Design and Analysis of Suspension Cable Bridge

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***Abstract*— Infrastructure including bridges, rivers, canals, lakes, and buildings are all included in the field of civil engineering, which deals with the design, construction, and administration of both man-made and natural structures. For civil engineers, bridging has always been one of the most fascinating problems. Concrete, steel, iron, and wood were used in the bridge's construction. India is home to the vast bulk of reinforced concrete bridges. This project evaluates and designs a cable suspension bridge using STAAD Pro in accordance with standard design requirements specified in Indian Codes. The proposed suspension cable bridge is designed using STAAD Pro. The analysis of lateral loads often uses a variety of loads and configurations. The State Limit system must be followed when conducting structural design.**

The purpose of long-span bridges is to cross obstacles. Bridges are built to make it easier to cross rivers, lakes, valleys, roadways, and other barriers. Cable-stayed bridges have become the most structurally common technique for long spans throughout the last 20 years. High-strength materials and innovative techniques can be used to build a long-span bridge. The expansion of infrastructure facilities in every country is driving up demand for long-span bridges. High-strength materials and innovative analytical techniques can be used to build a long span bridge. Both suspension and cable-stayed designs are included in the category of cable-supported bridges. The behavior of cable-supported bridges is quite flexible. Through tension cables fastened to the tower, the bridge deck concurrently balances the live load and the dead load of the superstructure, which is the bridge deck's self-weight. The entire operational load is supported by the bridge's tower. Cable-stayed bridge decks, in which the deck structure is supported by steel cables, are the result of creative ways to reduce the depth of girders in large-span bridges. The goal is to perform a thorough investigation and analysis of the cable-stayed bridge, an effective structure that is constantly changing.

Keywords: Civil engineering, STAAD, cable bridge.

A suspension link is a structure that suspends the deck (the bearing segment) using vertical suspenders that are joined by suspension joints. The main examples of this growth that are currently available were successful throughout the middle of the nineteenth century. There is a long history of simple, vertical suspension stretches on numerous uneven surfaces around the world. In addition to vertical suspension connections that convey the deck's underlying gravity during cross operation, this grinding technique uses links suspended between towers. To provide more versatility for this approach, the deck may be flat or arched upward. Like other suspension connector types, this composition is also built without falsework. Every load connected to the extension of these fundamental connections is converted to tension, so the suspension links must be secured at every termination point. The primary connections reach the backrests at the field's deck level after passing through the columns. Holders are vertical suspenders or bars that support the path. In some cases, the towers might be placed on the edge of a valley or a barrier where the path precisely follows the primary track. The fabric, which may be strengthened by the suspender ties, usually has a two-liter capacity between the column alignment and the road. The separable theoretical ties in the previously given example would be similar to the lack of a circular section.

Advantages

Compared to other types of bridges, longer necessary spans are possible.

Even at attainable spans, less fabric might be required than with other bridge styles, which would lower construction costs. can be more resilient to seismic shocks than bridges that are heavier and more rigid.

Extremely high voltage is carried by suspension bridges' principal cables. Careful steps must be taken to prevent corrosion because system failure is a real possibility. To provide the best possible safety for the vital wires in suspended bridges, a complex, all-encompassing safeguarding strategy was developed. A corrosion protective agent will be put to the wire in multiple layers after installation. An example of the various levels that follow is:

Encapsulation in polyester film

The initial plastic resin layer

A layer of non-woven glass mat that has been crushed

An additional sheet of plastic resin

Cable-stayed bridges are important and visually arresting structures. Because of their attractive designs and lower construction costs, cable-stayed bridges are being built more frequently worldwide. Due to their great flexibility and poor damping, cable-stayed bridges, which are now common, are susceptible to severe seismic activity. The structural system of cable-stayed bridges consists of a deck and continuous girders, which are held up by cables fastened to towers at the main piers. The main span, the tower, and the rear span can all be made more rigid by adding intermediate tension piers, using backstays on specific components, or using rigid towers to create total structural stiffness. This method has a number of advantages over suspension bridges, chief among them being the need for fewer foundations, the introduction of high-strength steel, improvements in welding technology, advances in structural analysis, and the use of modern building methods.

METHODELOGY

The most extensively integrated, effective, and useful structural software on the market right now is STAAD PRO. With well-designed templates, complex models can be produced and merged. Along with comprehensive automated assessments of metal and urban layout codes in compliance with US, Canadian, and international requirements, the integrated layout code functionalities may independently generate wind, wave, bridge, and earthquake analyses.

