



Semester : II

Course : Introduction to civil engineering

Course Instructor : Aryada Deshpande

Note: In addition to this handout students must read textbooks and reference books as suggested.

UNIT 3

COMPUTATIONAL METHODS

Introduction Today, technology is circulating in almost every field of human life, whether it is social life, business management, construction, engineering or medical. Back in 1970s, where the usage of computer technology was very limited in Civil Engineering field, and that's why the construction of buildings was very slow at that time. It was not only the speed factor in constructing buildings, but also the quality and strength was not so advance and satisfactory. Today, buildings are much stronger than before. So, let's study some of the areas of Civil Engineering where computer technology provides assistance.

Softwares used in civil engineering

- 1)AUTOCAD
- 2)STAADPRO
- 3)ETABS
- 4)SAP2000
- 5)SAFE
- 6)ANSYS
- 7)QUANTITY SURVEY
- 8)CIVIL3DCADD
- 9) REVIT
- 10)GOOGLE SKETCHUP
- 11) RHINO
- 12) PRIMAVERA
- 13) MSP
- 14) ARCHICAD



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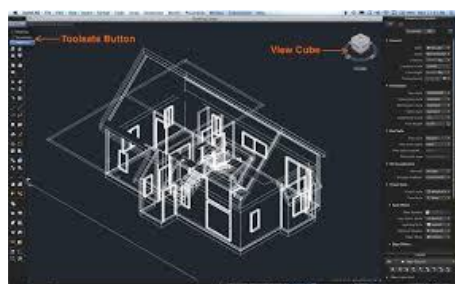
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1. AUTOCAD

AutoCAD is a commercial computer-aided design (CAD) and drafting software application. It was initially released in December 1982 by John walker. It is Marketed and developed by AUTO DESK. CAD allows civil engineers to plan layout sites, roads, bridges, sidewalks, etc. It Saves time. Saving time is equal to earn greater income by greater output. The software allows civil engineers to draw and edit 2D and 3D designs more efficiently. Corrections and edits can be time-consuming while working by hand on a physical medium. You can access easily AutoCAD designs from anywhere as the software also provides cloud integration. There are multiple tools which allow you to view your drawing from different perspectives and in a variety of styles. All these can be useful while working on complex drawings with a large number of components. The software allows you to share drawings and files with multiple members who work simultaneously on a project. The software automatically stores every change and addition you make to a file. It is a simple software with the real user friendly interface. It gives more accuracy than manual drafting and drawing. AutoCAD is used in industry, by architects, project managers, engineers, graphic designers, city planners and other professionals. AutoCAD comes with a set of specific drafting tools for generating standard industry based geometric dimensions, surface texture symbols, mechanical symbols etc. It has flexibility in design changes. It offers easy reuse of designs and existing ideas can be modified that saves time. Drawings can be sent/ received via email in seconds.





