DESIGN OF SILT+3 FLOOR BUILDING USING STAAD Pro

ABSTRACT

This project describes design and analysis of a S+3 floor building using Staad pro. The design and analysis will be carried out with Staad pro software. The main consideration for designing a building is the structural design which plays a major role for specifying the shape and size of the structural members which are designed for different loads and moments acting on the structure. These loads and moments are to be distributed to each and every structural members like beams which transfer loads to the columns and then transferred to footings.

STAAD Pro is an advanced software developed by "BENTLEY" which is used for designing structural elements in various aspects with accurate results saving the time.

My project is to DESIGN OF SILT +3 FLOOR BUILDING USING STAAD Pro considering all loading conditions using Stand pro.

Key words: Columns ,Beams, building design, floors, roofs, Mechanism, Civil Engineering

1. INTRODUCTION:

1.1 General:

A man-made structure with a roof and walls that stands more or less permanently in one location is referred to as a building. Buildings occur in a range of forms, sizes, and purposes and have been altered throughout history for a variety of reasons, including the availability of construction materials, weather conditions, land values, ground conditions, specialised applications, and aesthetic considerations.

1.2 SILT MATERIAL:

Typically consisting of shattered quartz grains, silt is a fine-grained substance ranging in size from sand to clay and with a consistency between the two. Silt may exist as soil (typically in a mixture with sand or clay) or as sediment suspended in water, depending on its form. When dry, silt often has a floury texture to it, and when wet, it lacks flexibility. Silt may also be perceived as granular by the tongue when it is put on the front teeth (even when mixed with clay particles).

1.3 Slabs:

A slab is a structural element that is used to construct flat and functional surfaces such as floors, roofs, and ceilings. Slabs are used in the building of many different kinds of constructions.

1.3.1 Load Transfer Mechanism in Slabs:

The transmission of forces from the slab to the beams might take place in one direction or in two directions. The geometrical dimensions of the slab are critical to the overall system's performance.

1.4 Beams:

Vertical loads, shear stresses, and bending moments are all accommodated by the beam, which is a horizontal structural element that spans the width of the structure. In response to the loads applied to the beam, reaction forces are generated at the beam's support points, as seen in the illustration below.

Fig.1: Reinforced concrete beam **Fig.2: Transfer loads from beams to column**

1.4.1 Load Transfer Mechanism in Beams:

It is necessary to transport the weights applied throughout their length to their end points before the weights may be transferred to columns or other structural components that sustain the weights throughout their length.

1.5 Columns:

When it comes to structural engineering, a column is a vertical structural element that is used to support loads that are primarily in compression. It is regarded as the most significant structural component of a building since the strength of a building's columns is directly proportionate to the overall safety of the structure.

Fig 3: Reinforced concrete column **Fig 4: Load transfer mechanism from column to footing**

1.5.1 Loads Transfer Mechanism in column:

In order to accommodate all the other components, the weight has been moved from them to the columns, which are supported by a foundation. Later, the column-to-footing axial force will be transferred into the footing via the column necks that are located next to and inside the footing.

1.6 Footings:

Footings are structural components that transfer the weight of the whole superstructure to the underlying earth underneath the building. They are made of concrete or steel.

1.6.1 Load Transfer Mechanism in Footing:

The soil serves as the foundation for the footing. In touch with the footings, all of the forces that come into contact with them will be transmitted to the earth. The carrying capability of the soil will determine how well it will handle these loads.

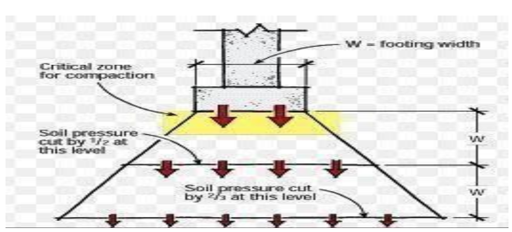

Fig. 5: Dissipating loads of footing in underlying soil

2. DESIGN METHOD:

2.1 WORKING STRESS METHOD:

Traditionally, utilised design approaches were used not just for reinforced concrete structures, but also for structural steel and wood structures, in addition to the design of other kinds of building materials. The approach is predicated on the assumptions that structural materials behave in a linear elastic manner and that adequate safety may be attained by suitably managing the stresses in the material induced by the expected "working loads" on the structural members. It is claimed that the assumption of linear elastic behaviour is validated by the fact that the stated permitted stresses are kept at a level that is much lower than the material's maximum strength.