STAAD Pro stands for Structural Analysis and Design Program. Generally, structural analysis software consists of three parts:

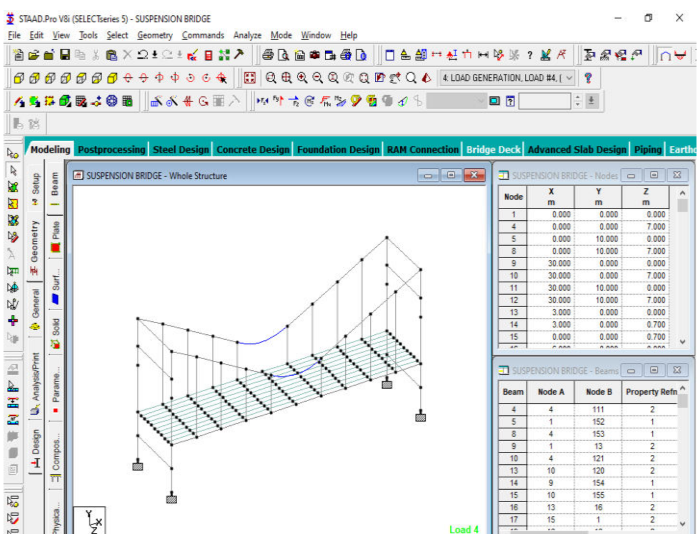
• Preprocessing: builds the model and gathers and organizes the information needed for the analysis.

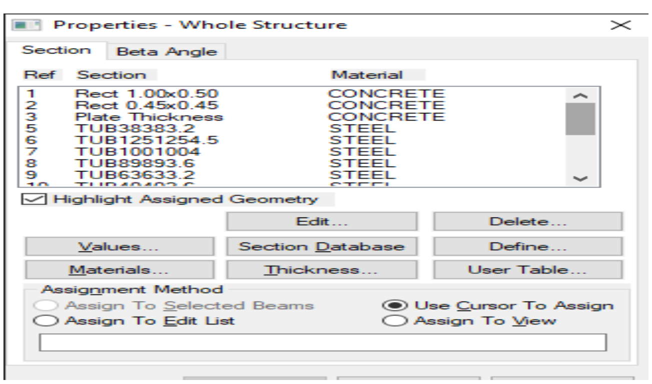
• Processing: Calculates stresses, reactions, member forces, displacements, etc.

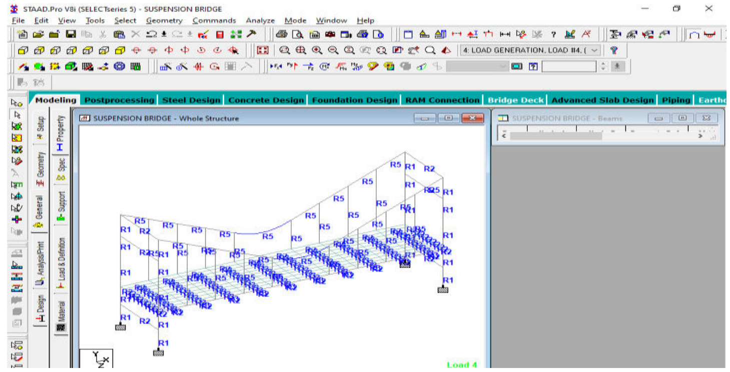
• Post-processing: Shows the results.

The program's tabbed structure naturally suggests that the STAAD.Pro modeling and design process can be condensed into a typical workflow.

One. Basic Geometry: Using beams, columns, plates, and/or solid components, describe the structure's basic geometry..

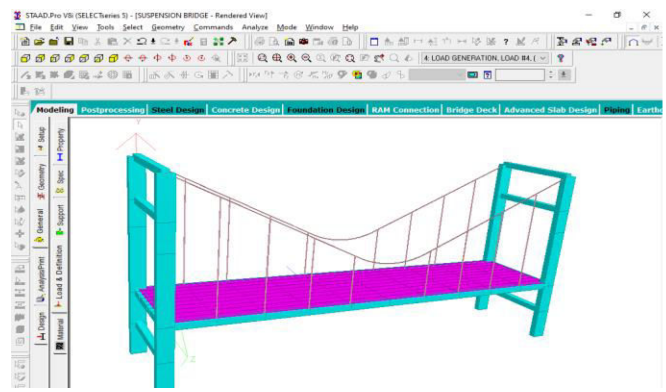






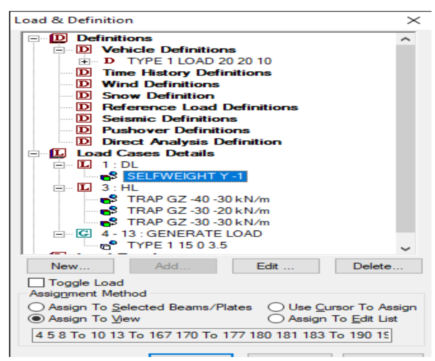
3. Materials Constants: Specify material such as timber, steel, concrete, or aluminum to define Poisson's Ratio, Coefficient of Thermal Expansion, density, etc.

