EFFECT OF CABLE ARRANGMENT ON NONLINEAR STATIC ANALYSIS OF CABLE-STAYED BRIDGE

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Abstract - Cable stayed bridges have good stability, optimum use of structural materials, aesthetic, relatively low design and maintenance costs, and efficient structural characteristics. A cable stayed bridge consists of one or more towers with cables supporting the bridge deck. In terms of cable arrangements, the most common type of cable stayed bridges are fan, harp, and semi fan bridges. In these bridges, the cables are the main source of nonlinearity. In the present study, nonlinear static analysis of cable-stayed bridge will be carried out for the different span lengths and cable arrangements. Linear static and nonlinear static analysis will be done using this software SAP2000. Results of cable tension, deck deflection, and base shear are compared for the study of behavior of cable-stayed bridge.

***Key Words*: Cable stayed bridge, Cable Arrangement, Nonlinear Analysis**

1. INTRODUCTION

Modern cable structural system that consists of girders, deck and supporting m towers in compression and stay cables in tension. A typical cable one or more towers erected above piers in the middle of the span. From these towers, cables stretch down diagonally (usually to both sides) and support the girder. Because the only part of the structure that extends above the road is the Cable stayed bridges have a simple and elegant look. In this paper, a cable stayed bridge has a different longitudinal layout as harp, fan and radiating is analyzed.

1.1 Types of Cable Stayed Bridge

Cable-stayed bridges can be distinguished by the number of spans, number of towers, girder type, number of cables, etc. There are many variations in the number and type of towers, as well as the number and arrangement of cables. Therefore, cable-stayed bridges can also be categorized according to the construction material used for major structural components, configurations of stay cables and tower. For example, different types of construction materials used for the main components like girders in cablestayed bridges: steel, concrete, and hybrid cable-stayed bridge.

1.2 Objective of Study

The Objectives of the study are:

1. To justify use of non linear static analysis instead of linear static analysis.
2. To obtain nonlinear behavior of cable stayed bridge with different span length and different cable arrangements having material nonlinearity.
3. To apply geometrical nonlinearity for analysis.
4. To compare results and give appropriate cable arrangement for relevant spans

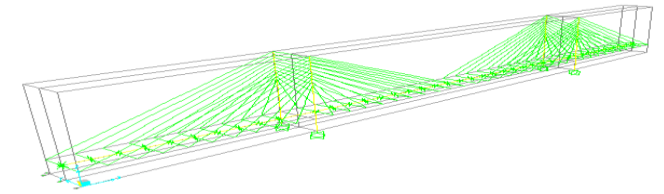
2. Nonlinear Analysis of Cable Stayed Bridge

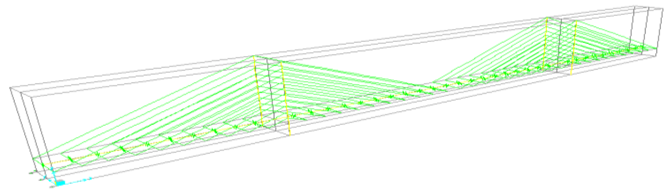
In this chapter effect of cable arrangement on nonlinear static analysis of cable-stayed bridges with central span of 200 m, 300 m and 400 m is analyzed. The geometric nonlinearity is considered in this analysis.

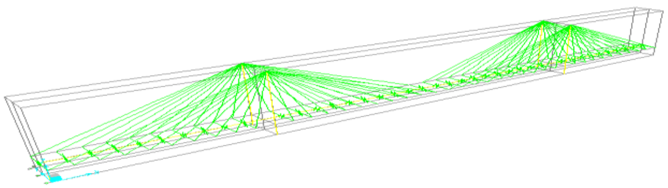
Table -1: Bridge Span Lengths

Description	Span 200	Span 300	Span 400
Length	410 m	610 m	810 m
Mid Span	210 m	310 m	410 m
Side Span	100 m	150 m	200 m

Based on the data total 9 model prepared in SAP2000. The cable arrangements are taken as Fan, Harp and Radiating for each set of data. Figure shows cable arrangements model in SAP2000.







The dead and live loads are applied on the model and nonlinear static analysis was done. The loading consequently applied on each plane of cable.