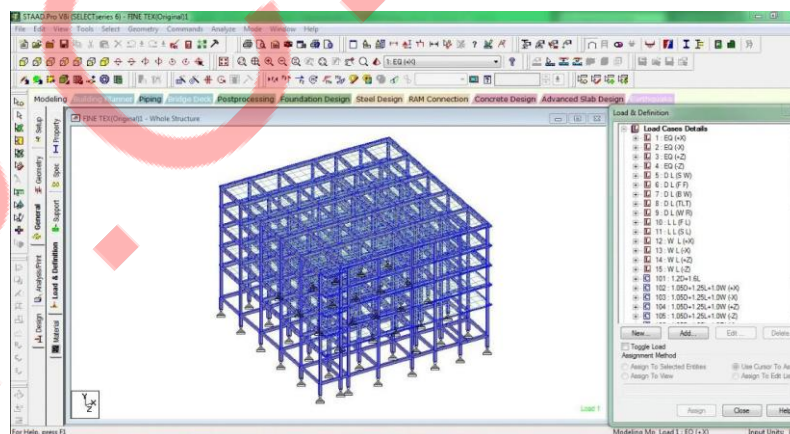
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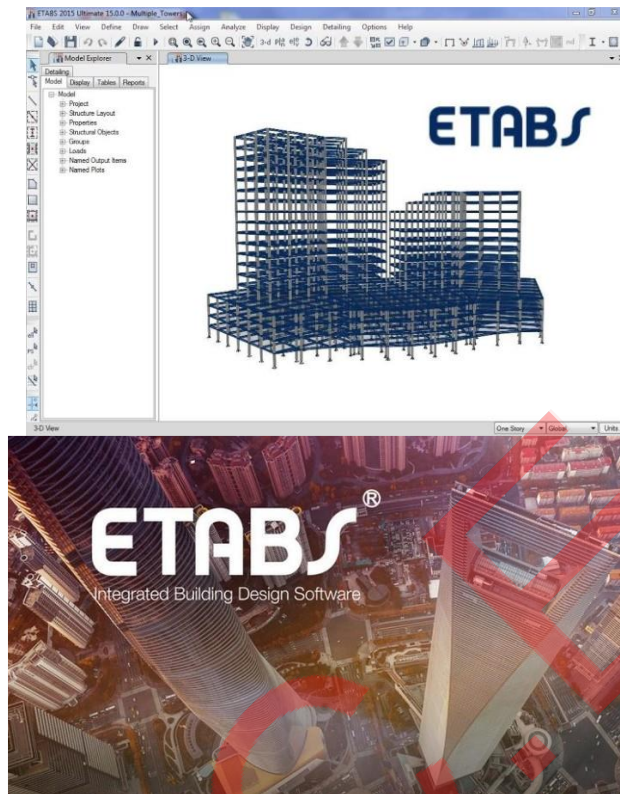
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2) STAAD PRO. STAAD or (STAAD.Pro) is a structural analysis and designs Software application originally developed by Research Engineers International in 1997. In late 2005, Research Engineers International was bought by Bentley Systems. STAAD.Pro is one of the most widely used structural analysis and design softwares. It consists of flexible modelling environment. It supports over 90 international steel concrete, timber & aluminium design codes. It can make use of various forms of analysis from the traditional static analysis to more recent. Analysis methods like p-delta analysis, geometric non-linear analysis, Push over analysis (Static-Non Linear Analysis) or a buckling analysis STAAD can be used for analysis and design of all types of structural projects from plants, buildings, and bridges to towers, tunnels, metro stations, water/waste water treatment plants and others.



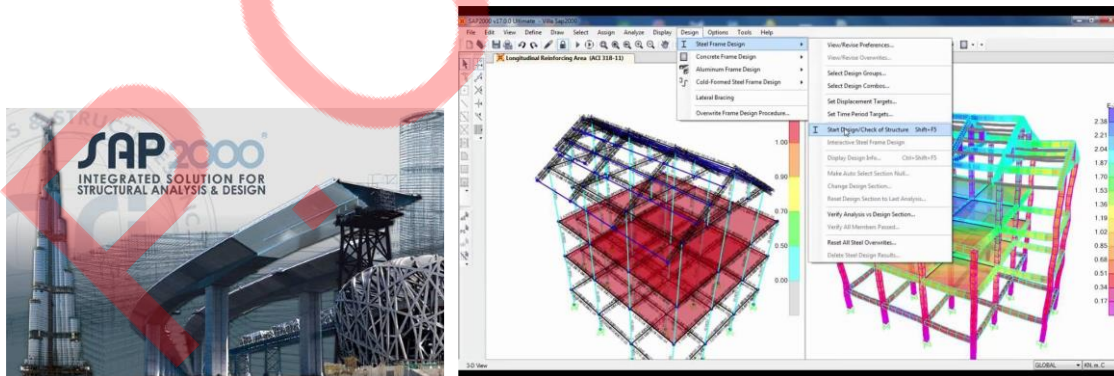
3) ETABS

ETABS is an engineering software product that caters to multi-story building analysis and design. It offers extended three dimensional analysis of building structure. Marketed and developed by CSI (COMPUTER & STRUCTURE INC). It is used in the analysis of structures greater than G+30. Modelling tools and templates, code-based load prescriptions, analysis methods and solution techniques, all coordinate with the grid-like geometry unique to this class of structure. It is also used in the analysis of earthquake loads. It is economical when compared to Staad pro. This software is mainly used in middle east countries.



