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Use Of AI Tools To Design A Structure And Compare With Conventional Software

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Abstract: The project evaluates two architectural design methods which use artificial intelligence tools and traditional engineering software. STAAD.Pro was used for structural analysis while Microsoft Excel was utilized for calculation tasks. The development team created an AI chatbot using Chatbase technology to support design operations. The study assessed three main factors which included accuracy and efficiency and design time requirements. The findings demonstrate that AI technology boosts work efficiency however traditional software remains essential for conducting detailed analysis and validating.

Index Terms - Structural Engineering, Conventional Software, Chatbase, Chatbot.

INTRODUCTION

The importance of structural design in engineering, which protects structures from damage while ensuring their structural integrity throughout their entire lifespan, establishes its value. The absence of proper design will result in structural failures and reduced lifespan of materials. Engineers use STAAD.Pro software for structural analysis and they rely on Excel to perform their calculations and manage their data. The traditional method requires that. The introduction of AI technology has created new tools which offer assistance to users. Chatbase can analyze data and create design recommendations while it also performs automated mathematical calculations. The system offers potential benefits for improving speed yet its current dependability remains difficult to assess. The project involves testing AI capabilities to design structures which will be evaluated against established software design methods. We will evaluate the system by testing its accuracy and usability while assessing its performance and operational efficiency. The research aims to determine whether AI technology enables engineers to do their work more efficiently without compromising safety standards. The process of comparing these two methods will reveal their advantages while demonstrating how AI technology has limitations when applied to conventional systems. The subject becomes complicated when we attempt to understand it. Some people probably think AI will take over soon, others say stick to what works. The study requires us to examine the way these tools interact with each other.

LITERATURE SURVEY

1. Authour : Alexander Nikitin & Sergey Sinenke, 2024.

The authors of the article consider what features appear when using artificial intelligence (AI) in the generative design of construction facilities. Every day artificial intelligence becomes more and more important in various fields of human activity. One of the areas of activity in which AI is actively being implemented is construction, namely digital (BIM) and generative (GD) building design.

2. Authour : Hao Xie, et al, 2025.

The author explains that the use of Artificial Intelligence (AI) in structural engineering has increased rapidly in recent years. Engineers now use AI technology to create structural designs which they can analyze and verify their results through new methods. The author reviewed 134 research papers about AI applications in structural design. The research shows that AI techniques enable engineers to create structural designs which meet both optimization requirements and code standards.

3. Author : Mohammed Hamza Momade, et al, 2021.

The author conducts an extensive study of 165 research articles from Elsevier's Scopus database to examine how artificial intelligence (AI) tools function in construction operations. The research identifies various AI tools by explaining their functions through different application domains and their use in specific regions.

4. Author : Sanggook Kim, et al, 2019.

The author demonstrates through his literature survey that engineering problems present extreme difficulty because they require experts from different fields to work together on multiple objectives in designing extensive systems which exceed human and machine computational abilities. The author demonstrates that recent machine learning developments now enable humans and machines to work together through a new system which he named hybrid intelligence.

5. Author : Mingshu Li, et al, 2024.

The study presents an AI-based automated design framework as a solution to the complicated and time-intensive civil engineering design processes established by traditional methods. The authors introduce their design process optimization model through the combination of a Markov Decision Process and reinforcement learning techniques. The AI agent successfully created viable and optimal solutions for the planar truss bridge design by solving multiple design restrictions. The study demonstrated that the system achieved 12% better design precision and 88% faster computational speed than traditional techniques. The research demonstrates how AI techniques can significantly enhance civil engineering design processes through improved speed and accuracy and automation capabilities.

6. Author : Shrikant M. Harle, 2017.

The study investigates how to design and evaluate multi-storey buildings by using traditional structural analysis software. The authors used STAAD.Pro for structural analysis and seismic evaluation, where parameters such as shear force, bending moment, deflection, and reinforcement details were obtained. The MATLAB programming language was used to create design patterns for structural components which include slabs and beams and columns and footings to check design calculations. The combination of commercial software and programming tools is shown to provide precise structural design results according to the study.

