4D MODELLING AND STRUCTURAL ANALYSIS OF MULTISTORED BUILDING USING DESIGN SOFTWARES

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ABSTRACT

4D Building Information Modeling (BIM) Models contain data consisting of 3D objects which also include information relating to construction scheduling and cost aspects, and has the potential to be used by modeling , in a collaborative project environment with design team members such as architects and engineers. Thought that 4D BIM would have an extremely significant impact in the future, as the process becomes more prevalent. The main elements of 4D modeling is planning, designing, modeling, Analysis, scheduling and costing. The planning is performed in AUTOCAD and designing, modeling and scheduling and costing is performed in AUTODESK REVIT. Analysis is performed in STAAD PRO. Planning is done by using building bye laws and vasthu sastram. By using STAAD PRO we should analyze the dead load, live load, bending moment, shear force, torsion and reaction forces (fx, fy, fz87) by using the IS875 PART 1 for dead load and IS875 PART 2 for live load. By using AUTODESK REVIT we can modeling and drafting footings, columns, beams, slab, and reinforcement. By using Autodesk Revit wecan also prepare scheduling and costing.

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I INTRODUCTION

Building construction is the engineering deals with the construction of building such as residential houses. In a simple building can be define as an enclose space by walls with roof, food, cloth and the basic needs of human beings. In the early ancient times humans lived in caves, over trees or under trees, to protect themselves from wild animals, rain, sun, etc. as the times passed as humans being started living in huts made of timber branches. The shelters of those old have been developed nowadays into beautiful houses. Rich people live in sophisticated condition houses. Buildings are the important indicator of social progress of the county. Every human has desire to own comfortable homes on an average generally one spends his two-third life times in the houses. The security civic sense of the responsibility. These are the few reasons which are responsible that the person do utmost effort and spend

hard earned saving in owning houses. Nowadays the house building is major work of the social progress of the county. Daily new techniques are being developed for the construction of houses economically, quickly and fulfilling the requirements of the community engineers and architects do the design work, planning and layout, etc., of the buildings. Draughtsmen are responsible for doing the drawing works of building as for the direction of engineers and architects. The draughtsman must know his job and should be able to follow the instruction of the engineer and should be able to draw the required drawing of the building, site plans and layout plans etc., as for the requirements. A building frame consists of number of bays and storey. A multi-storey, multi-paneled frame is a complicated statically intermediate structure. A design of R.C building of G+5 storey frame work is taken up. The building in plan (45'*62') consists of columns built

monolithically forming a network. The size of building is 45x62ft. The design is made using software on structural analysis design (staad-pro). The building subjected to both the vertical loads as well as horizontal loads. The vertical load consists of dead load of structural components such as beams, columns, slabs etc. and live loads. The horizontal load consists of the wind forces thus building is designed for dead load, live load and wind load as per IS 875. The building is designed as two dimensional vertical frame and analyzed for the maximum and minimum bending moments and shear forces by trial and error methods as per IS 456-2000. The help is taken by software available in institute and the computations of loads, moments and shear forces and obtained from this software.

II BUILDING INFORMATION MODELING

Definition:

Building Information Modeling (BIM) is a digital representation of physical and functional characteristics of a facility. A BIM is a shared knowledge resource for information about a facility forming a reliable basis for decisions during its life-cycle; defined as existing from earliest conception to demolition.

Traditional building design was largely reliant upon two-dimensional technical drawings (plans, elevations, sections, etc.). Building information modeling extends this beyond 3D, augmenting the three primary spatial dimensions (width, height and depth) with time as the fourth dimension (4D) and cost as the fifth (5D). BIM therefore covers more than just geometry. It also covers spatial relationships, light analysis, geographic information, and quantities and properties of building components (for example, manufacturers' details). BIM involves representing a design as combinations of "objects" – vague and undefined, generic or product-specific, solid shapes or void-space oriented (like the shape of a room), that carry their geometry, relations and attributes. BIM design tools allow extraction of different views from a building model for drawing production and other uses. These different views are automatically consistent, being based on a single definition of each object instance. BIM software also defines objects parametrically; that is, the objects are defined as parameters and relations to other objects, so that if a related object is amended, dependent ones will automatically also change. Each model element can

carry attributes for selecting and ordering them automatically, providing cost estimates as well as material tracking and ordering. For the professionals involved in a project,

Statement of project

Salient features:

Utility of building building	:Residential
No of stories	:G+5
Shape of the building	
	:
1 APARTMENT	
No of staircases	
	:
1	
No. of flats	25
No of lifts	1
Type o	
R.C.C framed structure	
Types of walls	: brick wall

Geometric details:

Ground floor	:3m
Floor to floor height	:3.48m.
Height of plinth	:0.6m
Depth of foundation	:500mm

Materials:

Concrete grade	:M20

Design of multi storied residential building:

General:

A structure can be defined as a body which can resist the applied loads without appreciable deformations. Civil engineering structures are created to serve some specific functions like human habitation, transportation, bridges, storage etc. in a safe and economical way. A structure is an assemblage of individual elements like pinned elements (truss elements), beam element, column, shear wall slab cable or arch. Structural engineering is concerned with the planning, designing and thee construction of structures.