4) SAP 2000

SAP2000 means Structural Analysis Program 2000. It is a structural analysis and design software produced by Computer and Structures, Incorporated (CSI), a structural and earthquake engineering company. It is ranging from 2D to 3D. It is used in modelling, loading and analysis. It is used for the design of beam and columns only.



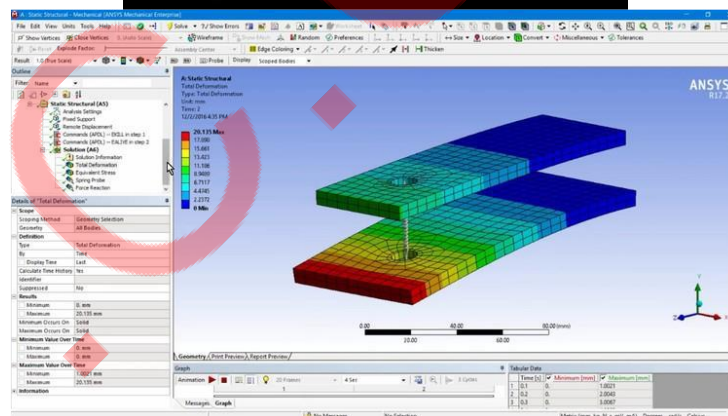
5) SAFE

SAFE is a comprehensive package that combines all the aspects of engineering design process—from creating layout to detail drawing production in a single, intuitive environment. It is tailored for the engineering of elevated floor and foundations lab systems. It supports conditions and loadings in order to carry out analysis. It enables highly advanced local assessment of foundation systems within larger structures and imports files from CAD, ETABS ,and SAP2000.



6) ANSYS

ANSYS software is used to design products and semiconductors, as well as to create simulations that test a product's durability, temperature distribution, fluid movements, and electromagnetic properties. It is used to predict how product designs will behave in real-world environments. It develops and markets finite element analysis software used to simulate engineering problems.



7) QUANTITY SURVEY

Quantity survey is a construction estimating software. It is broadly concerned with the estimation, planning and control of the cost on construction projects. It covers a wide range of activities including cost estimation, cost planning, value engineering, feasibility studies, cost benefit analysis, life cycle costing and valuation.

8) CIVIL 3D CAD

AutoCAD Civil3D software is a design and documentation solution for Civil Engineering that supports building information modelling (BIM) workflows. With this software, you can improve project performance, maintain consistent data, follow standard processes, and respond faster to change.

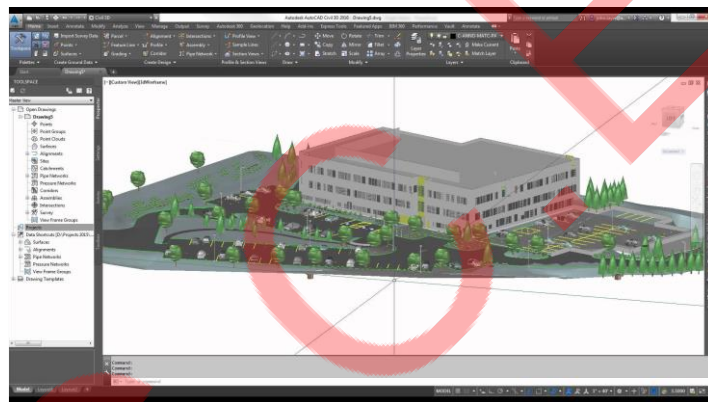


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9) REVIT

Autodesk Revit is a building information modelling software for architects ,landscape architects, structural engineers ,mechanical ,electrical and plumbing(MEP) engineers, designers and contractors. Revit family consist of THREE software

- REVIT STRUCTURES
- REVIT MEP
- REVIT ARCHI
- The software allows users to design a building and structure and its components in 3D, annotate the model with 2D drafting elements, and access building information from the building model's database. Building information modelling, or BIM, is a core function of Revit.
- Revit empowers the civil engineers to render the best performance with the creation of virtual illustration of building products. Starting from the Design Development & Coordination, 3D modelling, drawing set creation to quantity take-off, civil engineers can obtain the separate product specifications of the building.