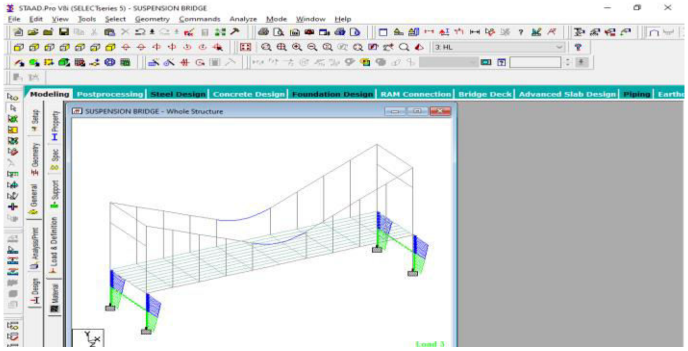
4. Member Specifications: Define member orientations, member offsets, member releases where moment transfer is to be limited or eliminated, and conditions that only allow a partial transfer of certain types of forces such as tension-only.



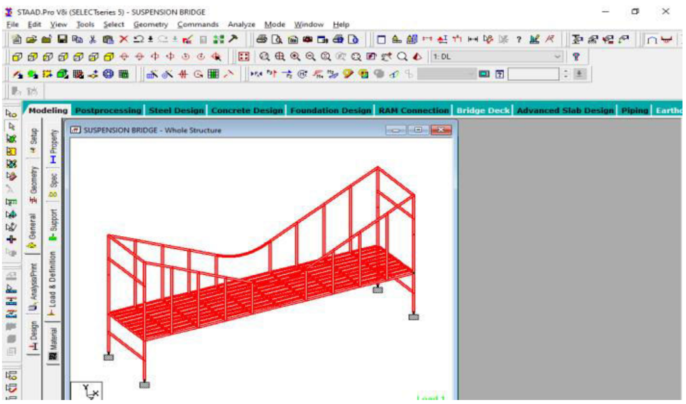
5. Supports: Define support locations and boundary conditions including moment fixity, support stiffness, and support angle.