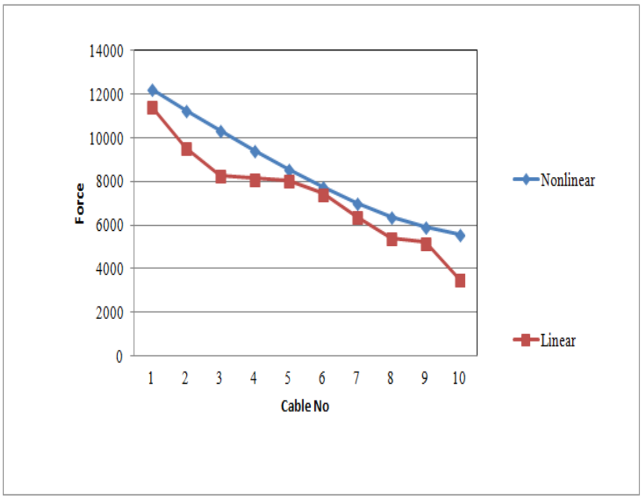


Chart -1: Nonlinear Analysis Cables FAN arrangement, mid span 200m

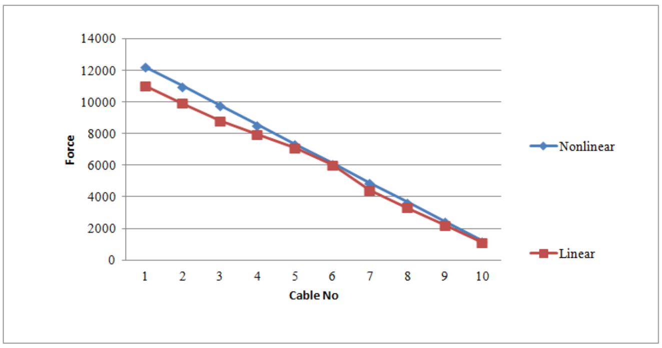


Chart -2: Nonlinear Analysis Cables HARP arrangement, mid span 200m

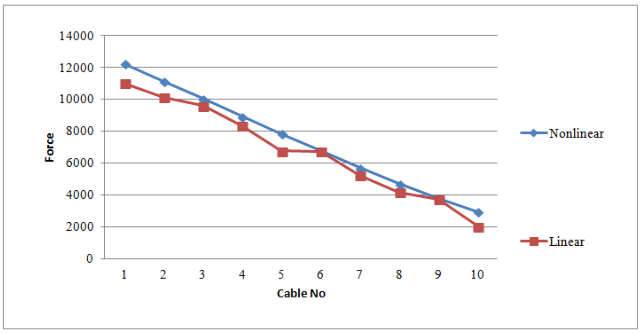


Chart -3: Nonlinear Analysis Cables RADIATING arrangement, mid span 200 m.

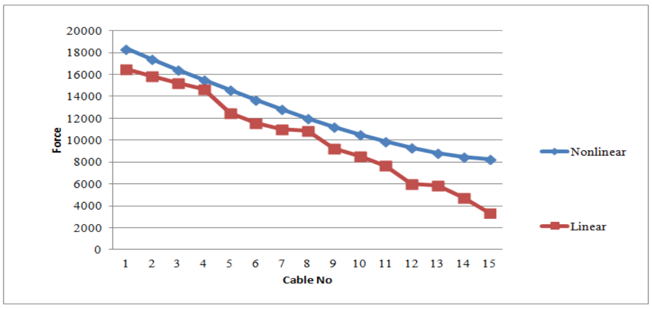


Chart -4: Nonlinear Analysis Cables FAN arrangement, mid span 300m

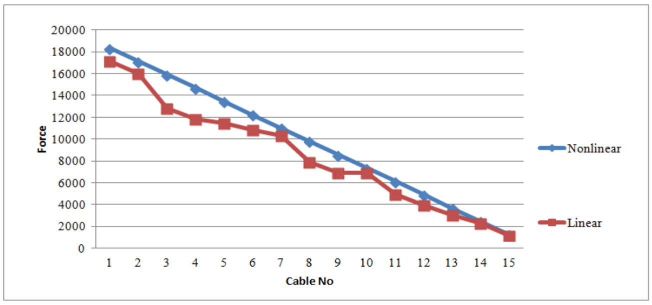


Chart -5: Nonlinear Analysis Cables HARP arrangement, mid span 300m

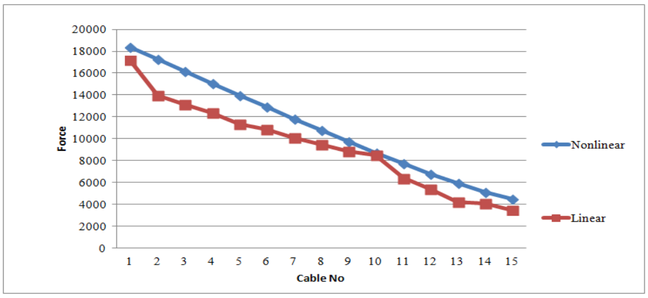


Chart -6: Nonlinear Analysis Cables RADIATING arrangement, mid span 300 m.