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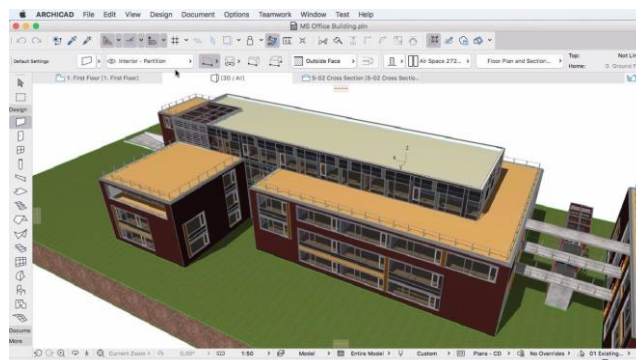
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10) ARCHICAD

ARCHICAD is the leading Building Information Modelling (BIM) software application. It is developed by the Hungarian company Graphisoft.

- ARCHICAD offers computer aided solutions for handling all common aspects of aesthetics and engineering during the whole design process of the built environment — buildings, interiors, urban areas, etc.
- ARCHICAD has been recognized as the first CAD product on a personal computer able to create both 2D and 3D geometry, as well as the first commercial BIM product for personal computers.
- It can store large amount of information within the 3D model. It provides suitable drawing tools for creating accurate and detailed technical drawings.
- A 3D CAD interface specially developed for architects capable of creating various kind of building forms. A high performance rendering tool to produce photo-realistic pictures or videos. A central data storage server with remote access with backup and restore features.
- Used by architects, designers, engineers and builders to professionally design, document and collaborate on building projects.





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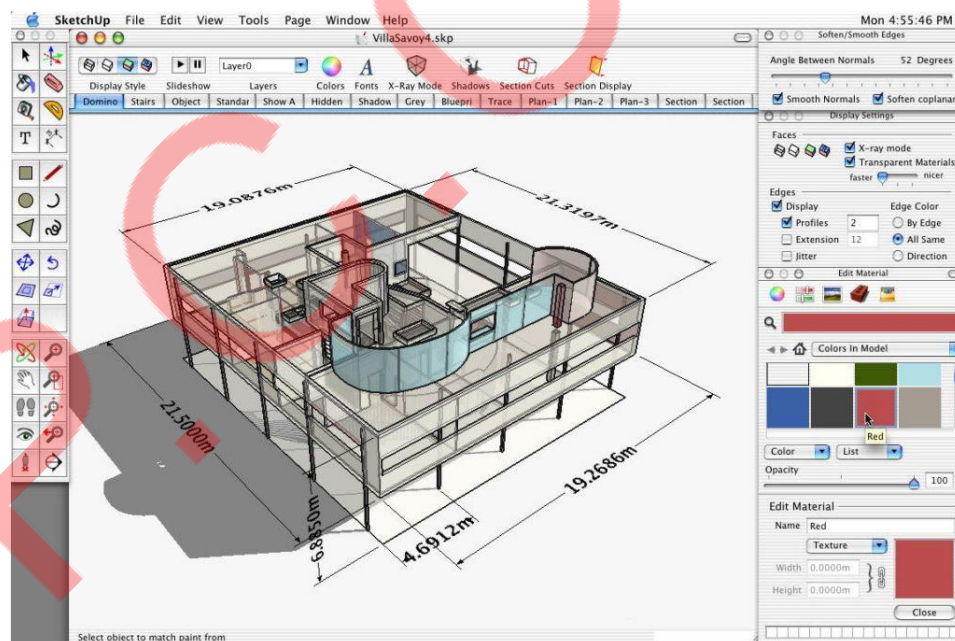
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11) SketchUp

