"Dynamic analysis of box girder bridges"

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Abstract - Now days the dynamic performance of structure is very much essential while designing any structure. Analyzing the PSC Box girder bridge, statically and dynamically is the basic aim of this dissertation. Here with and without application of dynamic loads, the performance of bridge is studied. The study of bridge with bearing between girder and top of pier are included. By applying moving load, vehicle (or) truck load, pre-stress and axial forces, the effects of bridge model is carefully studied. Determining the actual seismic demand of bridge depends on the behavior of these model and also the importance of bearing between girder and top of pier is taken into consideration. Box girder bridges can have a considerable effect on the behavior of the bridge especially in the short to medium range of span such as 30m, 40m and 50m. In our project we study the behavior of box girder bridges with respect to support reaction shear force, bending moment, torsion and axial force under standard IRC Class AA loading and the box girder bridges models analyzed by finite element method.

Key Words: Dynamic Analysis, Box girder, Truck loads, Pre stress members, Bridges

1.INTRODUCTION

It has been several centuries with development in civilization, civil engineer dealing with bridge engineering. For the first time a timber bridge trestle type of crossing over bridges was pioneered by a Switz around 4000 B.C". A pedestrian stone slab bridge is the oldest stone in working condition it was built across the "Meles River" 2800 years ago. "Rodolphe Perronet" considered as the "Father of Modern Bridge Building", as he perfected masonry arch bridge with the introduction of slender piers.

1.1 DEFINITION AND CLASSIFICATION OF BRIDGES

"A bridge can be defined as a crossing the road, railway and river (or) a natural obstacle, [Water coarse, sound, valley etc....] and allowing people vehicles, animals etc.. to go easily from a point to another according to the nature of the way carried, the bridge is called road bridge railway bridge (or) canal bridge".

1.2 CLASSIFICATION OF BRIDGES

Bridges are classified based on form, type of materials used for construction, Inter span relationship, so on. Some main type of bridges under consideration are,

Steel Bridges: steel bridge may use a wide variety of structural steel components and systems: girders, frames, trusses, arches, and suspension cables.

Concrete Bridges: There are two primary types of concrete bridges: reinforced and pre-stressed.

Timber Bridges: Wooden bridges are used when the span is relatively short.

Metal alloy bridges*:* Metal alloys such as aluminum alloy and stainless steel are also used in bridge construction.

Bridges using both steel and concrete as structural materials.

Plate Girder Bridges: The main girders consist of a plate assemblage of upper and lower flanges and a web. H or I-cross-sections effectively resist bending and shear.

Box Girder Bridges: The single (or multiple) main girder consists of a box beam fabricated from steel plates or formed from concrete, which resists not only bending and shear but also torsion effectively.

Composite Girder Bridges: The concrete deck slab works in conjunction with the steel girders to support loads as a united beam. The steel girder takes mainly tension, while the concrete slab takes the compression component of the bending moment.

Culverts: Bridges having length less than 8 m are called culverts.

2. RESULTS AND DISCUSSIONS:

In this Chapter we discuss about the results obtained from the analysis of box girder model which are obtained from the SAP model. Analysis Results obtained from the software SAP-2000, from the analysis results bending moment, shear force, displacement and torsion are extracted along with stress variations along different section for different cases are discussed and max deflection of box girder and stress behavior in box girder due to pre-stressing force is studied.

2.1 ANALYSIS RESULTS

2.1.1 BEHAVIOUR OF BOX GIRDER DUE TO DEAD LOAD

Following are the results which are extracted from the model of box girder of 60m, 80m and 100m span length and effective end to end length of box girder is 65m, 85m and 105m for the dead load combination. Self-weight of the box girder is the dead load and from analysis as it is modeled as simply supported case it is extracted that the maximum moment is at center of span and minimum moments will be at support which is shown in the table 6.1, 6.2, 6.3.