6. Loads: Assign loads such as self-weight, dead, live, wind and seismic, and define load combinations.

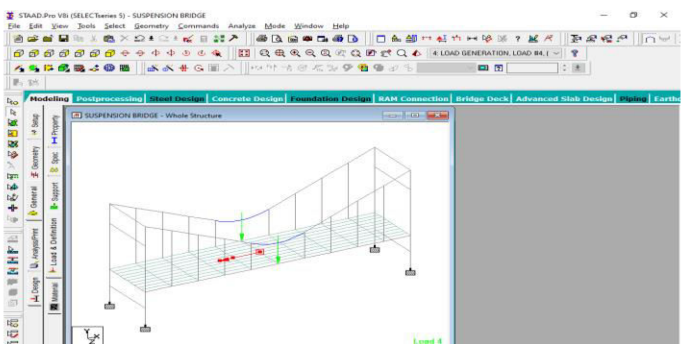




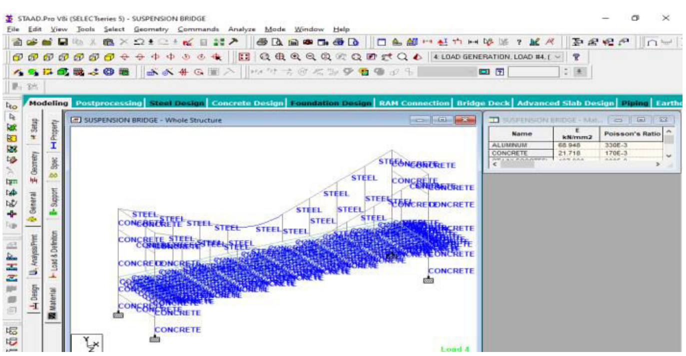
HYDROSTATIC LOAD



DEAD LOAD

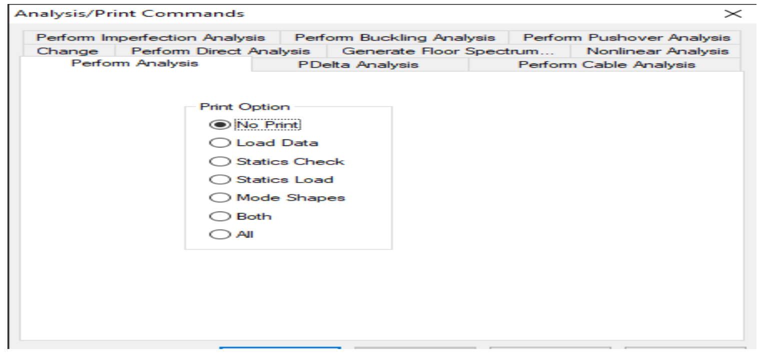


VEHICLE LOAD

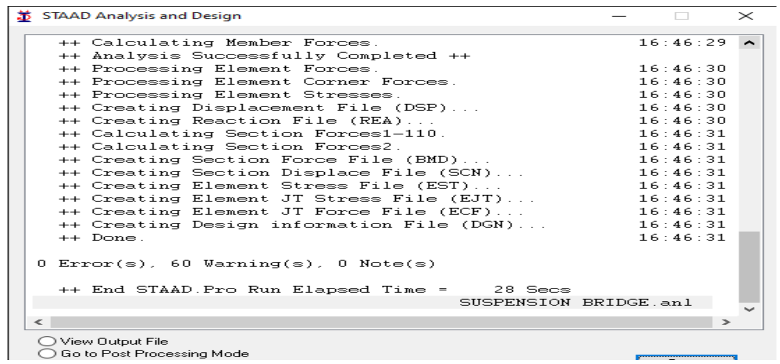


MATERIAL

7. Analysis Instructions: Indicate the type of analysis to be performed (regular analysis, P-delta, Buckling, Pushover, etc.) and define associated options.

