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ANALYSIS AND DESIGN OF RC BEAM UNDER DIFFERENT END CONDITIONS USING STAAD-PRO

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ABSTRACT

Structural designers especially in India use STAAD software to execute the structural analysis, but for the design purpose still manual calculations and excel spread sheets are being used. It leads to cumbersome and time consuming process to obtain analysis results from STAAD Pro to design calculations, hence to automate this process an MS Excel spread sheet has been developed. The present project deals with the analysis and design of beams and columns under different end conditions . The dead load &live loads are applied and the design for beams, columns is obtained from STAAD Pro with its new features surpassed its predecessors, and compotators with its data sharing capabilities with other major software like AutoCAD. We conclude that staad pro is a very powerful tool which can save much time and is very accurate in Designs. Thus it is concluded that staad pro package is suitable for the analysis and design of beams and columns..

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1. INTRODUCTION

Reinforced concrete is the most widely used material, widely used for multifarious structural applications in the world today and it has the unique distinction of being the universally suitable material to be used in different types of environment conditions. Reinforced concrete is a composite material comprising concrete and steel and the versatility of the material is such that it can be used at site in cast insitu form, precast to the required size in the factory and it can be designed to have suitable strength by varying the content of the concrete ingredient. The worldwide consumption of this unique material exceeds several billion cubic meters per year and with rapid innovations in the quality of concrete and steel.

1.1 Beam

A beam is a structural element that primarily resists loads applied laterally to the bea
m's axis. Its mode of deflection is primarily by bending. The loads applied to the beam result in reaction forces at the beam's supports points. The total effect of all the forces acting on the beam is to produce shear forces and bending moments within the beam, that in turn induce internal stresses, strains and deflections of the beam. Beams are characterized by their manner of support, profile (shape of cross-section), length, and their material.

Column

A column or pillar in architecture and structural engineering is a structural element that transmits, through compression, the weight of the structure above to other structural elements below. In other words, a column is compression member. The term column applies especially to a large round support (the shaft of the column) with a capital and base pedestal which is made of stone or appearing to be so. A small wooden or metal support is typically called a post and supports with a rectangular or other non-round section are usually called piers. For the purpose of wind or earthquakes engineering, columns may be designed to resist lateral forces. Other compression members are often termed ―columns because of the similar stress conditions.

Analysis

Analysis is a procedure to find information and a better idea about the engineering system. This helps to decide the parameters of the system i.e. design. It means that analysis is done before design. An example would be the analysis of a structural system where you try to find out the forces and moments in a structure (let's say a beam) so that you can design the members to be adequate enough to take the stresses that are induced in the structure because of the forces.

Design

Design is a term that is often used in engineering which refers to deciding on the parameters of an engineering system by performing calculations or using software tools. That engineering system could be anything ranging from a bridge to a water treatment plant. These parameters can be related to various field studies, so we can have structural design or hydraulic design or others.

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There could be overlapping of the same parameter and that's where designing a system holistically comes into picture.

About Staad.pro

STAAD.Pro is a structural analysis and design computer program originally bought by Bentley systems. It is one of the most widely used structural analysis and design software

products worldwide. The commercial version of STAAD. Pro supports over 90 international steel, concrete and timber design codes. The structures- buildings, bridges, towers, transportation, industrial and utility structures including culverts, petrochemical plants, tunnels, piles can be analysed and designed. It helps structural engineers automate their tasks by removing the tedious and long procedures of the manual methods and allows analysing and designing virtually any type of structure. The following list represents the capabilities of this software system,

1. Analyse gravity and lateral load design.
2. Check designs for cold-formed sections.
3. Design and analyse with finite elements.
4. Design and analyse structural models.
5. Design beams and columns and walls.
6. Generate design loads and load calculation.
7. Integrate slab, foundation and steel connections design.

2. OBJECTIVES

The following are the objectives of present work,

1. Analysis and Design of beam and column manually by referring IS: 456-2000 and SP: 16.
2. Analysis and Design of beam and column in STAAD.Pro.
3. Comparing the results of both manual calculation and STAAD.Pro.
4. Detailing in AUTOCAD or STAAD.Pro.

