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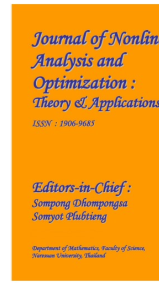

ANALYSIS AND DESIGN OF COMPOSITE STEEL FRAME STRUCTURE

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Abstract: Composite steel frame structures present a compelling alternative to conventional steel or concrete construction methods[1], offering a host of benefits that enhance their appeal in modern building projects[2]. By combining steel and concrete elements, these structures achieve an exceptional strength-to-weight ratio[3], bolstering their load-bearing capacity while minimizing overall weight. [4]This reduction in weight not only facilitates cost savings but also affords greater design flexibility and ease of construction[5], ultimately contributing to shorter project timelines. Moreover, [6]the incorporation of concrete encasement provides inherent fire resistance,[7] bolstering the safety and longevity of the structure.[8] To ensure the efficacy of composite steel frames, a thorough analysis and design approach is essential.[9] Finite element analysis software is employed to meticulously evaluate structural behavior under diverse loading conditions, encompassing dead loads, live loads, wind, and seismic events.[10] Throughout the design process, careful consideration is given to various factors,[11] including the selection of appropriate steel sections tailored to specific structural requirements,[12] the determination of concrete properties to optimize compatibility and performance,[13] and the meticulous design of shear connectors to facilitate effective load transfer between steel and concrete elements.

Keywords:*Composite steel frame structure , conventional steel;, sustainable construction*

1. INTRODUCTION

- A composite steel structure is a type of construction where steel and concrete are combined to create a single, integrated structural system[14]. In such structures, the steel and concrete elements work together to optimize the performance of the building or structure[15]. Here's a brief explanation of the key components and advantages of composite steel structures[16] .The steel sheeting provides adequate tensile capacity in order to act with no shear reinforcement[17]. The shear between the steel and concrete must be carried by friction and bond between the materials[18]. The mechanical keying action of the embarrassments is of great importance. This is especially so in open trapezoidal profiles, where the embarrassments must also provide resistance to vertical separation[19]. In addition to structural adequacy, the finished slab must be capable of satisfying the requirements of fire resistance The combination of steel and concrete exploits the strengths of each material[20], resulting in a structure that offers superior performance compared to traditional steel or concrete structures alone.Composite steel frames are well suited to high-traffic structures like buildings and bridges[21]. They have several benefits over traditional steel or concrete beam structures, including[22]: Higher span-to-depth ratio, Reduced deflections, and Higher stiffness ratios.Composite steel structures are a type of construction that combines steel and other materials[23], such as concrete, to create a stronger and more efficient building system.

- Concrete is good at resisting compression, but not tension. Steel is used to reinforce the concrete and carry tensile forces[24]. The two materials are structurally tied together so that the concrete can carry compression and the steel can carry tension the long-term response of composite columns[25], slabs and beams considered separately[26]. In the case of composite columns, 5 particular attention has been devoted to the influence of time effects on the ultimate response, role of confinement at service conditions and possible occurrence of creep buckling[26]. Very limited work has been carried out to date on the long-term response of composite slabs[27]. Because of this, only brief considerations are provided on this solution while still presenting recent research dealing with the development of shrinkage gradients through the slab thickness when cast on steel decks[28]. The work outlined on composite beams has been categorized according to different design issues[29], which include shear-lag effects, the shear deformability of the steel beam[30], influence of time effects on the ultimate response, prestressing, time-dependent buckling, and sequential casting of the slab[31].

2. MATERIALS USED

A. Steel beams

steel beams form the primary load-bearing elements of the structure**[32]**. These beams provide support for the floors and transfer the loads to the columns and foundations**[33]**. They are typically made of high-strength steel and come in various shapes and sizes depending on the structural requirements

B. . Concrete Slabs

Concrete slabs are used to form the floor and roof decks in composite steel structures. These slabs are typically poured onto steel decking, creating a composite action between the concrete and steel**[34]**. The concrete slabs enhance the stiffness and strength of the floor system while providing fire resistance and sound insulation.

