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Research Article

Comparative analysis of structural steel design of IS vs. AISC code standards

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Abstract

This Research presents a comparative evaluation of steel structures designed using Indian Standard (IS) and American Institute of Steel Construction (AISC) codes, focusing on structural performance, material strength and deformation behavior. The analysis reveals significant differences due to variations in design philosophy, safety factors and material specifications. AISC W18X46 sections demonstrate superior working load capacity (3185.78 kN) compared to ISMB300 (2387.47 kN), while IS100X100X8 angles exhibit higher yield strength than AISC L4X4X5/16. AISC sections show lower shear strength, potentially due to more conservative evaluation methods. Deflection analysis indicates AISC beams outperform IS beams by reducing deflections by 6.5% to 12%, attributed to higher moments of inertia and stricter serviceability limits. Axial force values in AISC beams are 5.47% to 8.07% lower, suggesting optimized load distribution and better material utilization. Similarly, bending moments are reduced by 3.77% to 6.18% in AISC designs, reflecting improved structural efficiency. Stress ratio variations between the two codes remain minimal (0.11%–0.20%), ensuring safety in both approaches. The study concludes that while both IS and AISC provide safe structural designs, AISC offers enhanced performance and efficiency, making it preferable for high-performance, cost-effective applications depending on project demands and regional design standards.

1. Introduction

Steel buildings are structured by using steel as the main material for framing and support. These buildings offer a versatile and durable solution for various applications, including residential, commercial, industrial and agricultural purposes. The use of steel in construction provides several advantages over traditional building materials like wood or concrete. Steel is known for its strength and durability, making it an ideal material for constructing buildings. Steel structures can withstand extreme weather conditions, seismic activity and other environmental challenges. Authors are providing a comprehensive foundation for structural steel design, covering both theoretical and practical aspects. The IS codes (IS 800, IS 1893, IS 875) provide guidelines for steel construction, seismic, dead, imposed and wind loads. To provide key insights into structural steel design and wind load analysis for high-rise buildings. Discussion across-wind loads on tall

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structures, essential for wind-resistant design. AISC 360-10 serves as the standard for structural steel buildings, ensuring safety and efficiency. ASCE/SEI 7-05 establishes minimum design loads, covering wind, seismic and other forces. An explore diagrid structural systems, emphasizing their effectiveness in high-rise steel buildings. Together, these sources contribute to a comprehensive understanding of steel design, load considerations and innovative structural systems for modern construction practices. A valuable comparison between different steel design codes and structural systems. Analyze the Steel Structure Component Design based on IS 800 (2007), AISC 13th Code Edition & BS 5950, highlighting key differences. Also explores IS 800 and its comparison with international standards, aiding engineers in understanding global design practices. With compare RCC & steel structures, considering Wind-Induced and Earthquake-Induced Force effects by using STAAD Pro., offering insights into structural performance under different loading conditions. Together, these studies enhance the understanding of steel design methodologies and their practical implications in construction.

2. Research Background

Analyzing shear forces, bending moments, deflections and reinforcement details to ensure structural safety and determine the most economical and efficient system for hospital construction by A, B et al. [1]. An incorporates AISC 360-10 Specification guidelines, which ensure safety, consistency, and reliability in the design, fabrication, and erection of structural steel systems in AISC 360-10[2]. ASCE/SEI 7-10 outlines minimum design load requirements for buildings and structures, covering dead, live, wind, seismic, snow, and other environmental loads. It updates wind and seismic provisions with new maps and includes a detailed commentary to aid code development and structural safety compliance in ASCE/SEI 7-05 [3]. Pre-Engineered Buildings (PEBs) using cold-formed steel with conventional steel structures for an industrial warehouse in Nagpur. Using STAAD-Pro, both structures were analyzed under dead, live, and wind loads per Indian codes to evaluate performance, efficiency, and cost-effectiveness of modern construction techniques over traditional methods by Bade, D et al. [4]. Performance Based Seismic Design (PBSD) of multistoried bare and braced steel frames using STAAD Pro Advanced. Through nonlinear static analysis, frame behavior under earthquake loading is evaluated. Results, including displacement, shear, and capacity curves, help identify frames meeting desired performance levels during seismic events Bagal, S., et al. [5]. Analyzes the impact of vertical irregularities in RCC and steel-framed buildings of varying heights under seismic loading, comparing structural responses to evaluate performance differences and recommend appropriate provisions for improved seismic safety by Dod, A et al. [6]. Indian Standard codes provide essential guidelines for structural design and analysis to ensure safety, stability and efficiency. IS 1893-2002 specifies the criteria for earthquake-resistant design, outlining seismic zones and dynamic analysis procedures. IS 800-2007 offers comprehensive guidelines for general construction in steel using the limit state design method. IS 875 (Part 1) - 1987 provides unit weights of building materials for calculating dead loads, while IS 875 (Part 2) - 1987 defines imposed (live) loads based on occupancy and usage. IS 875 (Part 3) - 1987 outlines methods for evaluating wind loads considering terrain, building height, and wind speed. Together, these codes form a robust framework for designing safe and reliable structures under various loading conditions, especially in steel-framed buildings in [7-11]. Design analysis of a multi-story building project in Hyderabad, focusing on load cases, combinations, support reactions, and reinforcement checks using IS 456:2000 and SP 16 for structural reliability by Kumar, K. S [12]. Pre-Engineered Buildings (PEB) and Conventional Steel Buildings across various spans, analyzing steel quantity savings in primary frames using IS 800:2007 standards and STAAD Pro Connect Edition for efficient industrial building design by Grover K et al. [13]. An investigation across-wind dynamic responses in super-tall buildings through wind tunnel tests on 15 models, deriving new load formulas and validating them via aeroelastic testing, emphasizing the significance of aerodynamic damping and structural behavior by M. Gu Y et al. [14]. The structural design of a pre-engineered steel hangar for Airbus A-380 using STAAD Pro V8i, following IS:800-2007, IS:875-2015, and IS:1893-2016 codes, ensuring efficiency, stability, and durability by Mohammed, M et al. [15]. Comprehensive insights into the design of steel structures in Design of Steel Structures by N. Subramanian et al. [16]. Fundamental and advanced design principles based on modern codes. "Limit State Design of Steel Structures by Prof. Dr. V. L. et al. [17] emphasizes limit state concepts with practical examples in Design of Steel Structures by Prof. S.R. Sathish Kumar et al [18] and Prof. A.R. Santha Kumar offers detailed theoretical and practical knowledge for structural engineering applications in [20]. Analysis and Design of a steel silo using STAAD Pro V8i and AutoCAD, addressing various loading conditions to evaluate plate stress, critical supports and structural performance as per IS 800 standards by S, D. M., et al. [21]. S.K. Duggal's et al. [22] "Limit State Design of Steel Structures" provides a clear and comprehensive understanding of steel structure design principles based on the limit state method, aligned with IS codes, supported by practical examples and illustrations.