Structure analysis involves the determination of the forces and displacements of the structures or components of a structure. Design process involves the selection and detailing of the components that
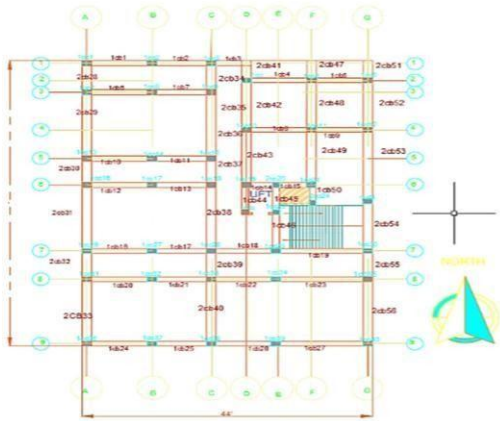
make up the structural system.

Figure 1 plan in autocad software

The main object of reinforced concrete design is to achieve a structure that will result in a safe economical solution.

The objective of the design is

1. Foundation design.
2. Column design.
3. Beam design.
4. Slab design

These all are designed under limit state method

PLAN

The auto cad plotting no.1 represents the plan of a g+5 building. The plan clearly shows that it is an apartment. In the apartment the entire floor consists of a five room house which occupies entire floor of a block. It represents a rich locality with huge areas for each house.

It is a g+5 proposed building, so for 1 block we have 5*5=25 flats.

The plan shows the details of dimensions of each and every room and the type of room and orientation of the different rooms like bed room, bathroom, kitchen, living room etc... All the flats the apartment have similar room arrangement.

The entire plan area is about 2475 sq. m. There is some space left around the building for parking of

In the middle we have a small construction which

consists of one lift and those who want to fly through lift can use this facility and we know for a building with more than g+4 floors should compulsory have lift and the charges for the facilities is collected by all the members. So these

represent the plan of our building and detailed explanation of remaining parts like elevations and designing is carried in the next sections.

Figure 2 Skelton structure

Below figure represents the skelton structure of the building which is used to carry out the analysis of our building.

All the loadings are acted on this skeletal structure to carry out the analysis of our building. This is not the actual structure but just represents the outline of the building in staad.pro. A mesh is automatically created for the analysis of these building.

Dead Loads:

Dead loads consist of the permanent construction material loads compressing the roof, floor, wall, and foundation systems, including claddings, finishes and fixed equipment. Dead load is the total load of all of the components of the components of the building that generally do not change over time, such as the steel columns, concrete floors, bricks, roofing material etc. In staad pro assignment of dead load is automatically done by giving the property of the member. In load case we have option called self-weight which automatically

calculates weights using the properties of material i.e., density and after assignment of dead load the skeletal structure looks red in color as shown in the figure.
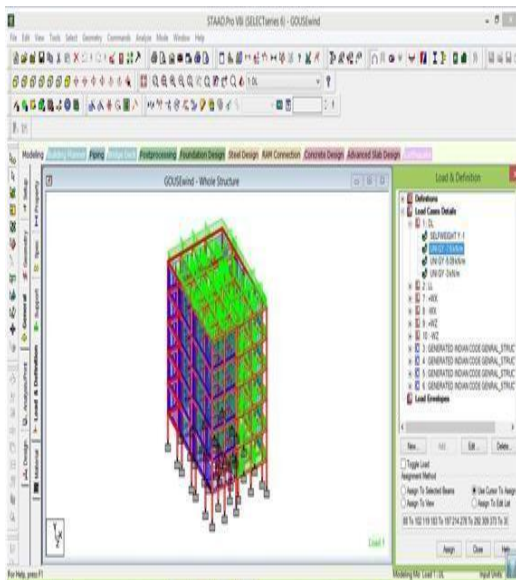

Figure 3 dead load acting in staad

An Example for calculation of dead load;

Dead load calculation Weight=Volume x Density

Self-weight floor

finish=0.12*25+1=3kn/m^2 the above example shows a sample calculation of dead load. Dead load is calculated as per IS 875 part 1

Live Loads:

