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BEHAVIOR ANALYSIS OF STAYED BRIDGE WITH DIFFERENT CABLE ARRANGEMENT USING STAAD PRO

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ABSTRACT

This work will deal with the design and analysis for different cables arrangement with the different shapes of pylon using STAAD Pro. There are many types of cable arrangements among these we chose fan type, radial type, star type and harp type arrangements. The pylons are of two laterals of stays i.e. “A” shape, “Y” shape, “H” shape and one axial layer of stays i.e. circular shape pylon. All the considered shapes of pylon have cross sectional area but are of circular shape.The most efficient arrangement will be proposed after analysis among these configurations. The comparison is made for shear force, bending moment, displacements for all the cases. The conclusion will make in respect to the efficiency of one of the arrangements. This can be useful in the modifying the drawbacks of others. This work will give directions to make other arrangements more efficient.Finally, among all these the circular H shape with harp and the fan shape configuration is the best configuration.

I. INTRODUCTION

Cable stayed bridges have good stability, optimum use of structural materials, aesthetic, relatively low design and maintenance costs, and efficient structural characteristics.

Therefore, this type of bridges are becoming more and more popular and are usually preferred for long span crossings compared to suspension bridges. A cable-stayed bridge consists of one or more towers with cables supporting the bridge deck.

In terms of cable arrangements, the most common types of cable stayed bridges are fan, harp, and semi fan bridges. Because of their large size and nonlinear structural behaviour, the analysis of these types of bridges is more complicated than conventional bridges.

In these bridges, the cables are the main source of nonlinearity. An optimum design of a cable-stayed bridge with minimum cost while achieving strength and serviceability requirements is a challenging task.

In this work, cable stayed bridge is analysed by changing the cables arrangement and with different shapes of phylon each time, to obtain the results for bending moment, forces, deflection. The three cable’s arrangement taken is fan, semi fan and harp arrangement. The pylons are of two laterals of stays i.e. “A” shape, ”Y” shape, ”H” shape and one axial layer of stays i.e. circular shape pylon. All the considered shapes of pylon have cross sectional area but are of different shape.

Comparison between the arrangement types, in terms of forces, bending moment and deflection, is carried out in this work. The bridge is analysed by the commercial finite element based software STAAD Pro.

II. LITERATURE REVIEW

PawanPatidar and Sunil Harne (2017) checked the economic status of Plate Girder Bridge (Railway) on various spans keeping one parameter constant and other parameters varying.

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Guru prasad D (2016) made comparison of these two bridges are made to find of the most economical bridge for the six traffic lanes. He conclude that three plane cable configuration of cable stayed bridge is economical for the bridges having more width as compared to that of two plane cable configuration.

Shivanshi and Pinaki (2016) considered fan type, semi fan type and harp type cable arrangements. The bridge is designed and analysed for these cables arrangement by STAAD Pro software. The most efficient arrangement is proposed after analysis among three. The comparison is made for Shear force, bending moment, displacements for the cases. The results indicated that the fan arrangement is more efficient then two other arrangement.

G. M. Savaliya (2015) performed the analysis of cable-stayed suspension Hybrid Bridge. Modeling of cable-stayed suspension Hybrid Bridge in SAP2000 software and its validation is carried out. The nonlinear static analysis and modal time history analysis of cable-stayed suspension hybrid bridge is carried out in SAP2000 software. The time period of bridge for different mode shape is presented to compare the result of research paper with Sap 2000 software.

Atul K. Desai (2013) increase the maximum span of cable-stayed bridges has developed a modified static system. The basic idea of this new concept is the use of pairs of inclined pylon legs that spread out longitudinally from the foundation base or from the girder level. Spread-pylon cable-stayed bridge has distinct advantage like reduction of sag of cables and oscillation of cable during earthquake over traditional cable-stayed bridges.

Deep Gupta et al (2016) design and build a bridge at the intersection of NH-58 and Kaliyar road in front of COER. This will eliminate traffic congestion and delay at the highway as well as eliminate conflicts between pedestrians and motor vehicles. In recent years, the interest in solar energy has risen due to environmental concern and also to support green building initiative of College, a solar power generation system also incorporates in the design.