C. Shear Connectors:

Shear connectors are used to ensure composite action between the steel beams and concrete slabs**[35]**. These connectors are typically welded to the top flange of the steel beams and extend into the concrete slab. They enhance the load transfer between the steel and concrete, allowing them to act together as a single unit under load

D. Steel Columns

Steel columns provide vertical support for the structure and transfer the loads from the beams to the foundations**[36]**. Similar to steel beams, columns are made of high-strength steel and come in various shapes and sizes depending on the structural requirements**[37]**. They are typically connected to the beams using welding or bolting**[38]**.

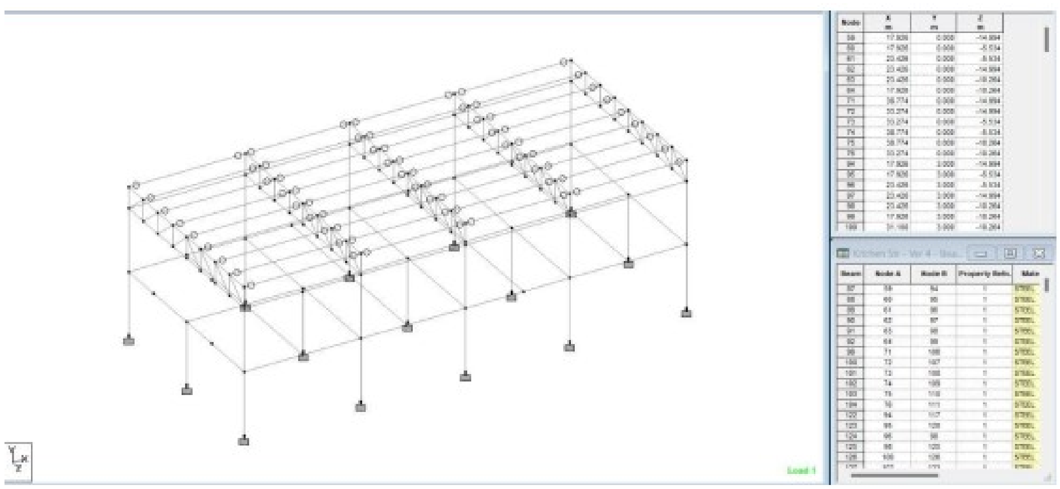
3. CALCULATION

A. NUMBER OF JOINTS 136

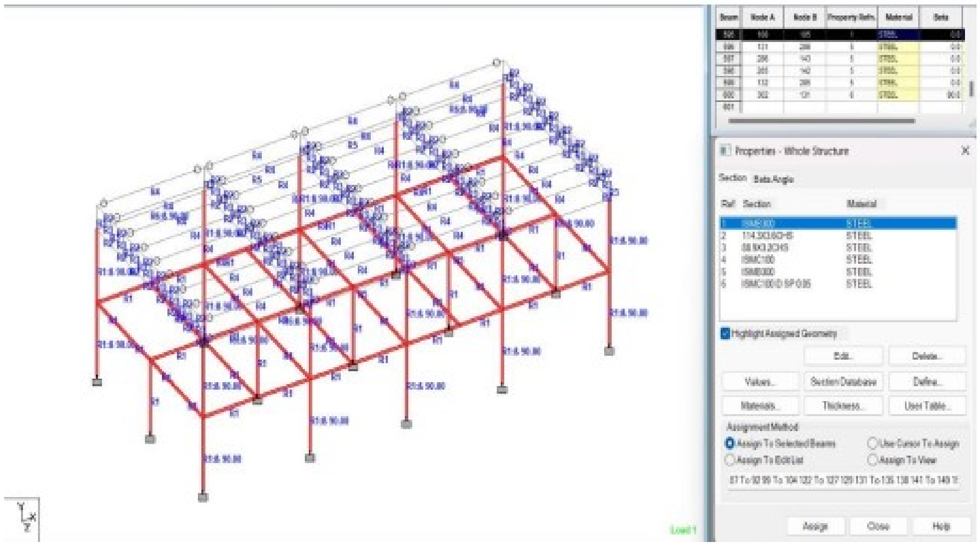
B. NUMBER OF MEMBERS 280
C. NUMBER OF PLATES 0
D. NUMBER OF SOLIDS 0
E. NUMBER OF SURFACES 0
F. NUMBER OF SUPPORTS 15
G. . 50 DXF IMPORT OF KITCHEN CENTERLINE.DXF -- PAGE NO. 5 SOLVER USED IS THE OUT-OF-CORE BASIC SOLVER ORIGINAL/FINAL BAND-WIDTH= 100/ 24/ 138 DOF TOTAL PRIMARY LOAD CASES = 2, TOTAL DEGREES OF FREEDOM = 726 TOTAL LOAD COMBINATION CASES = 8 SO FAR. SIZE OF STIFFNESS MATRIX = 101 DOUBLE KILO-W

