

Guru Nanak Dev Engineering College, Ludhiana

(An Autonomous College Under UGC ACT)

DEPARTMENT OF CIVIL ENGINEERING



CAD-BIM (LPCCS-106)

LABORATORY FILE

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Objectives

- **Design and Modeling:** Utilize FreeCAD and LibreCAD to create precise 2D and 3D models for engineering, architectural, or creative projects.
- **Visualization and Analysis:** Leverage the capabilities of both software to visualize designs, perform simulations, and analyze structures or components for feasibility and functionality.
- **Collaboration and Documentation:** Facilitate collaboration among team members by using Free CAD and LibreCAD to share document designs, ensuring accurate communication and efficient workflow management.

Introduction Of LibreCAD

1. Overview:

- LibreCAD is an open-source computer-aided design (CAD) software primarily focused on 2D drafting and design.
- It provides users with a platform to create technical drawings, schematics, diagrams, and plans with precision and efficiency.
- LibreCAD is developed and maintained by a community of volunteers and is distributed under the GNU General Public License (GPL).

2. Features:

- **User Interface:** LibreCAD offers a clean and intuitive user interface, making it accessible to both novice and experienced CAD users.
- **Drawing Tools:** It provides a comprehensive set of drawing tools, including lines, circles, arcs, ellipses, polygons, and more, allowing users to create intricate designs with ease.
- **Editing Functions:** LibreCAD offers various editing functions such as move, scale, rotate, trim, extend, fillet, chamfer, and mirror, enabling users to modify and refine their drawings efficiently.
- **Layer Management:** Users can organize their drawings using layers, allowing for better organization and control over different elements within the design.
- **Dimensioning:** LibreCAD supports dimensioning tools to add accurate measurements and annotations to drawings, ensuring clarity and precision.
- **Snap and Grid Options:** It provides snap and grid options to assist users in aligning objects and maintaining uniformity in their designs.
- **Printing and Export:** LibreCAD supports printing to scale and exporting drawings to various file formats such as DXF, DWG, PDF, SVG, and more, facilitating compatibility and sharing with other software and collaborators.
- **Customization:** Users can customize LibreCAD through plugins and extensions, extending its functionality to suit their specific needs and workflows.
- **Cross-Platform Compatibility:** LibreCAD is available for multiple operating systems, including Windows, macOS, and Linux, ensuring accessibility across different platforms.

3. Applications:

- **Architectural Drafting:** Architects can use LibreCAD to create floor plans, elevations, and other architectural drawings.
- **Engineering Design:** Engineers can utilize LibreCAD for mechanical drawings, schematics, and technical diagrams.
- **DIY Projects:** Hobbyists and DIY enthusiasts can employ LibreCAD for designing projects such as furniture, woodworking plans, and home renovations.
- **Educational Purposes:** LibreCAD can be used in educational settings to teach CAD principles and techniques to students and professionals.

4. Community and Support:

- LibreCAD benefits from a vibrant and supportive community of users, developers, and contributors who actively participate in forums, mailing lists, and social media channels.
- Users can find tutorials, documentation, and resources online to aid in learning and troubleshooting LibreCAD.
- Additionally, community-driven development ensures that LibreCAD continues to evolve and improve with feedback and contributions from users worldwide.

Introduction Of FreeCAD

FreeCAD is an open-source parametric 3D CAD modeler software that is widely used for modeling, designing, and creating 3D CAD projects. It offers a range of tools and features for designing various objects, from simple to complex. Here's an overview of some of the key tools available in Free CAD:

- **Part Design Workbench:** This workbench is used for creating 3D models from sketches. It provides tools for creating sketches on different planes and then using those sketches to create 3D shapes by extruding, revolving, or lofting.
- **Sketcher Workbench:** The Sketcher workbench allows users to create 2D sketches that can be used as the basis for creating 3D models. It offers various drawing tools such as lines, rectangles, circles, arcs, constraints, and dimensions to create precise sketches.
- **Part Workbench:** This workbench offers tools for creating basic 3D shapes like cubes, cylinders, spheres, etc. It's useful for creating simple geometric shapes that can be further modified or combined to create more complex models.
- **Draft Workbench:** The Draft workbench provides tools for working with 2D shapes and sketches. It includes tools for drawing lines, rectangles, circles, arcs, and polygons, as well as tools for modifying and transforming objects.
- **Arch Workbench:** This workbench is specifically designed for architectural design. It includes tools for creating walls, windows, doors, stairs, and other architectural elements. It also supports features like layers, levels, and grids for organizing and structuring architectural projects.
- **Part Design Workbench:** This workbench is focused on creating parametric 3D models. It allows users to create sketches and then use them to create 3D shapes using features like extrusion, revolution, and filleting. It also supports constraints and parameters to define the dimensions and relationships between different parts of the model.
- **Drawing Workbench:** The Drawing workbench is used for creating 2D drawings and technical documentation from 3D models. It provides tools for creating views, dimensions, annotations, and other elements commonly found in engineering drawings.
- **Mesh Design Workbench:** This workbench is used for working with mesh objects. It offers tools for importing, exporting, and editing mesh files, as well as tools for repairing and refining mesh geometry.