7. Author : K. Surender Kumar, et al, 2024.

This study discusses the structural analysis and design of a multi-storey building with the objective of achieving efficiency, safety, and long-term serviceability. The authors focus on accurate load case generation, load combinations, support reactions, and reinforcement detailing of beams and columns. The analysis evaluates whether structural members satisfy design requirements under applied loads. The case study is based on an ongoing building project in Hyderabad and follows IS 456:2000 and SP 16, highlighting the importance of proper analysis and code compliance in multi-storey building design.

8. Author : Dr. A.K. Chitkeshwar, 2024.

The study analyzes how Machine Learning (ML) Deep Learning (DL) and Artificial Intelligence (AI) technology affects different engineering processes used to study structures and build designs. Existing research shows that these technologies have strong potential in areas such as structural health monitoring performance evaluation and design optimization. ML combined with IoT technology enables continuous structural monitoring which leads to better predictions of building durability and performance. Through its capacity to optimize multiple design factors ML-based multi-objective optimization helps designers

achieve a balance between project expenses and safety requirements. The sector continues to face two substantial problems which include restricted access to data and difficulties in validating various models. The study reveals that AI technologies require additional research and educational programs to achieve effective implementation across the field of structural engineering.

METHODOLOGY

1. PRELIMINARY ANALYSIS

The structural analysis process requires a reinforced concrete (RCC) building structure as its primary analysis and design framework.

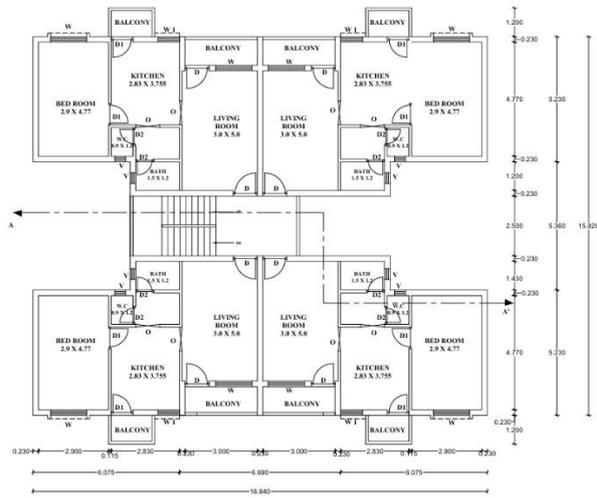


Fig.1. Architectural Plan

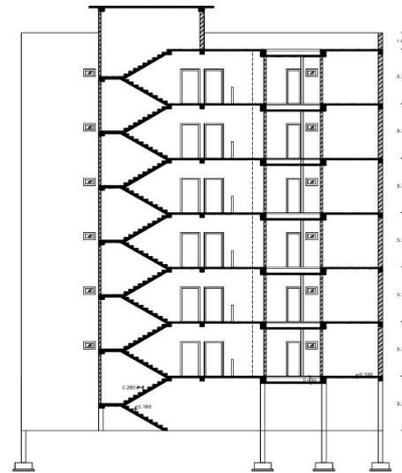


Fig.2. Front View

The building plan establishes architectural details through its determination of floor count and column placements and beam distribution and slab system design.

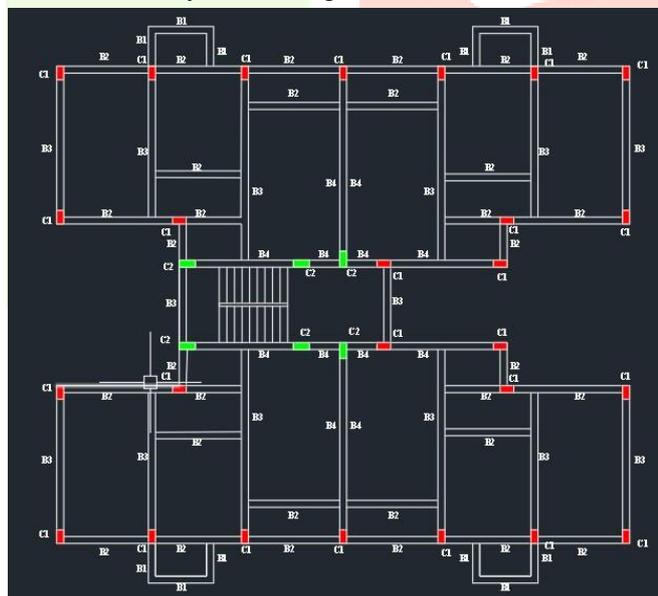


Fig.3. Beam & Column Position

Structural Engineering uses Artificial Intelligence tools to estimate dead load live load and wind/seismic loads which engineers verify through traditional methods.



