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COMPARATIVE STUDY OF STEEL CONNECTION USING US AND IS CODE ON TEKLA STRUCTURE

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Abstract

This paper presents a comprehensive comparative study of steel connections implemented in Tekla Structures software, employing both the US and IS (Indian Standards) codes. The investigation focuses on analyzing the differences in design criteria, detailing requirements, and fabrication practices between the two codes. Specifically, the study explores variations in bolt sizing, beam and column dimensions, as well as detailing specifications for bolted connections. Through detailed examination and comparison, significant disparities are identified, highlighting the importance of adhering to specific standards to ensure structural integrity and compatibility in construction projects.
Additionally, the study addresses the implications of these differences on material estimation, cost evaluation, and overall project outcomes. By providing insights into the utilization of US and IS codes within Tekla Structures, this research contributes to enhancing the understanding and implementation of international standards in structural engineering practices.

Keyword- Tekla Structure, Steel Structure, Us and Is Codes

I. INTRODUCTION:

In steel structures, globalization brings Engineers a new challenge since nowadays an engineer can design structures in different places around the world. The design procedure can be similar; however, each country or area is governed by its design specifications. The steel connections are one of the main components of steel structures and their role is to connect the steel members in a structure. The steel elements can be connected by bolting, welding, or by both elements. This comparison studies the specifications of connection design in two design codes. This study compares the connection design specifications from the United States of America & India.

When comparing the Indian Standard (IS) and the United States (US) steel codes, several differences and similarities emerge based on structural design methodologies, industry practices, and regulatory frameworks. Here are some key points regarding the results of comparing these two steel codes:

1. **Design Philosophy:**

- The IS steel code, represented by standards such as IS 800:2007, follows design philosophies tailored to Indian engineering practices, environmental conditions, and construction norms.
- In contrast, the US steel code, governed primarily by the American Institute of Steel Construction (AISC), reflects design philosophies and methodologies prevalent in the United States, incorporating factors like seismic considerations, wind loads, and snow loads.

2. **Material Specifications**:

- Both the IS and US steel codes provide specifications for various grades of structural steel materials, detailing their mechanical properties, chemical compositions, and allowable stresses.
- While some similarities may exist in material specifications between the IS and US codes, differences may arise due to regional steel manufacturing practices and material availability.

3. **Connection Design and Detailing:**

- Both the IS and US steel codes provide guidelines for the design and detailing of connections, including bolted connections, welded connections, and other structural fastening methods.
- However, specific detailing requirements, bolt sizes, weld types, and connection capacities may vary between the two codes based on engineering practices and industry standards.

4. **Regulatory Framework:**

- The IS steel code is regulated by the Bureau of Indian Standards (BIS), which establishes and maintains standards for various industries in India, including steel construction.
- In the United States, the AISC develops and updates steel design standards in coordination with other regulatory bodies and professional organizations, ensuring compliance with national building codes and regulations.

II. OBJECTIVE:

1. To compare the design methodologies and criteria for steel connections outlined in the American and Indian standards (AISC and IS respectively) within the Tekla Structures software environment.
2. Enable precise and efficient 3D modeling of steel structures, including beams, columns, connections, and secondary elements, to accurately represent the geometry and components of the steel frame.
3. Facilitate the design and detailing of steel connections according to industry standards and best practices
4. To prepare a comprehensive 3D model of the steel structure utilizing Tekla software, ensuring accurate representation of all structural components, including beams, columns, connections, and secondary elements.

III. LITERATURE REVIEW:

Syed firoz ,S kanakambara Rao: "Modeling concept of sustainable steel building ISSN : 2278-067x, Volume 1, Issue 5 (June 2012) , PP.18-24

- The work by Syed Firoz and S. Kanakambara Rao on the modeling concept of sustainable steel building addresses the growing need for environmentally friendly construction practices in the steel industry. Steel buildings are a significant contributor to the construction sector, and their sustainability is paramount for mitigating environmental impacts.
- The literature surrounding sustainable steel buildings emphasizes various aspects, including energy efficiency, material selection, life cycle assessment, and design optimization. Firoz and Rao's work builds upon these principles, aiming to develop a comprehensive modeling concept that integrates sustainability considerations into the design and construction phases of steel buildings.
- A thorough literature review reveals that sustainable steel buildings have garnered increasing attention in recent years. Numerous studies have highlighted various critical factors contributing to the sustainability of steel structures. Among these factors, energy efficiency, material selection, life cycle assessment (LCA), and design optimization emerge as key considerations. Firoz and Rao's research aims to advance the existing knowledge base by introducing a novel modeling concept that effectively incorporates sustainability principles into the design and construction processes of steel buildings.