METHODOLOGY:

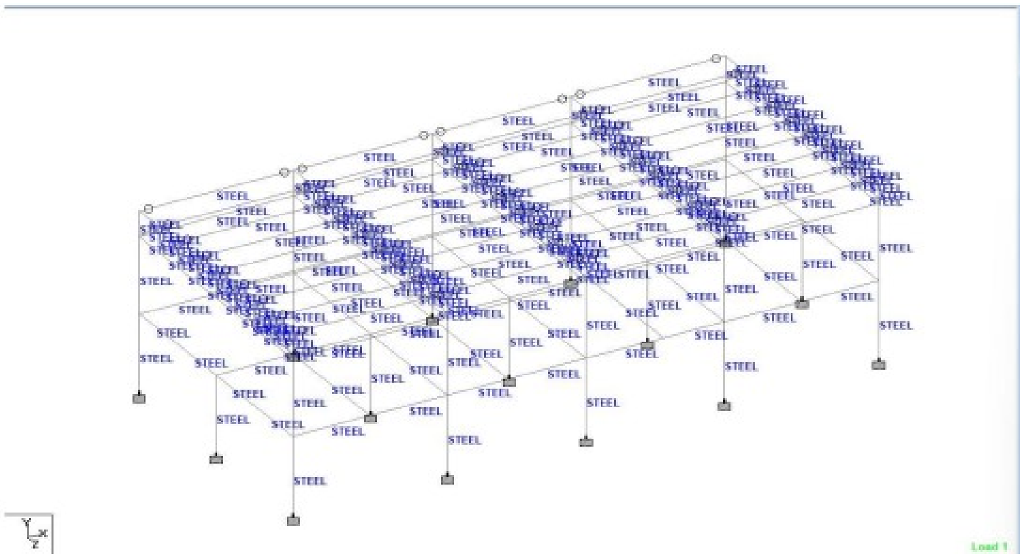
Geometry: Geometry is used to define the connectivity between structural members. Users specify how beams, columns, and other elements are connected at joints or nodes**[39]**. This connectivity information is essential for determining the structural response and load distribution throughout the model**[40]**.For each structural member (beams, columns, braces, etc.), users define the geometry, including the cross-sectional dimensions and orientation. This information is crucial for accurately analyzing the behavior of each member under various loading Geometry is used to specify the locations where loads are applied to the structure. Users define the coordinates or nodes where loads such as dead loads, live loads, wind loads, etc., are applied. This ensures that loads are accurately distributed throughout the Structure during analysis