Fig. 4. Load on Structure

Initial Member Size Assumption Standard design practices require engineers to choose initial structural

BEAM NO.	SIZE	COLUMN NO.	COLUER	SIZE
B1	230 X 300 mm	C1		230 X 450 mm
B2	230 X 380 mm	C3		230 X 530 mm
B3	230 X 450 mm			
B4	230 X 530 mm			

element dimensions for beams and columns before they begin detailed analysis work.

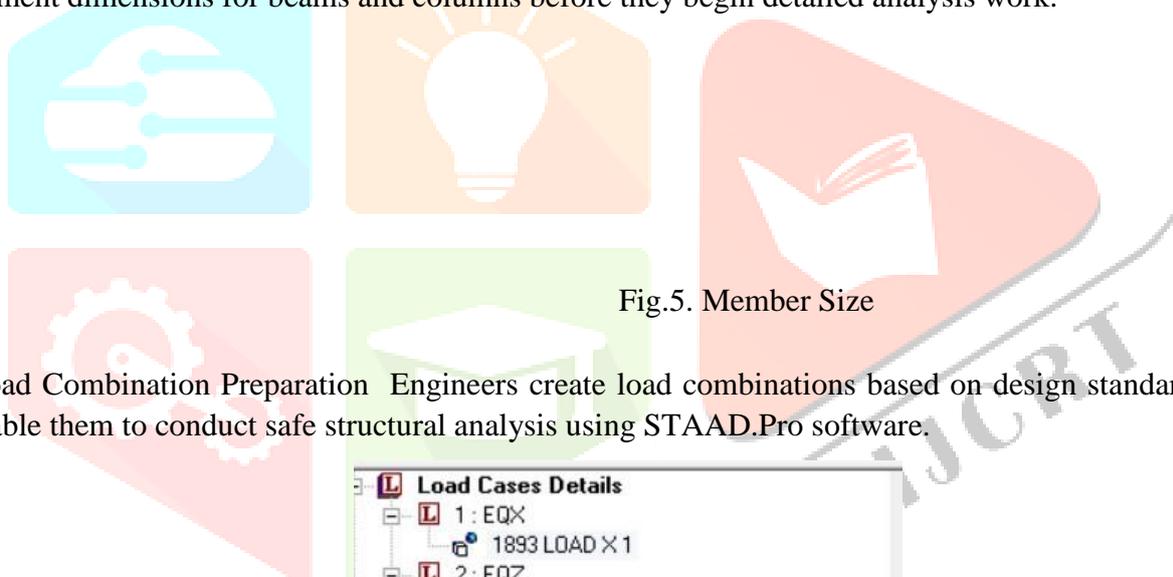


Fig.5. Member Size

Load Combination Preparation Engineers create load combinations based on design standards which enable them to conduct safe structural analysis using STAAD.Pro software.