Materials And Equipment

1. **Computer System:** Both FreeCAD and LibreCAD require a computer system to run, which typically includes a desktop or laptop computer. The specific system requirements may vary depending on the complexity of the designs and the size of the projects. Generally, a modern computer with a decent processor, sufficient RAM, and adequate storage space is recommended for smooth operation.
2. **Operating System:** FreeCAD and LibreCAD are compatible with multiple operating systems, including Windows, macOS, and Linux. Users can choose the operating system that best suits their preferences and workflow requirements. The software installation process may vary slightly depending on the operating system, but both FreeCAD and LibreCAD offer versions for different platforms.
3. **Input Devices:** To interact with FreeCAD and LibreCAD, users need input devices such as a keyboard and a mouse (or a touchscreen for devices with touch support). These input devices are essential for creating sketches, drawing shapes, navigating the user interface, and performing various operations within the software.
4. **Graphics Card:** While not always mandatory, having a dedicated graphics card can enhance the performance of FreeCAD and LibreCAD, especially when working with large and complex 3D models. A graphics card with good 3D rendering capabilities can improve viewport responsiveness, display quality, and overall user experience.
5. **Internet Connection:** Although not strictly required for the basic functionality of FreeCAD and LibreCAD, an internet connection can be beneficial for accessing online resources, downloading updates, accessing community forums, and collaborating with other users. Additionally, some features of the software may rely on internet connectivity for certain functionalities, such as cloud-based storage or online libraries.
6. **Documentation and Tutorials:** Users may also utilize various documentation resources and tutorials available online to learn how to use FreeCAD and LibreCAD effectively. These resources include official documentation, user guides, video tutorials, and community forums. Having access to comprehensive documentation and tutorials can help users master the software and leverage its full potential for their projects.

Procedure

Task –1 Flower

1. **Open LibreCAD:** Launch the LibreCAD software on your computer.
2. **Create New Drawing:** Start by creating a new drawing file where you will design your Flower.
3. **Set Drawing Units:** Set the drawing units to the desired measurement system (e.g., millimeters, inches). This can usually be done from the "Options" or "Preferences" menu.
4. **Draw Circles:** Use the Circle tool to draw circles of various sizes, which will form the basic elements of your Flower design. You can access the Circle tool from the toolbar or by typing the command "C" in the command line and pressing Enter.
5. **Specify Circle Parameters:** When drawing circles, LibreCAD will prompt you to specify the center point and radius of each circle. Click on the desired location for the center point, and then either enter the radius directly or click to define the circumference of the circle.
6. **Arrange Circles:** Arrange the circles in a visually appealing pattern to create your Flower design. You can experiment with different sizes, orientations, and positions to achieve the desired artistic effect.
7. **Add Details (Optional):** If desired, you can add additional embellishments or details to your Flower design using circles. For example, you could create concentric circles, overlapping circles, or patterns formed by repeating circle shapes.
8. **Save Your Work:** Once you're satisfied with your Flower design, save your drawing file to preserve your work. It's a good idea to save periodically to avoid losing any changes.
9. **Export or Print:** Depending on your preferences, you can export your rangoli design as a digital image file (e.g., PNG, JPEG) for sharing or printing. Alternatively, you can directly print your design from LibreCAD if you wish to display it in physical form.
10. **Optional: Add Color (Manual):** If you want to add color to your Flower design, you can do so manually using traditional methods after printing or exporting the design.

Task –2 Layout of House

1. **Start with a Rough Sketch:** Before diving into LibreCAD, it's helpful to start with a rough hand-drawn sketch of your house layout. This sketch should include the overall dimensions of the house, as well as the location of rooms, doors, windows, and other key features.
2. **Launch LibreCAD:** Open LibreCAD on your computer to begin creating the layout plan. LibreCAD's interface consists of various tools and menus for drawing and editing geometric shapes.
3. **Set Up Drawing Parameters:** Before drawing, set up the drawing parameters such as the drawing units (e.g., meters, feet, inches), grid spacing, and measurement precision. This ensures that your drawing is accurate and to scale.
4. **Draw Walls:** Use the Line tool to draw the outer walls of the house according to the dimensions from your rough sketch. You can specify precise lengths and angles for each wall segment.
5. **Add Interior Walls:** Once the outer walls are drawn, add interior walls to delineate different rooms and spaces within the house. Again, use the Line tool to draw these walls according to the desired dimensions.
6. **Insert Doors and Windows:** Use the Rectangle tool to draw rectangles representing doors and windows on the walls. Make sure to accurately place them according to your floor plan. You can also use the Modify tools to trim wall segments to accommodate doors and windows.
7. **Label Rooms and Spaces:** Use the Text tool to label each room and space within the house. This helps clarify the layout and identifies the purpose of each area (e.g., living room, bedroom, kitchen).
8. **Add Dimensions:** Use the Dimension tool to add dimensions to your layout plan, indicating the lengths of walls and distances between various features. This makes it easier to understand the spatial relationships within the house.
9. **Review and Edit:** Review your layout plan to ensure accuracy and completeness. Make any necessary adjustments or edits to fine-tune the design according to your requirements.
10. **Save and Export:** Once you're satisfied with the layout plan, save your work in LibreCAD's native file format (.dxf) or in a compatible format such as .dwg. You can also export the drawing to other formats for sharing or printing purposes.
11. **Print or Share:** Finally, print out the layout plan or share it digitally with others involved in the house planning process. Consider printing it to scale for better visualization and communication.

