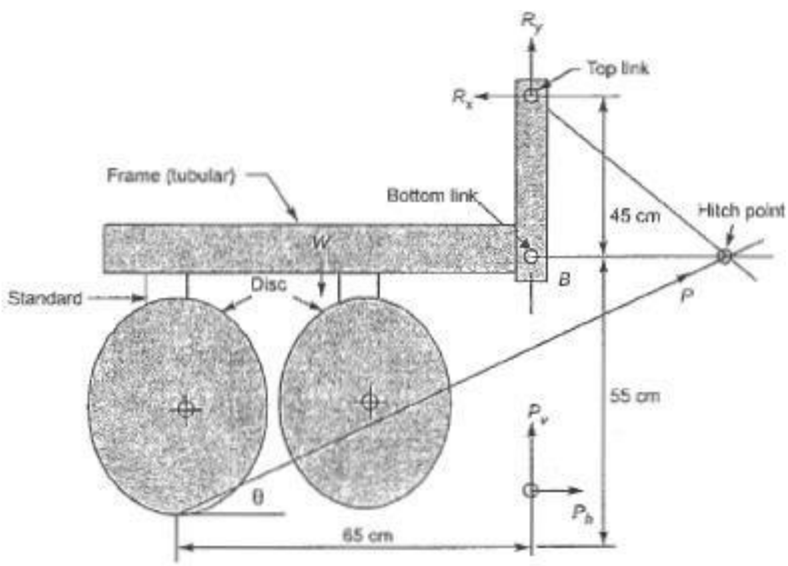
Now, from Fig.

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.

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

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

$R_x = 288.76$ kg

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

R_Y -= R_x. Tan 10° = 288.76 x 0. 18229 = 52.64 kg

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

Horizontal components in each lower link

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

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 = $n.W_c.d_p.k.\ F$

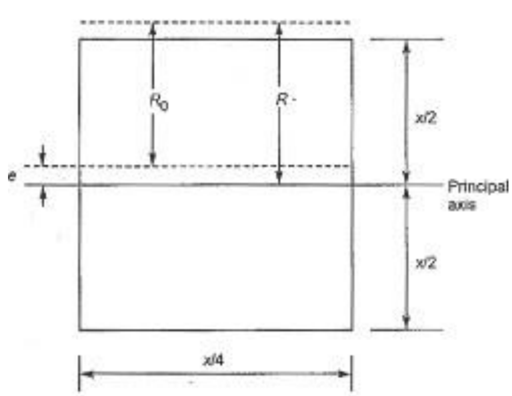
Where, n = no. of bottoms or discs in plough

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

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

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

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

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

Choose value of x such that value of '.f' is not greater than 500 kg/cm^2 say by taking x = 5 cm. We get f= 510 kg/cm^2 which is nearly equal to 500 kg/ cm^2.

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:

DESIGN AND DRAWING OF THRESHERS

Aim:

To design and draw the stationery thresher with the help of CAD software.

Introduction:

The operation of detaching the grains from the ear heads, cobs or pods is called threshing. Thresher is the machine used to separate grains from the harvested crop and provide clean grain without much loss and damage. During threshing, grain loss in terms of broken grain, un threshed grain, blown grain, spilled grain etc. should be minimum. Bureau of Indian Standards has specified that the total grain loss should not be more than five percent, in which broken grain should be less than two percent. Clean unbruised grain fetch good price in the market as well as it has long storage life. Parts of thresher:

A mechanical thresher (Fig. 9 .1) consists of the following parts:

1. Feeding device (chute/tray/trough/hopper/conveyor)

2. Threshing cylinder (hammers/spikes/rasp bars/wire loops/syndicator)

3. Concave (woven wire mesh/punched sheet/welded square bars)

4. Blower/aspirator

5. Sieve shaker/straw walker.

The crop is fed from the feeding tray into the threshing cylinder. The threshing cylinder is fitted

With spikes/bars/hammers or wire loops around its periphery according to the type of thresher.

Below the cylinder there is a concave and it covers lower portion of the cylinder. The cylinder rotates at high speed and thus the crop is threshed and the entire or a portion of threshed material falls from the concave on to top sieve of cleaning system. Due to reciprocating motion of top sieve lighter material accumulate at the top and grain falls on to the bottom sieve. In case of spike tooth thresher, an aspirator blower sucks out the lighter material from the top sieve and throws it out from blower. Outlet. The sieves help in further cleaning of the grain by allowing heavier straw to overflow. The type of thresher is generally designated according to the type of threshing cylinder fitted with. The machine. The major type of threshers commercially available are as follows:

I. Dummy type,

2. Hammer mill type,

3. Spike (peg) tooth type,

4. Rasp bar type,

5. Wire loop type,

6. Axial flow type, and

7. Syndicator type.

Performance of thresher depends upon:

- Concave length,
- Cylinder diameter,
- Cylinder speed,
- Cylinder-concave clearance,
- Feed rate,
- Moisture content, and
- Time of day.

Design of Components of A Stationary Power Thresher for Paddy Crop

1. Design of threshing unit
a) Threshing cylinder
b) Concave
2. Design of grain cleaning unit.
a) Blower
b) Sieve

Distribution of power at different components of the thresher

S. No.	Name of component	Power distribution range (For 5 HP prime mover)		
		Percentage	HP	
1	Threshing cylinder	57-64%	2.85-3.2	3 HP
2	Aspirator blower	34-40%	1.7-2.0	1.75 HP

3	Sieve shaker	2-5%	0.1- 0.25	0.25 HP

Source: CIATE Data book

Design of Threshing Unit

Threshing cylinder

Table 1: Recommended specifications for threshing cylinder

Particulars	**Specification**	**Selected**	**Reference**
Type of threshing cylinder	Spike tooth or Wire-loop	Spike tooth	CIAE Data book,2004
Peripheral speed of threshing cylinder, V_c	16-25 m/s	25 m/s	BIS:1990-1979
Rotational speed of threshing cylinder, N_c	675-1000 rpm	1000 rpm	BIS:1990-1979
Capacity (Weight of grain output per kW per hour)	$\geq$ 90kg kW−1h−1	150 kg/kW/h	BIS 6320:1985

Calculation:

0. Diameter of cylinder $D_c=(V_c\times60)/\pi N_c$

$= 25\times60/\pi\times1000$

$=0.477m\approx 500$ mm

Length of threshing cylinder:

Length of cylinder can be determine by the model given by E.I. Lipkovich

$L_c=q/\Delta\times\eta\times\rho\times u_1$

Where,

L_c=Length of threshing cylinder,(m)

q=Material feed rate ;(kg/s),

Δ= Thickness of the plant mass layer at the entrance in meter (equal to the concave clearance at the entrance)

η= Coefficient of cylinder length utilization (0.7-0.8), ρ= Bulk density of plant mass entering; (20-40kg/m^3Ref.data book and Kargbo F.R., 2010),

u_1= Velocity of plant mass entering (3-5m/s, Databook)

Recommended grain throughput rate for paddy thresher = 90 kg / kWh

Grain to straw ratio=1:1.3 to 1:3

Therefore, the crop throughput rate or material feed rate for 3.0 HP or 2.4 kW thresher-