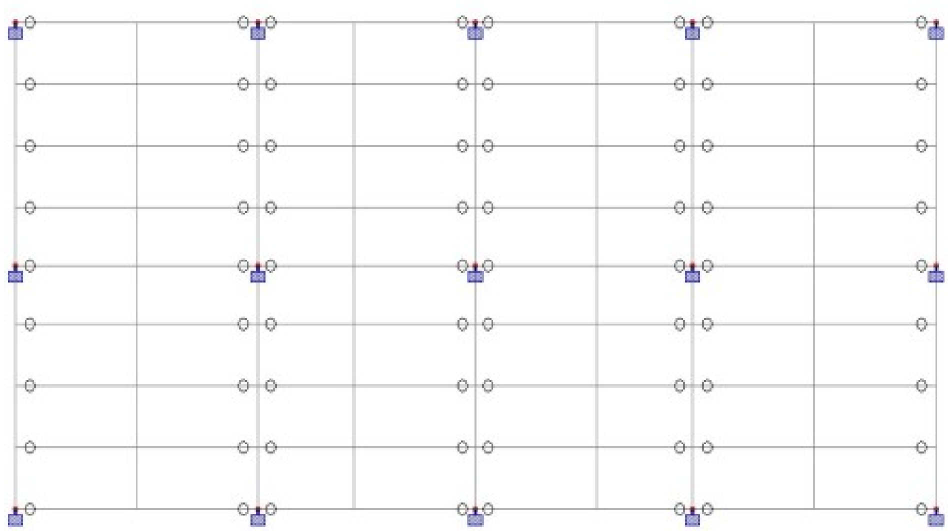
Properties : Properties define the geometric characteristics of structural members, such as beams and columns. These properties include dimensions like depth, width, flange thickness, web thickness, and shape (e.g., I-section, channel section, etc.). Section properties are crucial for calculating the stiffness, moment of inertia, and other structural properties necessary for analysis.Material properties define the mechanical properties of the materials used in the structure, such as steel, concrete, or composite materials. These properties include parameters like Young's modulus (E), yield strength, ultimate strength, density, Poisson's ratio, and thermal expansion coefficient. Material properties are vital for accurately modeling the behavior of the structure under various loading conditions and environmental factors. Support properties define the characteristics of supports or restraints applied to the structure



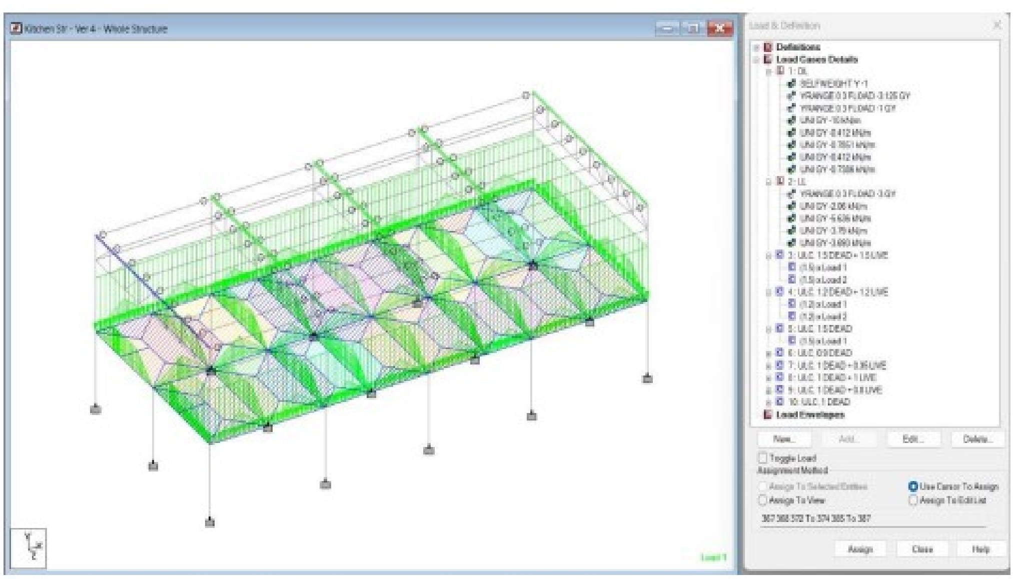
Materials: Materials play a crucial role in defining the mechanical properties of the structural elements used in the analysis and design of a structure. Here are some key materials typically used in STAAD.Pro Steel is commonly used for beams, columns, braces, and other structural elements in buildings and bridges. In STAAD.Pro, users can define various grades of structural steel, each with its own mechanical properties such as yield strength, ultimate strength, Young's modulus (modulus of elasticity), Poisson's ratio, and thermal expansion coefficient. Steel materials are specified according to relevant design codes such as AISC (American Institute of Steel Construction), Eurocode, or other international standards. Composite materials, such as reinforced concrete or composite steel-concrete sections, are often used to take advantage of the strengths of both steel and concrete. In STAAD.Pro, users can define composite sections by specifying the properties of the steel and concrete components separately and combining them to create a composite section with enhanced mechanical properties.