Mohammed Yakub Ali &GugulothuSwarna (2016)design Bridge where the traffic exceeds more than 2500 vehicles, for the elimination of conflicts between pedestrians and motor vehicles. As an average hourly traffic of more than 2500 vehicles in front of aurora's engineering college where students and other people cross the road. With this high average hourly traffic value, crossing by foot can not only be challenging, but can be dangerous. With this in mind, this project aims todesign and build a bridge at the intersection of roads in front of college building. This will eliminate traffic congestion and delay at the highway as well as eliminate conflicts between pedestrians and motor vehicles. We are designing the pedestrian bridge by using staad.pro.

T. Pramod Kumar and G. Phani Ram (2015) design of super structure of road cum Railway Bridge across Krishna River proposed on downstream side of existing bridge between Mahanadu road of Sithanagaram and P.N.Bus station, Vijayawada. The bridge is made of through type steel truss which carries two railway tracks at lower level and a roadway of three lane carriage way in the upper level. The span length matches with that of existing nearby Railway Bridge. Analyses of top floor members, truss members and bottom floor members are done using STAAD Pro. The design of structural members of the truss, top floor and bottom floor members is done as per Indian railway standard code and Indian roads congress code.

III. DESCRIPTION OF BRIDGE

Analysis is made for cable stayed bridge. The total span of the bridge is 200 m. The total width of the deck of the bridge is 10 m. The diagram of bridge is as shown in Fig. 1-3. In construction; firstly edge beams are erected and then followed by deck slab with crossbeams. The total height of bridge is 65 m. The pylon used here of different shape. Bridges with Fan arrangement, Radial arrangement, Star arrangement and harp arrangement are as shown in Figure 1, Figure 2 and Figure 3.

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Table 1: Description of Structure

Description	Value
Total span of the bridge	200 m
total width of the deck of the bridge	10 m
Total height of bridge	65 m
Dia. of column	0.3 m
Beam size (1)	0.5 x 0.45 m
Beam size (2)	0.5 x 0.5 m
Deck thickness	0.3 m
Support type	Fixed support

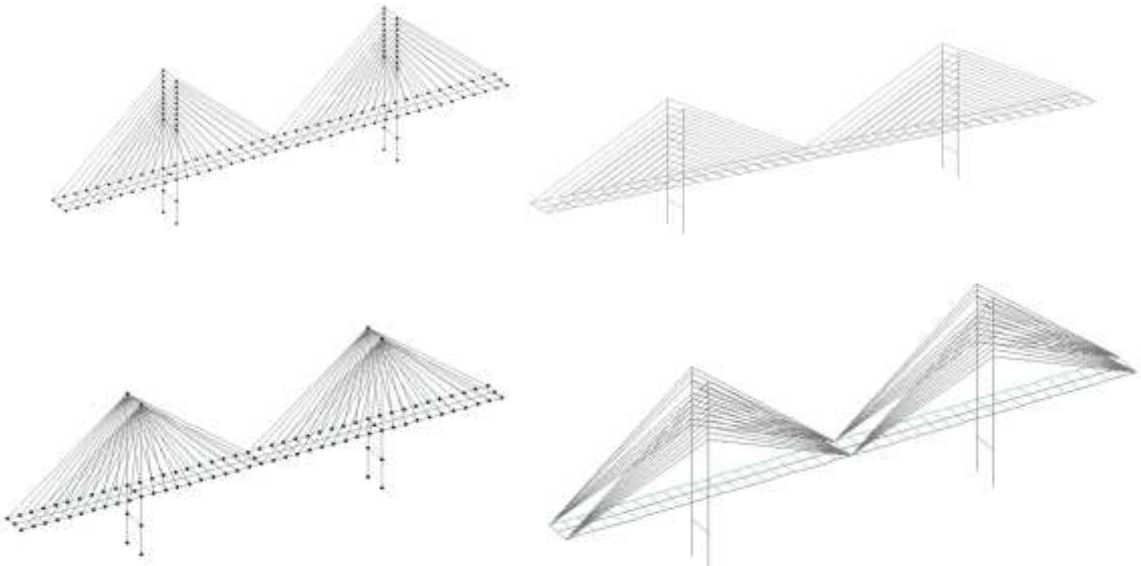
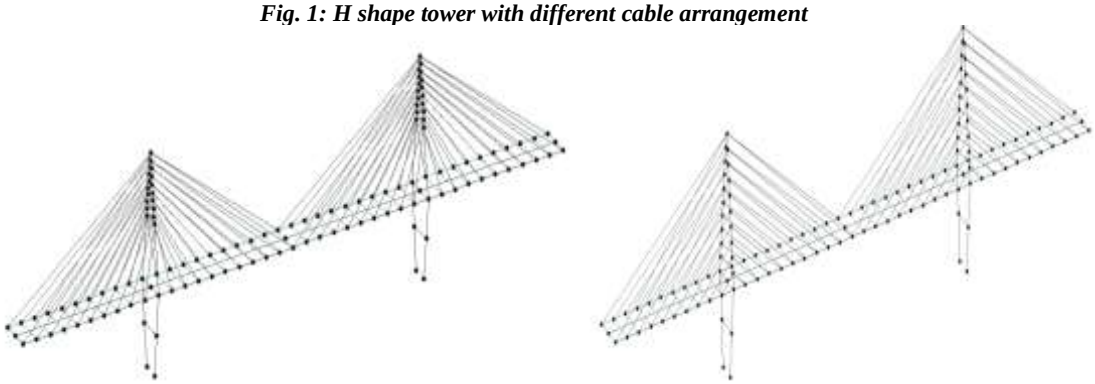