Through put rate = (Grain+Straw) × Power available

$q = (150+150\times3)\times2.24$

□=1332kg/h of crop=0.37kg/s

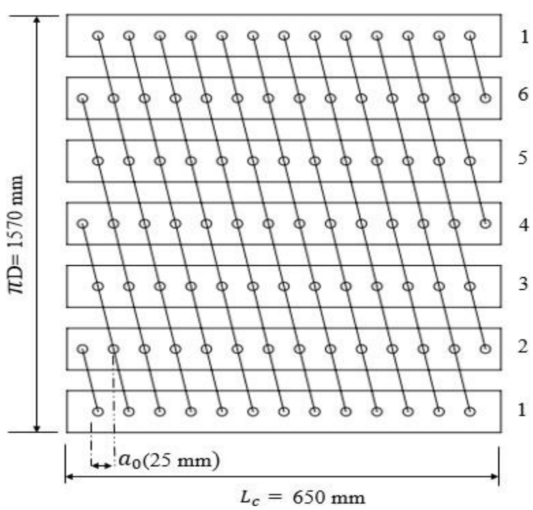
Length of cylinder will be-

$L_c = q / \Delta \times \eta \times \rho \times u_1$

$L_c = 0.37 / 0.015 \times 0.75 \times 30 \times 5$

□□=0.624 m ≈ 650 mm

Arrangement of Threshing Elements on Cylinder bar



Helical arrangement of threshing elements

Total number of elements can be calculated by the equation-

$$Z = M_p \times \left(\frac{L_C}{a_0} + 1\right)$$

Where, Z = Total number of teeth,

M_P=Number of helical pitches(number of bars on the periphery of the cylinder ring whose teeth tracing the same path), Recommended value = 3to5.Selected value M_P=3

L_C=Length of threshing cylinder, (mm);

a_o=Length of longitudinal pitch, (Recommended value 25-37.50 mm, IS:3327-1982. Selected value = 25mm).

Calculation:

$$Z = 3\times\left(\frac{650}{25}+1\right)$$

$$Z = 81 \text{ elements}$$

Design of Concave

Table 2 : Recommended specification for the curve

Parameters	**Specification**	**Selected**	**Reference**
Concave clearance for paddy crop	15-25 mm	15 mm	CIAE Data book
Clearance between concave bars	9 mm	9mm	CIAE Data book
Cross section of concave bar	6×6 mm^2	6×6 mm^2	CIAE Data book
Wrap angle	30to 120°	120°	Kanafojski,1976

Calculation:

Radius of the concave = (radius of the cylinder + Concave clearance)

= (250+15) = 265 mm

Wrap angle of concave = length of the concave arc / Radius of the concave

$$120°\times\left(\frac{\pi}{180}\right) = \text{length of the concave arc }/265$$

Length of concave arc = 555 mm

Length of concave arc = (clearance between axial slits + width of the axial slit)×total number of slits

555 = (9+6) ×total number of slits

Total number of slits =37

Dimensions of feed inlet

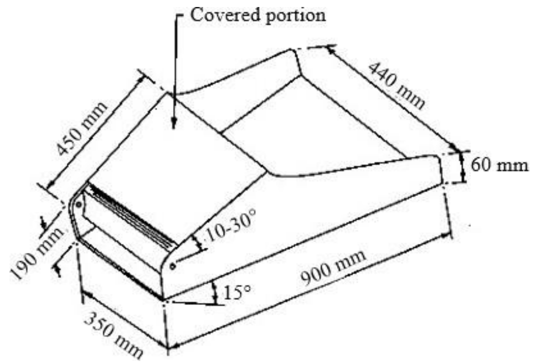
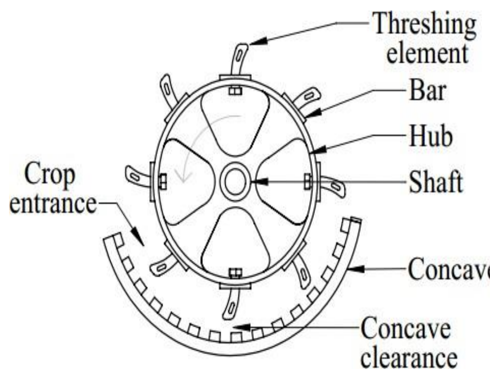
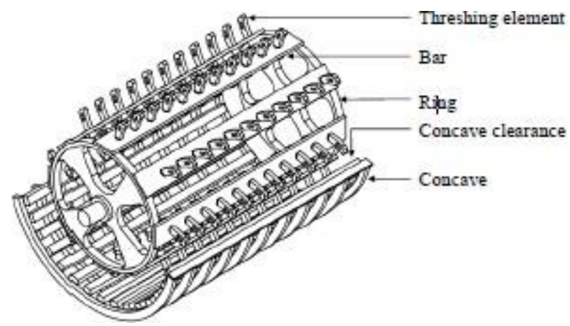


Fig. Dimensions of feed inlet (crop feeding chute) recommended by the Bureau of Indian Standard

IS: 9129-1979 Technical Requirements for Safe Feeding Systems for Power Threshers





Design of Grain Cleaning unit

1. MAIN BLOWER-Function of main blower is to remove straw from threshed mixture.

M_{MOG}= M_{straw}+ M_{chaff} (Assumption: Total MOG contains 75% straw and 25% chaff)

Thus, M_{straw}= 0.75M_{MOG}=0.2775×0.75 =0.208 kg/s, and

M_{chaff}= 0.25M_{MOG}= 0.2775×0.25 = 0.069 kg/s

Mass of air required to remove the straw per unit time (kg/s)=

$$\frac{(\square\square/\square)}{h\ (02\square\square 03, \square\square\square\square\square 1990)}$$

= 0.208 / 0.20 =1.04 kg/s

Volume flow rate of air for removal of straw (m^3/s) = Mass flow rate of air(kg/s) / Air density (kg/m^3)

= 1.04/ 1.275 = 0.8156 m□/s

Total mass flow rate = Mass flow rate of straw + Mass flow rate of air

= 0.208 +01.04 = 1.248 kg/s

Design of Grain Cleaning unit

Force required to lift the mass (N) = Mass flow rate (kg/s) ×Velocity of air (m/s)

= Total mass flow rate (kg/s) ×Terminal velocity ×Excess velocity coefficient (0.76 to 1.7, Bosoi, 1990)

= 1.248 ×5.25×1.5 = 8.354 N

Total Pressure required = Static pressure + Dynamic pressure

= $(\rho \times g \times h) + (1/2 \times \rho \times V_{\square}^2)$ (h=AC×tan25)

= $(1.275 \times 9.81 \times 0.325) + 1/2 \times 1.275 \times (7.875)^2 = 4.06 + 39.53 = 43.60$ N/m□

Cross sectional area of the duct = Force required to lift the material (N) /Total pressure (N/m^2)

A = 8.354/43.60= 0.1916 m2

Width of the main blower can be calculated by-

$$\text{Speed of fan(rpm)} = \frac{\text{Volume flow rate} \times 60\ (m^3/s)}{\text{Cross sectional area of fan } (m^2) \times \text{widht of fan blade (m)}} = N_F = \frac{Q_a \times 60}{\pi(r_o^2 - r_i^2)W_b}$$

Assumed that the cylinder and main blower are mounted on the same shaft , therefore rotational speed will same. (N_C=N_F=1000 rpm), Putting the values of speed and volume flow rate in above equation-

$1000 = (0.8156 \times 60)/ (0.1916 \times W_b)$

W_b=0.255m = 255 mm

Therefore, the length of duct cross section = Cross sectional area of the duct/ Width of the duct

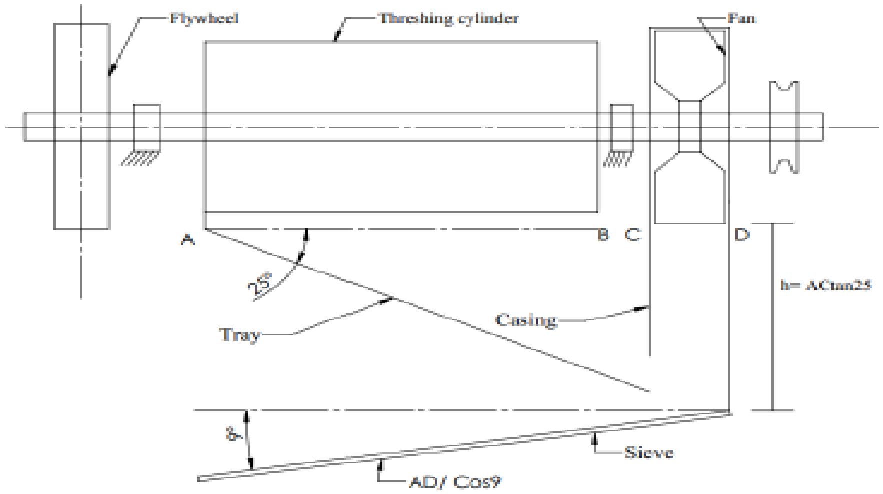
= 0.1916/0.255= 0.75m = 750 mm

The length of the duct cross section = Diameter of the main blower Do= 750 mm

Inner radius of the fan = 0.4×Outer radius of the blower (□=0.4×□)