Live loads are produced by the use and occupancy of a building. Loads include those from human occupants, furnishings, no fixed equipment, storage, and construction and maintenance activities. As required to adequately define the loading condition, loads are presented in terms of uniform area loads, concentrated loads, and uniform line loads. The uniform and concentrated live loads should not be applied simultaneously n a structural evaluation. Concentrated loads should be applied to a small area or surface consistent with the application and should be located or directed to give the maximum load effect possible in endues conditions. For example. The stair load of 300 pounds should be applied to the center of the stair tread between supports. In staad we assign live load in terms of U.D.L .we has to create a load case for live load and select all the beams to carry such load. After the assignment of the live load the structure appears as shown below.
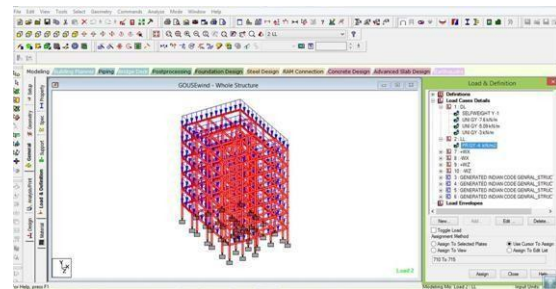

Figure 4Live Load

Live loads are calculated as per **IS 875 part 2.**

Wind loads:

In the list of loads we can see wind load is present both in vertical and horizontal loads. This is because wind load causes uplift of the roof by creating a negative (suction) pressure on the top of the roof. Wind produces non static loads on a structure at highly variable magnitudes. The variation in pressures at different locations on a building is complex to the point that pressures may become too analytically intensive for precise consideration in design. Therefore, wind load specifications attempt to amplify the design problem by considering basic static pressure zones on a building representative of peak loads that are likely to be experienced. The peak pressures in one zone for a given wind direction may not, However, occur simultaneously in other zones. For some pressure zones, the peak pressure depends on an arrow range of wind direction. Therefore, the wind directionality effect must also be factored into determining risk consistent wind loads on buildings.

Because they vary substantially over the surface of a building. Wind load star considered at two different scales. on large scale, the load produced on the overall building are on major structural systems that sustain wind loads from more than one surface of building, are considered the main wind force resisting systems (MWFRS).the MWFRS of a home includes the shear walls, Diaphragms that create the lateral force resisting systems (LFRS). As well as the structural systems such as trusses that experience loads from two surfaces are regimes of the building. The wind loads applied to the MWFRS account for the large effects of time varying wind pressures on the surface are surfaces of the building. On a Smaller scale, pressures are somewhat greater on localized surface area of the building, particularly near abrupt changes in building geometry (i.e., eaves, ridges, and corners).

These higher wind pressures occur on smaller areas, particularly affecting the loads borne by components and cladding (e.g., sheathing, windows, doors, purling, studs). The components and cladding (C&C) transfer localized time-varying loads to the MWFRS, at which point the loads average out both spatially and temporally since, at a given time, some components may beat near peak loads while others are at substantially less than peak. The next section presents a simplified method for determining both MWFRS and C&C wind loads. Since the loads in the section 3.6.2 are determined for specific applications, the calculation of MWFRS and C&C wind loads is implication the values provided. Design example 3.2 in section 3.10 demonstrate the calculation of wind loads by applying the simplified method of the following section 3.6.2to several design conditions associated with wind loads and the load combinations. Century, modernism morphed into the international style, an aesthetic epitomized in many ways by the Twin Towers of New York's world trade center. Many architects resisted modernism, finding it devoid of the decorative richness of ornamented styles. Yet as the movement lost influence in the late 1970s, postmodernism developed as a reaction against the austerity of Modernism. Robert ventures' contention that a "decorated shed" (an ordinary building which is functionally designed inside and embellished on the outside) was better than a "Duck" (a building in which the whole form and its function are tied together) gives an idea of this approach. Assignment of wind speed is quite different compared to remaining loads. We have to define a load case prior to assignment.

After designing wind load can be assigned in two ways 1. Collecting the standard values of load intensities for a particular heights and assigning of the loads for respective height. 2. Calculation of wind load as per IS 875 part 3. We designed our structure using second method which involves the calculation of wind load using wind speed. In Hyderabad we have a wind speed of 45 kmph for 10 m height and this value is used in calculation. After the assignment of wind load the structure looks as shown in figure.