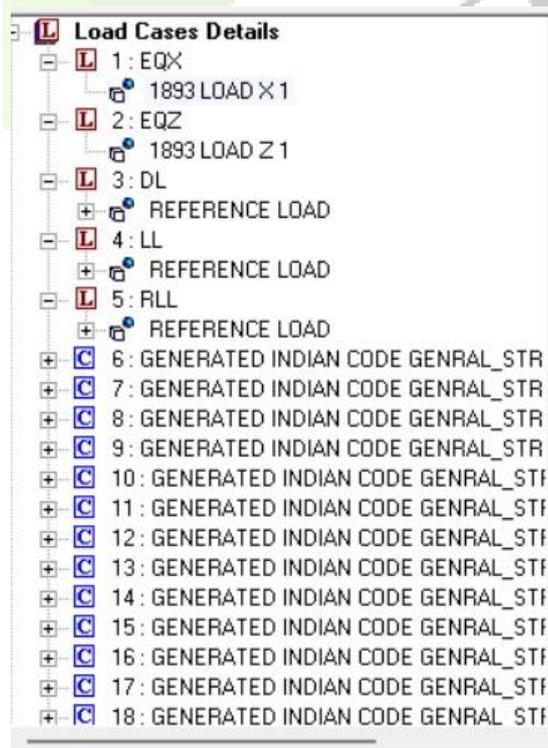


Fig.6. Load Cobination

2. CONVENTIONAL SOFTWARE ANALYSIS & DESIGN (STAAD.PRO).

1. Structural Modeling – The complete structural model is created using STAAD.Pro by defining nodes, members, supports, and material properties.
2. Load Application – Different types of loads such as dead load, live load, and other loads are applied to the structure according to standard practices in Structural Engineering.
3. Structural Analysis – The software performs analysis to calculate reactions, shear forces, bending moments, and deflections of structural members.
4. Design Calculations– Structural elements such as beams and columns are designed through the analysis results which Microsoft Excel helps engineers to process.
5. Result Verification – The obtained results are checked and verified to ensure safety, accuracy, and compliance with structural design standards.

STANDARD BEAM CHART															
SR.NO	TYPE	SIZE		BOTTOM REINFORCEMENT			TOP REINFORCEMENT						VERTICAL STIRRUPS		REMARK
		WIDTH	DEPTH	STRAIGHT	EXTRA AT MID-SPAN	EXTRA LENGTH	STRAIGHT	EXTRA	TOP EXTRA LENGTH AT VARIOUS SUPPORTS			AT SUPPORT UPTO "2d" FROM	AT MID SPAN		
									AT CONTINUOUS	AT COLUMN END	AT DISCONTINUOUS END BEAM				
A	SB1	230	530	16-2	16-2	1.085	16-2	16-2	0.3L1 + 0.3L2	0.3L1 + 57D	DO NOT PROVIDE			8@150mm/c	8@75mm/c
B	SB2	230	530	16-2	16-1	0.7L1	16-2	20-3	0.3L1 + 0.3L2	0.3L1 + 57D				8@150mm/c	8@75mm/c
C	SB3	230	450	16-2			16-2	16-2	0.3L1 + 0.3L2	0.3L1 + 57D				8@150mm/c	8@75mm/c
D	SB4	230	380	16-2			16-2	16-2	0.3L1 + 0.3L2	0.3L1 + 57D				8@150mm/c	8@75mm/c
E	SB5	230	300	12-2			12-2		0.3L1 + 57D					8@150mm/c	8@75mm/c

Table No. 2. Beam Chart

SCHEDULE FOR RCC CONCENTRIC COLUMN & FOOTING DETAILS																									
Sr. No.	COL CAT	GROUP	No of column	DETAILS OF FOOTING										DETAILS OF COLUMN				Confined Reinforcement For Lo length			SBC (KN/M2)				
				CONCRETE										Reinforcement				Size		Main Bar		Length	Dia. of Tie Bar	Spacing of Tie Bar	
				Len	Bre	Len	Bre	D	d	PARALLEL TO L	RPENDICULAR T	To	Per.	Dia.	No. of	Bar	Bars								
A	C1			2450	2200	2250	2000	450	450	8	52	8	48	530	300	16	16	600	8	75c/c					
B	C2			2200	2000	2000	1800	450	450	8	33	8	30	530	300	16	12	600	8	75c/c	FIG IV				
C	C3			2180	2010	2000	1810	450	450	8	35	8	32	450	300	16	12	600	8	75c/c	FIG III				
D	C4			1900	1740	1700	1540	450	450	8	20	8	12	450	300	16	8	600	8	75c/c	FIG III				

Table NO.1. Column Chart

3. AI DESIGN

The structural design data upload process allows users to upload their design data through PDF and text file and website link and FAQ file formats to Chatbase.