Analyzes of eight models to evaluate the impact of sloping ground in seismic Zones 2 and 5, revealing that steel structures outperform RCC frames under varying seismic intensities and ground conditions using structural analysis techniques Tayade, P et al. [23]. Analyzing a seven-storied steel commercial building using STAAD Pro and Tekla Structures, emphasizing structural modeling, load combinations, and manual connection design per international standards and OSHA rules for enhanced safety and efficiency Vimala, L et al. [24]. Developing an optimized steel Foot Over Bridge (FOB) design for Mumbai using STAAD Pro, focusing on durability, safety, and cost-efficiency by analyzing structural parameters, static loads, and serviceability through vibration and utilization assessments Jha SK et al. [25]. Seismic pounding effects between adjacent steel moment-resisting frames (SMRFs) of equal and unequal heights using Monte Carlo simulation, incremental dynamic analysis, and fragility curves to assess collapse probabilities and structural performance Sadeghi A et al. [26].

Breasting dolphin structure using Finite Element, Grid Analogy, and Equivalent Frame Methods to evaluate internal forces, highlighting method-based variations in design accuracy and ensuring structural safety for heavy-load port applications Lopes W et al. [27]. This investigation is steel-encased portal frames with varying shear connector spacing through cyclic static load tests, revealing enhanced ductility and load capacity, and analyzing failure modes and hysteresis behavior without pinching effects for improved structural performance Ebenezer SJ et al. [28].

3. Structural Model Creation of Steel Building by Using STAAD Pro

The steel structure model is meticulously crafted using STAAD Pro software, facilitating subsequent analysis and design processes. In this model, the global coordinate system defines the orientation, with X and Z representing horizontal directions, while Y denotes the vertical direction (depth). To provide robust support to the main steel columns, reinforced cement concrete plinth beams are strategically placed.

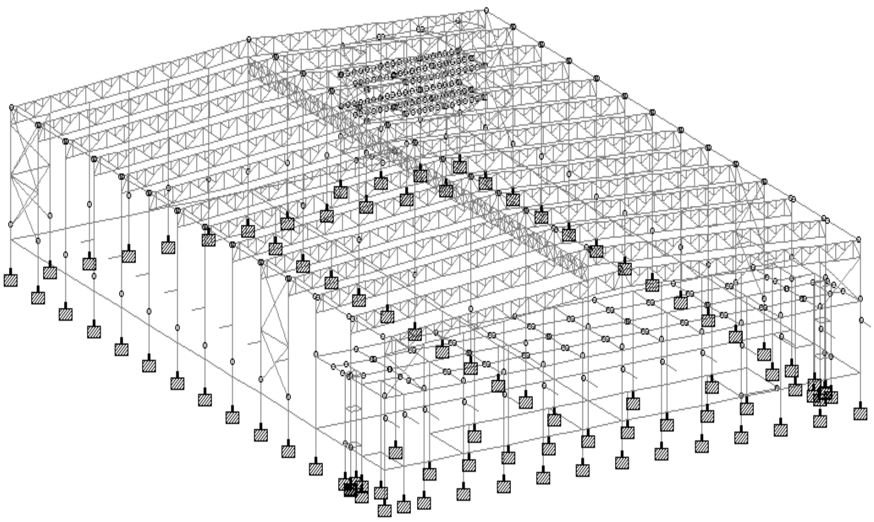

Fig. 1. Perspective view of steel building

These plinth beams feature a geometric dimension of 360mm width and 600mm depth, ensuring adequate load-bearing capacity and structural stability. By integrating reinforced concrete elements with steel components, the structural integrity and overall performance of the building are enhanced, meeting stringent safety and durability requirements. The utilization of STAAD Pro software streamlines the design process, enabling engineers to optimize structural configurations and ensure compliance with design standards and specifications.