Task – 3 Footing/ Column/ Beam (Anyone)

1. **Prepare Your Drawing:** Launch LibreCAD and open a new or existing drawing where you want to design the footing, column, and beam. Ensure that your drawing is set up with appropriate units and scale for accurate measurements.
2. **Create Footing:**
 - a. Select the Line tool or Polyline tool from the toolbar.
 - b. Draw the outline of the footing by clicking to create vertices and defining the shape of the footing.
 - c. Use the Modify tools such as Trim, Extend, or Offset to adjust the dimensions and shape of the footing as needed.
 - d. Add dimensions and annotations to specify the dimensions and details of the footing.
3. **Design Column:**
 - a. Use the Line tool or Polyline tool to draw the outlines of the column base and top.
 - b. Adjust the dimensions of the column base and top to meet the design requirements using the Modify tools.
 - c. Add dimensions and annotations to specify the dimensions and details of the column.
4. **Design Beam:**
 - a. Draw the outline of the beam using the Line tool or Polyline tool, specifying its length and width.
 - b. Use the Modify tools to adjust the dimensions and shape of the beam as needed.
 - c. Add dimensions and annotations to specify the dimensions and details of the beam.
5. **Add Detailing and Annotations:**
 - a. Use the Text tool to add labels, notes, and other annotations to your drawing, specifying materials, dimensions, and other relevant details.
 - b. Utilize the Dimension tool to add linear, angular, and radial dimensions to accurately represent the size and spacing of various components.
6. **Review and Finalize:**
 - a. Review your drawing to ensure that all components are accurately represented and dimensioned according to the design requirements.
 - b. Make any necessary adjustments or corrections to the drawing as needed.
 - c. Save your drawing in the appropriate file format for future reference or sharing with others.

7. Optional: Export or Print:

- a. If needed, you can export your drawing to a compatible file format such as DXF or PDF for sharing with other software or printing.
- b. Use LibreCAD's printing capabilities to print your drawing directly from the software if a hard copy is required for documentation or presentation purposes.

Task – 4 Manual: BIM modelling

1. **Launch FreeCAD:** Open FreeCAD on your computer.
2. **Create a New Project:** Start a new project by clicking on "File" > "New".
3. **Switch to Part Workbench:** FreeCAD has different workbenches for different tasks. For building modeling, switch to the Part Workbench by selecting it from the dropdown menu at the top of the screen.
4. **Create the Base Sketch:** Click on the "Create a new sketch" icon from the toolbar. Choose the plane where you want to create the base sketch (e.g., XY-plane). Draw a rectangle representing the base of your building using the sketch tools. Click "Close" when you're done.
5. **Pad the Sketch:** Select the sketch you just created and click on the "Pad" tool from the toolbar. Enter the desired height for your building and click "OK". This will extrude the sketch into a solid object.
6. **Create Openings for Doors and Windows:** Create sketches on the faces of the solid object representing where you want doors and windows to be. Use the sketch tools to draw shapes for the openings. You can create multiple sketches for different openings.
7. **Cut Openings:** Select each sketch representing an opening and use the "Pocket" tool to cut through the solid object. Specify the depth of the cut and click "OK".
8. **Add Details:** Use additional sketches and features to add details such as roof, stairs, columns, etc. You can create sketches on existing faces or planes and use tools like Pad, Pocket, and others to add these details.
9. **Apply Materials (Optional):** If you want to apply materials to different parts of your building, you can do so by selecting faces or parts of the model and assigning materials from the appearance toolbar.
10. **Save Your Project:** Once you're satisfied with your building model, save your project by clicking on "File" > "Save" and choose a location on your computer to save the file.

Task – 5 Slab Reinforcement

1. Launch FreeCAD on your computer.
2. Begin a new project or open an existing project where you want to design the slab reinforcement.
3. Select a BIM Workbench And Set a Top view.
4. Create a 2-point rectangle, for Center Align set (X, Y & Z : 0, 0 & 0).
5. After that Choose a appropriate parameter of Slab.
6. Create a Slab from a planar Shape.
7. Next select a Reinforcement Workbench and Select a correct face of Slab.
8. Then, Create a Slab Reinforcement from a selected face of the Structural element.
9. Depending on the design requirements, adjust the parameters of the reinforcement such as spacing, diameter, cover, etc.
10. Ensure that the reinforcement configuration meets the design specifications and standards.
11. Inspect the model to ensure that the reinforcement is placed correctly and meets the structural requirements.
12. Save your FreeCAD project to preserve your work and modifications.