2.2 ULTIMATE LOAD METHOD:

After years of growing awareness of the shortcomings of the working stress method in reinforced concrete design, combined with an improved understanding of the behaviour of reinforced concrete under ultimate loads, the ultimate load method of design emerged as a viable alternative to the working stress method in reinforced concrete design.

2.3 LIMIT STATE DESIGN:

A civil engineering designer's responsibility is to guarantee that the buildings and facilities he develops are appropriate for their intended use, (ii) safe, and (iii) cost-effective and long-term in nature. As a result, one of the most important roles of the designer is to ensure the safety of the product. However, determining how safe a suggested design would be during the design stage may be challenging at the early stages of development.

2.3.1 IMPORTANCE OF LIMIT STATE DESIGN:

Through consideration of all conceivable limit states, the limit state technique employs a multiple safety factor structure that assists in providing appropriate safety at ultimate loads as well as acceptable serviceability at service loads.

- It is possible to define the limit state function for calculating the failure probability as (7.28 g (X) = R L, where R is the platform capacity in terms of the greatest lateral load that the platform can sustain before failing or collapsing, and L is the failure probability.
- The Working Stress Method treats dead and live loads equally, i.e., the factor of safety would be the same regardless of the kind of load being considered in the calculation (dead or live). Take the entire load that you anticipate on the structure and apply a single factor of safety to the members (say, 1.5) regardless of the type of the load in this situation.
- It is recognised that loads are inherently unpredictable and give a significantly greater factor of safety to live loads (we raise them by 1.5–1.6), although it acknowledges that dead loads are substantially closer to what we compute (we increase them by 1.5–1.6). (We only multiply dead loads by 1.2).
- The Limit State Method also takes into account the uncertainty associated with various failure types. The flexural capacity of a concrete beam, for example, is generally predictable; as a result, we can rely on 90% of the theoretical value for this parameter.When it comes to shear in concrete, however, the outcome is far more unpredictable, and we can only rely on 70% of the value.

- The working stress approach is characterised by the fact that the members are never allowed to exceed their elastic range. As a result, the maximum stress that a member can withstand is restricted, and the plastic range is not explored at all.
- When applied to a member beyond its initial yielding, the limit state approach takes advantage of the member's ultimate strength and allows for some plastic deformation.

3. BUILDING ANALYSIS USING STADD Pro:

3.1 STAAD Pro:

This structural analysis and design software tool, which was first created by Research Engineers International in 1997 and is now extensively used across the globe, was developed by Research Engineers International in 1997. Research Engineers International (REI) was acquired by Bentley Systems in the fourth quarter of 2005, and its researchers became part of the Bentley Systems team. Structural systems analysis and design software is available. Around the globe, STAAD Pro is one of the most frequently used structural analysis and design software programmes, with more than a million users in more than 100 countries. The software is compatible with more than 90 design guidelines from across the world for steel, concrete, wood, and aluminium buildings, as well as with other materials.

The use of several types of analysis is conceivable, ranging from the most fundamental static analysis to more contemporary approaches such as p-delta analysis, geometric nonlinear analysis, pushover analysis (static-nonlinear analysis), or buckling analysis, among others. For example, there are several different types of dynamic analysis methodologies that may be used in conjunction with it, ranging from time history analysis to response spectrum analysis, and they are included below. Response spectrum analysis capabilities are offered for a variety of international code-specific spectra, in addition to the ability to analyse response spectrum for user-defined spectra and a variety of other spectra.

Also interoperable with programmes like RAM Connection, Auto PIPE, SACS, and a range of other engineering design and analysis software, it facilitates even more cooperation across the numerous disciplines involved in a project. STAAD Pro is a free software package that may be obtained by visiting the STAAD website and downloading the programme. The structural analysis and design software STAAD can be used for a wide range of projects, including everything from towers and tunnels to metro stations, water and wastewater treatment facilities, and other similar structures. STAAD can also be used for research and design of plants, buildings, and bridges, among other things.

3.1.1 Advanced Concrete Design :

The Advanced Concrete Design process gives STAAD Pro models have direct access to the RCDC programme, allowing them to make use of its powerful features. This is a stand-alone programme that is not connected to the STAAD in any way. environment, but it requires the use of a model and the findings of an appropriate study. Typically, beams and columns should be used to construct the structure (plates are currently not supported). A variety of structural elements, such as pile caps and footings, column and wall designs, as well as beams and slabs, may be created with RCDC.

Each design created in RCDC is kept and shown when RCDC is re-entered, enabling previous designs to be recalled and/or resumed at any point throughout the project's duration. Extensive, detailed drawings and BBS of high quality may be created on demand, and they are ready for transmission to the fabrication factory for use in the manufacturing process.