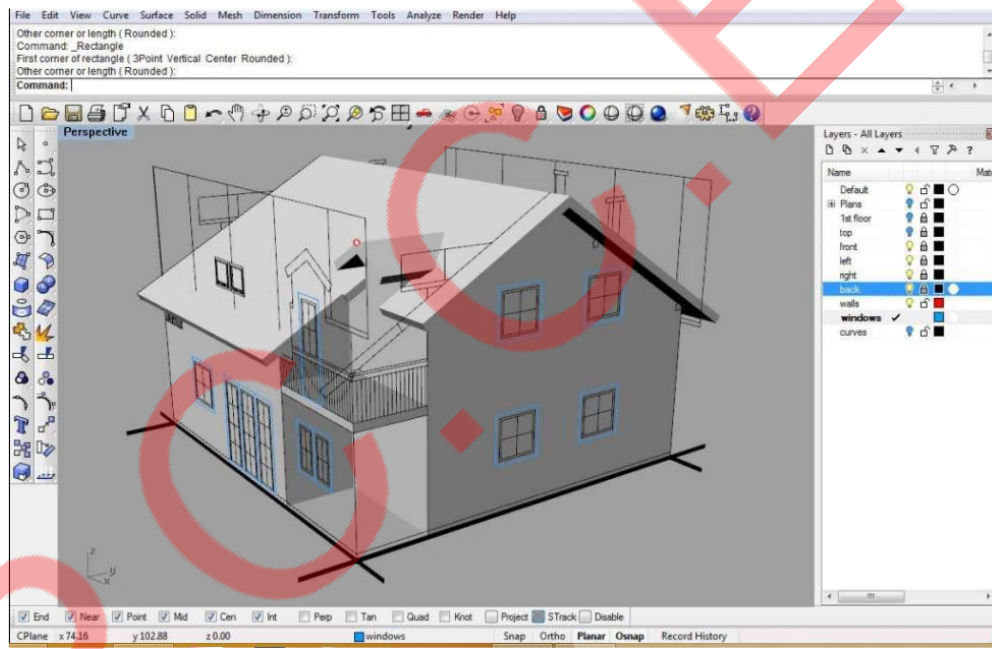
SketchUp (formerly Google SketchUp).

- SketchUp is a 3D modelling computer program for a wide range of drawing applications such as architectural ,interior design, landscape architecture, civil and mechanical engineering, film and video game design.
- It is owned by Trimble Inc., a mapping surveying and navigation equipment company.



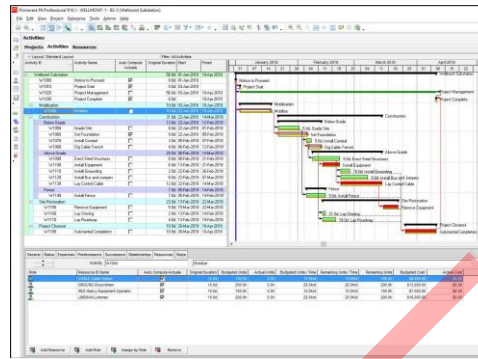
12) RHINOCERES 3D

- **Rhinoceros** (typically abbreviated **Rhino** or **Rhino3D**) is a commercial 3D computer graphics and computer-aided design (CAD) application software.
- It is developed by Robert McNeel & Associates, an American COMPANY.
- Rhinoceros is used for computer-aided design (CAD) , computer-aided manufacturing (CAM), rapid prototyping, 3D printing and reverse engineering in industries including architecture, industrial design (e.g. automotive design, watercraft design), product design as well as for multimedia and graphic design.



13) PRIMAVERA

- Primavera is an enterprise project portfolio management software.
- It includes project management, scheduling, risk analysis, opportunity management, resource management, collaboration and control capabilities, and integrates with other enterprise software. Primavera was launched in 1983 by Primavera Systems Inc.
- It is used in Civil Engineering for project planning and management.
- It is an easy to use Software that focuses on forecasting of project activities, time resource and cost management.
- It helps easily prepare and control project things to be performed.