3. METHODOLOGY

1. Beam and Column is analysed and designed manually as per IS 456:2000 Plain and Reinforced Concrete Code of Practice and SP: 16.
2. Beam and Column is analysed and designed using STAAD. Pro software
3. Beam and column are designed under different conditions.
4. Comparing the results of manual calculation and STAAD. Pro.
5. Detailing of drawings in AUTOCAD.

4. RESULTS AND DISCUSSIONS

In this paper we have analyzed the beam under different end conditions. After analyzing the beams we have designed based on analysis. The analysis and design are done using the STAAD.Pro, below tables are the results obtained for different end conditioned beam,

Simply Supported Beams

SL. No	BEAM No	SIZE (mm)	LOAD(udl) kN/m	Max SF(kN)	Max BM(kNm)
1	B1	200*400	10	25.655	25.65
2	B2	250*500	15	38.836	38.836
3	B3	300*600	20	52.72	52.72

Table 1: Analysis Result of Simply supported beam

SL. No	BEAM No	SIZE (mm)	LOAD (udl) kN/m	Area of reinforcement		Shear reinforcement
				tension	compression	
1	B1	200*400	10	2 # 12mmφ	2 # 12mmφ	6mm dia @ 255mm c/c
2	B2	250*500	15	3 # 12mmφ	3 # 12mmφ	8mm dia @ 300mm c/c
3	B3	300*600	20	3 # 16mmφ	2 # 16mmφ	8mm dia @ 300mm c/c

Table 2: Design Result of Simply supported beam

Fixed beam

SL. No	BEAM No	SIZE (mm)	LOAD(udl) kN/m	Max SF(kN)	Max BM(kNm)
1	B1	200*400	10	25.655	17.103
2	B2	250*500	15	38.836	25.89
3	B3	300*600	20	52.72	35.149

Table 3: Analysis Result of Fixed beam

SL. No	BEAM No	SIZE (mm)	LOAD (udl) kN/m	Area of reinforcement		Shear reinforcement
				tension	compression	
1	B1	200*400	10	2 # 12mmφ	2 # 12mmφ	8mm dia @ 275mm c/c
2	B2	250*500	15	3 # 12mmφ	3 # 12mmφ	8mm dia @ 300mm c/c
3	B3	300*600	20	4 # 12mmφ	4 # 12mmφ	8mm dia @ 300mm c/c

Table 4: Design Result of Fixed beam

Cantilever beam

SL. No	BEAM No	SIZE (mm)	LOAD(udl) kN/m	Max SF(kN)	Max BM(kNm)
1	B1	250*500	10	57.67	115.342
2	B2	300*600	15	85.447	170.89
3	B3	350*700	20	114.64	229.271

Table 5: Analysis Result of Cantilever beam

SL. No	BEAM No	SIZE (mm)	LOAD (udl) kN/m	Area of reinforcement		Shear reinforcement
				tension	compression	
1	B1	250*500	10	2 # 25mmφ	2 # 25mmφ	8mm dia @ 300mm c/c
2	B2	300*600	15	3 # 20mmφ	2 # 20mmφ	8mm dia @ 300mm c/c
3	B3	350*700	20	3 # 20mmφ	2 # 20mmφ	8mm dia @ 255mm c/c

Table 6: Design Result of Cantilever beam

Continuous beam under different end condition:

SL. No	End condition	SIZE (mm)	LOAD(udl) kN/m	Max SF(kN)	Max BM(kNm)
1	Simple support at ends	300*600	20	40.78	32.23
2	Fixed ends	300*600	20	32.72	21.81
3	Over hanging	300*600	20	40.9	32.72

Table 7: Analysis Result of Continuous beam under different end condition

SL. No	End condition	SIZE (mm)	LOAD (udl) kN/m	Area of reinforcement		Shear reinforcement
				tension	compression	
1	Simple support at ends	300*600	20	3 # 16mmφ	2 # 16mmφ	8mm dia @ 300mm c/c
2	Fixed ends	300*600	20	3 # 16mmφ	2 # 16mmφ	8mm dia @ 300mm c/c
3	Over hanging	300*600	20	3 # 16mmφ	2 # 16mmφ	8mm dia @ 300mm c/c