Fig. 1: H shape tower with different cable arrangement



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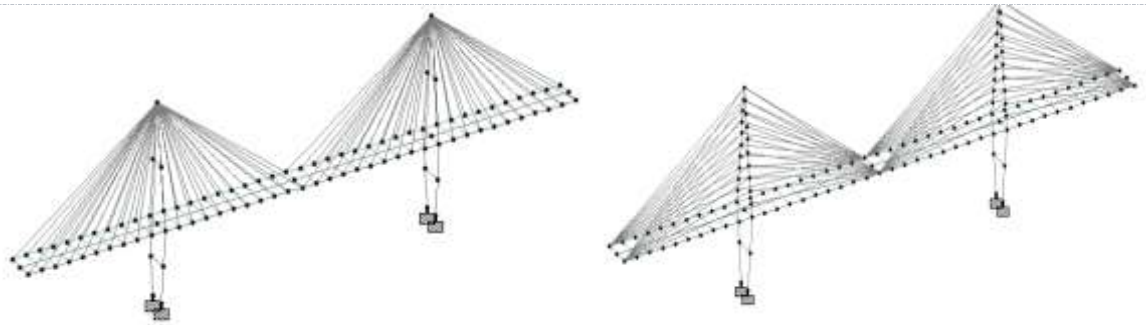