3.1.2 Advanced Slab Design:

Because it is a fully integrated tool that functions inside the STAAD PRO environment, it enables sophisticated slab design to be done within the STAAD PRO environment. It is possible to define concrete slabs, and the data may be sent to RAM Concept for further processing. RAM Concept provides data that includes geometry, section and material characteristics, loads and combination information, and analysis conclusions, all of which are contained in the data delivered.

3.1.3 Earthquake Mode:

For the most part, these fundamental requirements have been set to ensure that structures can endure seismic loads without collapsing, that they can do so without sustaining unacceptable damage, and that they can continue to function even after being exposed to an earthquake. In order to assess whether or not the structure conforms to the essential geometric standards defined in Eurocode 8, it is required to use this STAAD PRO process (EC8). This workflow is in addition to the conventional post-processing workflow, which is responsible for generating the various results of the study and is described in more detail below. In order to advance to the design phase of the project, you will need to conduct these inspections in order to get a "feel" for the structure. These inspections are not mandatory.

Table: 1: Statement of the project:

Structural Part	Dimensions
Type of building	Commercial building
Plan dimensions	12mx16m
Number of floors	3
Length in X-direction	12m
Length in Y-direction	16m
Floor to floor height	3m
Bottom floor height	2m
Total height of building	14m
Slab thickness	125mm
Column size	300x600mm
Beam size	300x600mm
Zone	II
Seismic intensity	Low
Importance factor(I)	1.5
Response reduction factor	3 for SMRF
Soil type	TYPE II (Medium soil)
Grade of concrete	M25
Reinforcement	Fe500

Unit weight of concrete	25kN/m3

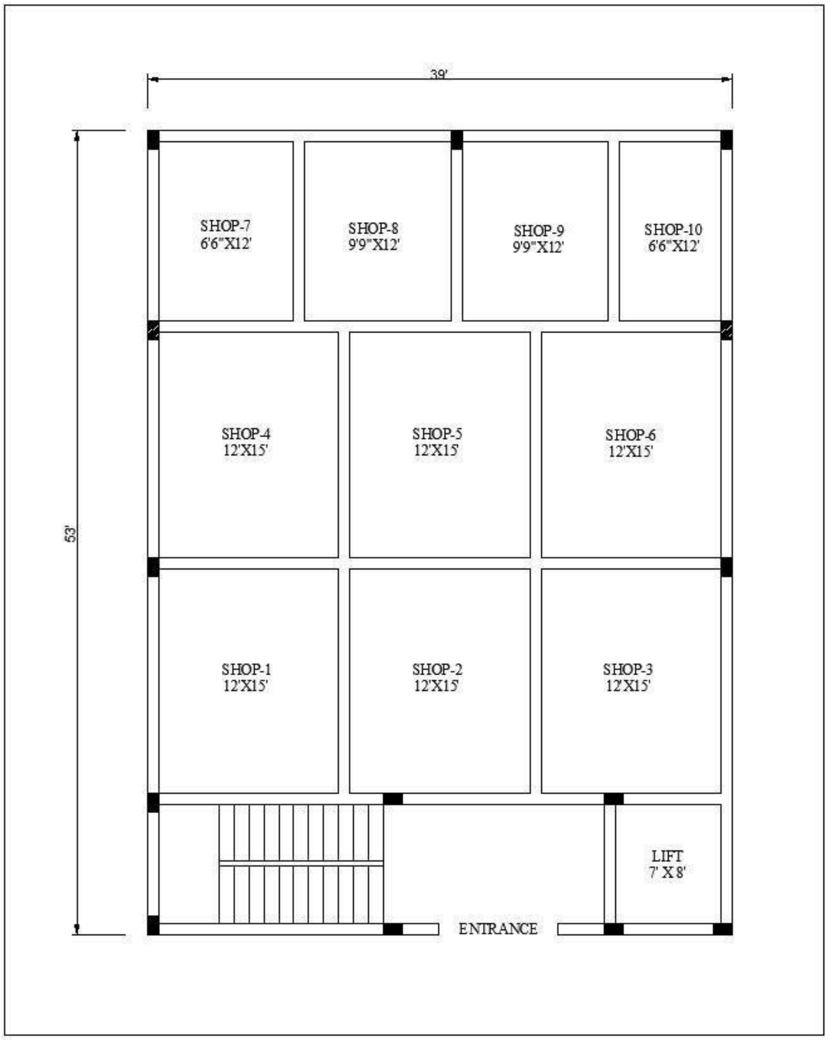

Fig 6: Building plan

3.2 STADD Pro MODEL:

Fig 7: Building model (isometric view)

3.3 Behavior of structure under lateral loads:

In recent years, there has been a substantial increase in the number of tall buildings, both residential and commercial, with the current trend moving towards projects that are both taller and slender in appearance, as well as more energy efficient. So the effects of lateral loads, such as wind forces, earthquake forces, blast pressures, and other similar events, are becoming more relevant, and nearly every designer is presented with the task of providing adequate strength and stability to withstand lateral loads. Because prior building designers frequently planned for vertical loads first, and then analysed the finished design for lateral loads as a last-minute addition, this is a novel concept. In this situation, the lateral loads were validated first, and the vertical loads were planned first.