Table 8: Design Result of Continuous beam under different end condition

5.1 Simply Supported Beam:

SL. No	BEAM No	SIZE (mm)	LOAD (udl) kN/m	Staad Results		Manual Results	
				Max SF (kN)	Max BM (kNm)	Max SF (kN)	Max BM (kNm)
1	B1	200*400	10	25.655	25.65	25.76	25.76
2	B2	250*500	15	38.836	38.836	39.008	39.008
3	B3	300*600	20	52.72	52.72	52.97	52.97

Table 9: Analysis Result of staad pro and manual of simply supported beams

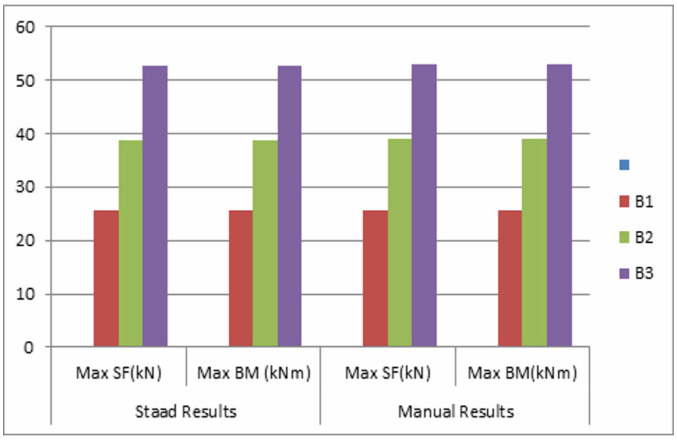

Chart 1: Comparison of results of manual and staad pro of simply supported beam

Fixed Beam:

SL. No	BEAM No	SIZE (mm)	LOAD (udl) kN/m	Staad Results		Manual Results	
				Max SF (kN)	Max BM (kNm)	Max SF (kN)	Max BM (kNm)
1	B1	200*400	10	25.655	17.103	25.76	17.173
2	B2	250*500	15	38.836	25.89	39.008	26.005
3	B3	300*600	20	52.72	35.149	52.97	35.31

Table 10: Analysis Result of staad pro and manual of fixed beam

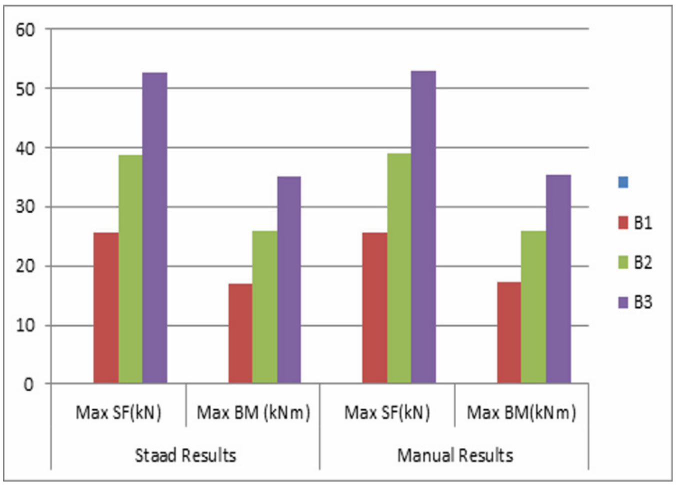

Chart.2: Comparison of results of manual and staad pro of fixed beam

Cantilever Beam

SL. No	BEAM No	SIZE (mm)	LOAD (udl) kN/m	Staad Results		Manual Results	
				Max SF (kN)	Max BM (kNm)	Max SF (kN)	Max BM (kNm)
1	B1	200*400	10	57.67	115.342	58.016	116.032
2	B2	250*500	15	85.447	170.89	85.94	171.88
3	B3	300*600	20	114.64	229.271	115.308	230.616