The AI system learns from the uploaded data through its processing activities which utilize Artificial Intelligence techniques.

The development of a tailored chatbot enables users to get answers to their questions about structural engineering and design assistance.

The chatbot provides analysis result interpretation support while it offers design recommendation services for structural design.

STANDARD BEAM CHART														
SR.NO	TYPE	SIZE		BOTTOM REINFORCEMENT			TOP REINFORCEMENT					VERTICAL STIRRUPS		REMARK
		WIDTH	DEPTH	STRAIGHT	EXTRA AT MID-SPAN	EXTRA LENGTH	STRAIGHT	EXTRA	TOP EXTRA LENGTH AT VARIOUS SUPPORTS			AT SUPPORT UPTO "2d" FROM	AT MID SPAN	
									AT CONTINUOUS	AT COLUMN END	AT DISCONTINUOUS END BEAM			
A	SB1	230	530	20-2	20-2	MID SPAN	20-2	20-2	0.3L1 + 0.3L2	0.3L1 +57D	DO NOT PROVIDE	8@150mm/c	8@75mm/c	
C	SB2	230	450	16-2	16-1	MID SPAN	16-2	16-1	0.3L1 + 0.3L2	0.3L1 +57D		8@150mm/c	8@75mm/c	
D	SB3	230	380	16-2			16-2		0.3L1 + 0.3L2	0.3L1 +57D		8@150mm/c	8@75mm/c	
E	SB4	230	300	12-2			12-2			0.3L1 +57D		8@150mm/c	8@75mm/c	

Table No. 3. Beam Chart

SCHEDULE FOR RCC CONCENTRIC COLUMN & FOOTING DETAILS																					
Sr. No.	COL CAT	GROUP	No of column	DETAILS OF FOOTING								DETAILS OF COLUMN				Confined Reinforcement For Lo length			SBC (KN/M2)	REMARK	
				EXCAVATION		CONCRETE			Reinforcement			Size		Main Bar		Length	Dia. of Tie Bar	Spacing of Tie Bar			
				Len	Bre	Len	Bre	D	d	PARALLEL TO L	PERPENDICULAR TO L	To	Per.	Dia.	No. of Bars						
				MM	MM	MM	MM	MM	MM	Dia.Bar	lo. of Bar	Dia.Bar	lo. of Bar	L	To L	Bar	Bars				
A	C1			2450	2200	2250	2000	450	450	8	52	8	48	600	300	20	8	600	8	75c/c	
B	C2			2200	2000	2000	1800	450	450	8	33	8	30	600	300	16	8	600	8	75c/c	
C	C3			2160	2010	2000	1810	450	450	8	35	8	32	700	300	20	12	600	8	75c/c	

Table No. 4. Column Chart

4. COMPARISON AND VALIDATION

Parameter	Conventional Method (STAAD + Excel)	AI Tool (Chatbot using Chatbase)
Beam Size	Beam sizes such as 230×530, 230×450, 230×380 are selected based on structural analysis results from STAAD.Pro	AI suggests beam sizes using trained data and rules from Chatbase is as as 300×530, 300×450, 300×380
Bottom Reinforcement	Reinforcement like 20-2, 16-2 etc. calculated through manual design using Microsoft Excel	AI gives reinforcement suggestions based on input loads and design guidelines is 20-2, 16-2
Top Reinforcement	Extra bars at supports and midspan calculated using conventional design formulas 20-1, 16-1	AI recommends similar reinforcement is 20-1, 16-1
Stirrups Spacing	Stirrup spacing such as 8@150 mm c/c at support and 8@75 mm c/c at mid-span determined through design checks	AI suggests spacing 8@150 mm c/c at support and 8@75 mm c/c at mid-span
Overall Result	Highly accurate and verified method used in professional structural design	Faster guidance and design suggestions, but requires verification with con. Software.

Table No. 6. Comparison Percentage Difference (Approx.)