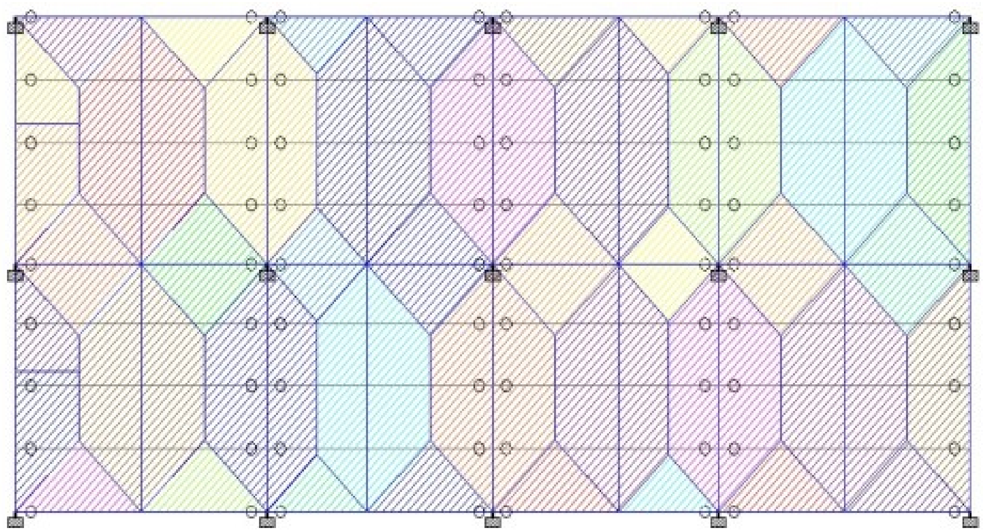
Supports : Supports play a crucial role in modeling the boundary conditions of a structure, representing how the structure interacts with its supports or foundations. Supports restrain the degrees of freedom of the structure at specific locations, influencing its behavior under loading conditions. Here are some common types of supports used in STAAD.Pro drawings: A fixed support fully restrains all translational and rotational degrees of freedom at a specified node. This means that the structure cannot translate or rotate at the fixed support location. Fixed supports are typically used to represent rigid connections or foundation conditions where movement is restricted in all directions. By applying these types of supports appropriately in STAAD.Pro, engineers can accurately model the behavior of the structure under various loading conditions and analyze its response to external forces while considering the support conditions at different points within the structure.