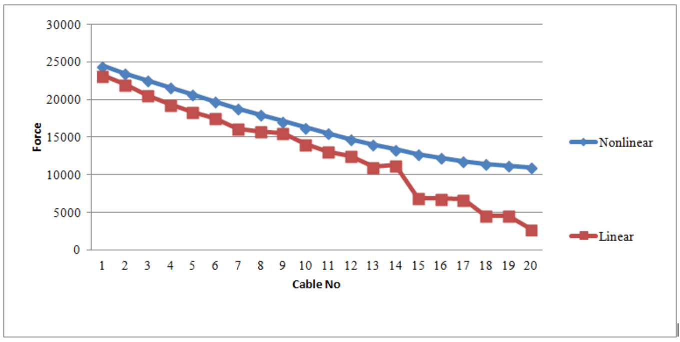


Chart -7: Nonlinear Analysis Cables FAN arrangement, mid span 400 m.

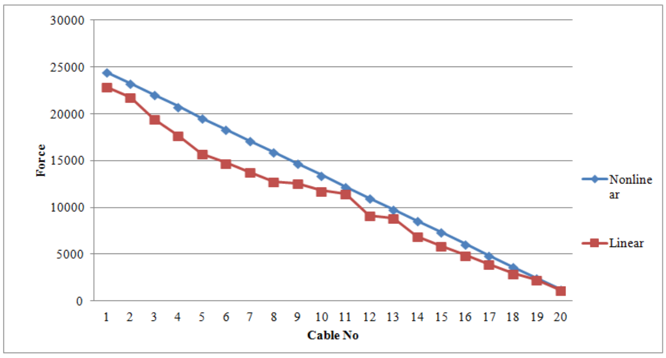


Chart-8: Nonlinear Analysis Cables HARP arrangement, mid span 400m

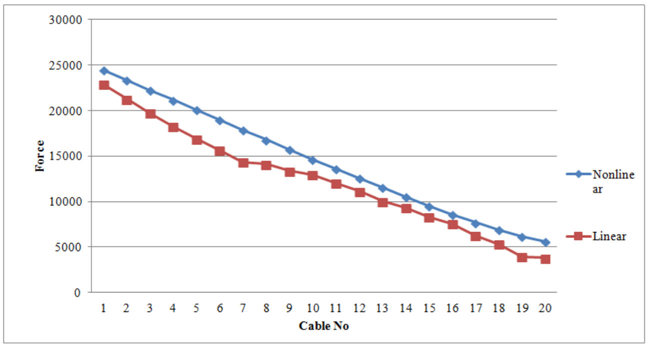


Chart -9: Nonlinear Analysis Cables RADIATING arrangement, mid span 400 m

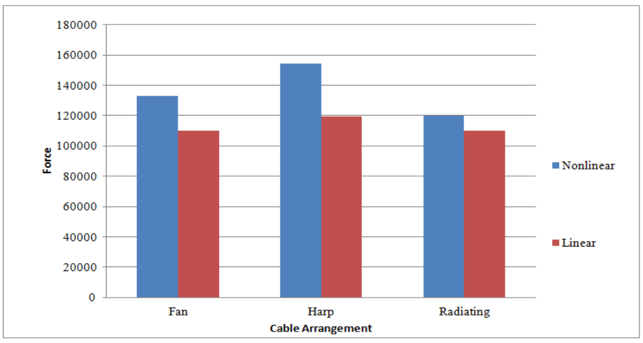


Chart -10 Nonlinear For pylon Axial force, Span 200 m.

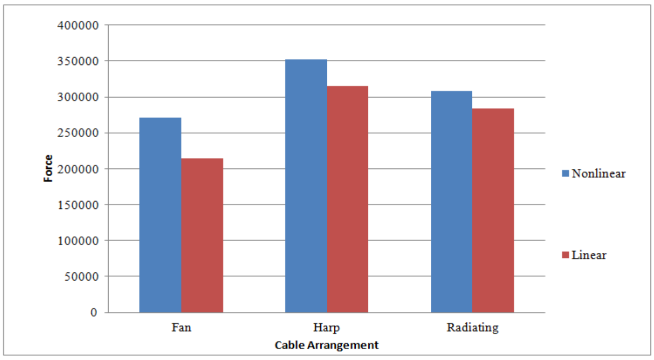


Chart -11 Nonlinear For pylon Axial force, Span 300 m.