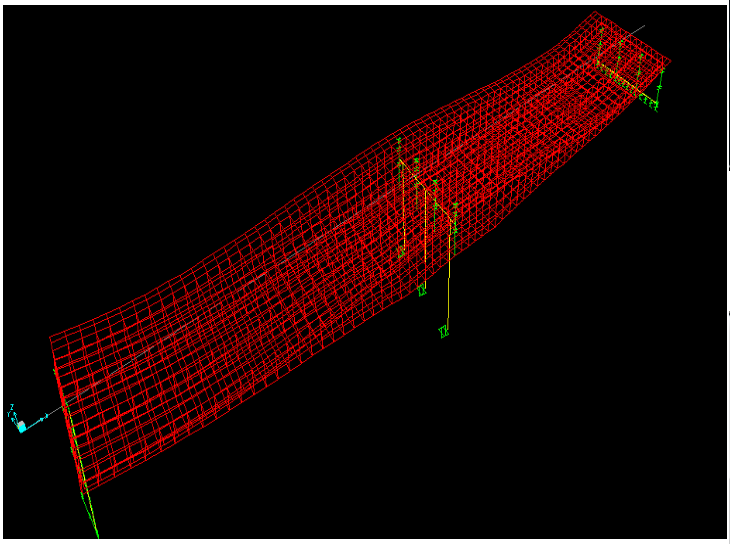

Fig 2.1. Deformation due to DL for 60 m span Bridge

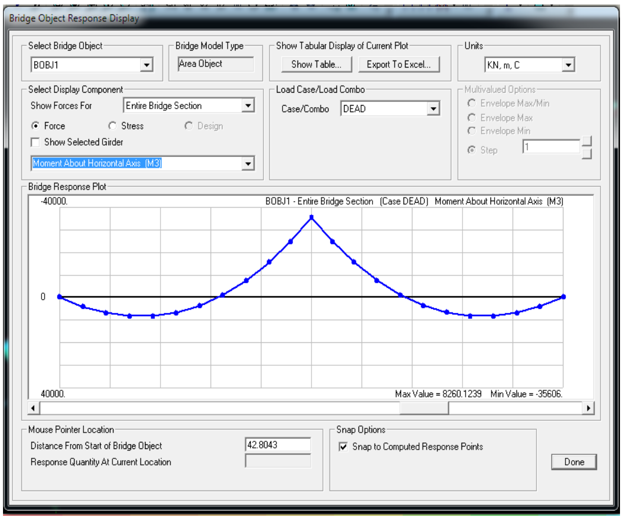

Fig.2.2 Maximum and Minimum Moment due to DL For 60m span Bridge

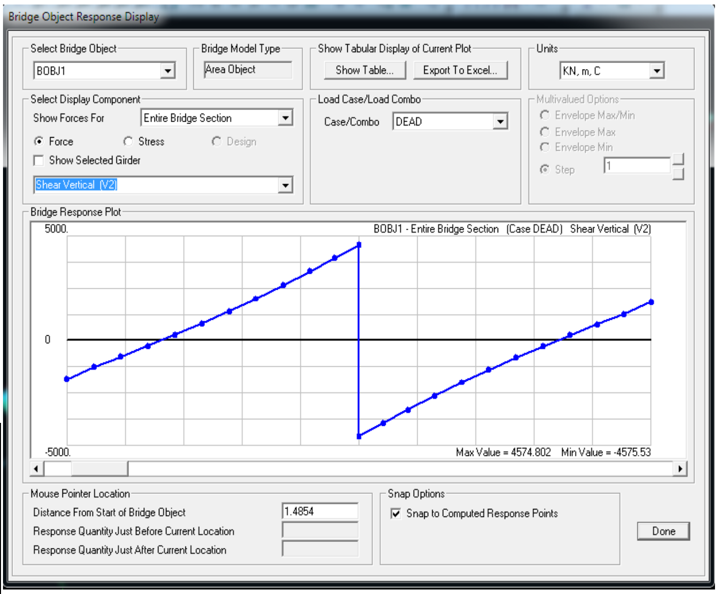

Fig 2.3 Maximum and Minimum Shear force due to DL for 60m Bridge

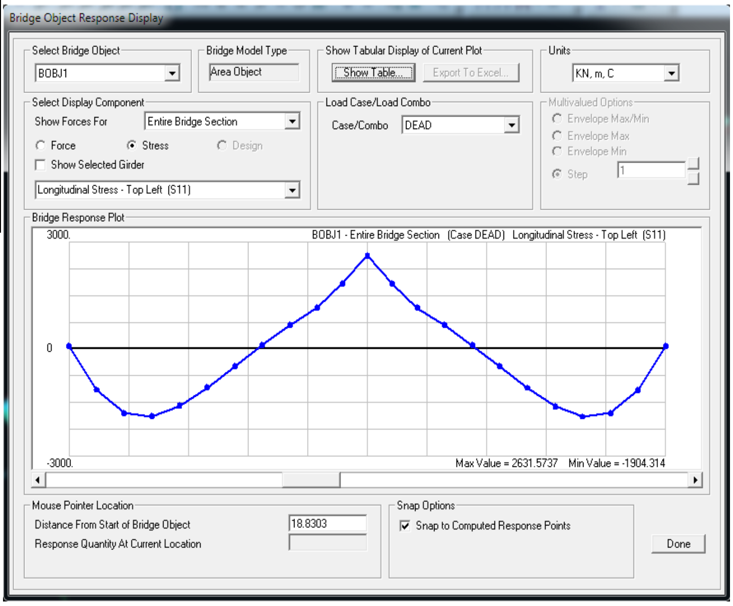

Fig 2.4 Maximum and Minimum Stresses due to DL for 60m Bridge

Fig 2.2, 2.3 and 2.4 shows the variation of moment, shear force and stresses due to dead load for 60mbridge

2.1.2 BEHAVIOUR OF BOX GIRDER DUE TO PRE-STRESSING FORCE:

Following are the results which are extracted from the model of box girder of 60m, 80m and 100m span length and effective end to end length of box girder is 65m, 85m and 105m for the pre-stressing force. Pre-stressing force of the box girder is analyzed using the model and the results for the deformation, moment, shear and stresses are tabulated and plotted.