Thus,r_o =diameter of blower / 2=0.75m = 375mm

And ri =0.4×375=150mm



0. **SIEVE**

Table 3: Recommend values for sieve design

Parameters	Specification	Selected	Reference
Diameter of hole	8mm	8mm	CIAE Databook
Sieve inclination	6-9°	9°	CIAE Databook
Permissible load	0.65 kg/m^{2}s	0.65 kg/m^{2}s	Bosoi, 1990

Length of sieve = AD/ Cos 9

Where AD = length of cylinder +bearing width + fan width

= 650+50+255 = 1140 mm

Length of sieve = 955 / Cos 9 = 970 mm

Width of sieve = Area of sieve / length of sieve

Required area of screen for sieving (m2) = $\frac{\text{Mixture of threshed material delivered (kg/s)}}{\text{Permissible Specific load per unit area(kg/m2s)}}$

= 0.37/0.65 = 0.57 m^2

Width of sieve = 0.57/0.97 = 0.587 m≈ 600 mm

Area of the single opening = (□/4)d^2=50.26mm^2

Spacing between opening = 0.9√□=0.9√8= 2.54 mm

Pitch of opening = d/2+ edge to edge distance between consecutive opening +d/2 = 4+2.5+4 = 10.54 mm

Number of opening in transverse direction = width of sieve / pitch = 600/10.54= 57

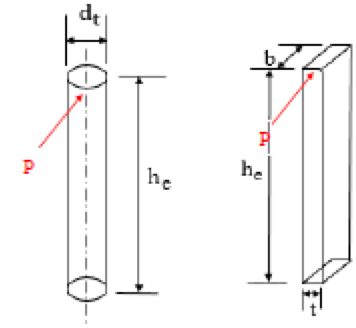
Number of opening in longitudinal direction = length of sieve / pitch = 970/10.54 = 92

Total area of perforation = area of opening ×number of openings

$= 50.26 \times (57 \times 92)\ mm^2 = 0.2635\ m^2$

Percentage of opening area = Area of opening/ Total sieve area

$= [0.2635 / (0.970 \times 0.60)] \times 100 = 46\%$



(a) Spike tooth
Circular cross section

(b) Peg tooth
Rectangle cross section

Design of threshing element:

Assumptions:

1. Cross section of the spike tooth and peg tooth type threshing elements are circular and rectangular shape, respectively.
2. Threshing element is subjected to bending stress only which is offered by the crop during threshing.
3. The point where the bending force acts is 80 mm above the cylinder bar (height of element, $h_{e)}$
4. Width to thickness ratio of peg tooth type threshing element b:t = 3:1., (t=0.33b), kanafojski 1976.
5. Threshing element is made of mild steel has yield stress σb=175Mpa.

Size of threshing element is determined by the equation−

$\sigma b/y = M/I$

Where, σb= Working bending stress of mild steel.

(Yield stress/factor of safety = 175/2.5 = 70 Mpa)

(Yield stress = 175 for Mild Steel, CIAE Databook)

y=Distance of neutral axis from the point of application of force; (m),

Dt/2forcircularcrosssection, and b/2forrectangularcrosssection,

M=Bending moment acting on threshing element; (Nm),

$M = P \times h_e = P \times 0.08 Nm$

I=Moment of area of cross section m^4.

$(\pi/64) \times d_t^4$ for circular cross section, and

$(t \times b^3)/12$ for rectangular cross section

Tangential force acting on the element during threshing-

$P=P1+P2$

Where, P1=Peripheral force appears when the plant mass impacted and brought into motion, calculated by-

$P_1\Delta t=\Delta m V_P$(Impulse=Momentum obtained by plant mass, Goryanchkin theory)

$P_1=(\Delta m/\Delta t).V_P=m'.VP$

Where, Δt=Striking time;(s), Δm=Mass of material struck by tooth;(kg),

V_P=Speed of material obtained in time Δt, m/s(equal to drum's peripheral speed)

P2=Resistance force encountered by the drum while displacing the plant mass in the clearance.

$P2=f.P$

Where,f is the proportionality coefficient of material's rubbing in working slit.

(0.7-0.8forpegtooth).

Adding forces $P_1$and P_2

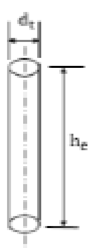
$P=(m'V_P+f.P)$

$P=(m'\times V_p)/(1-f)$

$P=(0.37\times25)/(1-0.70)=46.25$N. Therefore,

Therefore the bending moment

$M = P \times h_e = 46.25 \times 0.08 = 3.70$ Nm

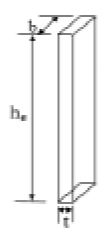


$\sigma_b/y = M/I$

$(70 \times 10^6)/(d_t/2) = 3.70/[(\pi/64) \times d_t^4]$

$d_t = 8.00$ mm

Circular shaped element



$\sigma_b/y = M/I$

$70 \times 10^6/(b/2) = 3.70/(t \times b^3/12)$

$70 \times 10^6/(b/2) = 3.70/[(0.33b \times b^3)/12]$

b = 10.00 mm and t = 3.50 mm

Rectangular shaped element

Design of the shaft

Shaft of cylinder subjected to

1. Torsional stress (τ): Due to tangential force acting on shaft.
2. Bending stress (σb): Due to the weight of the threshing cylinder, blower, flywheel and the pulley.

The combined stress is called equivalent stress.

Torsional stress-

$$\tau = \frac{T\times r}{J} = \frac{T\times(d/2)}{(\pi/32)d^4} = \frac{16\times T}{\pi\times d^3}$$

Bending stress-

$$\sigma_b = \frac{M \times y}{I} = \frac{M \times (d/2)}{(\pi/64)d^4} = \frac{32 \times M}{\pi \times d^3}$$

Equivalent stress can be calculated by-

$$\sigma_e = \frac{1}{2}\sqrt{\sigma_b{}^2 + 4.\tau^2} = \frac{1}{2}\sqrt{\left(\frac{32M}{\pi d^3}\right)^2 + 4\left(\frac{16T}{\pi d^3}\right)^2} = \frac{16}{\pi d^3}\sqrt{M^2 + T^2}$$

When shaft is subjected to fluctuating load then the equivalent stress is given by the equation

$$\sigma_e = \frac{16}{\pi d^3}\sqrt{(K_b M)^2 + (K_t T)^2} = \frac{16}{\pi d^3}\sqrt{(1.5M)^2 + (1.25T)^2}$$

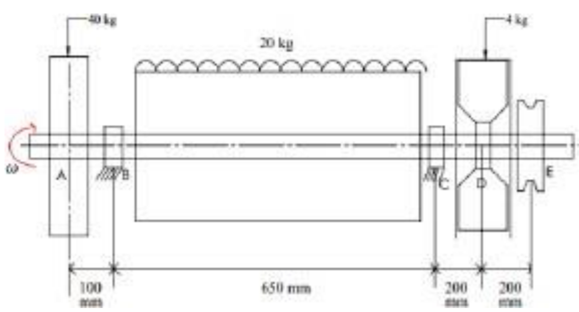
K_b and K_t stands for combined shock and fatigue factor for bending, and combined shock and fatigue factor for torsion. Respectively, 1.5-2.0 and 1.0to1.5 for suddenly applied minor shock