Basic wind speed:

Gives basic wind speed of India, as applicable to 1m height above means ground level for different zones of the country. Basic wind speed is based on peak just velocity averaged over a short time

interval of about 3 seconds and corresponds to mean heights above ground level in an open terrain. The wind speed for some important cities/towns is given table below.
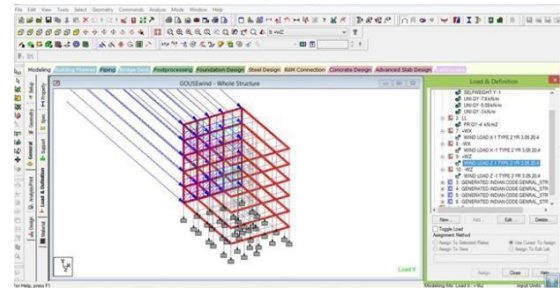

Figure 5 Wind Load

The following figure shows the reinforcement details of a beam in staad. The figure represents details regarding

1. Transverse reinforcement
2. Longitudinal reinforcement

The type of bars to be used, amount of steel and loading on the column is represented in the below figure.

BEAMS

Beams transfer load from slabs to columns .beams are designed for bending.

In general we have two types of beam: single and double. Similar to columns geometry and perimeters of the beams are assigned. Design beam command is assigned and analysis is carried out, now reinforcement details are taken.

Beam design:

A reinforced concrete beam should be able to resist tensile, compressive and shear stress induced in it by loads on the beam.

There are three types of reinforced concrete beams

1.) Single reinforced beams
2.) Double reinforced concrete 3.) Flanged beams

Singly reinforced beams:

In singly reinforced simply supported beams steel bars are placed near the bottom of the beam where they are more effective in resisting in the tensile bending stress. I cantilever beams reinforcing bars
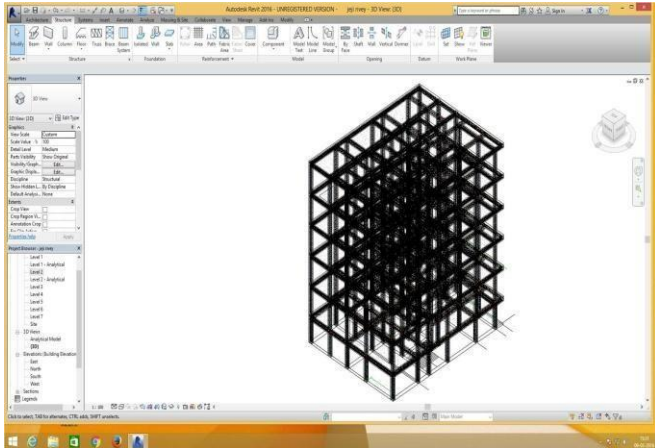

Figure 6 Structure design in revit

placed near the top of the beam, for the same

reason as in the case of simply supported beam.

Doubly reinforced concrete beams:

It is reinforced under compression tension regions. The necessity of steel of compression region arises due to two reasons. When depth of beam is restricted. The strength availability singly reinforced beam is in adequate. At a support of continuous beam where bending moment changes sign such as situation may also arise in design of a beam circular in plan.

III REVIT ARCHITECTURE

Autodesk Revit Architecture is a robust architectural design and documentation software application created by Autodesk for architects and building professionals. The tools and features that make up Revit Architecture are specifically designed to support building information modeling (BIM) workflows. By utilizing BIM as opposed to computer-aided drafting (CAD), Revit Architecture is able to leverage dynamic information in intelligent models — allowing complex building structures to be accurately designed and documented in a short amount of time. Each intelligent model created with Revit Architecture represents an entire project and is stored in a single database file. This allows changes made in one part of the model to be automatically propagated to other parts of the model, thus enhancing the workflow for Revit Architecture users.

Steps by step procedure for modelling:

➢ Considering one area for construction, here we considered Vijayawada (Zone 3)

➢ According to Building Bylaws, provision of plot area and plinth area considering F.S.I.

➢ Provision of setback distances with respect to building height.

➢ Preparing different plans for different floors, within the plinth area

➢ Importing the individual floors in a separate Revit windows and by using Revit software modelling is done for individual plans

➢ After the completion of the modelling of individual floors, deleting the unnecessary layers of imported data

➢ Open a new Revit window and import all the individual floors in separate levels and all the floors are joined as a single element.

1) All the exterior modifications required are done, after placing of the floors
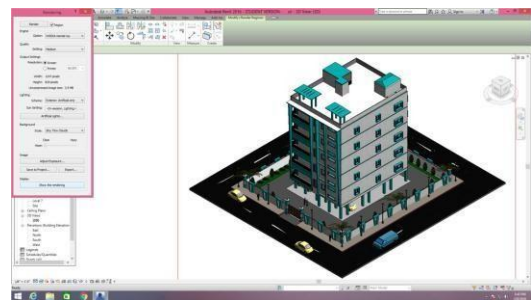2) A complete 3D model is available now.