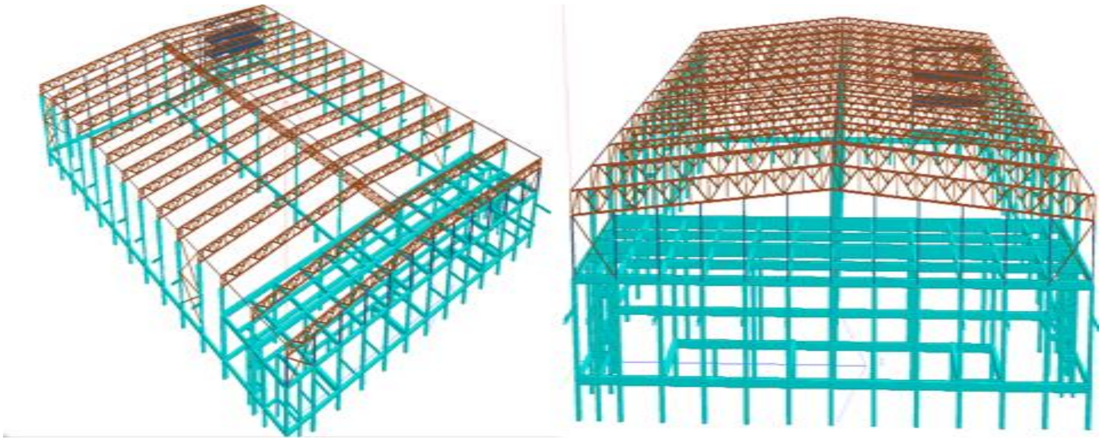

Fig. 2. Rendering view of steel building

3.1 Analysis by using STAAD Pro

Structural analysis using Bentley's STAAD Pro. software, leveraging finite element analysis techniques, ensures comprehensive evaluation of the steel structure's performance. Fundamental units utilized in this analysis include Length (m), Force (kN) Moment (kNm) and Stress (N/mm^2). Material properties are such as Modulus of Elasticity (E), Shear modulus (G), Density, Poisson’s ratio and Coefficient of thermal expansion, are crucial inputs for accurate analysis. With Young's modulus at 310,000 N/mm^2 and Shear modulus at 80,000 N/mm^2, the structural behavior under various loading conditions can be precisely modeled. The alignment of the structure with True North and the orientation of principal axes in STAAD Pro enhance the accuracy of the analysis. Specifically, X direction aligns with the east direction, the Y axis points in upward and Z axis aligns with north direction. This alignment facilitates consistent interpretation of results and ensures proper orientation of structural components within the software environment.

3.2 Building Information

Location of Site	:	Coimbatore
Purpose	:	Ware House building
Category of Structure	:	Steel
Length of Structure (l)	:	103.2 m
Width of Structure (w or b)	:	75 m
Height of Structure (h)	:	14.8 m
Class of foundation	:	Isolated
SBC	:	17 t/m2
Height of Foundation	:	2.25 m

3.3 Assessment of Dead and Live Loads for the Mezzanine Floor

Table 1. Dead and Live Loads as per IS 875 (Part 1&2)

Dead Load (IS 875) Part 1	Tk [mm]	Total Unit weight kN/m^3	Total calculated load	Measurements
Static load for Slab (175mm Tk)	175	25	4.4	kN/m^2
Flooring load (FL)	50	21	1	kN/m^2
Plastering load (Celling)	12	21	0.3	kN/m^2
Total Loads from Mezzanine floor			5.7	kN/m^2
Total Imposed Load on Mezzanine floor			1	kN/m^2

Total Load on Slab Element	6.7	kN/m^2

3.4 Loads from Truss element (Dead Load & Live Load)

Dead load is 4 kN/m^2 (From IS 875 Part I)

Imposed load is 7.5 kN/m^2 (From IS 875 Part II)

3.5 Wind Load Calculation (From IS 875 Part III-1987)

Dimension of the Structure (l)	= 102.3 m	
Breath of the Structure (b)	= 75 m	
Depth of the Structure (d)	=14.8 m	
Angle (θ)	= 3	
Depth to width Ratio d/b	= 14.8/75 = 0.20	[IS 875-Part III]
Basic wind Pressure V_b	=50 m/Sec	(Table 2) [IS 875-Part III]
	K1= 1.08	[Clause 5.3.3.1]
Category -II (Class – C)	K2= 0.97	[Clause 5.3]
	K3= 1	[Clause 5.4]
Design of wind speed Vz	= Vb x K1 x K2 x K3 = 50 x 1.08 x 0.97 x1 = 53 m/s	
Design of wind pressure Pz	= $0.6Vz^2$ = 0.6 x 532 = 1646.19 N/m^2 = 1.65 kN/m^2	

Table 2. Atmospheric Wind Pressure

Angle	EF (-)	GH (-)	EG (-)	FH (-)
0˚	0.90	0.40		
90˚			0.80	0.40

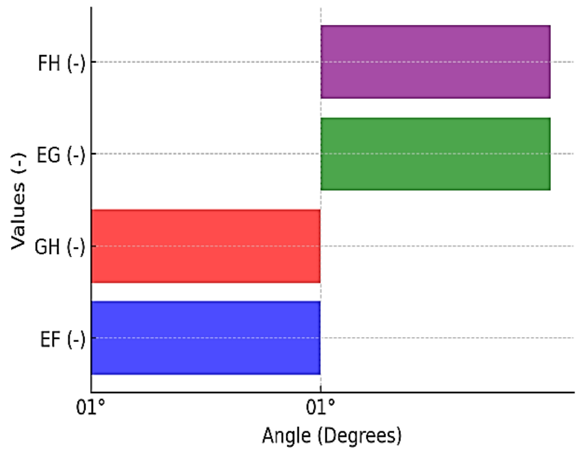

Fig. 3. Atmospheric Wind Pressure

Factor of Internal Pressure (Cp_i)	= ± 0.5	[Clause 6.2.3.2]
Co-efficient of External Pressure (cp_e)	= $\frac{h}{w} < \frac{1}{2}$	

θ=90 Wind force is acting on + z direction

Wind force = (Cp_e-Cp_i)

Table 3. Load due to wind [Z] in positive axis (θ =90) based on $+_{ve}$ Internal pressure

Wind Facing	Wall [m]	Factor [Cp_e-Cp_i]	Pressure [kN/m^2]	Wind force [kN/m]	Concentrated load
WWS	3.8	-1.3	1.65	-8.132	-10.98
LWS	7.6	-0.9	1.65	-11.26	-15.2
LWS	9.35	-0.9	1.65	-13.853	-18.70
LWS	4.675	-0.9	1.64	-6.926	-9.35

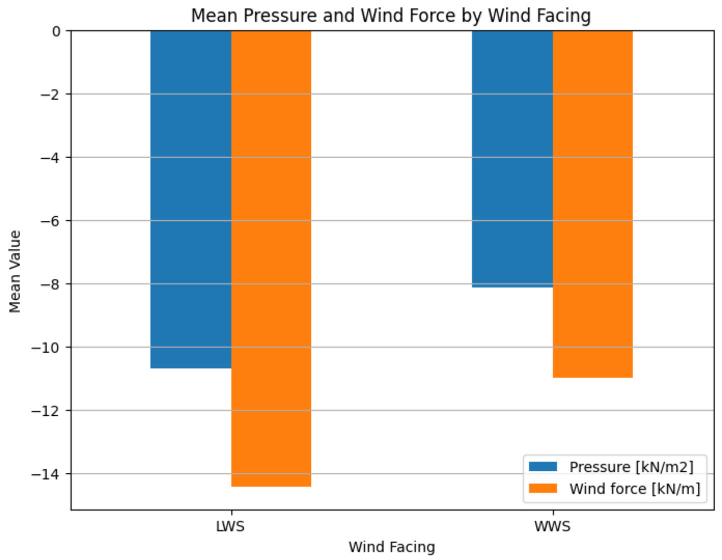

Fig. 4. Comparison of wind force [z] and concentrated force in $+_{ve}$ axis with positive internal pressure