Conclusion :

The most important feature governing the choice of steel (I-section)& form of construction for any component is its structural integrity. Where as high specific strength and well-planned project with Tekla software. It is used to select the steel I-Sections for strength and durability of the building to resist various types of dead loads, live loads and wind loads. Planning for energy efficiency, water efficiency and to improve the indoor environment. Tekla software is used for the steel structure for work shop drawings and it gives the connections guide which is use full for better beam column joints strength, there is today an increasing emphasis on other criteria such as environmental durability, embedded energy. The project has been quite instrumental in designing in green concept the knowledge bringing together to planning, designing, analysis, modeling and detailing for the good environmental design concept.

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- The field of structural engineering has seen significant advancements in recent years, particularly in the realm of 3D modeling and detailing. Tekla Structures, developed by Trimble, stands out as a prominent software solution widely used for creating detailed, accurate, and constructible models of steel and concrete structures.
- Several studies and resources in the literature highlight the capabilities and benefits of Tekla Structures in 3D modeling and detailing for structural engineering projects.
- Tekla Structures is a Building Information Modeling (BIM) software that enables architects, engineers, and construction professionals to create accurate 3D models of buildings and structures. The software offers advanced modeling tools for designing steel and concrete elements, including beams, columns, slabs, and connections. Additionally, Tekla Structures provides comprehensive detailing capabilities for generating fabrication drawings, erection plans, and material lists.

Conclusion:

Tekla structures is a vast product that covers the entire structural designs process in a single environment. It enables a single BIM model to be used from the conceptual stages right through to fabrication and beyond its ability to reuse data through design, analysis and detailing phases and model in steel, concrete and timber is somewhat unique in the industry. In terms of modeling this software is extremely powerful. This software does an excellent job of bridging the gap between design and fabrication and through its single environment provides the perfect conduit for data to flow smoothly from engineer to detailer. Most importantly, through it has been potential to simplify the management of an often-fragmented process, leading to enhanced collaboration, better designs, reduce times, and of course the lower cost.

IV. METHODOLOGY

Tekla Structures is a structure data demonstrating programming ready to display structures that integrate various types of building materials, including steel, cement, lumber and glass. Tekla permits primary drafters and architects to plan a structure and its parts utilizing 3D demonstrating, create 2D drawings and access building data. Tekla Structures is utilized in the development business for steel and substantial enumerating, precast and cast in-situ. The product empowers clients to make and oversee 3D underlying models in cement or steel, and guides them through the interaction from idea to manufacture.

V. RESULTS

1. Change In Bolt Size

- Bolt sizes in the SI standard are typically measured in millimeters (mm) and may have designations like M8, M10, M12, etc., indicating the nominal diameter.
- In the US standard, bolt sizes are often denoted in inches (in) and may have designations like 1/4", 3/8", 1/2", etc., indicating the nominal diameter.

2. Change In Beam And column Size

Dimensional Units:

- In the SI standard, beam and column dimensions are typically specified in millimeters (mm) or meters (m).
- In the US standard, dimensions are often specified in inches (in) or feet (ft).

Nominal Sizes:

- Beam and column sizes are denoted differently between the two standards.
- In the SI standard, common beam sizes might include 100x100 mm, 150x150 mm, etc., while column sizes could be 200x200 mm, 250x250 mm, etc.
- In the US standard, beam sizes might be specified as W10x33, W12x45, etc., where the first number indicates the nominal depth in inches and the second number represents the weight per foot in pounds.

3. Difference Bolted Connection By Using IS And Us Standard

Bolt Specifications:

- Both the IS and US standards specify requirements for bolt materials, dimensions, grades, and mechanical properties.
- However, differences in bolt specifications may exist due to regional manufacturing practices, availability of materials, and historical preferences.

Connection Detailing and Fabrication:

- The IS and US standards provide guidelines for detailing bolted connections, including requirements for bolt spacing, edge distances, hole sizes, and tightening procedures.

- Specific detailing and fabrication practices may vary between the two standards based on engineering preferences, construction norms, and industry standards.

4. Steel Quantity:

- In this project, the steel quantity used for the US standard is 28,735 kilograms, while the steel used in the IS standard is 22,680 kilograms.