Torque acting on cylinder shaft can be determined by –

Power transmitted through belt = 5 hp=3.73 kW

T = Rated power ×60000/ (2πN)

T= 3.73×60000/ (2π×1050) = 35.61Nm



Bending moment at different point of the shaft

1. Bending moment due to weight of flywheel at point B-

$M_{AB} = W_A \times L_A$= (40×9.81)×0.1 = 49.05 Nm

2. Bending moment at length AC due to weight of cylinder (UDL)

M_{BC}= ($W_c \times L_c$)/8= (20×9.81)×0.65/8 = 16 Nm

3. Bending moment at point C, due to the weight of fan+ Load due to belt tension

Bending load on shaft due to belt tension

Tmax= (Tt–Ts) ×Radius of the pulley mounted of the shaft

35.61 = (Tt–Ts) ×0.05

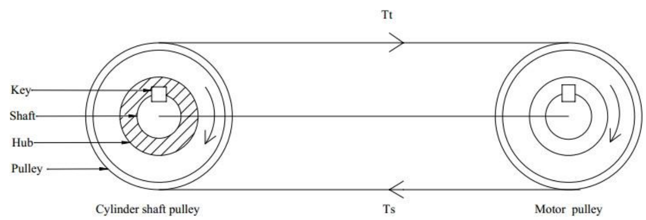
(Tt–Ts) = 712.2 N

Assumed that tension ratio is Tt:Ts= 3:1

Thus, Ts= 356.10 N and Tt= 1068.3 N

The net horizontal force act on the shaft of the cylinder

T = Tt+Ts= 356.1+1068.3 = 1424.4 N



Tension force acting on shaft due to V-belt

Total bending force acting on point C = Load due to fan+ load due to belt tension

= (4×9.81)+1424.4=1463.64

The bending moment at point C, M_{EC}= Total bending force ×Distance (EC) = 1463.64×0.4= 585.45 Nm

Therefore,

$$72\times10^6 = \frac{16}{\pi d^3}\sqrt{(1.5\times1463.64)^2+(1.25\times35.62)^2}$$

$$d = 53.77 \text{ mm.}$$

- Threshing unit

1. Diameter of threshing cylinder = 500 mm
2. Length of threshing cylinder = 650 mm
3. Diameter of circular threshing element = 8 mm,
4. Width and thickness rectangular = 10 and 3 mm respectively.
5. Concave radius = 265 mm
6. Wrap angle of concave = 130°
7. Diameter of the shaft = 53.77 mm

- Grain cleaning unit

1. Inner radius of the fan = 150 mm
2. Outer radius of the fan = 375 mm
3. Width of the fan = 255 mm
4. Length of sieve = 970 mm
5. Width of sieve = 600 mm.

Result:

Hence the thresher is drawn based on the calculated design parameters

Ex. No: Date:

DESIGN AND DRAWING OF WINNOWERS

Aim: To Study the design aspects of Winnowers

Winnowing is an agricultural method developed by ancient cultures for separating grain from chaff. It is also used to remove weevils or other pests from stored grain. Threshing, the loosening of grain or seeds from the husks and straw, is the step in the chaff- removal process that comes before winnowing.

In its simplest form it involves throwing the mixture into the air so that the wind blows away the lighter chaff, while the heavier grains fall back down for recovery. Techniques included using a winnowing fan (a shaped basket shaken to raise the chaff) or using a tool (a winnowing fork or shovel) on a pile of harvested grain.

The rotary winnowing fan was exported to Europe, brought there by Dutch sailors between 1700 and 1720. Apparently they had obtained the from the Dutch settlement of Batavia in Java, Dutch East Indies. The swedes imported some from south China at about the same time and Jesuits had taken several to France from China by 1720. Unit the beginning of the 18th century, no rotary winnowing fans existed in the west.

In 1737 Andrew Rodger, a farmer on the estate of Cavers in Roxburghshire, developed a winnowing machine for corn, called a ‘Fanner’ These were successful and the family sold the fanners as sins against God, for wind was a thing specially made by him and an artificial wind was a daring and impious attempt to usurp what belonged to God alone. As the Industial Revolution, the winnowing process was mechanized by the invention of additional winnowing machines, such as fanning mills.

Torque bending force

Air resistance acting against the blades, combined with inertial effects causes propeller blades to bend away from the direction of rotation.

The propeller’s efficiency is determined by

$$\eta = \frac{\text{propulsive power out}}{\text{shaft power in}} = \frac{\text{thrust} \cdot \text{axial speed}}{\text{resistance torque} \cdot \text{rotational speed}}.$$

The blade efficiency is in the ratio between thrust and torque:

$$\text{blade element efficiency} = \frac{V_a}{2\pi N r} \cdot \frac{1}{\tan(\varphi + \beta)}$$

Design:

Shafts and pulleys

For a system with two shafts and two pulleys.

$D1n1=D2n2$

Where

D1=driving pulley diameter

n1= revolutions of the driving pulley

D2= driven pulley diameter

n2= revolutions of the driven pulley

The revolution of driven pulley

$n_2 = (d_1 n_1)/d_2$

The revolution of driven pulley

$n_1 = (d_2 n_2)/d_1$

The diameter of the driven pulley

$d_2 = (d_1 n_1)/d_2$

Diameter of the driven pulley

$d_1 = (d_2 n_2)/n_2$

Design of the shaft

There are two shafts required:

- That which connects the hand lever and the driving pulley\
- That which the fan blades are mounted on and is connected to the driven pulley

Shaft transmitting power on the hand lever to be 50N

Height of the hand lever is 15cm.

Revolutions made per minute are 100

The power transmitted by the shaft in watts is given by

$$P = \frac{2\pi NT}{60} = T \cdot \omega$$

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

Torque, T = force*radius

= 50N x 0.15 m

= 7.5 N-m

Therefore, P = $\frac{2\square\square 100\square 7.5}{60}$

P = 78.5 watts

The length of the shaft = 60 cm

The radius of the shaft = 1 cm

For the shaft on which the fan blades are mounted

Length of the shaft = 50 cm

The radius of the shaft = 1 cm

Power transmitted to the shaft by the driven puller:

$$\frac{\square 1}{\square 2} = \frac{\square 2}{\square 1}$$

Diameter of the driven pulley, D_1 = 15 cm

Diameter of the driven pulley, D_2 = 10 cm

N_1 = 100 r.p.m

N_2 = 100 X 15/10 = 150 r.p.m

Length of an open belt drive

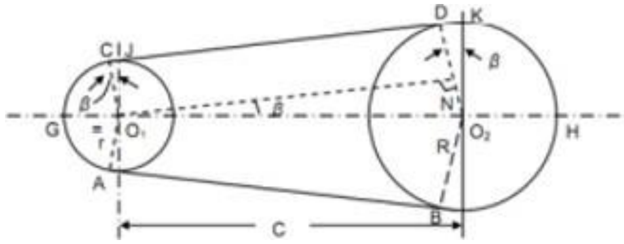
The open belt drive is illustrated in Fig. Assume O_1 and O_2 are the pulley centers and AB and CD are the common tangents on the circles demonstrating the two pulleys. The entirety length of the belt 'L' is given by following

L = AB + Arc BHD + DC + Arc CGA

Assume r be the radius of the smaller pulley,

R be the radius of the larger pulley,

C be the centre distance among the pulleys, and



Draw O_1 N parallel to CD to meet O_2 D at N

By geometry, $\angle O_2 O_1, N = \angle C O_1 J = \angle D O_2 K = \beta$

Arc BHD = ($\pi + 2\beta$) R,

Arc CGA = ($\pi + 2\beta$) r,

AB = CD = $O_1N = O_1 O_2 \cos \beta = C \cos \beta$

Sin β = R-r/C

Or,

B = $\sin^{-1}$ (R – r)/C

$$\cos \beta = \sqrt{1 - \sin^2 \beta} = \left(1 - \frac{1}{2}\sin^2 \beta\right)$$

$$L = (\pi + 2\beta) R + (\pi - 2\beta) r + 2C\left(1 - \frac{1}{2}\sin^2 \beta\right)$$