Fig. 2: A shape tower with different cable arrangement

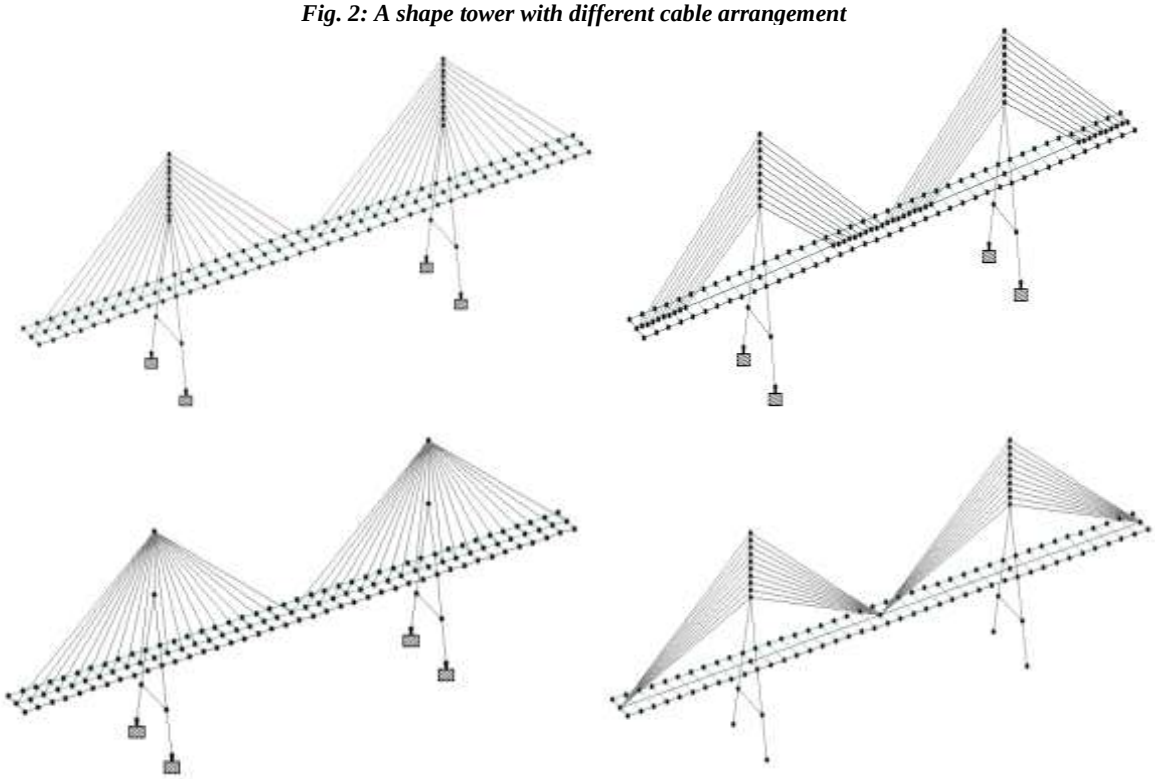

Fig. 3: Y shape tower with different cable arrangement

IV. LOAD CONSIDERATION

Considered loadings for the proposed bridge are as follows

1. Dead Load

Gravity load

2. Live Load

Moving load

3. Seismic Load

Seismic parameter type: UBC 1997
Seismic zone: 4
Seismic zone factor: 0.4
Soil profile type: 4

4. Temperature effect

Temperature change for axial elongation - 16°F
Temperature difference from top to bottom - 10°F
Temperature difference from side to side – 10°F

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5. Wind Effect

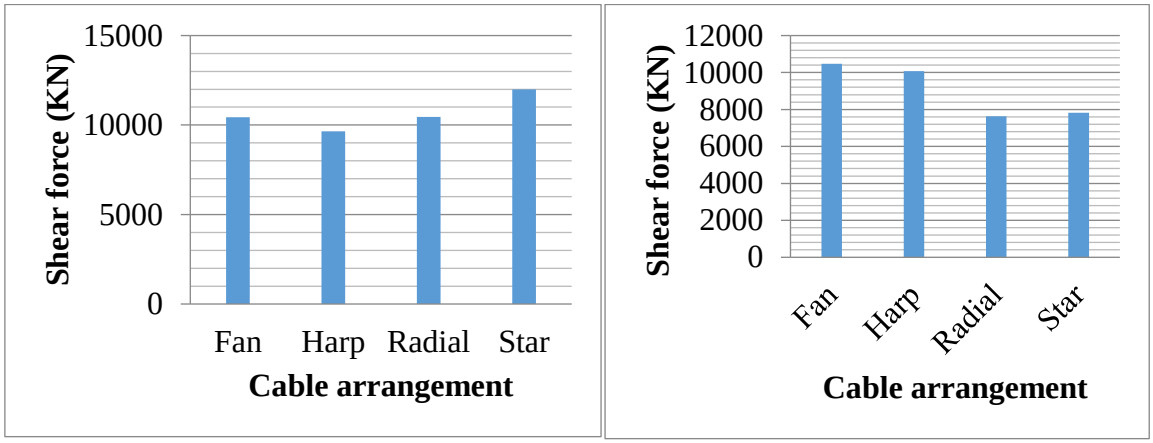
Exposure type: Type C
Base wind velocity: 100 mph
Category: I
Structure type: Lattice framework
Common data: ASCE-7, 2002

V. RESULTS AND DISCUSSIONS

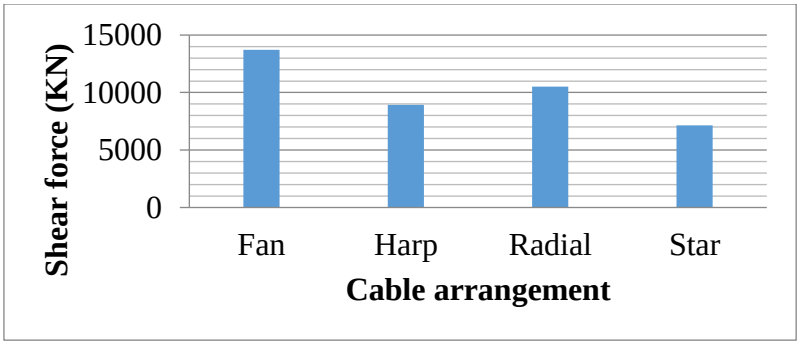
In this section, the results for the efficient design of the four arrangements of cable-stayed brides including star, fan, radial and harp arrangements with different shape of tower are presented.