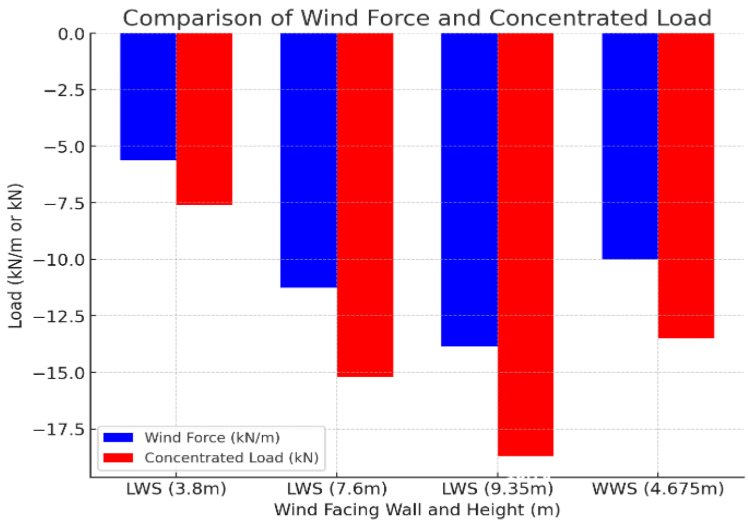

Fig. 5 Comparison of wind force [z] and concentrated force in negative axis with positive internal pressure

Table 4. Load due to wind in [Z] negative axis (θ =90) due to $+_{ve}$ Internal pressure

Wind Facing	Wall [m]	Factor [Cp_e-Cp_i]	Pressure [kN/m^2]	Wind force [kN/m]	Concentrated load
LWS	3.8	-0.9	1.65	-5.630	-7.6
LWS	7.6	-0.9	1.65	-11.260	-15.201
LWS	9.35	-0.9	1.65	-13.853	-18.70
WWS ward	4.675	-1.3	1.65	-10.005	-13.5

Table 5. Load due to wind in [X] positive axis (θ =0) due to $+_{ve}$ Internal pressure

Wind Facing	Wall [m]	Factor [Cp_e-Cp_i]	Pressure [kN/m^2]	Wind force [kN/m]	Concentrated load
WWS	3.8	-1.4	1.65	-8.758	-11.82
WWS	7.6	-1.4	1.65	-17.516	-23.64
WWS	9.35	-1.4	1.65	-21.549	-29.09
WWS	4.675	-1.4	1.65	-10.774	-14.55
LWS	3.8	-0.9	1.6	-5.63	-7.60
LWS	7.6	-0.9	1.6	-11.26	-15.20
LWS	9.35	-0.9	1.6	-13.85	-18.70
LWS	4.675	-0.9	1.6	-6.92	-9.35

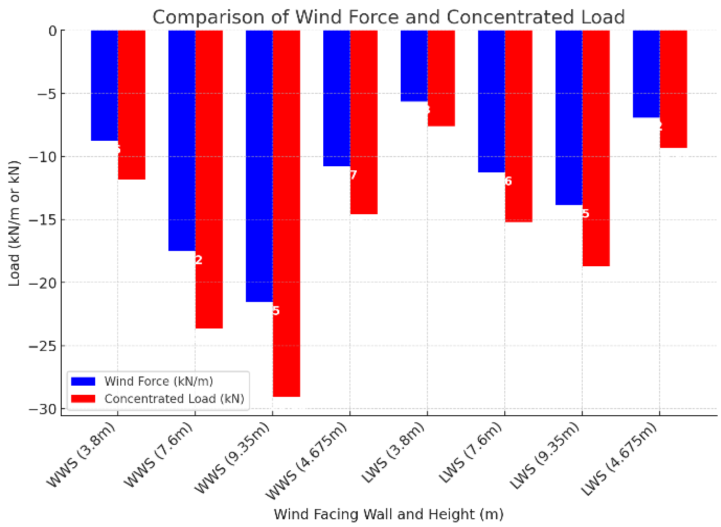

Fig. 6. Comparison of wind force [x] and concentrated force in positive axis with positive internal pressure

3.6 Load Combination

1 Dead [DL] + Imposed [LL]
2 Dead + Imposed + Wind Load
3 Dead + Imposed + Wind in +X Direction
4 Dead + Imposed + Wind in -X Direction
5 Dead + Imposed + Wind in +Z Direction
6 Dead + Imposed + Wind in -Z Direction
7 Dead + Wind in +X Direction
8 Dead + Wind in -X Direction
9 Dead + Wind in +Z Direction
10 Dead + Wind in -Z Direction
11 Dead + Earthquake in +X Direction
12 Dead + Earthquake in +Z Direction

3.7 Assign Loads to The Structure with Respecting to The Coordinate System +Z (Wind ward and Leeward Side)

Calculated wind loads are applied to the model with the +z Wind ward side and -Z Leeward side.