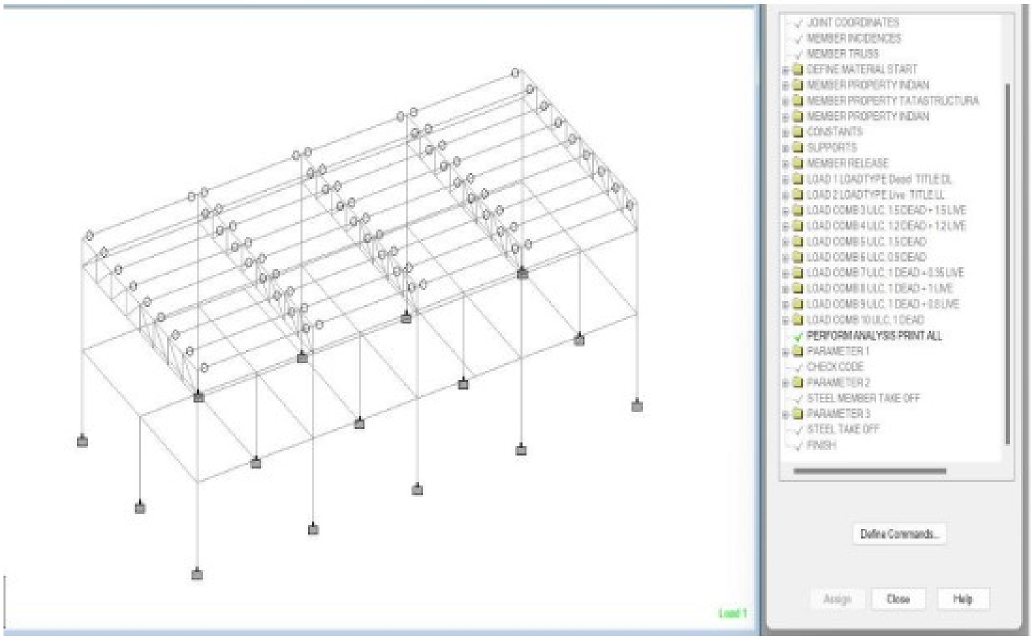
Loadings : Loadings refer to the external forces and moments applied to the structure, which include dead loads, live loads, wind loads, seismic loads, temperature loads, and other environmental or imposed loads. Here are the main types of loadings typically considered in STAAD drawings : Dead loads represent the permanent or stationary loads acting on the structure due to its own weight and the weight of its permanent components, such as the self-weight of structural members, finishes, partitions, equipment, and fixed installations. Live loads represent the variable or transient loads acting on the structure due to the occupancy or intended use of the building or structure. Examples include occupant loads, furniture loads, equipment loads, snow loads, and temporary construction loads. STAAD.Pro allows users to define load combinations that consider the simultaneous effects of different types of loads acting on the structure. Load combinations are defined based on applicable design codes and standards, considering factors such as load factors, load durations, and load combinations for strength and serviceability criteria. loadings in STAAD drawings are essential for accurately simulating the behavior of the structure under various loading conditions and performing structural analysis and design to ensure safety, stability, and compliance with applicable codes and standards



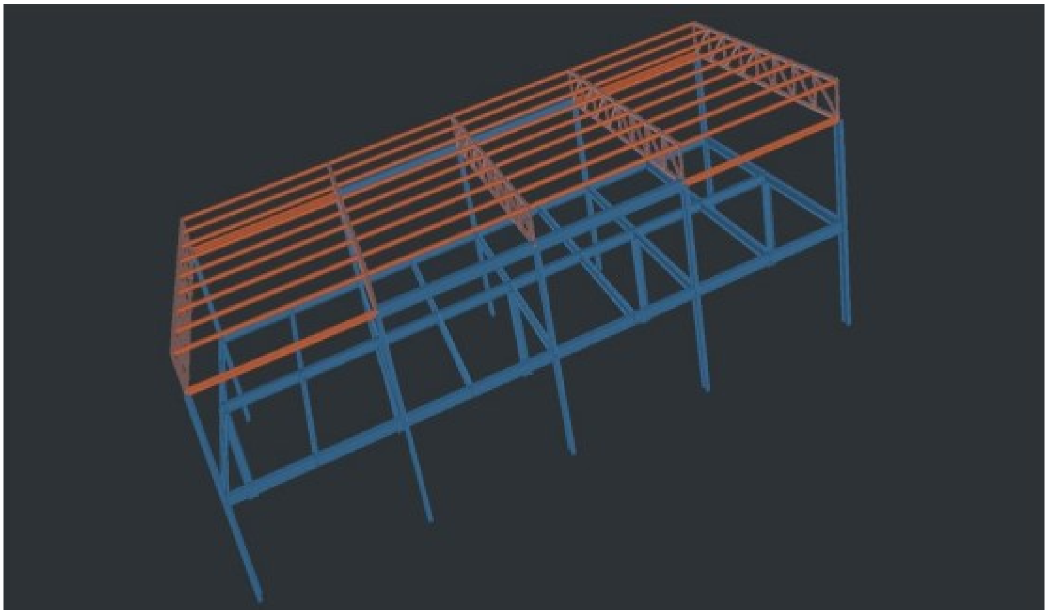
Load Distribution : Load distribution refers to how loads are distributed among the structural elements within a model during the analysis process. Load distribution is a critical aspect of structural analysis as it determines how various loads, such as dead loads, live loads, wind loads, and seismic loads, are transmitted and distributed throughout the structure Before running an analysis, users must assign loads to the structural model. This involves specifying the magnitude, direction, and distribution of loads, as well as load combinations and load cases. Loads can include dead loads (permanent loads), live loads (variable loads), wind loads, seismic loads, temperature loads, etc. Once loads are assigned, STAAD.Pro calculates how these loads are transferred and distributed among the various structural elements in the model. This includes determining how loads are transmitted through beams, columns, slabs, walls, and other members based on their stiffness, connectivity, and support conditions STAAD.Pro calculates load paths within the structural model to determine how loads are distributed from their point of application to the supports. This involves analyzing the structural system to identify the most efficient paths for load transfer while ensuring equilibrium and stability.