5.1 Shear force and bending moment

Magnitude of maximum shear force and bending moment for various cable arrangements has been plotted in figure number 4-5, it is observed that in this comparative study maximum shear force and max. Bending moment is in star arrangement whereas harp type arrangement shows minimum shear force and min. bending moment value which results in balanced section.



H shape towerA shape tower



Y shape tower

Fig. 4: Variation of shear force in various arrangements

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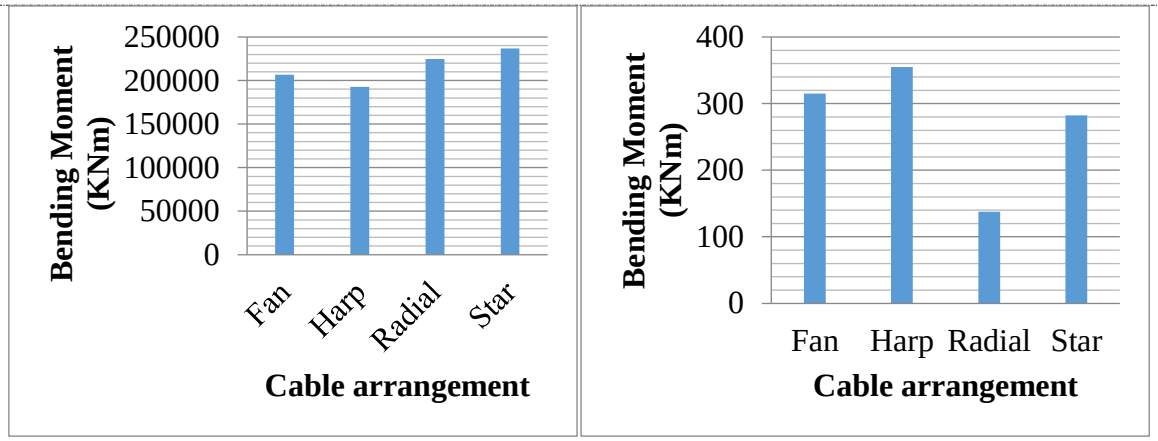
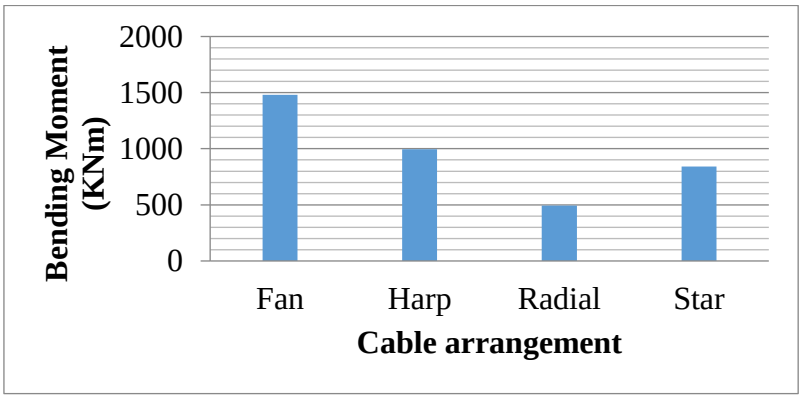


H shape towerA shape tower



Y shape tower

Fig. 5: Variation of bending moment in various arrangements

5.2 Deflection

Magnitude of maximum displacement for various forms of truss has been plotted in figure number 6-8, below it is determined that deflection is maximum in star cable arrangement whereas minimum in harp cable arrangement which indicates that star cable arrangement will require more supports as compared to other cases.