Task – 6 Beam Reinforcement

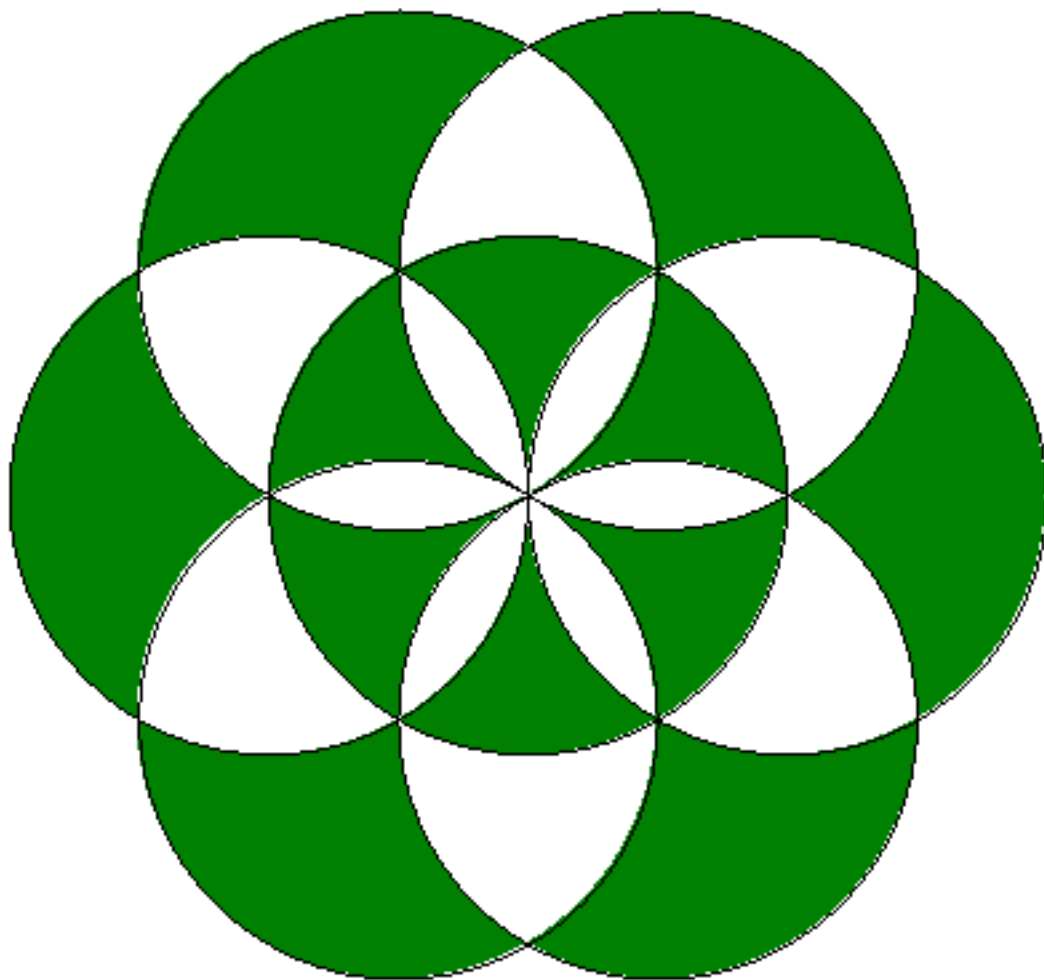
1. Launch FreeCAD on your computer.
2. Begin a new project or open an existing project where you want to design the Beam reinforcement.
3. Select a BIM Workbench And Set a Top view.
4. Create a 2-point rectangle, for Center Align set (X, Y & Z : 0, 0 & 0).
5. After that Choose a appropriate parameter of Slab.
6. Create a Beam from a planar Shape.
7. Next select a Reinforcement Workbench and Select a correct face of Beam.
8. Then, Create a Beam Reinforcement from a selected face of the Structural element.
9. Depending on the design requirements, adjust the parameters of the reinforcement such as spacing, diameter, cover, etc.
10. Ensure that the reinforcement configuration meets the design specifications and standards.
11. Inspect the model to ensure that the reinforcement is placed correctly and meets the structural requirements.
12. Save your FreeCAD project to preserve your work and modifications.