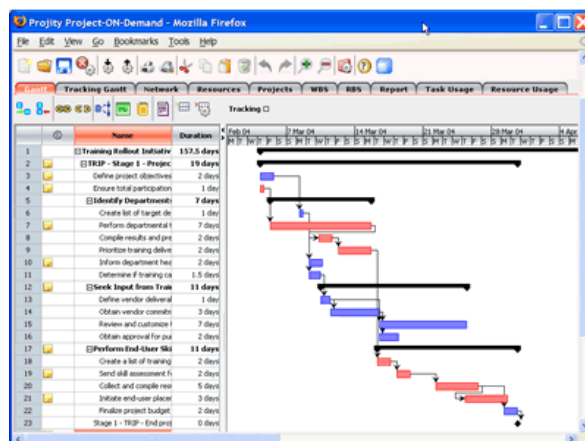


14) MICROSOFT PROJECTS

- **Microsoft Project** is a project management software product, developed and sold by Microsoft. It is designed to assist a project manager in developing a schedule, assigning resources to tasks, tracking progress, managing the budget, and analyzing workloads.
- As resources are assigned to tasks and assignment work estimated, the program calculates the cost, equal to the work times the rate.
- Resource definitions (people, equipment and materials) can be shared between projects using a shared resource pool. Each resource can have its own calendar, which defines what days and shifts a resource is available.
- Microsoft Project can recognize different classes of users. These different classes of users can have differing access levels to projects, views, and other data.



Microsoft Project





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Building Information modelling(BIM)

- **BIM** is an acronym for Building Information Modelling. **Building information modelling (BIM)** is a process supported by various tools, technologies and contracts involving the generation and management of digital representations of physical and functional characteristics of places.
- Building information models (BIMs) are computer files which can be extracted, exchanged or networked to support decision-making regarding a built asset (building). BIM software is used by individuals, businesses and government agencies who plan, design, construct, operate and maintain buildings and diverse physical infrastructures, such as water, electricity, gas, communication utilities, roads, railways, bridges, ports and tunnels.
- It is a highly collaborative process that allows architects, engineers, real estate developers, contractors, manufacturers, and other construction professionals to plan, design, and construct a structure or building within one 3D model.
- It can also span into the operation and management of buildings using data that building or structure owners have access to. This data allows governments, municipalities, and property managers to make informed decisions based on information derived from the model— even after the building is constructed.

BUILDING INFORMATION MODELING SOFTWARES

- AUTOCAD
- REVIT
- SKETCH UP
- AUTOCAD MEP
- AUTOCAD ARCHITECTURE
- AUTOCAD PLANT 3D
- ARCHICAD
- CIVIL 3D CAD



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ADVANTAGES OF USING BIM

1. Capture the most accurate representations of the site. BIM can make use of a wide range of advanced design and mapping tools. 3D scanning is increasingly being used to build up incredibly detailed 3D representations of existing sites and structures.
2. Improved Communications. BIM improves communication among architects, clients, contractors, and other relevant parties involved in the project. Everyone involved in the project can see the information and even offer suggestions of their own.
3. BIM can be used to automate steps, such as enumerating the numbers of windows or other components required which leads saving time and reducing errors. Any reduction in time and work directly translates to a monetary saving.
4. BIM systems typically utilize functions such as auto save and connections to a project history to ensure that additions and changes are never lost and that a deleted or corrupted file need not be a disaster.
5. BIM can be used to create more than just 2D drawings and 3D models. Some systems can be used to produce models that incorporate additional elements, such as time and cost and information regarding the functionality as well as the design of the building.
6. BIM software can detect clashing elements such as electrical conduit or ductwork into a beam. It has the potential to detect issues before they happen.
7. Sequence the steps of building process. Constructing a building is an extremely detailed process. BIM give a detailed, accurate step-by-step guide to help ensure that all those meticulous plans and models are re-created accurately on the ground.
8. BIM models and other information can be accessed on different devices and in different locations at any time, whether the user is travelling, in their own offices, or deployed onsite.
9. BIM models can also be used to create visualizations that bring designs to life , allowing anyone to see what the finished project will look like onsite. This is ideal for making visual presentations to owners, backers, investors and other stakeholders to review design changes or evaluate clashes between systems.
10. BIM enables a more faster design thurs saving time and labour. Also helps in minimizing human errors. Also helps in cost savings and waste reduction.



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BIM LEVELS

Different levels of BIM can be achieved for various types of projects. Each level represents a different set of criteria that demonstrates a particular level of 'maturity.' BIM levels start with 0 and go to 4D, 5D, and even 6D BIM. The purpose of these levels is to gauge how effectively, or how much information is being shared and managed throughout the entire process.

Level 0 BIM: Paper-based drawings + zero collaboration

This level of Building Information Modelling only includes 2D drawings using CAD. Participants only share files, documents, drawings etc. via electronic prints and paper. There is no collaboration.