Analysis : Analysis refers to the process of determining the internal forces, displacements, and other response characteristics of a structural model subjected to various loads and boundary conditions. STAAD.Pro offers different types of analysis methods to accommodate different types of structures and loading conditions. Here's an overview of the analysis process in STAAD.Pro The analysis process starts with creating a structural model in STAAD.Pro. Users can define the geometry of the structure by inputting nodes, members (beams, columns, etc.), and supports using the graphical user interface or by importing a model from a CAD software. Dynamic analysis calculates the dynamic response of the structure to transient loads, such as seismic or wind loads. It considers the effects of inertia, damping, and stiffness to determine the dynamic behavior of the structure. the analysis process in STAAD.Pro involves creating a structural model, assigning materials and loads, defining support conditions, selecting appropriate analysis methods, running the analysis, and interpreting the results to ensure the structural integrity, safety, and performance of the design



Design : Design in STAAD.Pro involves the process of verifying whether a structural model meets specific design code requirements and standards for structural safety and performance. STAAD.Pro offers various design modules tailored to different types of structures and design codes. Here's an overview of the design process in STAAD.Pro Users define load combinations based on design codes and standards. Load combinations typically include various load cases such as dead loads, live loads, wind loads, seismic loads, temperature loads, etc. These load combinations are used to assess the structural response under different loading scenarios. After completing the design process, STAAD.Pro generates design results including design reports, design drawings, design charts, and other documentation summarizing the design calculations, member sizes, reinforcement details, and other design parameters the design process in STAAD.Pro involves setting up the model, selecting design parameters and criteria, running the design modules, reviewing the design results, and verifying the structural integrity and safety of the design according to applicable design codes and standards



CONCLUSION

composite steel and concrete systems are a viable alternative to both bare steel and reinforced concrete structures. They exhibit enhanced stiffness, strength and ductility. Moreover, their technology allows an easy of construction along with economy. Composite columns are structural members which benefit more of the composite action. In fact, concrete cover and/or filler prevents the occurrence of local buckling; in turn, steel hollow section enhances the concrete confinement. Additionally, fire and corrosion resistance can be achieved by using ordinary thicknesses of concrete. Composite frames benefit of the improved performance of steel and concrete columns; beams are generally in bare steel to yield at an early stage in compliance with the capacity design rules. Recently, different codes of practice have been issues for both static and seismic loads. However, the implemented provisions should be further investigated and their reliability re-assessed. Interaction between steel and concrete, beam-to-column and base column connections require additional extensive experimental and numerical work as the corresponding design rules relies on limited datasets.

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