For small value of β

$$\beta = (R - r) / C$$

$$L = \pi (R + r) + 2 (R - r) \frac{(R - r)}{C} + 2C\left[1 - \frac{1}{2}\left(\frac{R - r}{C}\right)^2\right]$$

$$= \pi (R + r) + \frac{(R - r)^2}{C} + 2C\left[1 - \frac{1}{2}\left(\frac{R - r}{C}\right)^2\right]$$

It provides approximate length

Offset crank mechanism

F = 147.15N

R = 0.12m

$\alpha = 30^o$

Torque = F*r*sin α

Let F = mg

$= 15 \text{ X } 9.81 = 147.15\ N$

Torque = $15 \text{ X } 9.81 \text{ X } 0.12 \text{ X } \sin 30^o = 8.829\ N\text{m}$

Weld joints

A weld joint is a permanent joint obtained by fusion of the edges of the two parts to be joined together, with or without the application of pressure and a filler material. Welding is extensively used in fabrication as an alternative method for casting and as a replacement for bolted or riveted joints

Advantages of welded joints

1. The welded structures are usually lighter than riveted structures
2. Modifications and addition can be easily made in the existing structures
3. The welded structure is smooth in structure
4. In welded connections, the tension members are not weakened as in the case of riveted joints.
5. A welded joint has the strength of the parent metal itself.
6. Welding process is shorter than riveting process

MIG welding will be used in this design. MIG welding is a semi-automatic process that uses a continuous wire feed as an insert or semi-inert gas mixture to protect the weld from contamination.

Several types of welded joints exists, these include the following

- Lap joint or the fillet joint. The lap joint is obtained by overlapping the plates and then welding the edges of the plates. The cross-section of the fillet is approximately triangular It is further categorized into single transverse fillet, double transverse fillet and parallel fillet joint.
  Butt joint. It is obtained by placing the plates edge to edge.
  It is further categorized into;
    - Square butt joint
    - Single or double V – butt joint
    - Single or double U – butt joint

  In this design double transverse fillet joint will be used
  Strength of transverse fillet welded joints
  In order to determine the strength of the fillet joint, it is assumed that the section of fillet is a right angled equal two side’s triangle

  The minimum area of the weld is obtained at the throat, which is given by the product of the throat thickness and length of the weld.

Minimum are of the weld or throat area A is given by

$$A = 0.707sxl$$

If σt is the allowable tensile stress for the weld metal, then the tensile strength of the joint for double fillet weld is given by

$$P=2\times0.707\times S\times\sigma_t\times l=1.414\times S\times\sigma_t\times l$$

$$12.384 \times 10^3 = 1.414 \times S \times 0.3 \times 13.76 \times 10^6$$

Result:

$$S = 0.0021$$

Thus the design aspects of winnowers and other recent technologies were studied

Parts of cereals winnower

1) Fan and its housing

2) Metallic stand (rectangular in shape)

3) Pulley system

4) Combination of the three sieves (wire mesh)

5) Offset-crank mechanism

Components

1) Shafts (two)

2) Bearings (four)

3) Pulleys (two)

4) V-belt

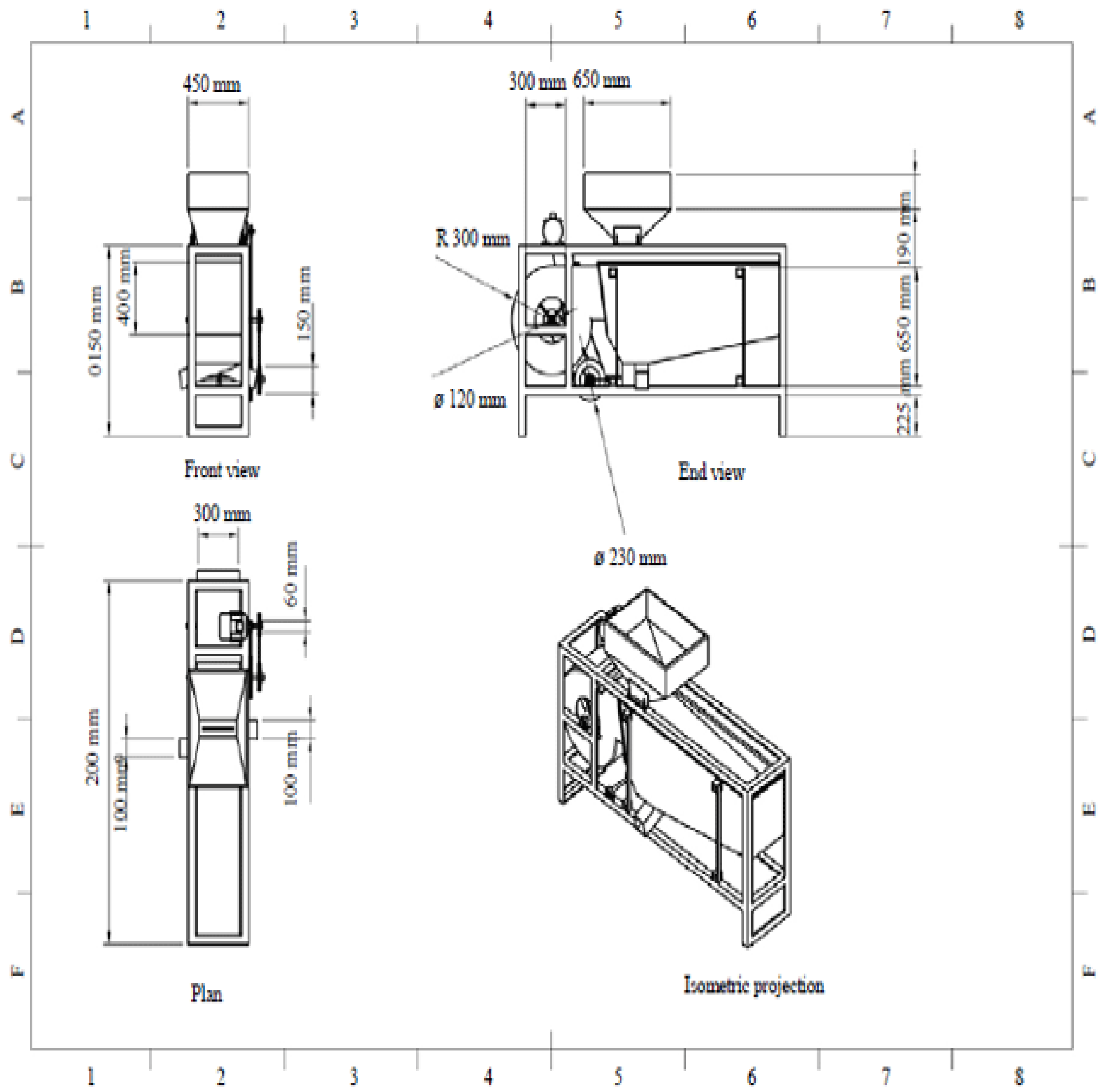
5) Fan and its housing

6) 3 sieves (different openings-large, medium and small)

7) Slider-crank mechanism

8) Handle

9) Frame


450 mm
300 mm
650 mm
R 300 mm
190 mm
400 mm
0150 mm
150 mm
650 mm
ø 120 mm
225 mm
Front view
End view
300 mm
ø 230 mm
60 mm
200 mm
100 mm
100 mm
Plan
Isometric projection

Ex. No: Date:

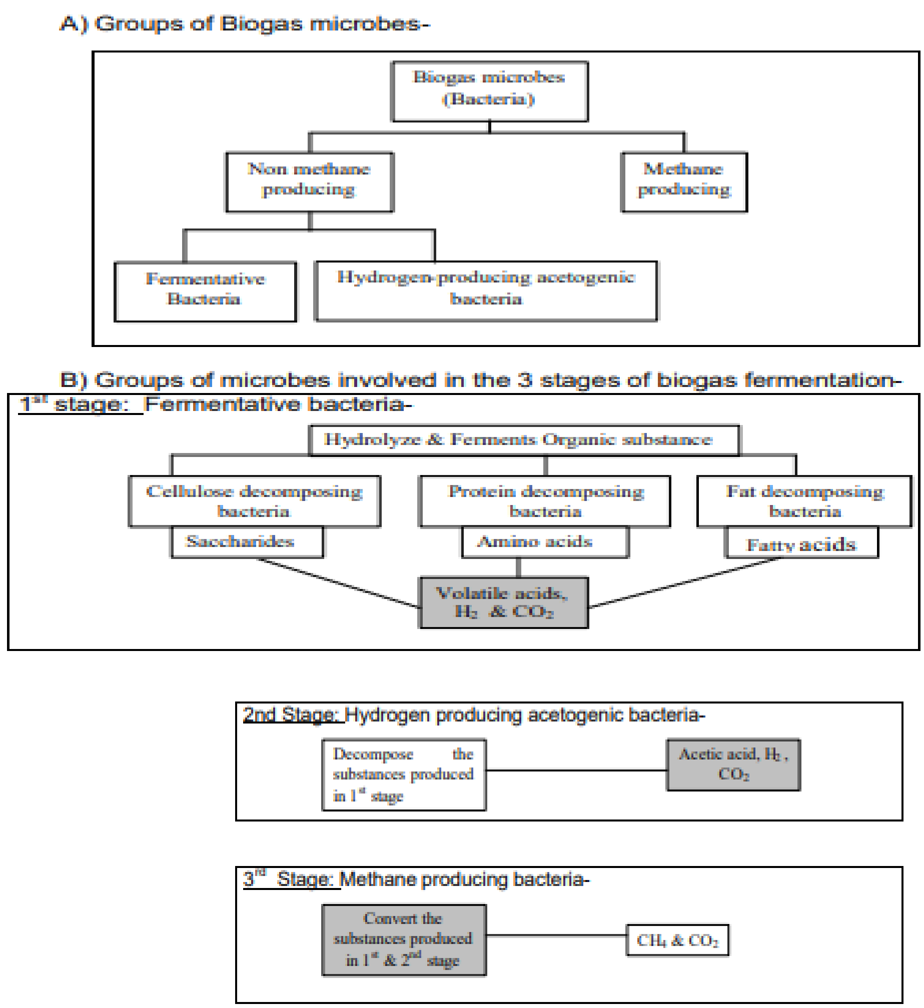
DESIGN OF BIOGAS PLANT

Introduction:

Biogas can be obtained from any organic materials after anaerobic fermentation by three main phases.

Mechanism of biogas fermentation

A) Groups of Biogas microbes



Design perameter:

A) Selection of materials:

B) Total solid (TS) contains calculations of organic materials Organic Materials

Solid part: Total solid contained in a certain amount of materials is usually used as the material unit to indicate the biogas- producing rate of the materials. Most favorable TS value desired is 08%

Liquid part: As per Annexure-I

C) Favorable temperature, PH value & C/N ratio for good fermentation-

Temperature: Mesophilic; 20^o c to 35^o c (Annexure-II).
P^H value: Neutral P^H and ranges 6.8 to 7.2
C/N ration: Ranges from 20:1 to 30:1 (Annexure- VI)

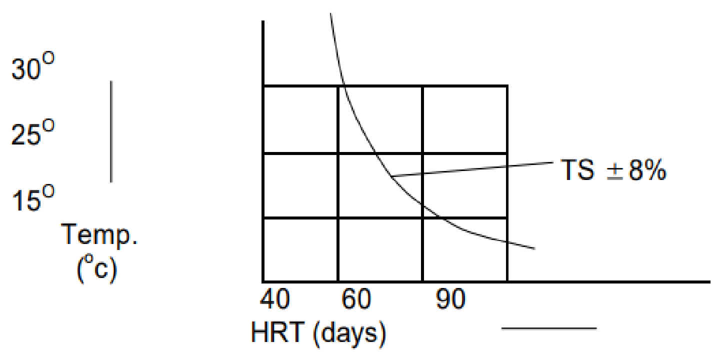
D) Table showing discharge per day, TS value of fresh discharge and water to be added to make favorable TS condition

Kinds	Body weight (kg)	Discharge per day (kg)	TS value of fresh discharge (% by wt.)	Water to be added with fresh discharge to make the TS value 8% (kg)
Human	50	0.5	20	0.75
Cow	200	10	16	10
Chicken	1.5	0.1	20	0.15
Pig	50	5	20	7.5

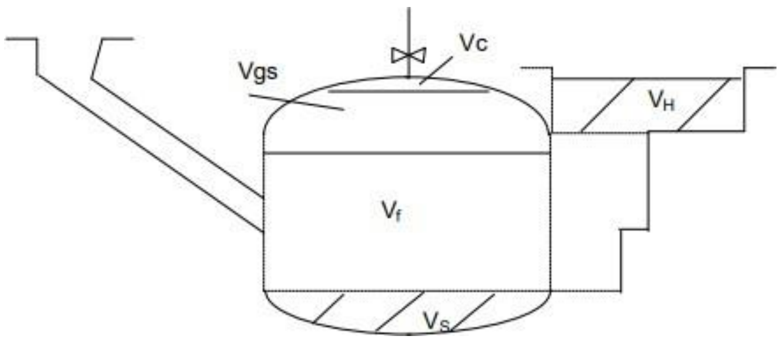
E) Hydraulic retention time (HRT)-

For Mesophilic digestion where temp. Varies from 20^o c to 35o C and HRT is greater than 20days.

Relationship between temperature, HRT & TS value of 8% :



1.5 Cross-section of a digester:



a) Volume of gas collecting chamber = Vc

b) Volume of gas storage chamber = Vgs

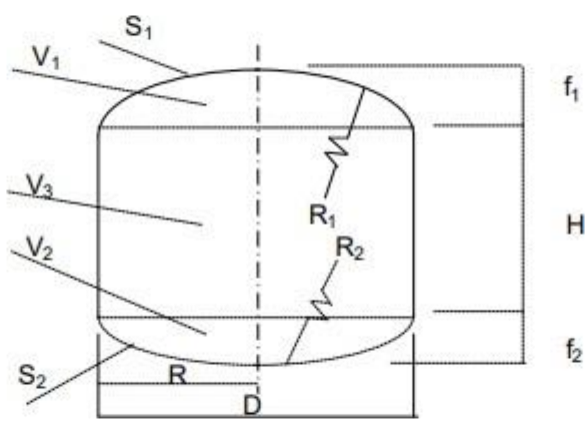
c) Volume of fermentation chamber = V_f

d) Volume of hydraulic chamber = V_H

e) Volume of sludge layer = Vs

Total volume of digester V =Vc+Vgs+V_f+V_s

1.6 Geometrical dimensions of the cylindrical shaped biogas digester body:



1.7 Assumptions:

For volume	**For geometrical dimensions**
Vc ≤ 5% V Vs ≤ 15% V Vgs + V_f= 80% V	D=1.3078 X $V^{1/3}$ V_1=0.0827 D^3 V2 = 0.05011 D^3

$V_{gs} = V_H$ $V_{gs} = 0.5 (V_{gs} + V_f + V_s) K$ Where K = Gas production rate per m^3digester volume per day. For Bangladesh K = 0.4 m^3/m^3d.	V3 = 0.3142 D3 R1= 0.725 D R2= 1.0625 D f1 = D/5 f2 = D/8 S1 = 0.911 D2 S2 = 0.8345 D2

Volume calculation of digester and hydraulic chamber:

A) Volume calculation of digester chamber

Given: 6 cows of body weight 200 Kg each.