Task – 7 Column Reinforcement

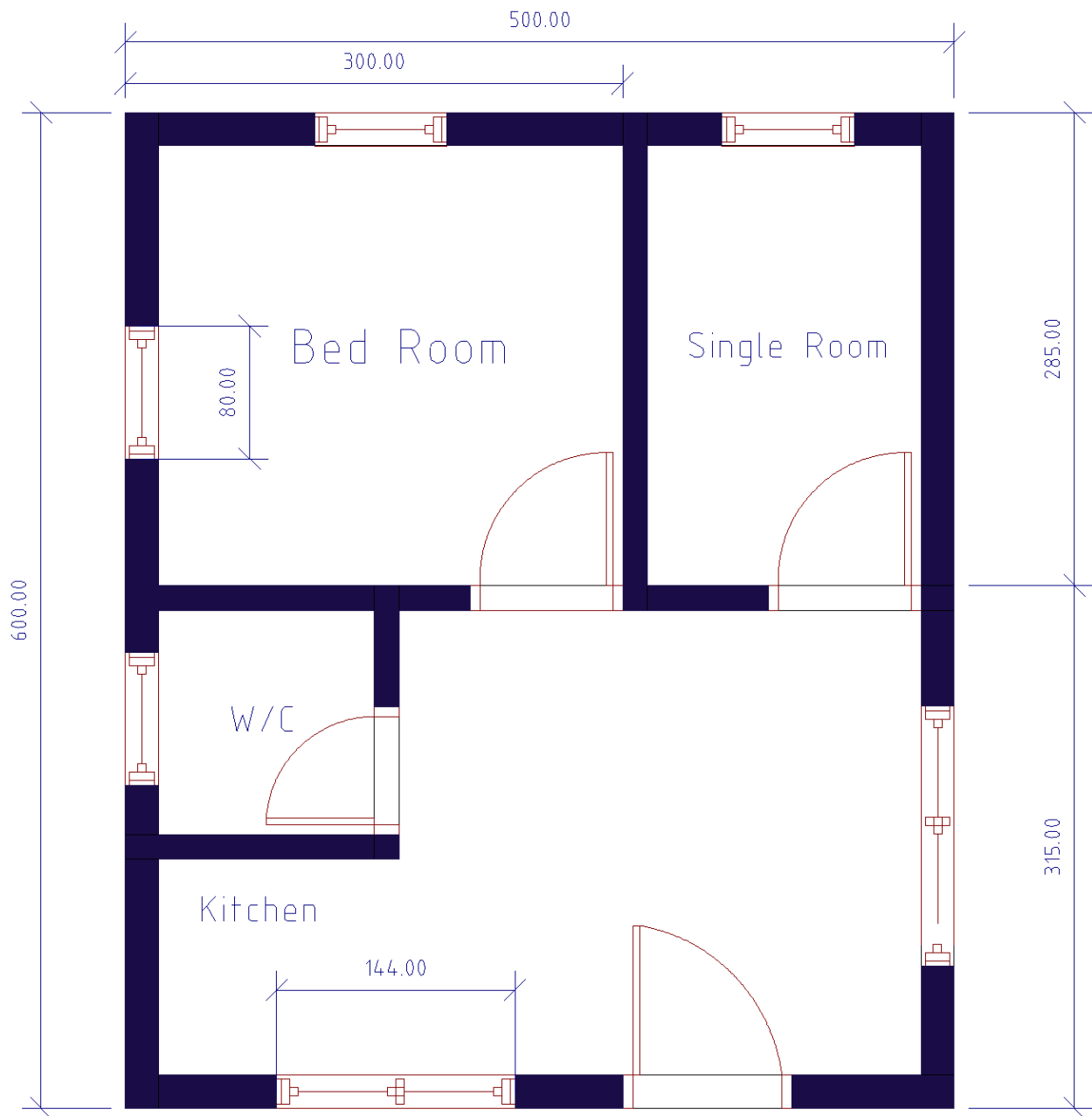
1. Launch FreeCAD on your computer.
2. Begin a new project or open an existing project where you want to design the Column reinforcement.
3. Select a BIM Workbench And Set a Top view.
4. Create a 2-point rectangle, for Center Align set (X, Y & Z : 0, 0 & 0).
5. After that Choose a appropriate parameter of Column.
6. Create a Column from a planar Shape.
7. Next select a Reinforcement Workbench and Select a correct face of Column.
8. Then, Create a Column Reinforcement from a selected face of the Structural element.
9. Depending on the design requirements, adjust the parameters of the reinforcement such as spacing, diameter, cover, etc.
10. Ensure that the reinforcement configuration meets the design specifications and standards.
11. Inspect the model to ensure that the reinforcement is placed correctly and meets the structural requirements.
12. Save your FreeCAD project to preserve your work and modifications.