Parameter	Conventional Method (STAAD.Pro + Microsoft Excel)	AI Tool (Chatbase)	Difference
Beam Size	230×530, 230×450, 230×380	Mostly same sizes	0–5%
Bottom Reinforcement	e.g., 20-2, 16-2	Similar reinforcement suggested	5–10%
Top Reinforcement	Based on design formulas	Slight variation in extra bars	5–8%
Stirrup Spacing	8@150 mm (support), 8@75 mm (mid span)	Similar	0%
Overall Reinforcement Output	Detailed and precise	Very close to conventional results	~5–8% average difference

Table No. 7. Percentage Difference.

Comparison: Conventional Method vs AI Tool

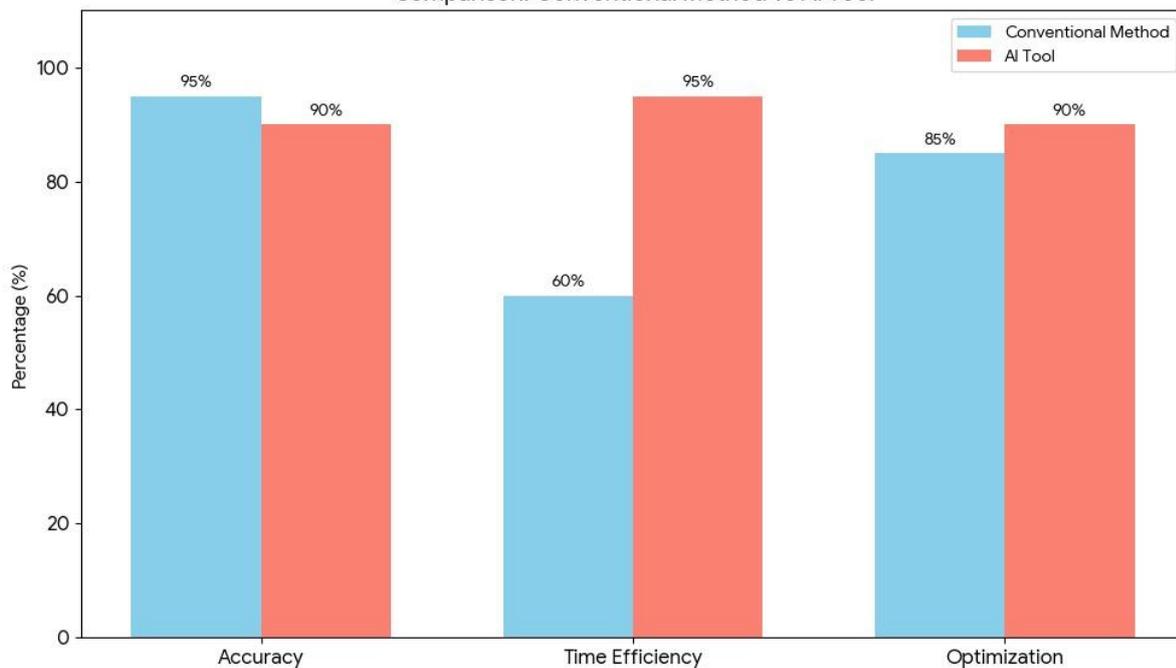


Fig.7. Evaluation of AI Tool Integration Performance against Conventional Standards

Conclusion:

The reinforcement output from the AI-assisted method differs by **approximately 5–8% from the conventional design results**, which shows that AI tools can provide **close preliminary design suggestions**, but final verification should still be done using conventional structural design methods in Structural Engineering.

1. **Accuracy**

The reinforcement and member size results obtained from the AI tool show only minor variation compared with designs from STAAD.Pro and Microsoft Excel. The reinforcement difference is about 5–8%, indicating that AI can provide reasonably accurate preliminary design guidance in structural engineering.

2. Time Efficiency

The conventional method involves multiple steps such as modeling, load application, analysis, and manual calculations using STAAD.Pro and Microsoft Excel. In contrast, AI tools like Chatbase can quickly process input data and suggest designs, reducing preliminary design time by about 40–60%.

3. Optimization

AI systems can rapidly evaluate multiple design options and suggest optimized member sizes or reinforcement layouts. However, conventional tools such as STAAD.Pro provide more detailed checks and reliable results for final structural verification and safety.

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