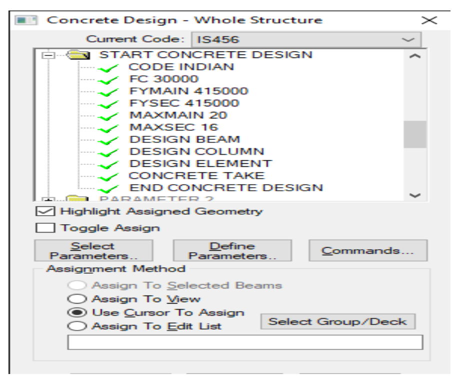


PERFORM ANALYSIS

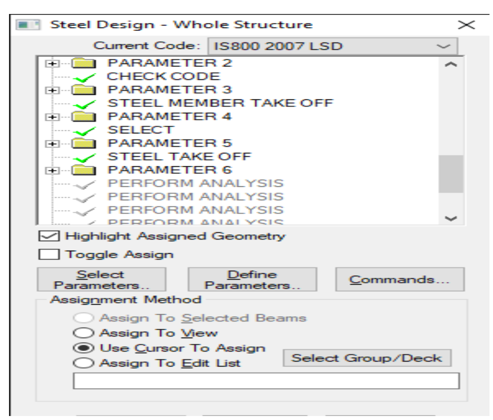


ANALYSIS

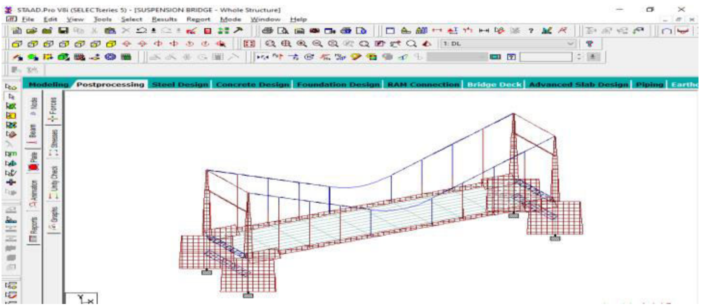
RESULT



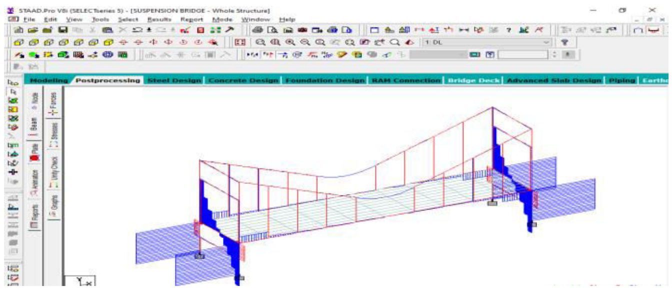
CONCRETE DESIGN



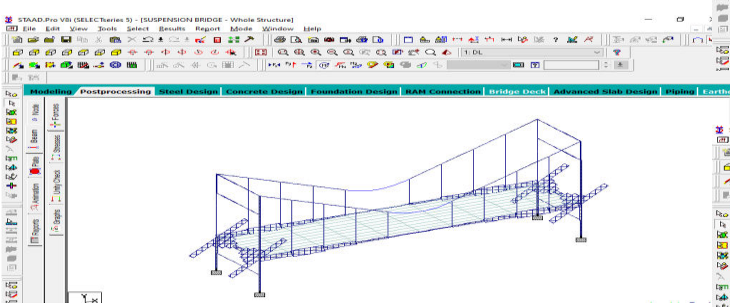
STEEL DESIGN



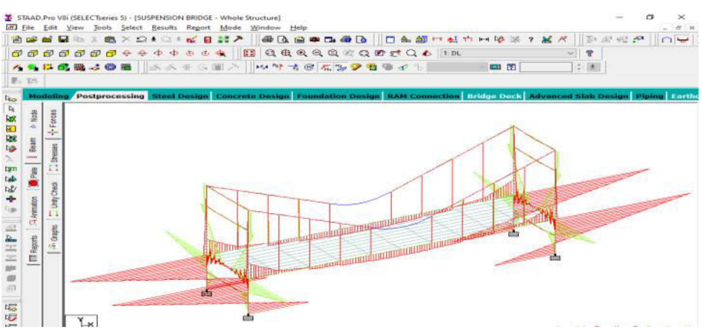
SF-X UNDER DEAD LOAD



SF-Y,Z UNDER DEAD LOAD



BM-X UNDER DEAD LOAD



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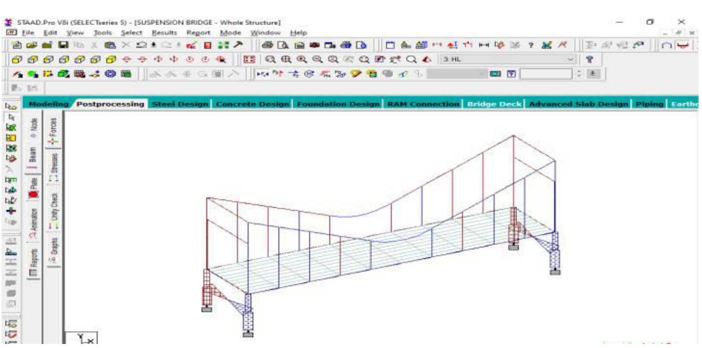
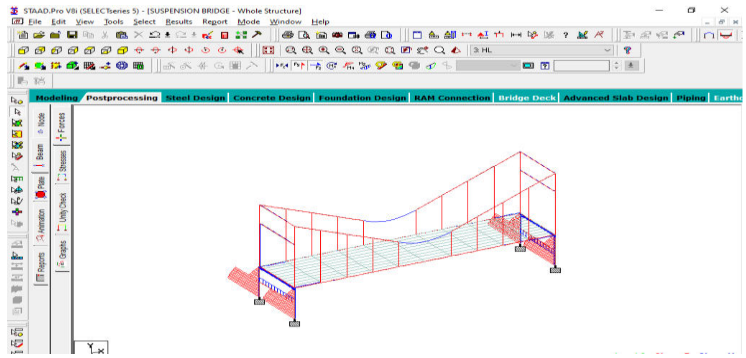
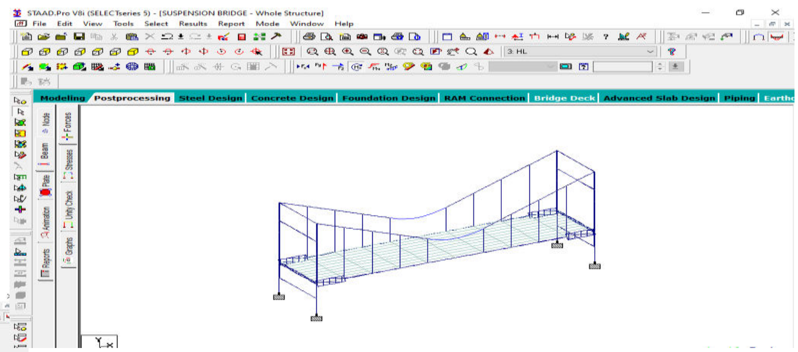