Level 1 BIM: 2D construction drawings + some 3D modeling

It is not only about 2D drawings here, but 3-dimensional views are also considered. In level 1 BIM, teams are sharing information using a Common Data Environment (CDE) That allows them to collaborate easily on projects.

Level 3 BIM: Teams work with a shared 3D model

BIM level 3 is even more collaborative. Instead of each team member working in their own 3D model, Level 3 means that everyone uses a single, shared project model. The model exists in a central environment and can be accessed and modified by everyone.

Levels 4, 5, and 6 BIM: Adding in scheduling, cost, & sustainability information

BIM level 4 brings a new element into the information model: time. This information includes scheduling data that helps outline how much time each phase of the project will take or sequencing of various components. Level 5 BIM adds cost estimations, budget analysis, and budget tracking to the information model. Level 6 BIM information is useful for calculating the energy consumption of a building before it's built.



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IS CODES

All major countries like India, USA, UK, Australia are having their own standards for material standards, testing standards, design procedures and for finished products. Before independence, India followed British standards, but after independence it was felt there is need to prepare the standards to meet the Indian environment. Hence Indian Standard Institution was established, which is now known as Bureau of Indian Standards. It has prepared more than 4000 standards and now and then new standard codes are brought out.

The following codes help engineers to design buildings:

1. IS 456–2000. It is code of practice for the design of plain and reinforced concrete. It was first brought out in 1953. It was revised in 1957, 1984 and the latest revision is in the year 2000. It gives specifications or specifies the other codes for the requirement of various materials used in making concrete. It classifies concrete into various grades based on 28 days concrete cube strength. It specifies the methods and care to be taken in transporting, placing, compacting and using of concrete. It gives general design considerations, special design requirements and gives design procedure for various structural elements by limit state method approach. Both strength and serviceability requirements are to be satisfied in the design.

2.IS 800–2007: It titled as General Construction in steel-code and practice. To achieve efficient and optimum standards for structural steel products, Indian Standard Institution initiated action in 1950 and was able to bring out a code in 1956. The code was revised in 1962, 1984 and the latest revision is in the year 2007. It gives guidelines for various class of steel, loads to be considered in the design and the method of designing steel members by limit state method. It gives the serviceability requirements to be fulfilled in the design.

3. IS 875–1987: It is the Indian Code of practice for Design Loads for Building and Structures. It is available in five parts. Specifications are available for taking loads such as dead loads, live loads, wind loads, snow loads, crane loads etc. Dead load depends upon the type of structures and also on the part of structure. Wind loads and snow loads depend upon the region, location of site, slopes of building roof, height of building etc. The code gives the guidelines for determining these loads on the building to be designed. Code also gives the combination of loads to be considered in the building design.

4. IS 1343–1980: It is the code of practice for pre stressed concrete. It gives guidelines for selecting materials, specifies workmanship, inspection and testing. General design requirements and limit state method for structural design are presented. Requirements for durability are also specified.



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5. IS 1893–2002: It gives criteria for Earthquake Resistant Design of Structures.

6.IS 4928–1993:is the code of practice for Earthquake Resistant Design and Construction of Buildings.

7.IS 13827–1992 gives guidelines for Improving Earthquake Resistance of Low Cost Strength Masonry Buildings.

8. IS 13920–1997: It is the code of practice for Ductile Detailing of Reinforced concrete structures subjected to Seismic Forces.

9.IS 13935–1993 gives guidelines for Repair and Seismic Strengthening of Buildings.

IS CODES FOR BUILDING MATERIALS AND CONSTRUCTION

The following is the list of some of the IS code giving requirements for building materials:

IS 269–1989. Specification for ordinary portland cement.

IS 455–1989. Specification for portland slag cement.

IS 516–1959. Method of tests for strength of concrete.

IS 1123–1975. Method of identification of natural building stones.

IS 383–1970. Specifications for coarse and fine aggregates.

IS 432–1982. Specification for mild steel.

IS 3495–1976. Gives specifications for building bricks.

IS 287–1973. Gives maximum permissible moisture content in timber for different zone and for different uses.