Temp. = $30^{O}C$ (average)

Solution:

Let HRT = 40 days (for temp. $30^{O}C$)

Total discharge = 10 kg X 6 = 60 Kg/day

TS of fresh discharge = 60 kg X 0.16 = 9.6 Kg.

In 8% concentration of TS (To make favorable condition)

8 Kg. Solid = 100 Kg. Influent

1 Kg. Solid = 100 / 8 Kg influent

9.6 Kg Solid = 100 x 9.6/ 8 = 120 Kg. Influent.

Total influent required = 120 Kg.

Water to be added to make the discharge 8% concentration of TS

=120 Kg – 60 Kg. = 60 Kg.

Working volume of digester = $V_{gs} + V_f$

$V_{gs} + V_f = Q.HRT$

= 120 Kg/day X 40 days

= 4800 Kg. (1000 Kg = 1 m^3) = 4.8 m^3.

From geometrical assumptions:

$V_{gs} + V_f = 0.80\ V$

Or

V= 4.8/0.8 = 6.0 m^3. (Putting value $V_{gs} + V_f = 4.8\ m^3$) & $D = 1.3078\ V^{1/3} = 2.376\ m \cong 2.40\ m$.

Again

$$V_3 = \frac{3.14 \times D^2 \times H}{4}$$

(Putting $V3=0.3142D^3$)

$$\text{Or, } H = \frac{4 \times 0.3142 \times D^2}{3.14 \times D^2} = 0.96\text{m}$$

Say H = 1.00m

Now we find from assumption as we know the value of 'D' &

'H' $f_1 = D/5 = 2.40/5 = 0.480$ m

$f_2 = D/8 = 0.30$m

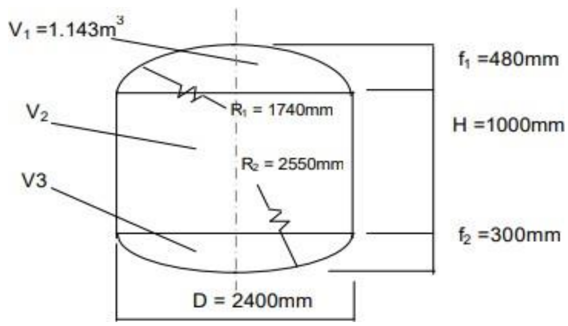
$R_1 = 0.725\ D = 1.74$ m

$R_2 = 1.0625\ D = 2.55$ m

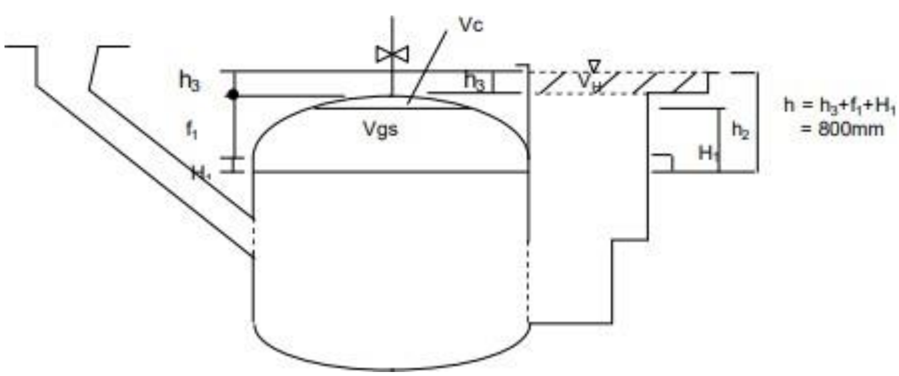
$V_1 = 0.0827\ D^3 = 1.143\ m^3$

$V_c = 0.05V = 0.3\ m^3$

Now the dimension of digester chamber is known & drawn below-



B) Volume calculation of hydraulic chamber



From assumptions:

$Vc = 0.05\ V = 0.3\ m^3$

$Vgs = 0.50 \times (Vgs + V_f + Vs) \times K$ (Where K = Gas production rate per m^3digeste vol./day)

$= 0.5 \times 5.7 \times 0.4 = 1.14\ m^3$

Again,

Vgs = 50% of daily gas yield

= 0.5 x TS x gas producing rate per Kg TS

= 0.5 x (60 kg x 0.16) x 0.28 m^3/kg TS (See Annex- III)

$= 1.344\ m^3$

From A & B let $Vgs = 1.344\ m^3$.

$Vc + Vgs = 0.3\ m^3 + 1.344\ m^3 = 1.644\ m^3$

Again $V1 = [\{(Vc + Vgs) - \{p\ D^2\ H1\}/4\ ]$

$= [1.644 - \{3.14 \times (2.4)2 \times H1\}/4]$

Or, $H1 = 0.110m$

We have fixed h = 800 mm water volume (1 mm = 10 N/ m^2)

$h = h3 + f_1 + H_1$

Or, $h_3 = 0.210$ m.

Again we know that

$Vgs = V_H$

Or, $1.344\ m^3 = 3.14 \times (D_H)^2 \times h_3/4$

Or, $D_H = 2.85m$

Now we know the dimension of hydraulic chamber. Moreover keeping h = 800 mm, we can choose or re-arrange the dimension considering availability of site and construction suitability. For most suitable dimensions we can select the drawing of Annexure- IX for 60 Kg cow dung per day as raw material.

Note: For ready reference 4 family type Biogas plant's drawing is shown (standard dimension's) in Annexure-VIII, Annexure-IX, Annexure-X & Annexure-X1 where 40 Kg, 60Kg, 80Kg and 100Kg cow dung is considered as raw material per day respectively. If bigger size plant is required, it can be designed keeping all safety considerations in design and construction.

TABLE-1: THE TOTAL SOLID CONTENT OF COMMON FERMENTATION MATERIALS IN RURALAREAS (APPROXIMATELY)

Materials	Dry matter content (%)	Water content (%)
Dry rice straw	83	17
Dry wheat straw	82	18
Corn stalks	80	20
Green grass	24	76
Human	20	80

excrement		
Pig excrement	18	82
Cattle excrement	17	83
Human Urine	0.4	99.6
Pig Urine	0.4	99.6
Cattle Urine	0.6	99.4

TABLE-2: BIOGAS-PRODUCING RATES OF SOME COMMON FERMENTATION MATERIALS ATDIFFERENT TEMPERATURES (m3/Kg TS)

Materials	**Medium temperature (35^o C)**	**Ordinary temperature (8^o~ 25^o C)**
Pig manure	0.45	0.25 ~ 0.30
Cattle dung	0.30	0.20 ~ 0.25
Human wastes	0.43	0.25 ~ 0.30
Rice straw	0.40	0.20 ~ 0.25
Wheat straw	0.45	0.20 ~ 0.25
Green grass	0.44	0.20 ~ 0.25

Experimental conditions:- The fermentation period of the excrement materials lasts 60 days and that of the stalk type lasts 90 days. The fermentation material concentration (total solid content) is 6%.

TABLE-3: BIOGAS PRODUCING RATES OF SOME FERMENTATION MATERIALS AND THEIR MAIN CHEMICAL COMPONENTS.