Results

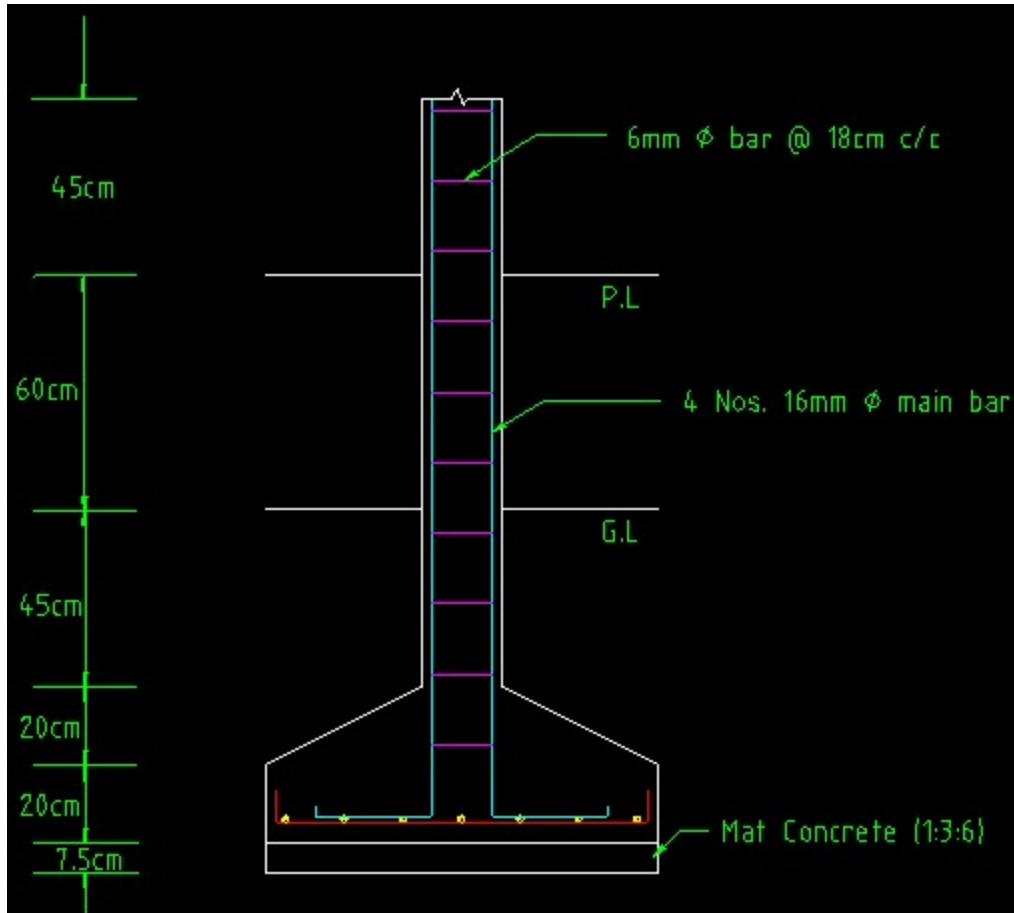
1. Flower



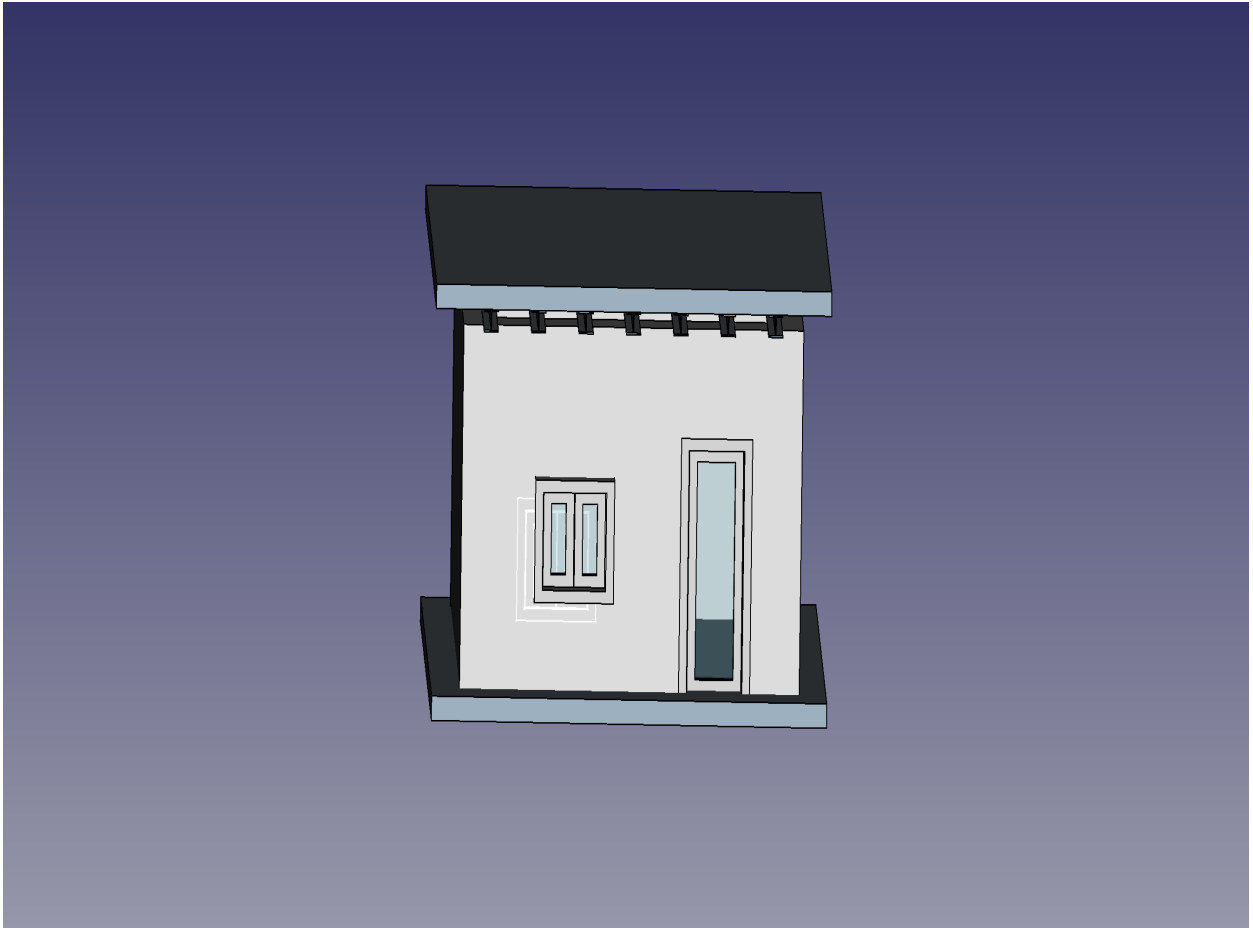
2. Layout Of House



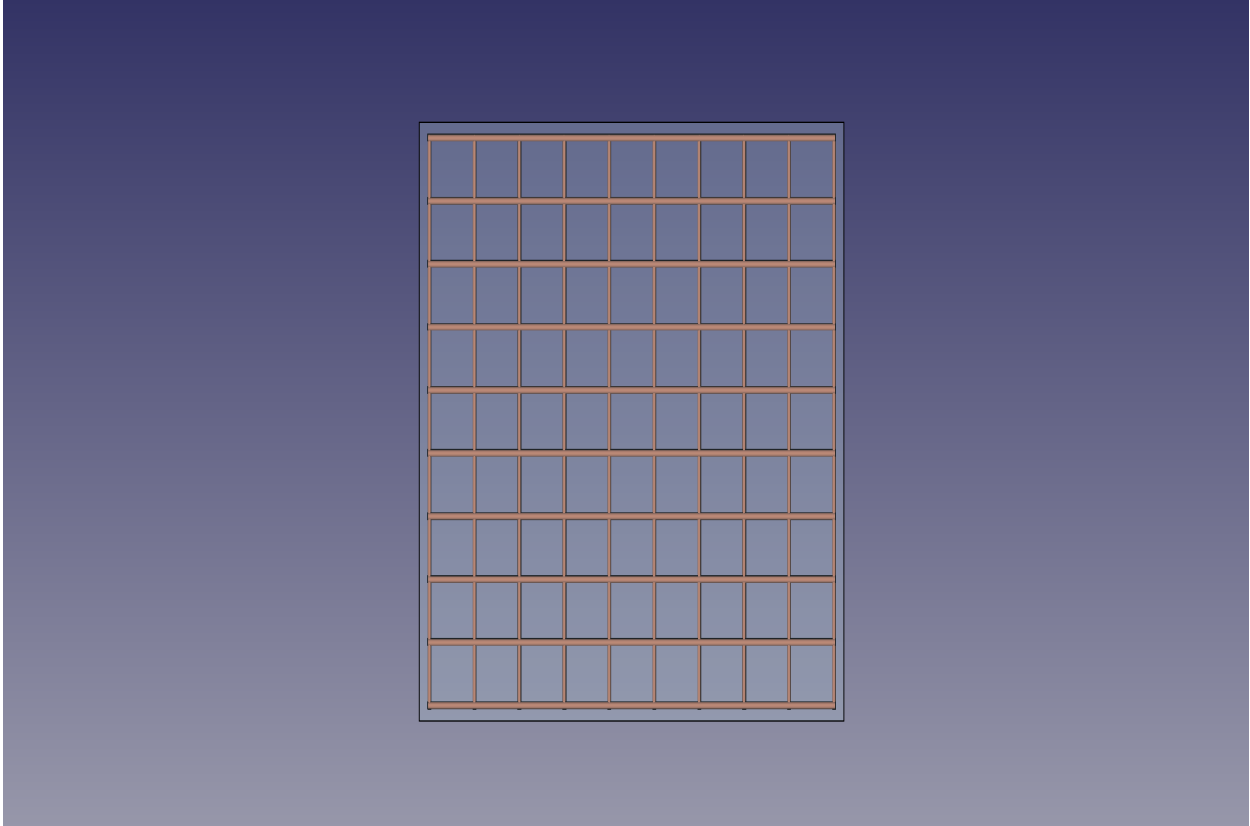
3. Column



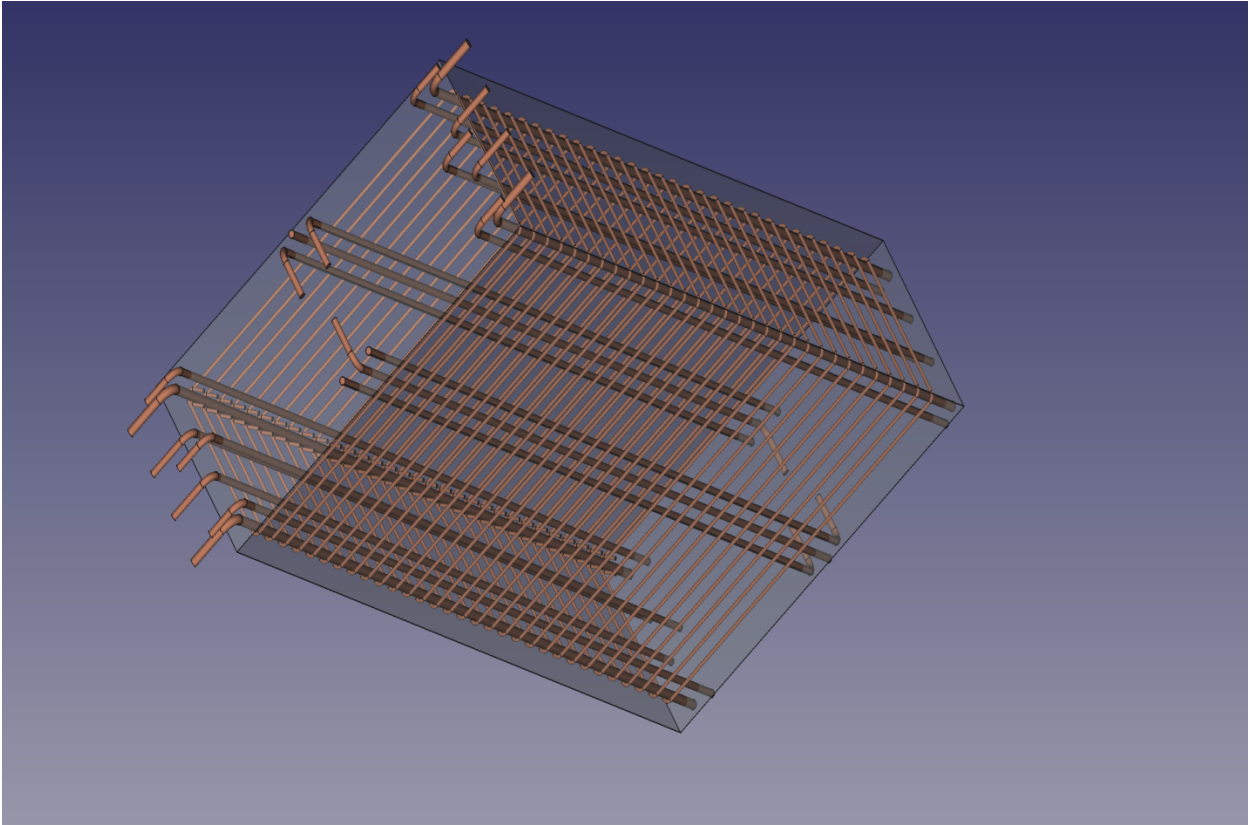
4. Manual : BIM Modeling



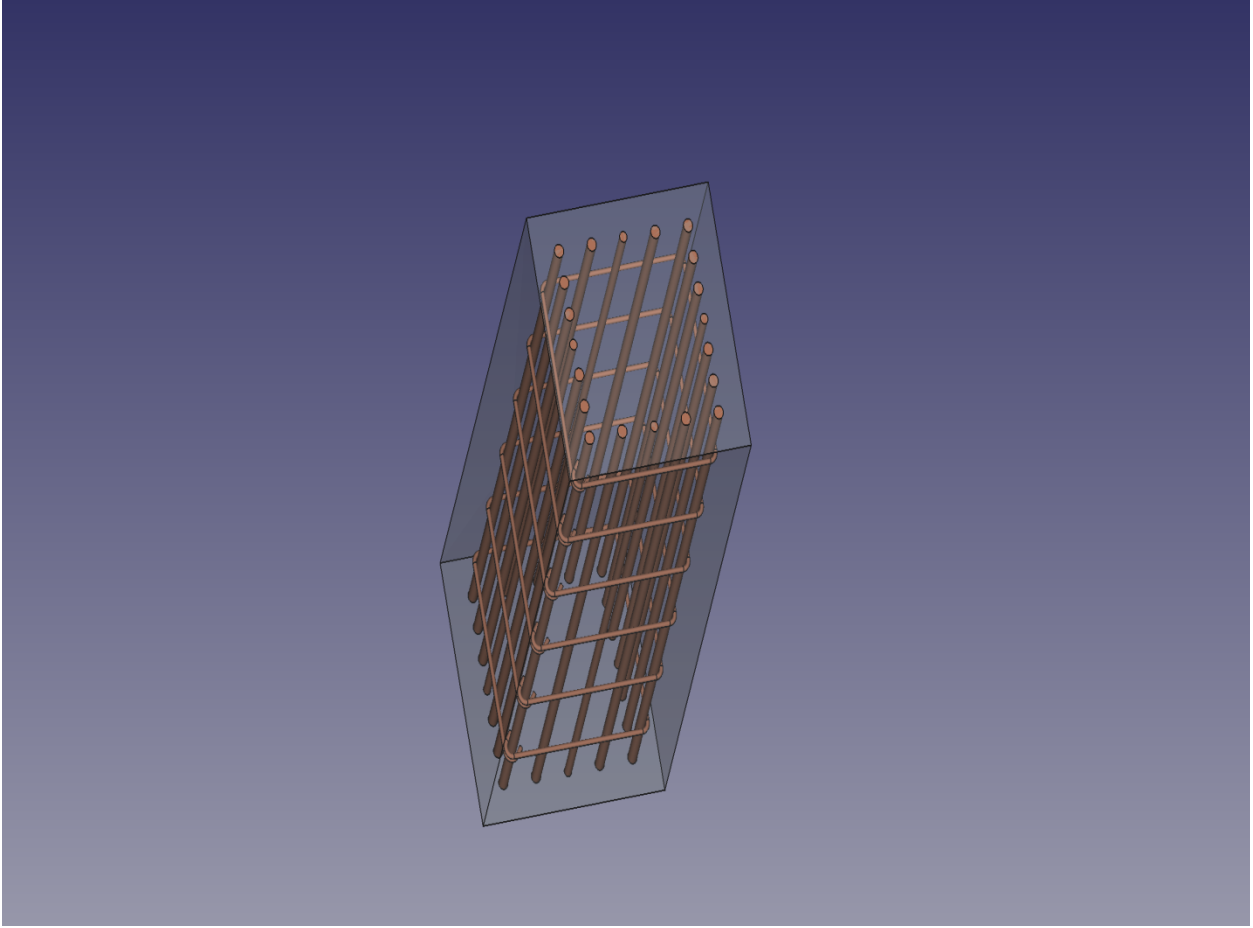
5. Slab Reinforcement



6. Beam Reinforcement



7. Column Reinforcement



Discussion

1. **Significance of Results:** The results obtained using FreeCAD and LibreCAD are significant as they allow users to create precise 2D and 3D models for various engineering, architectural, and design projects. These software tools enable users to visualize, analyze, and iterate upon designs, facilitating the development of innovative solutions and products. The ability to accurately represent real-world objects in a digital environment enhances collaboration, communication, and decision-making throughout the design process.