Figure 7 Structure of the apartment

ANALYSIS WORKING WITH STAAD. Pro:

Input Generation:

The GUI (or user) communicates with the STAAD analysis engine through the STD input file. That input file is a text file consisting of a series of commands which are executed sequentially. The commands contain either instructions or data pertaining to analysis and/or design. The STAAD input file can be created through a text editor or the GUI Modeling facility. In general, any text editor may be utilized to edit/create the STD input file. The GUI Modeling facility creates the input file through an interactive menu-driven graphics oriented procedure.

Types of Structures:

A STRUCTURE can be defined as an assemblage of elements. STAAD is capable of

analyzing and designing structures consisting of frame, plate/shell and solid elements. Almost any type of structure can be analyzed by STAAD. A SPACE structure, which is a three dimensional framed structure with loads applied in any plane, is the most general. A PLANE structure is bound by a global X-Y coordinate system with loads in the same plane. A TRUSS structure consists of truss members which can have only axial member forces and no bending in the members.

A FLOOR structure is a two or three dimensional structure having no horizontal (global X or Z) movement of the structure [FX, FZ & MY are restrained at every joint]. The floor framing (in global X-Z plane) of a building is an ideal example of a FLOOR structure. Columns can also be modeled with the floor in a FLOOR structure as long as the structure has no horizontal loading. If there is any horizontal load, it must be analyzed as a SPACE structure.

Generation of the structure:

The structure may be generated from the input file or mentioning the co-ordinates in the GUI. The figure below shows the GUI generation method.

Material Constants:

The material constants are: modulus of elasticity (E); weight density (DEN); Poisson's ratio (POISS); co-efficient of thermal expansion (ALPHA), Composite Damping Ratio, and beta Angle (BETA) or coordinates for any reference (REF) point. E value for members must be provided or the analysis will not be performed. Weight density (DEN) is used only when self-weight of the structure is to be taken into account. Poisson's ratio (POISS) is used to calculate the shear modulus (commonly known as G) by the formula,

$$G = 0.5 \times E / (1 + POISS)$$

If Poisson's ratio is not provided, STAAD will assume a value for this quantity based on the value of E. Coefficient of thermal expansion (ALPHA) is used to calculate the expansion of the members if
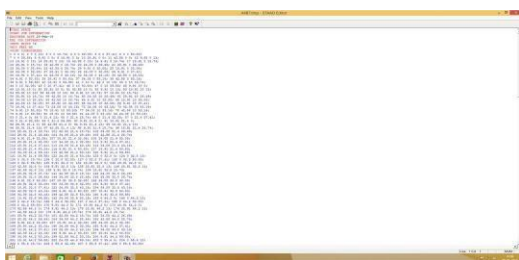

Figure 8 Staad input file

Temperature loads are applied. The temperature unit for temperature load and ALPHA has to be the same.

Supports:

Supports are specified as PINNED, FIXED, or FIXED with different releases (known as FIXED BUT). A pinned support has restraints against all translational movement and none against rotational movement. In other words, a pinned support will have reactions for all forces but will resist no moments. A fixed support has restraints against all directions of movement. Translational and rotational springs can also be specified. The springs are represented in terms of their spring constants. A translational spring constant is defined as the force to displace a support joint one length unit in the specified global direction. Similarly, a rotational spring constant is defined as the force to rotate the support joint one degree around the specified global direction.

Loads:

Loads in a structure can be specified as joint load, member load, temperature load and fixed end member load. STAAD can also generate the self-weight of the structure and use it as uniformly distributed member loads in analysis.

IV ANALYSIS OF G + 5 RCC FRAMED BUILDING USING STAAD.Pro

All columns = 0.50 * 0.50 m (until ground floor)
Columns at the ground floor: 0.8 * 0.8 m
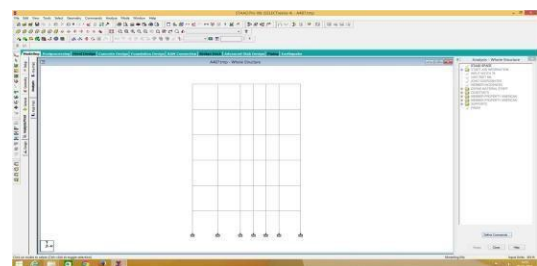
Figure 9 Elevation of the G+5 storey building

Physical parameters of building:

Length	=	45'
Width	=	62'

Height = 3.47*5 + 3*1 storeys @ 3.3m = 21.85m (1.5m parapet being non- structural for seismic purposes, is not considered of building frame height)Live load on the floors is 2kN/m2 Live load on the roof is 0.75kN/m2

Grade of concrete and steel used:

Used M25 concrete and Fe 415 steel

Generation of member property:

Generation of member property can be done in STAAD.Pro by using the window as shown above. The member section is selected and the dimensions have been specified. The beams are having a dimension of 0.5 * 0.3 m and the columns are having a dimension of 0.8 * 0.8 m at the ground floor and at the other top floors they are having a dimension of 0.5 * 0.5 m.