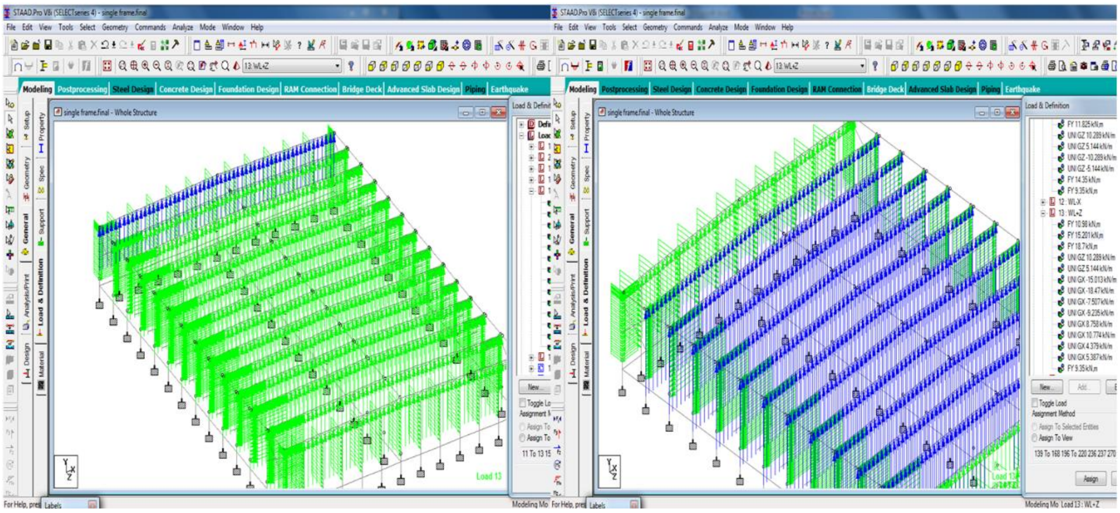

Fig. 7. Assignment of Wind Load +Z Direction (WW & LW)

3.8 Seismic Load (From IS 1893 – 2016 Part 2)

Zone coefficient: Z = 0.16
Factor of reduction: R.F = 3
Factor of Importance I =1
Rock and Soil factor-SS =1
Class of building ST =2
Damping ratio- DM =0.02

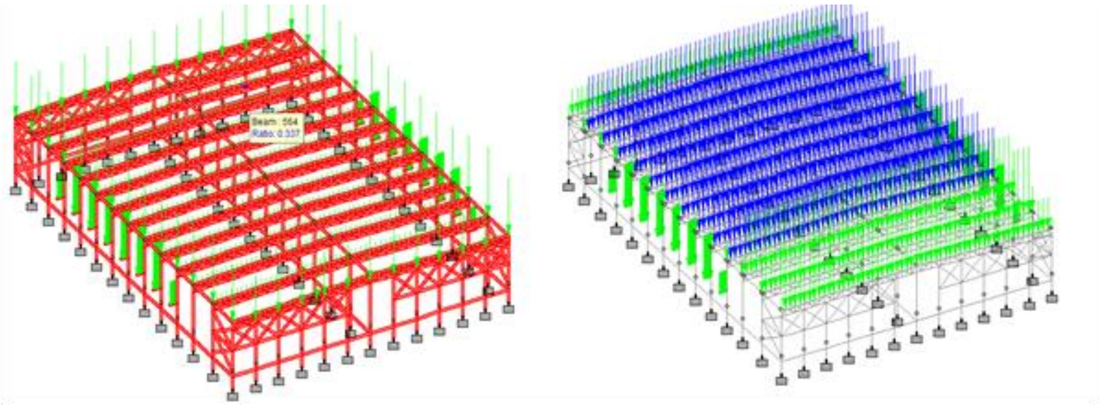

Fig. 8. Assignment of Dead Load & Live Load to the structure

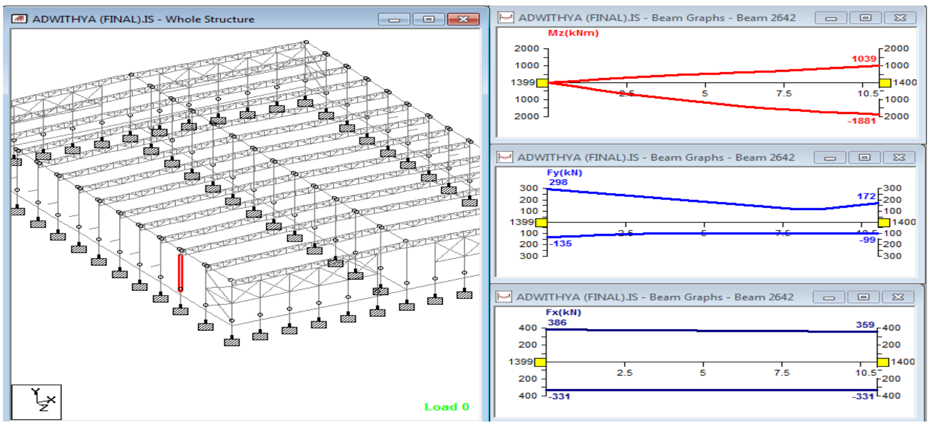

Fig. 9. Bending moment and shear force diagrams

3.9 Contrast the Steel Frame (IS Steel Section & AISC Steel Section)

3.9.1 Comparison of Strength Properties of Compression Member

The standard codes for structural steel sections provide specifications for various sizes and their corresponding working loads. For instance, according to IS (Indian Standard), the ISMB300 section has a working load capacity of 2387.474 kN, while according to AISC (American Institute of Steel Construction), the W18X46 section can handle a working load of 3185.78 kN. These specifications are crucial for engineers and architects in designing safe and efficient structures, ensuring compliance with relevant building codes and standards to guarantee structural integrity and safety.

Table 6. Axial strength of compression element

Standard	Section Class	Load (kN)
IS Code	ISMB 300	2387.47
AISC Code	W18X46	3185.78

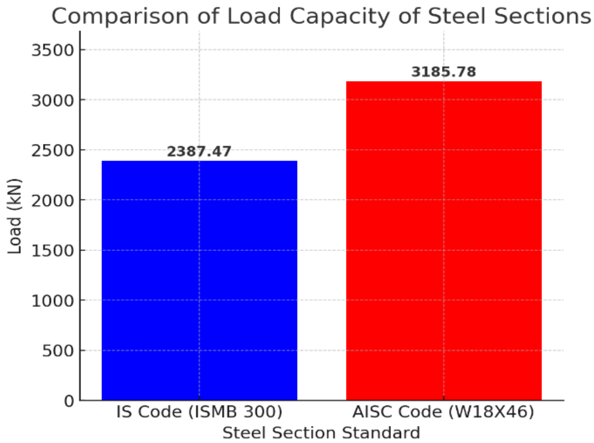

Fig. 10. Graphical representation of axial comparison with IS & AISC

3.9.2 Comparison of Strength Properties of Tension Member

Standard codes provide critical specifications for structural steel sections, including yielding strength, rupture strength, and shear strength, crucial for engineering designs. In IS (Indian Standard), the IS100X100X8 section exhibits a yielding strength of 426.36 kN, rupture strength of 450.38 kN and shear strength of 355.87 kN. Conversely, according to AISC (American Institute of Steel Construction), the L4X4X5/16 section demonstrates a yielding strength of 319.28 kN, rupture strength of 418.56 kN and shear strength of 269.00 kN. These specifications guide engineers in selecting appropriate materials to ensure structural stability and safety in construction projects, adhering to industry standards.