2. **Challenges Encountered:** Despite their usefulness, FreeCAD and LibreCAD may present challenges such as a learning curve for new users, especially those transitioning from proprietary CAD software. Additionally, compatibility issues with certain file formats or operating systems can arise, impacting workflow efficiency. Limited documentation and support resources may also pose challenges for users seeking assistance with complex tasks or troubleshooting issues.

3. **Possible Improvements or Modifications:** To address these challenges and enhance the usability of FreeCAD and LibreCAD, several improvements or modifications could be considered. These include:

- Enhancing user interfaces and providing more intuitive tools to streamline the design process.
- Expanding documentation and support resources to include comprehensive tutorials, user guides, and forums.
- Improving interoperability with other CAD software by implementing better file format support and compatibility.
- Incorporating advanced features such as parametric modeling, simulation, and rendering to broaden the software's capabilities.
- Actively engaging with the community to gather feedback, address user needs, and prioritize development efforts.

Conclusion

- FreeCAD offers powerful parametric modeling capabilities, making it ideal for complex 3D designs.
- LibreCAD excels in 2D drafting and drawing tasks, providing a user-friendly interface for creating precise technical drawings.
- Both software options are open-source and multi-platform, enabling accessibility and flexibility for users.
- Tips and tricks include leveraging parametric modeling in FreeCAD for iterative design processes and utilizing LibreCAD's snapping and grid features for precise 2D drafting.

References

- FreeCAD Documentation: https://wiki.freecadweb.org/Main_Page
- FreeCAD Forum: <https://forum.freecadweb.org/>
- LibreCAD Documentation: <https://librecad.org/docs/>
- LibreCAD Forum: <https://forum.librecad.org/>
- <https://chat.openai.com/>
- <https://Google.com/>