SF-X UNDER HYDROSTATIC LOAD



SF-Y,Z UNDER HYDROSTATIC LOAD



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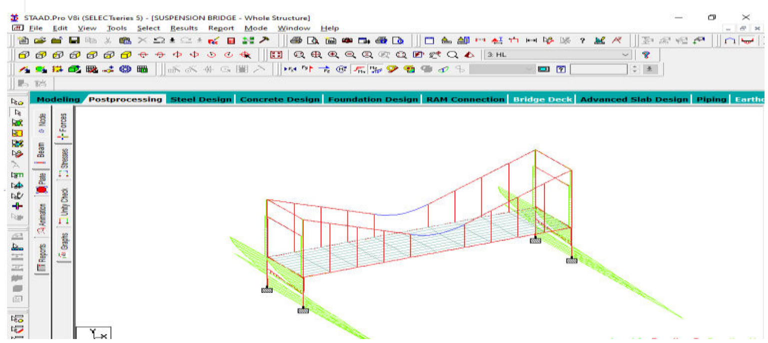
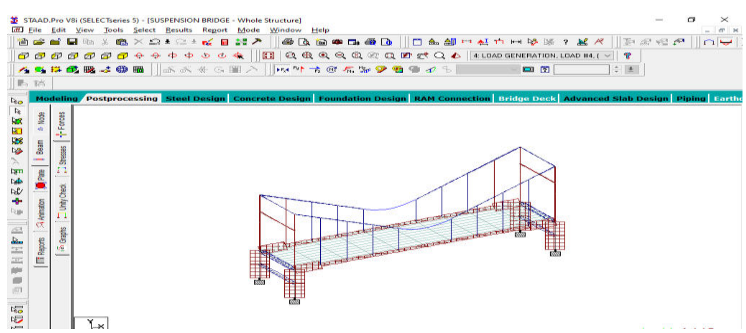
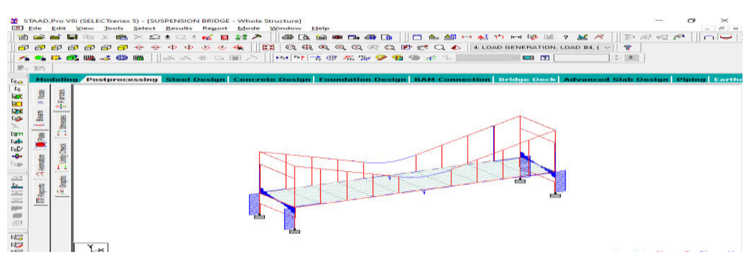


BM-Y,Z UNDER HYDROSTATIC LOAD



SF-X UNDER VEHICLE LOAD



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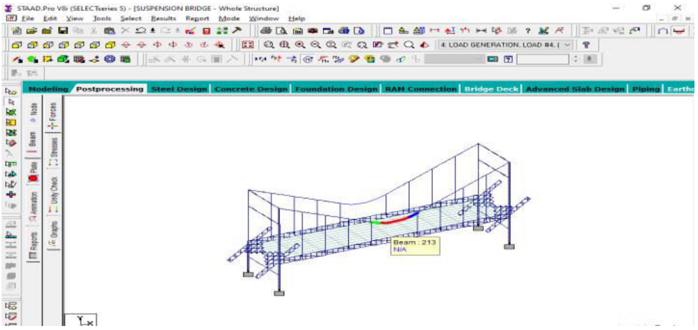

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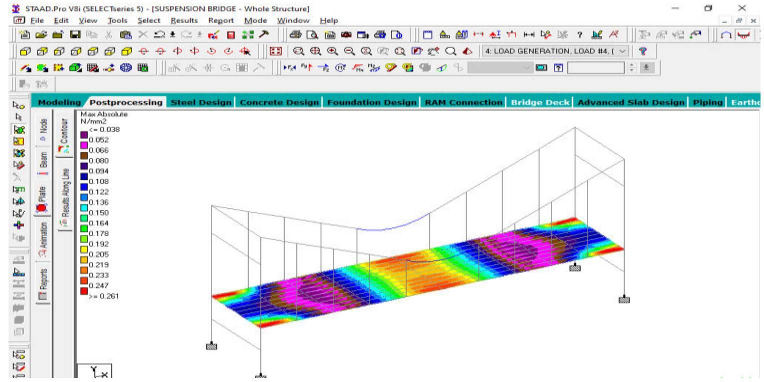
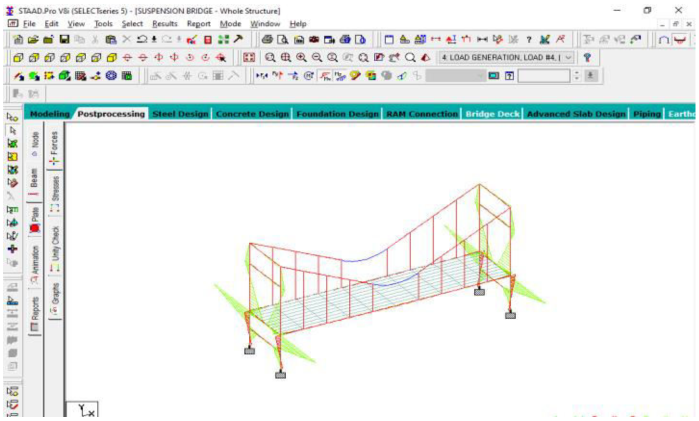
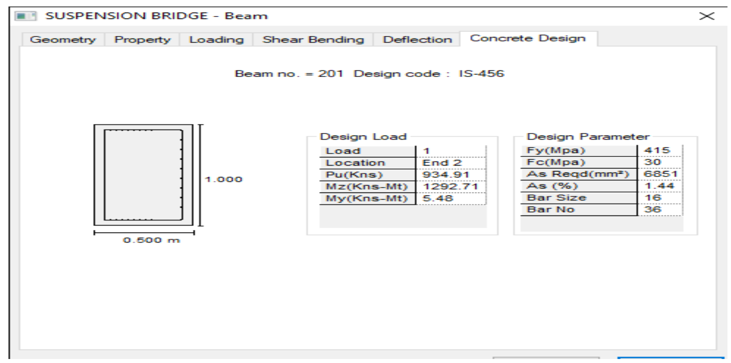