Table 7. Strength of the Tension Member

Standard	Property of steel section	Strength in Yield [kN]	Strength in Rupture [kN]	Strength in Shear [kN]
IS Code	IS 100X100X8mm	426.4	450.4	355.9
AISC Code	L4X4X5/16	319.3	418.6	269

Standard deviation, Equation (1) is used to quantify the variability in strength parameters of steel sections designed under IS and AISC codes. By analyzing yield, rupture and shear strengths. This study highlights the statistical dispersion between the two standards. The standard deviation values75.72 kN for yield, 22.48 kN for rupture and 61.45 kN for shear. It indicates notable differences in design strength and reliability. These findings emphasize the importance of understanding code-specific performance variations, which can impact safety margins, material efficiency and design optimization in structural engineering. The analysis supports informed decision-making in selecting appropriate design standards.

Standard Deviation (SD)	$SD = \sqrt{[(x_1 - \bar{x})^2 + (x_2 - \bar{x})^2] / (n - 1)}$ X_1 and X_2 =Data points; $\bar{x}$ = Mean Value; n = No. of Samples	(1)
Yield Strength	$SD = \sqrt{[(426.4 - 372.85)^2 + (319.3 - 372.85)^2] / (2 - 1)}$ SD= 75.72	
Rupture Strength	$SD = \sqrt{[(15.9)^2 + (-15.9)^2]}$ SD= 28.42	
Shear Strength	$SD = \sqrt{[(43.45)^2 + (-43.45)^2]}$ SD=61.45	

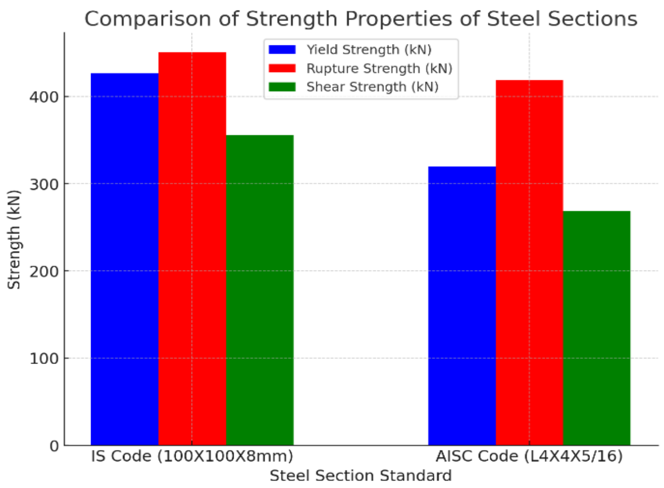

Fig. 11. Graphical representation of yield, rupture and shear comparison with IS & AISC

3.9.3 Contrast of Deflection Due to Load Combination

Beam deflection measurements are critical for assessing structural performance. A comparison between IS code and AISC code specifications reveals variations in deflection. For instance, Beam No. 108 showed a 10% decrease in deflection under AISC compared to IS, while Beam No. 213 and 215 exhibited reductions of 12% and 11.6%, respectively. Beam No. 230 experienced a 6.5% decrease, and Beam No. 345 had an 11.1% decrease. These comparisons highlight differences in design methodologies and standards, emphasizing the importance of selecting appropriate codes to ensure structural integrity and performance align with project requirements and safety standards.

Table 8. Structural deformation due to load effects

Beam ID	Deformation [mm]		
	IS code	AISC code	% of Changes
108	20	18	10.0
213	25	22	12.0
215	43	38	11.6
230	31	29	6.5
345	18	16	11.1

3.9.4 Axial Load Interaction in Load Combinations

The axial force measurements of beams under IS code and AISC code standards indicate variations in structural behavior. Beam No. 108 exhibited a 6.85% decrease in axial force under AISC compared to IS, while Beam No. 213 and 215 showed reductions of 5.47% and 7.26%, respectively. Beam No. 230 experienced a 6.96% decrease, and Beam No. 345 had an 8.07% decrease. These disparities underscore differences in design methodologies between standards, emphasizing the importance of selecting appropriate codes to ensure structural safety and performance meet project requirements and industry standards.

Table 9. Axial force due to load combination (kN)

Beam ID	Axial Force [kN]		
	IS code	AISC code	% of Changes
108	336	313	6.85
213	329	311	5.47
215	124	115	7.26
230	345	321	6.96
345	322	296	8.07

3.9.5 Evaluation of Bending Moments Under Different Load Combinations

Comparison of moments in beams under IS code and AISC code standards reveals variations in structural response. Beam No. 108 exhibited a 5.99% decrease in bending moment under AISC compared to IS, while Beam No. 213 and 215 showed reductions of 3.82% and 6.18%, respectively. Beam No. 230 experienced a 4.80% decrease, and Beam No. 345 had a 3.77% decrease. These differences highlight the distinct design approaches between standards, emphasizing the need to consider specific project requirements and safety factors when selecting applicable codes for ensuring structural integrity and performance.

Table 10. Analysis of Bending Moment Variations for Different Load Combinations

Beam ID	Moments [kNm]		
	IS code	AISC code	% of Changes
108	1487	1398	5.99
213	1363	1311	3.82
215	1278	1199	6.18
230	1562	1487	4.80
345	1432	1378	3.77

3.9.6 Comparison of Load-to-Capacity Ratio for the Steel Members

The provided data outlines the stress ratio measurements for two steel members comparing values according to two distinct standards: IS (Indian Standards) and AISC (American Institute of Steel Construction). Each beam is associated with its respective stress ratio under both standards along with the percentage change between them. Stress ratio is a critical parameter in structural engineering indicating the ratio of actual stress to allowable stress within a material. By comparing stress ratio values between IS and AISC standards engineers can assess the consistency or disparity between these widely recognized standards. For both Beam No. 1 and Beam No. 2 the stress ratio is nearly identical between the two standards with only a minimal percentage change of 0.11%. Such close alignment suggests a high degree of similarity between the stress calculation methodologies by IS and AISC for these particular element members. This finding can provide confidence to engineers regarding the reliability and applicability of both standards in evaluating stress levels within structural elements. However, further analysis may be warranted to understand the reasons behind the observed minor differences and to ensure that structural safety and performance requirements are consistently met across different standards and design contexts.