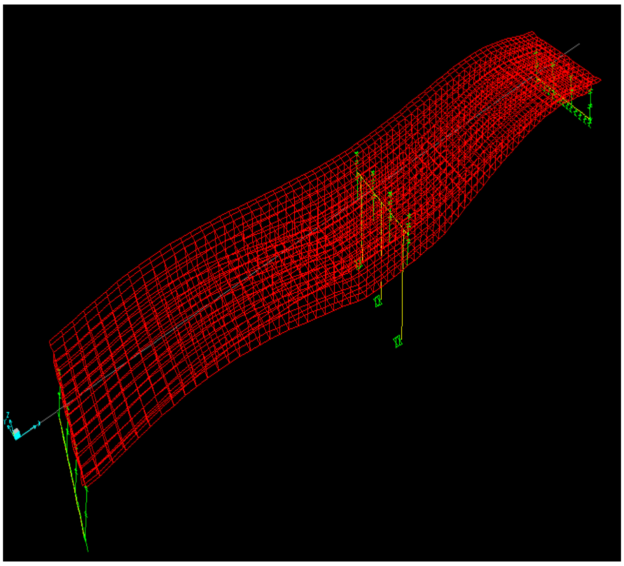

Fig 2.5 Deformation due to DL for 60 m span Bridge

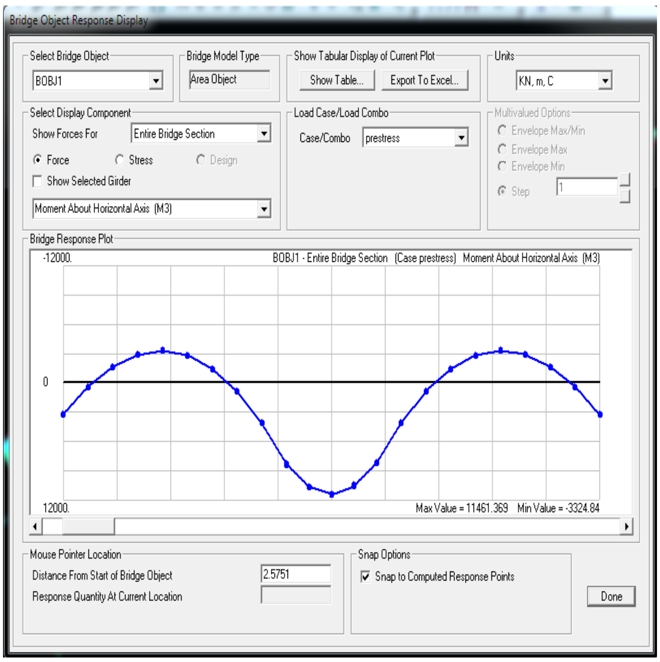

Fig 2.6 Maximum and Minimum Moment due to DL For 60m span Bridge

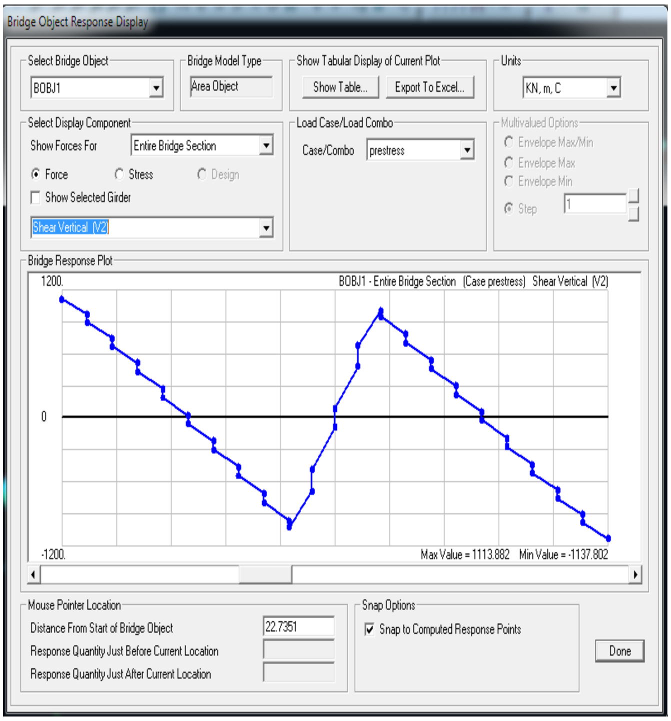

Fig 2.7 Maximum and Minimum Shear force due to DL for 60m Bridge

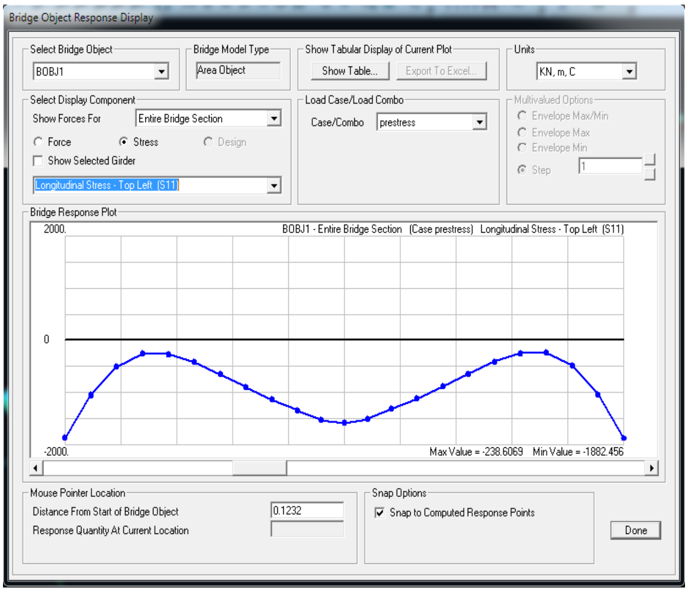

Fig 2.8 Maximum and Minimum Stresses due to DL for 60m Bridge

Fig 2.6, 2.7 and 2.8 shows the variation of moment, shear force and stresses due to Prestressing force for 60m bridge

3. CONCLUSIONS

The following conclusions have been drawn based on the results obtained from the analysis and design of the Multi-cell PSC Box Girder Bridge.

- The design of PSC multi-cell box girder performance is found to be an economical design corresponding to critical bending moment and shear forces developed due to various load combinations as per IRC specifications in comparison with the design of different span configuration using Box girders with deck slab.
- The HDPE pipes pipes have been used for cable ducts of PSC box girder modeling. The results obtained in girder with HDPE pipes are found to be more viable since the loss of pre-stress is much less in case of HDPE pipes thereby increasing the stress levels in the concrete sections.
- The cable profile has been determined so as to suit the bending moment diagram and cable profile adopted in the box girder is found to be most suitable considering the kern distances of the PSC section.
- The stresses that are developed in the box girder at service condition is found to be well according IRC specifications and no tension being developed at any cross section in the girder at service condition.
- Finite Element Analysis of Box Girder from SAP-2000 modeler software is found to be more accurate and close to reality in comparison to other analysis methods. The FEA results are in good agreement with the results obtained from other methods.
- It is found that the deflection obtained due to various loading conditions and at service condition is well within permissible limits as per IRC. The maximum vertical deflection is found to occur near mid-span location of the girder.
- The Model has also been checked for Ultimate moment and Ultimate shear cases separately as per IRC guidelines.

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