PLATE STRESS UNDER VEHICLE LOAD



BM-Y,Z UNDER VEHICLE LOAD



CONCRETE DESIGN FOR MEMBER201

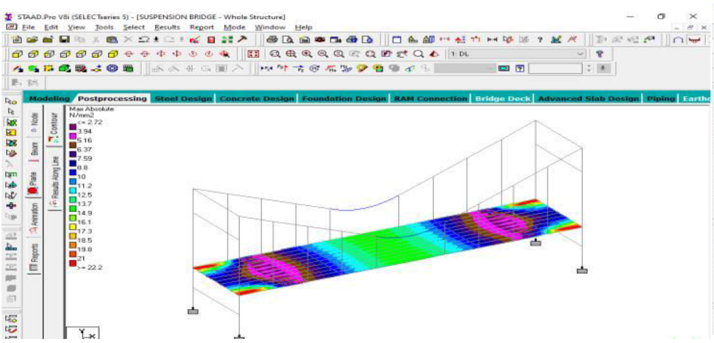
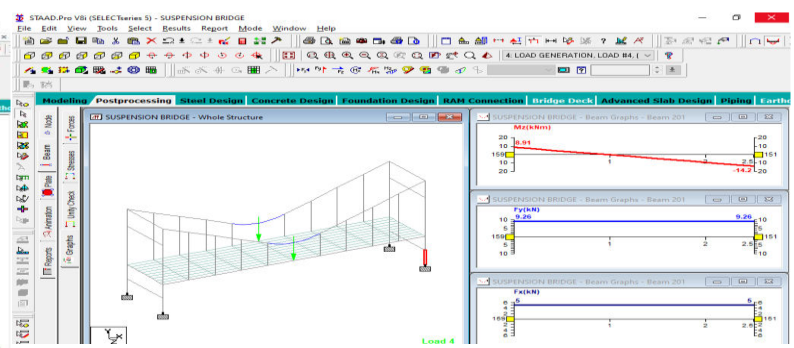


PLATE STRESS UNDER DEAD LOAD



SF AND BM FOR MEMBER201

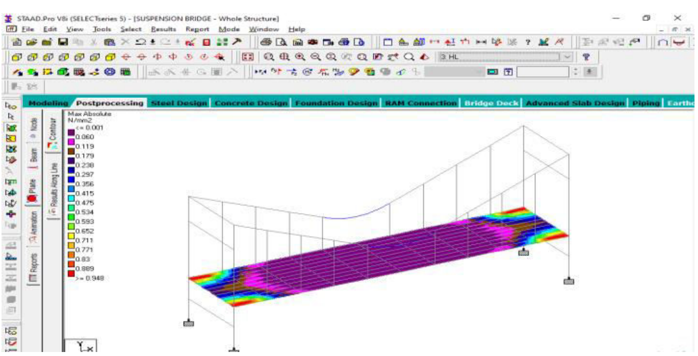
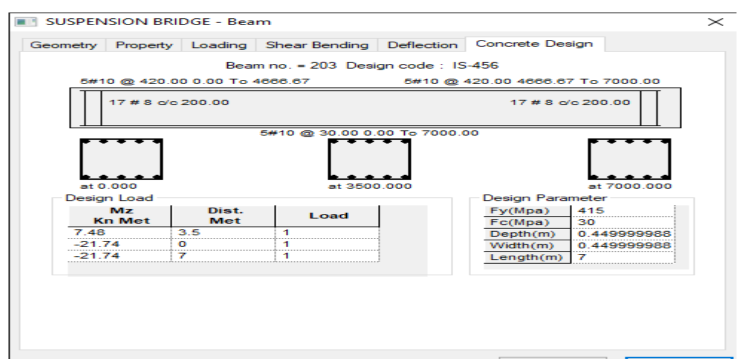
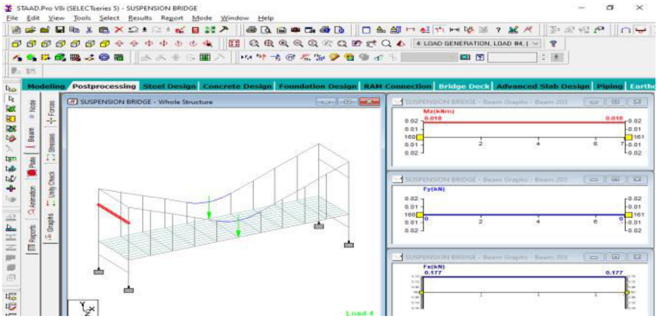