Table 11: Analysis Result of staad pro and manual of cantilever beam

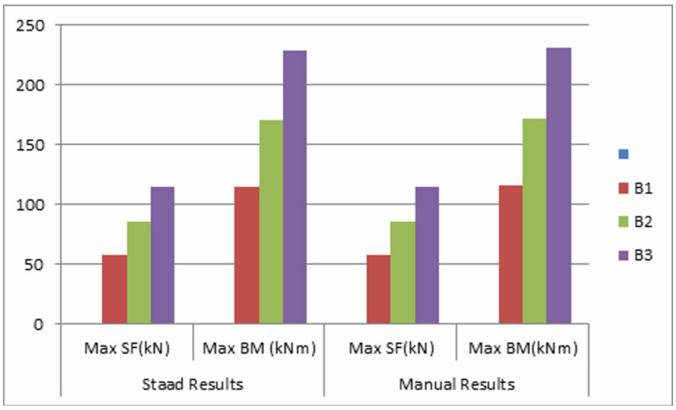

Chart.3: Comparison of results of manual and staad pro of cantilever beam

SL. No	End condition	SIZE (mm)	LOAD (udl) kN/m	Staad Results		Manual Results	
				Max SF (kN)	Max BM (kNm)	Max SF (kN)	Max BM (kNm)
1	Simple support at ends	300*600	20	40.78	32.23	41.215	32.97
2	Fixed ends	300*600	20	32.72	21.81	32.97	21.98
3	Over hanging	300*600	20	40.9	32.72	41.2125	32.97

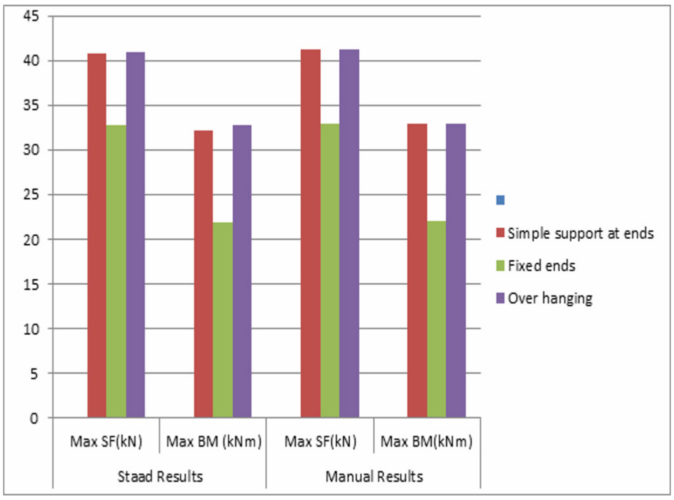

Chart.3: Comparison of results of manual and staad pro of continuous beam under different end conditions

6. CONCLUSION

In our project we concluded the following points,

1. We came across three methods of designing RCC structures (Working stress method, Ultimate method, and Limit state method) out which the limit state method gave an adequate section to satisfy strength and serviceability criteria.
2. The detailing of reinforcement is made as per IS-Code provision which provides ductility of the structure and hence better performance.
3. Initially the dimensions of Beams were assumed; the maximum percentage reinforcement in all structural elements is less than IS specifications.
4. All Analysis and Design are checked to satisfy the serviceability criteria and hence provided dimensions of all structural components are adequate.
5. Analysis and Design of Beams using STAAD.Pro have been accomplished. It reduces time, as compare to manual calculation for design of Beam and Column elements of the project.

7. FUTURE SCOPE

1. In future automation of the design process for Beam elements and optimization of RC elements can be carried out.
2. STAAD.Pro V8i advanced software which provides us a fast, efficient, easy to use and accurate platform for analysing and designing structures.
3. Using STAAD.Pro accurate results can be obtained for any end conditions, while in manual calculation it is tedious process.
4. STAAD.Pro gives the estimate quantity for the particular structure after the analysis and design. So that the manual calculation can be reduced.

This project can be further used to know the economic structures by comparing the quantity

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