Materials and their main components	**Yield of Biogas m3/kg TS**	**Methane content (%)**
Animal bamyard manure	0.260 ~ 0.280	50 ~ 60
Pig manure	0.561	
Horse droppings	0.200 ~ 0.300	
Green grass	0.630	70
Flax straw	0.359	
Wheat straw	0.452	59
Leaves	0.210 ~ 0.294	58
Sludge	0.640	50
Brewery liquid waste	0.300 ~ 0.600	58
Carbohydrate	0.750	49
Liquid	1.440	72
Protein	0.980	50

TABLE-4 BIOGAS- PRODUCING RATES OF SEVERAL SUBSTANCES

Material	YpCMDV (m3 /m3d)	YpKgM (m3 /KgTS)	Amount of biogas produced in a period of time (as a % of the total yield)			
			0 ~15 (d)	15 ~ 45 (d)	45 ~ 75(d)	75 ~13 (d)
Water Hyacinth	0.40	0.16	83	17	0	0
Alligator Weed	0.38	0.20	23	45	32	0
Water Lettuces	0.40	0.20	23	62	15	0
Cattle Dung	0.20	0.12	11	33.8	20.9	34.3
Pig Manure	0.30	0.22	19.6	31.8	25.5	23.1
Human Wastes	0.53	0.31	45	22	27.3	5.7
Dry Grass	0.20	0.21	13	11	43	33
Rice Straw	0.35	0.23	09	50	16	25

Note: - The fermenting temperature is 30^{o}C. It is batch-fed fermentation. YpCMDV Refers to the average yield of biogas per cubic meter of the digester volume during the period Of normal fermentation (m^3/ m^3d) YpkgM refers to the yield of biogas per kilogram of the Fermentation material (m^3/kg TS)

TABLE-5 : THE SPEED OF BIOGAS PRODUCTION WITH COMMON FERMENTATION MATERIALS.

Speed	Amount of biogas produced in a period of time (expressed as a percentage of the total yield of biogas)	Biogas Producing rate
Time(d)	10 20 30 40 50 60 70 80 90	(m3/kg TS)
Materials		
Human wastes	40.7 81.5 94.1 98.2 98.7 100 * * **	0.478
Pig manure	46.0 78.1 93.9 97.5 99.1 100 * * **	0.405
Green grass	- - - 98.2 – 100 **	0.410
Cattle dung	34.4 74.6 86.2 92.7 97.3 100 * * **	0.300
Wheat straw	8.8 30.8 53.7 78.3 88.7 93.2 96.7 98.9 100 * ** **	0.435

* Biogas production is at the highest speed.
** Amount of Biogas produced to more than 90% of the total yield of a fermentation period.
Experimental conditions: - Fermenting temperature 35^0C, the total length of fermentation Period being 60 days for the excrement material and 90 days for the stalk type, the materials Concentration; total solid content of the fermentative fluid being 6%.

TABLE -6. CARBON-NITROGEN RATIOS OF SOME COMMON FERMENTATION MATERIALS (APPROX.)

Material	Carbon content of Material (%)	Nitrogen content of Materials (%)	Carbon nitrogen ration (C/N)
Dry wheat straw	46	0.53	87:1
Dry rice straw	42	0.53	67:1
Corn stalks	40	0.7	53:1
Fallen leaves	41	1.00	41:1
Soybean stalks	41	1.30	32:1
Wild grass	14	0.54	27.1
Peanut stems and leaves	11	0.59	19.1
Fresh sheep droppings	16	0.55	29.1
Fresh cattle dung	7.3	0.29	25.1
Fresh horse droppings	10	0.42	24.1
Fresh pig manure	7.8	0.60	13.1
Fresh human wastes	2.5	0.85	29.1

TABLE-7 AMOUNT OF HUMAN AND ANIMAL WASTES DISCHARGED PER DAY (APPROX.)

Kinds	Body weight (kg)	Daily amount of excrement (kg)	Daily amount of urine (kg)	Annual amount of excrement discharged (kg)	Annual amount of excrement collection (kg)	Daily yield of biogas per capita (m3)
pig	50	6	15	2190	1752	0.18 ~ 0.25
Ox	500	34	34	12410	9928	0.36 ~ 0.96
Horse	500	10	15	3650	2920	

Sheep	15	1.5	2	548	438.4	
Chicken	1.5	0.10	0	36.80	29.44	0.0076 ~ 0.0112
Human	50	0.50	1	182.50	146.00	0.028

Note: The annual amount of excrements collected accounts for 80% of that discharge.

Result:

Hence the Bio gas plant is drawn based on the calculated design parameters.

Ex. No: Date:

INTRODUCTION TO 3D MODEL-LING

Aim: Introduction & demonstration on 3D modeling softwares like Pro/E, Creo, Solid works, Solid Edge etc.

Computer aided design or CAD has very broad meaning and can be defined as the use of computers in creation, modification, analysis and optimization of a design. CAE (Computer Aided Engineering) is referred to computers in engineering analysis like stress/strain, heat transfer, flow analysis. CAD/CAE is said to have more potential toproducts, which took years in the past to complete, is now made in days with the help of high-end CAD/CAE systems and concurrent engineering.

Model is a Representation of an object, a system, or an idea in some form other than that of the entity itself. Modeling is the process of producing a model; a model is a representation of the construction and working of some system of interest. A model is similar to but simpler than the system it represents. One purpose of a model is to enable the analyst to predict the effect of changes to the system. On the one hand, a model should be a close approximation to the real system and incorporate most of its salient features. On the other hand, it should not be so complex that it is impossible to understand and experiment with it. A good model is a judicious tradeoff between realism and simplicity. Simulation practitioners recommend increasing the complexity of a model iteratively. An important issue in modeling is model validity. Model validation techniques

Ex. No: Date:

STUDY ON RETAINING WALLS

Aim: Studying the purpose of retaining wall and its property.

Retaining walls are often found in places where extra support is needed to prevent the earth from moving downhill with erosion. The most basic function of a retaining wall is to battle gravity; the lateral force of the slope must be offset in the retaining wall's design. Retaining walls can also: Provide usable land. A wall that is built to keep the land behind it from sliding

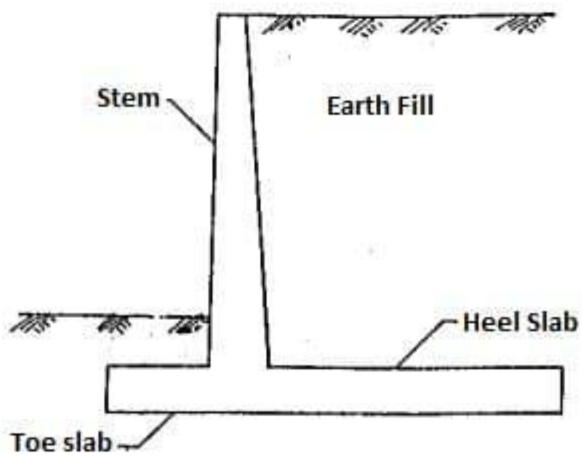
The four main types of retaining wall are:

Gravity retaining walls.

Cantilever retaining walls.

Embedded retaining walls.

Reinforced soil retaining walls.



Gravity Retaining Wall

- Gravity retaining wall depends on its self-weight only to resist lateral earth pressure.
- Commonly, gravity retaining wall is massive because it requires significant gravity load to counter act soil pressure.
- Sliding, overturning, and bearing forces shall be taken into consideration while this type of retaining wall structure is designed.
- It can be constructed from different materials such as concrete, stone, and masonry units.
- It is economical for a height up to 3m. Crib retaining wall, gabions, and bin retaining wall are also type of gravity retaining walls

Cantilever Retaining Wall

- Cantilever retaining wall composed of stem and base slab
- It is constructed from reinforced concrete, precast concrete, or prestress concrete.
- Cantilever retaining wall is the most common type used as retaining walls.
- Cantilever retaining wall is either constructed on site or prefabricated offsite i.e. precast.
- The portion of the base slab beneath backfill material is termed as heel, and the other part is called toe.
- Cantilever retaining wall is economical up to height of 10m.
- It requires smaller quantity of concrete compare with gravity wall but its design and construction shall be executed carefully.
- Similar to gravity wall, sliding, overturning, and bearing pressure shall be taken into consideration during its design

Counter-fort / Buttressed Retaining Wall

- It is a cantilever retaining wall but strengthened with counter forts monolithic with the back of the wall slab and base slab.
- Counter fort spacing is equal or slightly larger than half of the counter-fort height.
- Counter-fort wall height ranges from 8-12m.