Supports:

The base supports of the structure were assigned as fixed.

The supports were generated using the STAAD.Pro support generator.

Materials for the structure:

The materials for the structure were specified as concrete with their various constants as per standard IS code of practice.

Loading:

The loadings were calculated partially manually and rest was generated using STAAD. Pro load generator. The loading cases were categorized as: Self-weight, Dead load from slab Live load, Wind load, Seismic load, Load combinations
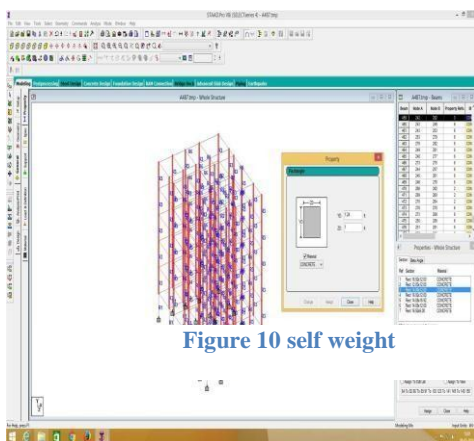

Figure 10 self weight

Self-weight:

The self-weight of the structure can be generated by STAAD. Pro itself with the self-weight command in the load case column.

Dead load from slab:

Dead load from slab can also be generated by STAAD. Pro by specifying the floor thickness and the load on the floor per sq m. Calculation of the load per sq m was done considering the weight of beam, weight of column, weight of RCC slab, weight of terracing, external walls, internal walls and parapet over roof. The load was found to be: 14.482 KN/sq m [terrace]

13.5 KN/sq m [typical floor]

14.37 KN/sq m [first floor]

V ESTIMATION AND COSTING

Before taking up any work for its execution, the owner or builder should have a thorough knowledge about the volume of work that can be completed within the limits of his funds or the probable cost that may be required to complete the proposed work.

It is therefore necessary to prepare the probable cost or estimate for the proposed work from its plan and specification.
Otherwise, it may so happen that the work has to be stopped before its completion due to the shortage of funds or of materials.

Besides the above, an estimate for any public construction work is required to be prepared and submitted beforehand so that sanction of necessary funds may be obtained from the authority concerned.

VI PURPOSE OF ESTIMATING:-

To ascertain the necessary amount of money required by the owner to complete then proposed work. For public construction work, estimates are required in order to obtain administrative approval, allotment of funds and technical sanction.

To ascertain quantities of materials required in order to programme their timely procurement. To procure controlled materials, if any, like cement, steel, etc. quantities of such materials are worked out from the estimate of the work and attached with the application for verification.

To calculate the number of different categories of workers that is to be employed to complete the work within the scheduled time of completion.

To assess the requirements of tool, plants and equipment required to complete the work according to the programmed.

To fix up the completion period from the volume of works involved in the estimate.

To draw up a construction schedule and

programmed and also to arrange the funds required according to the programming.

To justify the investment from benefit cost ratio.(for ideal investment ,this ratio should be more than one)

To invite tenders and prepare bills for payment.

An estimate for an existing property is required for valuation

LUMPSUM:

While preparing an estimate, it is not possible to work out in detail in case of petty items. Items other than civil engineering such items are called lump sum items or simply L.S.Items. The following are some of L.S. Items in the estimate.

➢ Water supply and sanitary arrangements.
➢ Electrical installations like meter, motor, etc.,
➢ Architectural features.

Contingencies and unforeseen items. In general, certain percentage on the cost of estimation is allotted for the above L.S. Items Even if sub estimates prepared or at the end of execution of work, the actual cost should not exceed the L.S. amounts provided in the main estimate.

VII WORK CHARGED ESTABLISHMENT:

During the construction of a project considerable number of skilled supervisors, work assistance, watch men etc., are employed on temporary basis. The salaries of these persons are drawn from the L.S. amount allotted towards the work charged establishment. That is, establishment which is charged directly to work. an L.S. amount of 1½ to 2% of the estimated cost is provided towards the work charged establishment.