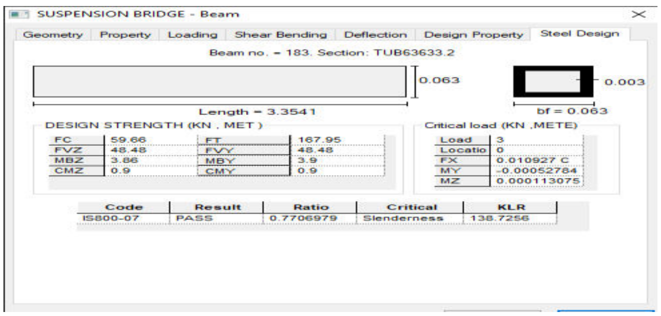
PLATE STRESS UNDER HYDROSTATIC LOAD



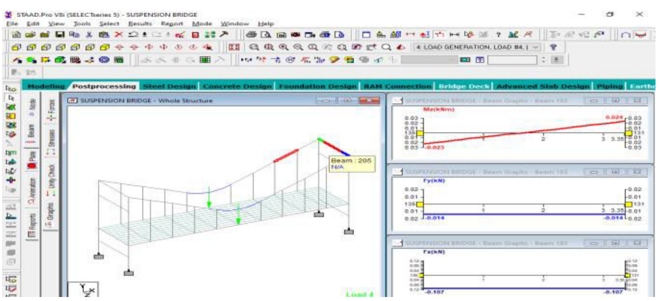
CONCRETE DESIGN FOR MEMBER203



SF AND BM FOR MEMBER 203



STEEL DESIGN FOR MEMBER183



SF AND BM FOR MEMBER 183

RESULTS

• The suspension cable bridge may provide spaces and amenities for people to gather for social, commercial, or recreational events. It may also allow shops and organizations whose continuity is necessary for a suspension cable bridge to interact within the preservation area of its premises. Since cables are extremely thin, externally influenced components, special consideration should be given during the design process. One common occurrence with cables is vibration. Damping systems are utilized to prevent unneeded vibration amplitudes from compromising the system's stability. This project involves a suspension bridge with a span length of 240 meters and a carriage width of 7.5 meters. The basic bridge components, including the deck slab, cable design, suspenders and pile foundation, and abutments, are designed manually and analyzed using STAD PRO. The results are displayed in this document.

• The study and redesign of a suspension cable bridge utilizing STAAD were highlighted in this paper.Pro®. STAAD was used to model the proposed suspension cable bridge.Pro®. The frame investigation includes a variety of loads and combinations. An environmental impact evaluation of the bridge's potential effects on the neighborhood and the logistics of its construction were also included. The design was completed by hand using pertinent IS codes for completeness.

• The stiffness of cable-stayed bridges is significantly higher than that of suspension bridges, which reduces deck distortion.

• Because cable stayed bridges were very statically indeterminate constructions, it was necessary to analyze them in order to determine the precise solution for these highly indeterminate systems.

• Because the cables can withstand more pressure, cable-stayed bridges are far more rigid.

• In this case, the research takes into account various cables, towers, and cable configurations.

• The way the cables are attached to the towers distinguishes suspension bridges from cable stayed bridges.

• In cable-stayed bridges, the cables are directly attached to the bridge tower's inclination.

The foundation receives loading in the following order:

• To the deck

• To the stay cable

• To the tower of the bridge

• Finally, to the foundation.

The load is transferred to the anchorages at either end of the suspension bridge while the cable freely travels across the tower.

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