3.9.7 Comparison of Load-to-Capacity Ratio for the Beam section

The stress ratios for two beams as per Indian Standards (IS) and American Institute of Steel Construction (AISC) standards are provided in the Table 11. Both standards yield similar stress ratios for both beams with a marginal difference of 0.11%. The stress ratio represents the ratio of actual stress in a material to its allowable stress indicating the safety margin in a structural element. The negligible variation between IS and AISC standards highlights the consistency in engineering principles across different codes. While minor differences may exist due to varying design philosophies and consideration of material properties the overall agreement underscores the reliability and robustness of structural design practices worldwide. Engineers and designers can confidently utilize either standard knowing that both adhere to stringent safety criteria and ensure the structural integrity of beams in diverse applications. Such harmonization facilitates international collaboration and the exchange of best practices in structural engineering ultimately contributing to safer and more resilient built environments.

Table 11. Load-to-Capacity Ratio Analysis for Beam Section

Beam ID	Load-to-Capacity Ratio		
	IS code	AISC code	% of Changes
1	0.988	0.99	0.11
2	0.988	0.99	0.11

3.9.8 Comparison of Stress Ratio for Column section

Table 12 illustrates the stress ratios for two columns under Indian Standards (IS) and American Institute of Steel Construction (AISC) specifications. Both columns are exhibit similar stress ratios with a marginal difference of 0.20% between IS and AISC standards. Stress ratio signifies the ratio of actual stress in a material to its allowable stress reflecting the safety margin within a structural component.

Table 12. Load-to-Capacity Ratio Analysis for Column Section

Beam ID	Load-to-Capacity Ratio		
	IS code	AISC code	% of Changes
1	0.93	0.929	0.20
2	0.93	0.929	0.20

Fig. 12. Graphical Representation for Changes (IS & AISC)