5. Connections

The bolted connections used for the both standard

- US standard - Column with stiffeners S (187) - 34 NO's
- IS standard - Column with stiffeners S (187) - 34 NO's

6. Bolting Standards:

United States (US) Standard:

American Institute of Steel Construction (AISC): AISC provides detailed specifications for structural bolting in steel construction through its "Specification for Structural Joints Using High-Strength Bolts."

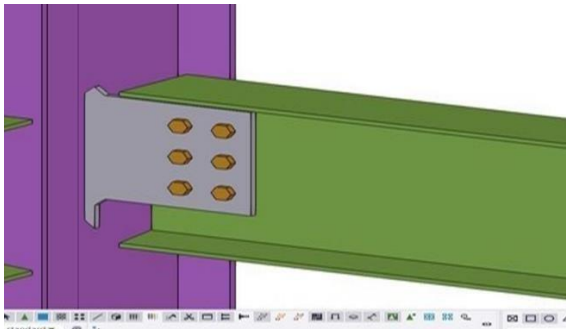
ASTM International: ASTM standards, such as ASTM A325 and ASTM A490, specify the requirements for high-strength bolts used in structural applications. These standards cover material properties, dimensions, testing procedures, and installation requirements.

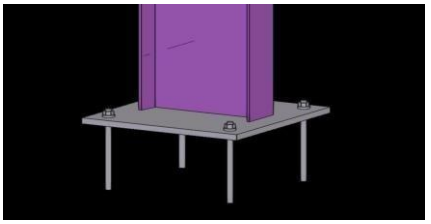
Research Council on Structural Connections (RCSC): RCSC produces guidelines and recommendations for the design, installation, and inspection of structural bolted connections.

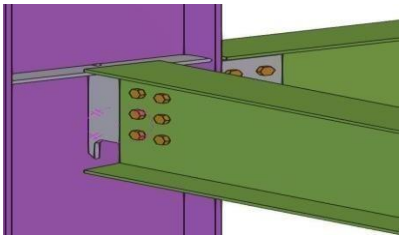
Indian Standard:

Bureau of Indian Standards (BIS): BIS publishes standards related to structural bolting in steel construction, including IS 3757 and IS 6623. These standards cover various aspects such as material specifications, dimensions, testing methods, and installation procedures for structural bolts.

Indian Roads Congress (IRC): IRC provides guidelines for bolted connections in bridges and highway structures, ensuring safety and durability in transportation infrastructure projects.







VI. CONCLUSION AND FUTURE SCOPE

1. Conclusion

- The comparison between the SI standard and the US standard reveals significant differences across bolt sizing, beam and column dimensions, and bolted connections. Bolt sizing varies significantly, with the SI standard using millimeters (mm) and the US standard using inches (in) for designation. Beam and column sizing disparities encompass dimensional units and nominal sizes, with the SI standard employing millimeters (mm) and the US standard using inches (in) and alphanumeric designations. These variations emphasize the importance of adhering to specific standards to ensure accurate bolt selection, beam and column sizing, and compatibility in construction projects.

- Furthermore, differences in bolt specifications, detailing, and fabrication practices are evident between the IS and US standards. While both standards outline requirements for bolt materials, dimensions, and mechanical properties, regional manufacturing practices and material availability may lead to disparities. Additionally, guidelines for detailing bolted connections, including bolt spacing, edge distances, and hole sizes, may vary between the standards based on engineering preferences and construction norms. Understanding these distinctions is essential for maintaining the integrity and reliability of bolted connections in structural applications following either the IS or US standards.

- The comparison of steel quantities used in the project based on the US and IS standards reveals notable differences. The steel quantity for the US standard is calculated to be 28,735 kilograms, whereas for the IS standard, it amounts to 22,680 kilograms. This variance in steel quantity may stem from differences in structural design criteria, material specifications, and fabrication practices

between the two standards. Understanding and accounting for these disparities are essential for ensuring accurate material estimation, cost estimation, and structural integrity in construction
projects adhering to either the US or IS standards.

2. Future Scope

- The integration of digital technologies such as Building Information Modeling (BIM), advanced simulation software, and artificial intelligence (AI) could revolutionize the design, analysis, and construction of steel structures. Future developments in these technologies could facilitate real-time collaboration, predictive modeling, and optimization of structural systems, leading to more efficient and sustainable construction practices.
- With increasing emphasis on sustainability and environmental conservation, future research could explore innovative approaches to minimize the environmental impact of steel structures. This could include the use of recycled materials, energy-efficient design strategies, and lifecycle assessment tools to evaluate the environmental footprint of steel construction projects.

VII. REFERENCES

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