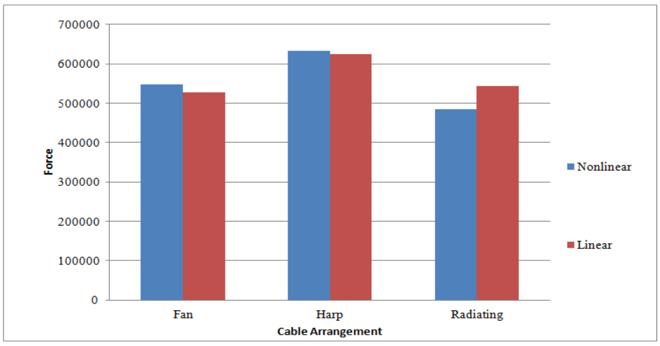


Chart -12 Nonlinear For pylon Axial force, Span 400 m.

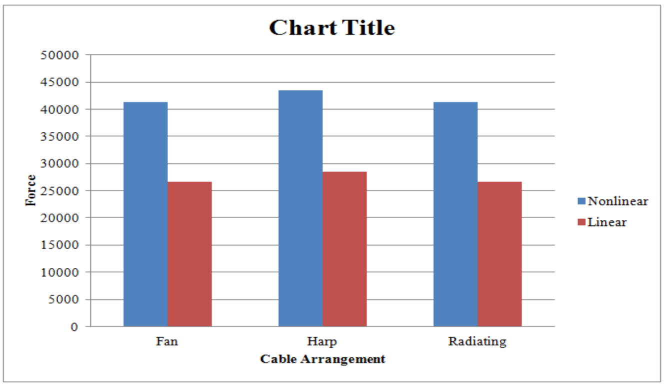


Chart -13 Nonlinear For DECK Axial force, Span 200 m.

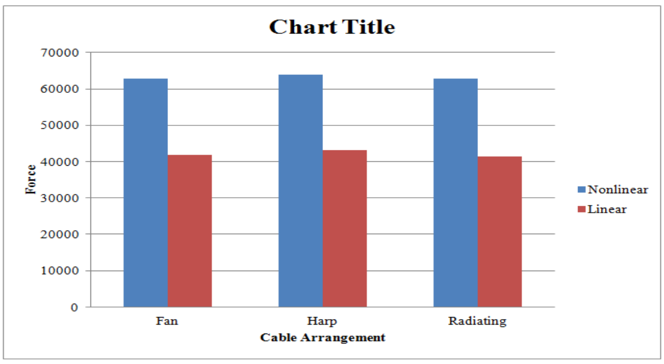


Chart -14 Nonlinear For DECK Axial force, Span 300 m.

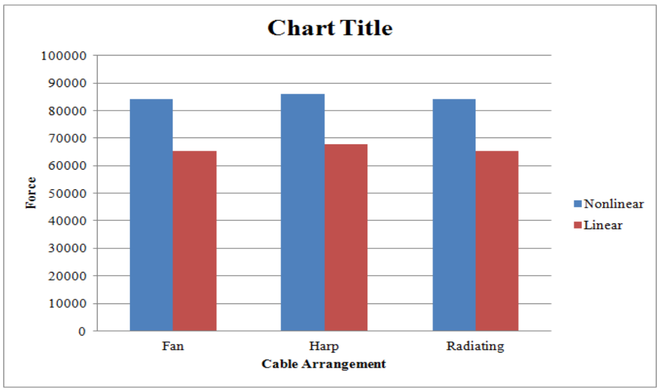


Chart -15 Nonlinear For DECK Axial force, Span 400 m

3. CONCLUSIONS

Linear v/s Nonlinear Analysis

• For cable forces the maximum percentage increase in 200, 300 and 400 m span are respectively 11.15% for Harp, 11.15 % for Fan and 6.84 % in Harp type. So comparatively cable forces in Harp type system are maximum in inear or nonlinear analysis. And minimum forces are in radiating type for linear or nonlinear analysis.

• For linear v/s nonlinear analysis the maximum increase value of pylon axial force for 200 m,300 m and 400 m are respectively 29.20% for Harp,26.81% for Fan and 11.48 % for Radiating. So we can say that in linear v/s nonlinear analysis the maximum pylon forces is in Harp type. And the minimum increment is in radiating type for all span length.

• For linear v/s non linear analysis, percentage increase in deck axial force is maximum for Fan and Radiating type and minimum value is for Harp type for all span length.

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• The minimum Axial Force value of deck was in radiating type and the maximum one was in harp type model.

• In pylons the axial force is minimum in radiating type and maximum one was in harp.

• It was observed that the forces are maximum in the longest cables of the central span. The maximum cable forces were noted in harp type system, and minimum forces were in radiating type system.

• The findings suggest that the harp cable arrangement appears less suitable than the fan and radiating cable arrangement especially for long-span bridges.

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