ESTIMATION OF CONCRETE:

GROUND FLOOR						
Category	Count	Dimensions	Material	Volume(cu m)	Rupees/cu m	Cost(Rupees)
Column	1	1'5"x1'	RCC	0.395	3600	1422
Total columns	36	1'5"x1'	RCC	14.22	3600	51192
Column	1	1'x1'	RCC	0.278	3600	1000.8
Total columns	4	1'x1'	RCC	1.112	3600	4003.2
Beams	1	1'5"x1'	RCC	0.63	3600	2248
Beams	1	1'5"x1'	RCC	1.48	3600	5328
Beams	1	1'5"x1'	RCC	1.48	3600	5328
Beams	1	1'5"x1'	RCC	1.48	3600	5328
Beams	1	1'5"x1'	RCC	1.098	3600	3952.8
Beams	1	1'5"x1'	RCC	0.63	3600	2268
Beams	1	1'5"x1'	RCC	0.621	3600	2235.6
Beams	1	1'5"x1'	RCC	0.624	3600	2246.4
Beams	1	1'5"x1'	RCC	0.644	3600	2318.4
Beams	1	1'5"x1'3'	RCC	2.53	3600	9108
Beams	1	1'5"x1'3'	RCC	2.53	3600	9108
Beams	1	1'5"x1'3'	RCC	1.98	3600	7128
Beams	1	1'5"x1'3'	RCC	1.1	3600	3960
Beams	1	1'5"x1'3'	RCC	1.1	3600	3960
Beams	1	1'5"x1'3'	RCC	0.602	3600	2167.2
Beams	1	1'x1'	RCC	0.129	3600	464.4
Beams	1	1'x1'	RCC	0.129	3600	464.4
Beams	1	1'x1'	RCC	0.191	3600	687.6
Beams	1	1'x1'	RCC	0.0753	3600	271.08
Beams	1	6"x1'5'	RCC	0.325	3600	1170
Beams	1	1'x1'	RCC	0.1084	3600	390.24
Slab	1	6"	RCC	1246.84	3600	4488624
Total						4616374.12

Figure 11 Table 1 estimation of concrete

FIFTH FLOOR						
Category	Count	Dimensions	Material	Volume (cu m)	Rupees/cu m	Cost(Rupees)
COLUMN	1	1'3"x1'	RCC	0.386	3600	1392.2
TOTAL COLUMNS	36	1'3"x1'	RCC	13.92	3600	50119.2
COLUMN	1	1'x1'	RCC	0.309	3600	1114.04
TOTAL COLUMNS	4	1'x1'	RCC	1.237	3600	4456.17
BEAMS	1	1'3"x1'	RCC	0.725	3600	2610
BEAMS	1	1'3"x1'	RCC	1.79	3600	6444
BEAMS	1	1'3"x1'	RCC	1.82	3600	6552
BEAMS	1	1'3"x1'	RCC	0.56	3600	2016
BEAMS	1	1'3"x1'	RCC	1.33	3600	4788
BEAMS	1	1'3"x1'	RCC	1.33	3600	4788
BEAMS	1	1'3"x1'	RCC	1.79	3600	6444
BEAMS	1	1'3"x1'	RCC	0.579	3600	2084.4
BEAMS	1	1'3"x1'	RCC	0.566	3600	2037.6
BEAMS	1	1'3"x1'	RCC	0.57	3600	2052
BEAMS	1	1'3"x1'	RCC	1	3600	3600
BEAMS	1	1'3"x1'	RCC	1.33	3600	4788
BEAMS	1	1'3"x1'	RCC	1.79	3600	6444
BEAMS	1	1'3"x1'	RCC	0.59	3600	2124
BEAMS	1	1'3"x1'	RCC	0.796	3600	2865.6
BEAMS	1	1'3"x1'	RCC	0.778	3600	2800.8
BEAMS	1	1'x1'	RCC	0.32	3600	1152
BEAMS	1	1'x1'	RCC	0.129	3600	464.4
BEAMS	1	1'x1'	RCC	0.075	3600	270
BEAMS	1	1'x1'	RCC	0.108	3600	388.8
EXTERIOR WALLS	4	6"	Brick masonry	28.235	3000	84705
INTERIOR WALLS	14	4"	Brick masonry	26.28	3000	78840
DOORS	5	30"x80"	Wood	0.39	12500	4875
DOORS	10	Door interior single	Wood	0.571	12500	7137.5
WINDOWS	17	36"x48"	Wood	2.88	12500	36000
WINDOWS	8	36"x48"	Wood	0.89	12500	11125
WINDOWS	1	36"X48"	Wood	0.224	12500	2800
SLAB	1	6"	RCC	1246.84	3000	3740520
TOTAL						4087797.71

Figure 12 fifth floor

VIII ESTIMATION OF REINFORCEMENT

(a) Beams:

GROUND FLOOR BEAM REINFORCEMENT SHEDULE						
Type	Structural Material	Length	Volume (m³)	Rupees (kg)		Cost
1'5"x1'	Concrete, Cast-in-Place gray	23.5	0.013372		59	6193.2418
1'5"x1'	Concrete, Cast-in-Place gray	42.57	0.02604833		59	12064.28404
1'5"x1'	Concrete, Cast-in-Place gray	42.57	0.02599329		59	12038.79226
1'5"x1'	Concrete, Cast-in-Place gray	42.57	0.03643091		59	16872.97597
1'5"x1'	Concrete, Cast-in-Place gray	34.03	0.01703296		59	7888.815424
1'5"x1'	Concrete, Cast-in-Place gray	18.88	0.00646577		59	2994.621376
1'5"x1'	Concrete, Cast-in-Place gray	18.33	0.02320908		59	10749.2854
1'5"x1'	Concrete, Cast-in-Place gray	18.5	0.00783438		59	3628.493097
1'5"x1'	Concrete, Cast-in-Place gray	18.88	0.00696479		59	3225.742489
1'5"x1' 3'	Concrete, Cast-in-Place gray	56.59	0.07786827		59	36064.68925
1'5"x1' 3'	Concrete, Cast-in-Place gray	56.59	0.08171641		59	37846.95529
1'5"x1' 3'	Concrete, Cast-in-Place gray	44.15	0.02877422		59	13326.77999
1'5"x1' 3'	Concrete, Cast-in-Place gray	24.74	0.01075882		59	4982.947483
1'5"x1' 3'	Concrete, Cast-in-Place gray	24.74	0.01054469		59	4883.773174
1'5"x1' 3'	Concrete, Cast-in-Place gray	13.02	0.03679169		59	17040.07122
1'x1'	Concrete, Cast-in-Place gray	5.58	0.0020159		59	933.664085
1'x1'	Concrete, Cast-in-Place gray	5.58	0.00360378		59	1669.090707
1'x1'	Concrete, Cast-in-Place gray	7.77	0.00101235		59	468.8699025
1'x1'	Concrete, Cast-in-Place gray	3.66	0.00165474		59	766.392831
6"x1'5'	Concrete, Cast-in-Place gray	19.07	0.01885117		59	8730.919386
1'x1'	Concrete, Cast-in-Place gray	4.83	0.001159		59	536.79085
Total						202907.196

(c) Slabs:

SLAB REINFORCEMENT SHEDULE					
Type	Structural Material	Thickness	Volume (m³)	Rupees (kg)	Cost
150mm Foundation Slab	Concrete, Cast-in-Place gray	0.49	0.8426	59	390250.19
150mm Foundation Slab	Concrete, Cast-in-Place gray	0.49	0.8426	59	390250.19
150mm Foundation Slab	Concrete, Cast-in-Place gray	0.49	0.8426	59	390250.19
150mm Foundation Slab	Concrete, Cast-in-Place gray	0.49	0.8426	59	390250.19
150mm Foundation Slab	Concrete, Cast-in-Place gray	0.49	0.8426	59	390250.19
150mm Foundation Slab	Concrete, Cast-in-Place gray	0.49	0.8426	59	390250.19
Total					2341501.14

IX CONCLUSION

This paper provides guidelines to help project teams implement 3D and 4D modeling on building construction projects. We believe these guidelines will help project teams overcome the technical, procedural, and organizational challenges that are often a barrier to adopting these technologies. Specifically, the paper describes different approaches for assembling a project team to leverage these technologies, the modeling requirements for implementing 3D and 4D projects, the 3D and 4D modeling processes, the benefits and shortcomings of the process and technologies, the effect of these technologies on the project's outcome, and the lessons learned.

We have found that 3D and 4D modeling can have a significant impact on the execution of a project. The benefits of 3D and 4D modeling are well documented and include: increased productivity, elimination of field interferences, increased pre-fabrication, less rework, fewer requests for information, fewer change orders,

less cost growth, and a decrease in time from start of construction to facility turnover. We also believe that the use of these tools will help project teams minimize risk and attract quality team members to construction projects, which will be critical in the coming years as the industry copes with the realities of a tight labor market.

To capitalize on the benefits offered by 3D and 4D technologies, owners, designers, and builders of facilities will need to develop new skills and implement organizational changes. Owners will need to bring a project team together early in the project. Designers will need to focus more on the overall design and coordination of design tasks and less on detailed design. General contractors will need to learn how to manipulate 3D CAD models, work more closely with the designers during design development, and provide input on how to model designs in 3D so that the CAD models are more usable by constructors. Subcontractors will also need to learn design software, as they will be performing more detailed design, working more closely with the architects and engineers through the design process, and addressing coordination issues early in design development.

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4. Reinforced concrete Structures by A.K. Jain and B.C. Punmia for design of beams, columns and slab.

5. Fundamentals of Reinforced concrete structure by N. c. Sinha

Code Books:

1. IS 456-2000 code book for design of beams, columns and slabs.

2. SP-16 for design of columns.

3. IS 875 part-1 & part-2 & part-3 code book for live loads, dead loads, wind loads.