3.3.1 Types of loads:

Vertical and horizontal loads are applied to the structures. The components of structures are planned just for vertical loads at the preliminary design stage. When the impact of lateral load is taken into consideration, an effective system should not need an increase in the size of the members in the first place. Such designers are referred to as "premium-free" designers, and their goals may vary from one another.

3.4 LOAD APPLICATION:

Fig 8: Application of self weight of the structure and wall load

Fig 9: Application of Wind loads on all sides

Fig 10: Application of floor load on residential slot

Fig 11: Application of seismic load

4. RESULTS AND DISCUSSION:

4.1 : Displacement summary:

			Horizontal	Vertical	Horizontal	Resultant	Rotational		
	Node	L/C	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
Max X	125	7 LOAD CASE 7	9.785	0.059	0.269	9.789	0	0	0
Min X	125	9 LOAD CASE 9	-9.785	-0.059	-0.269	9.789	0	0	0
Max Y	39	9 LOAD CASE 9	-3.482	0.549	0.094	3.526	0	0	0
Min Y	19	3 1.5 (DL + LL)	0.043	-37.099	0.684	37.106	0	0	-0.002
Max Z	155	8 LOAD CASE 8	-0.812	-0.098	12.707	12.733	0	0	0
Min Z	155	10 LOAD CASE 10	0.812	0.098	-12.707	12.733	0	0	0
Max rX	124	3 1.5 (DL + LL)	-0.063	-4.792	4.637	6.669	0.003	0	0
Min rX	107	3 1.5 (DL + LL)	0.95	-18.756	2.325	18.923	-0.006	0	0.003
Max rY	141	3 1.5 (DL + LL)	1.521	-8.352	3.9	9.342	-0.001	0	0.001
Min rY	129	3 1.5 (DL + LL)	0.289	-24.704	4.049	25.036	0	0	-0.004
Max rZ	105	3 1.5 (DL + LL)	0.719	-17.882	2.332	18.047	0	0	0.006
Min rZ	101	3 1.5 (DL + LL)	0.606	-13.176	2.419	13.409	0	0	-0.006
Max Rst	19	3 1.5 (DL + LL)	0.043	-37.099	0.684	37.106	0	0	-0.002

CONCLUSION:

- Our investigation included carrying out the analysis on various structural components using the steadpro programme and discovering the significance of the findings for different loads and combinations of loads.
- It has been noticed that correct findings result in a considerable reduction in the time for analysis.
- All of the structural components passed all of the tests that were performed on them, including the maximum relative displacements, responses, shearforce, and bending moments that were performed on them.
- As a result, it is possible to infer that the structure has met the criteria for the ultimate limit state and serviceability limit state conditions.
- Strength and stiffness are more essential factors in high-rise structures than other parameters, such as weight. As a result, bracing systems are used to improve the performance of each of these criteria.
- In order to include sustainability concerns into the selection and execution of ground renovation methods as effectively as possible,
- Research and development of biogeochemical approaches for soil stabilisation that are feasible, cost-effective, and ecologically safe are being researched and developed.
- The development of data bases for the variability of soil and material characteristics, which will be used in the design of ground improvement and soil stabilisation projects, is underway.

REFERENCE:

- Dr. Ashokkumar (2017) designed a G+3 hospital building using substitute frame method in STAAD.Pro.
- Varalakshmi V (2014) analyzed a G+5 storey residential building and designed the various components like beam, slab, column and foundation.
- Geethu (2016) made a comparative study on analysis and design of multi storied building by STAAD.Pro and ETABS softwares.
- Prakash Sangamnerkar (2015). Static and dynamic behaviour of reinforced concrete framed regular building.
- Indian Standard Code of practise for Dead loads , Imposed loads , Wind loads IS 875 1987 (Part 1, 2 & 3)
- IS 456 – 2000 Design code for RCC Structures : Indian standard plain and reinforced concrete – code of practice
- Ramamurutham.S (2016) " Structural Analysis", Dhanpat Rai Publishers,New Delhi.