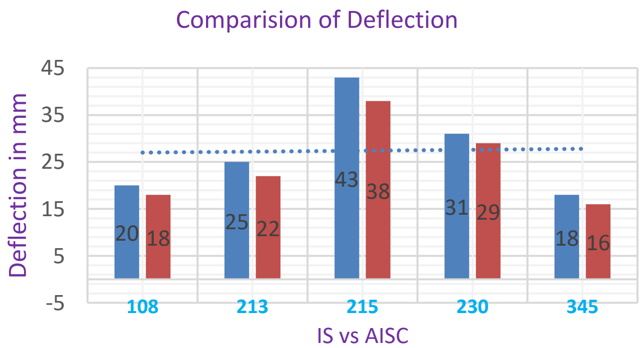

Fig. 13. Comparison of Deflection for IS & AISC

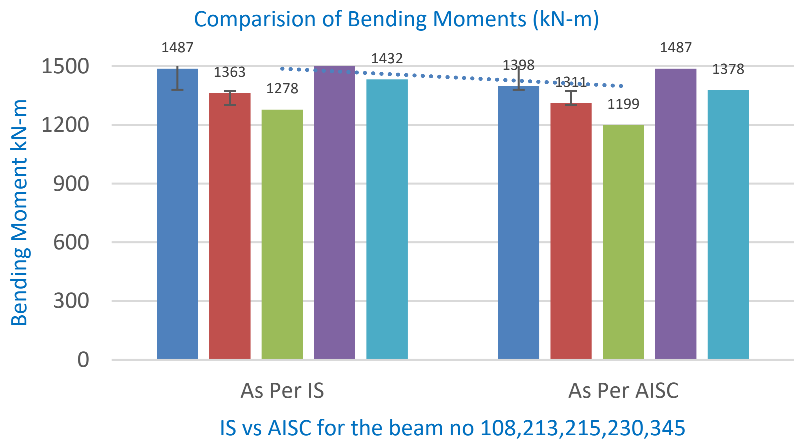

Fig. 14. Comparison of BM for IS & AISC

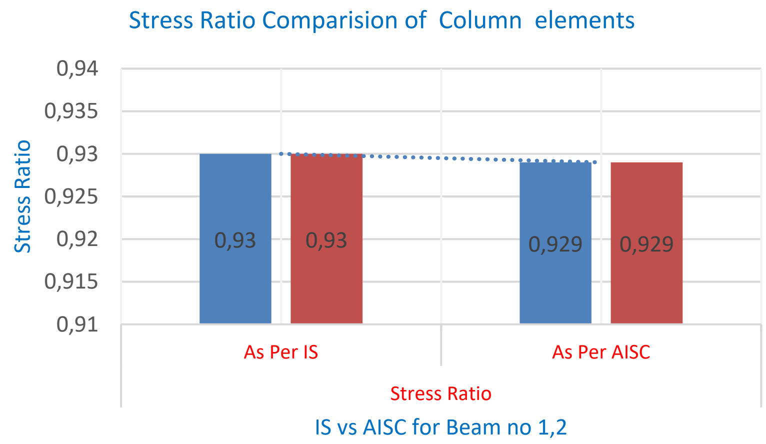

Fig. 15. Load-to-Capacity Ratio Comparison of Column elements

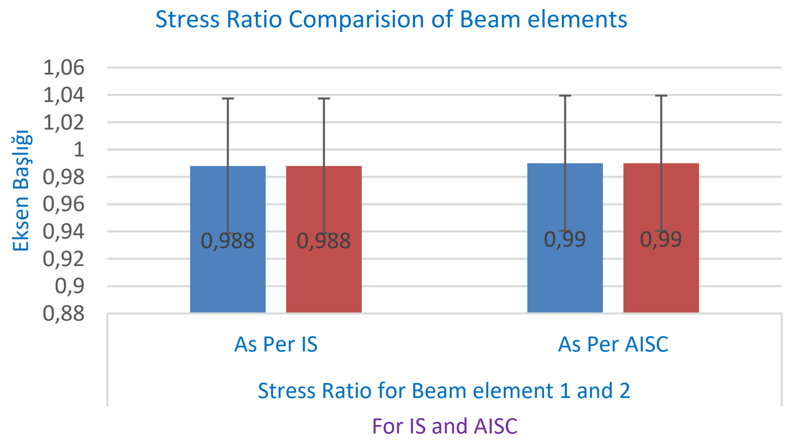

Fig. 16. Load-to-Capacity Ratio Comparison of Beam elements

The minor variance between IS and AISC standard highlights the convergence of engineering principles despite geographical and institutional differences. This consistency underscores the universality of structural design principles and the global pursuit of safety and reliability in engineering practice. Engineers can confidently apply either standard, assured of meeting rigorous safety criteria and ensuring structural soundness. Such alignment facilitates international collaboration and the exchange of best practices, fostering advancements in structural engineering and contributing to the construction of safer and more resilient infrastructure worldwide.

4. Result and Discussion

The comparative evaluation between IS and AISC design codes highlights significant differences in structural performance, material strength, and deformation characteristics.

- The comparison between AISC and IS sections reveals distinct performance variations due to differences in design philosophy, material standards and safety factors. The AISC W18X46 beam shows superior working load capacity (3185.78 kN) over ISMB300 (2387.47 kN), highlighting its enhanced load-bearing design. Conversely, IS100X100X8 angles exhibit higher yield strength than AISC L4X4X5/16, indicating stronger resistance in axial loading. AISC sections show lower shear strength, likely due to conservative shear evaluation methods in American codes compared to Indian standards.
- The deflection analysis indicates that AISC-designed beams consistently outperform IS-designed beams, with deflection reductions ranging from 6.5% to 12%. This improved performance is primarily due to higher moments of inertia and stricter serviceability criteria adopted in AISC codes. Greater stiffness in AISC sections ensures reduced deformation under load, which is vital for maintaining serviceability and structural integrity, especially in high-rise and industrial applications where excessive deflection can affect functionality, alignment, and long-term durability of the structure.
- This research analysis shows that AISC-designed beams exhibit 5.47% to 8.07% lower axial force values compared to IS-designed beams. This suggests that AISC standards offer more optimized axial load distribution, likely due to differences in safety factors, load combinations, and design philosophies. The reduced axial forces indicate more efficient load transfer mechanisms and superior material utilization in AISC sections. Such optimization contributes to structural efficiency and cost-effectiveness, making AISC sections preferable for axial load-dominant applications in modern construction.
- The bending moment analysis reveals that AISC-designed sections exhibit 3.77% to 6.18% lower values compared to IS-designed sections. This reduction suggests that AISC design methodology allows for more efficient moment redistribution and possibly incorporates advanced considerations such as secondary effects, frame action, and plastic behavior. These factors enhance structural performance without compromising safety. The slightly lower bending moments indicate optimized structural response and material efficiency, making AISC sections advantageous for applications demanding high structural performance with economic material usage.
- The stress ratio comparison between IS and AISC designs shows minimal variation, ranging from 0.11% to 0.20%, indicating both codes ensure similar safety and reliability levels. This close alignment reflects equivalent performance in terms of structural strength, despite differing design philosophies. However, AISC sections demonstrate greater optimization in terms of weight efficiency and load-carrying capacity. This suggests that while both standards are structurally sound, AISC designs are more refined for material utilization, offering advantages in cost-effective and high-performance application.

5. Conclusion

The analysis indicates that while IS and AISC codes provide structurally sound designs, AISC sections generally exhibit higher load-carrying capacity, reduced deflections and slightly lower axial forces and bending moments. These differences arise from variations in design philosophy, material properties, safety factors and load considerations. Engineers should consider these differences when choosing between IS and AISC for steel design, depending on project requirements, cost implications and structural efficiency.

- AISC sections demonstrate superior load-carrying capacity due to optimized cross-sectional geometry, higher material strength and advanced design provisions. This enhanced performance makes them more suitable for heavy-load applications, ensuring improved structural efficiency, reduced member sizes and better utilization of material properties compared to IS sections under similar loading conditions.

- AISC-designed beams exhibit reduced deflections, ranging from 6.5% to 12%, due to higher moment of inertia and stricter serviceability criteria. This indicates superior stiffness and enhanced structural performance under loading, making AISC sections more effective in maintaining functional integrity and durability in serviceability-critical structures such as high-rise and industrial buildings.
- AISC sections exhibit 3.77% to 8.07% lower axial forces and bending moments compared to IS sections, indicating more efficient load distribution and structural behavior. This optimization results from refined design methodologies, including advanced load combinations and reduced safety factors, leading to enhanced material utilization and overall structural efficiency in demanding applications.
- The minimal variation in stress ratios between IS and AISC designs (0.11% to 0.20%) confirms that both codes maintain equivalent safety and structural integrity levels. Despite differing design philosophies and material provisions, both standards ensure reliable performance under loading, validating their effectiveness in delivering safe and structurally sound designs.
- The selection between IS and AISC design codes should be guided by project-specific factors such as structural efficiency, material availability, economic feasibility, and compliance with regional standards. Each code reflects distinct design philosophies and choosing the appropriate standard ensures optimized performance, cost-effectiveness and adherence to regulatory and functional project requirements.

6. Future Recommendation

Future research should focus on expanding the comparative analysis between IS and AISC standards across a wider range of structural elements, including columns, connections and composite members. Incorporating dynamic loading conditions such as seismic and wind effects can provide deeper insights into performance differences under extreme events. Experimental validation of numerical findings through laboratory testing will enhance the reliability of comparative studies. Additionally, exploring life-cycle cost analysis and sustainability aspects of both standards could guide more environmentally responsible and economically viable design decisions.

Integration of Building Information Modeling (BIM) and parametric optimization tools within code-based design comparisons can further streamline the decision-making process. It is also recommended to develop a unified design framework and conversion guidelines for projects involving international collaboration, where both IS and AISC codes may be relevant. These advancements will contribute to improved structural efficiency, material optimization and informed code selection for diverse construction scenarios.

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