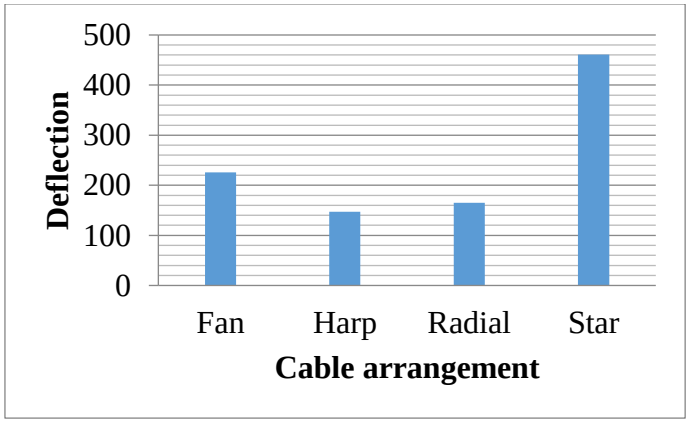


Fig.6: deflection for H shape tower

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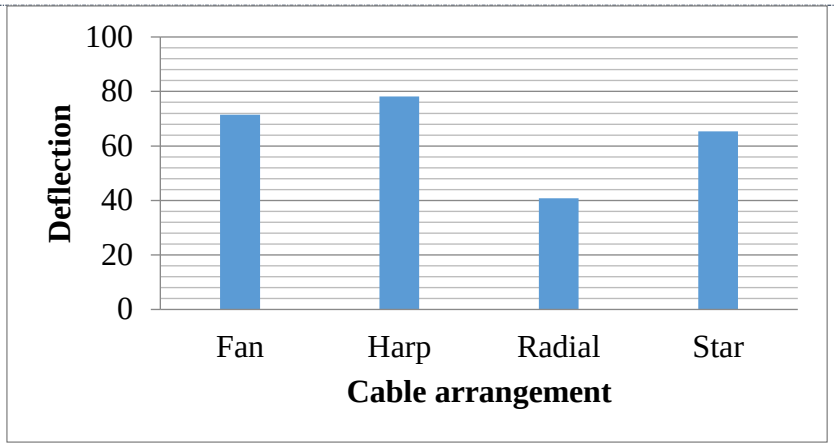

Fig. 7: deflection for A shape tower

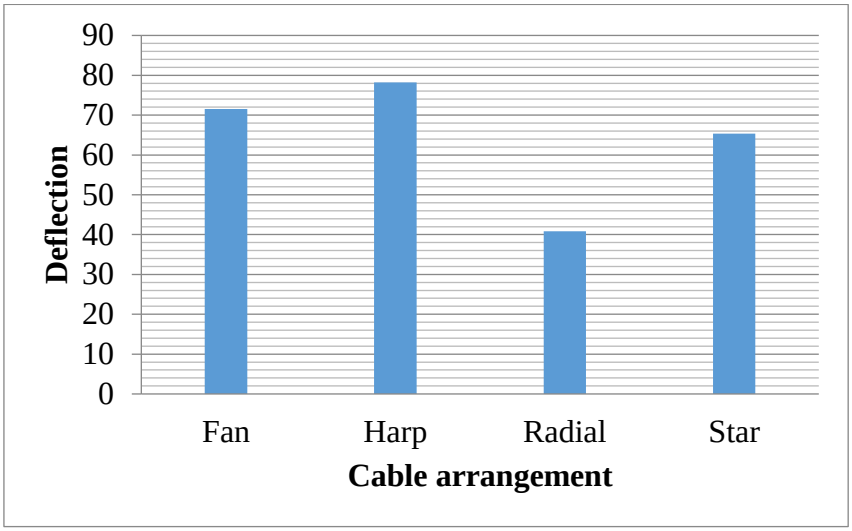

Fig. 8: deflection for Y shape tower

VI. CONCLUSIONS

We have considered various cases along with dead load & live load for the different cable arrangement with H, A and Y shape tower for analysis by using Staad-Pro software. Following are the conclusions of this study-

Based on cable configuration to the tower and the deck:

H shape tower

1. The shear force is more in star and least in harp arrangement
2. The bending moment is more in star and least in harp arrangement
3. Deflection is more in star and least in harp arrangement
4. The results indicated that the harp arrangement is more efficient then three other arrangement

A shape tower

1. The shear force is more in Fan and least in radial arrangement
2. The bending moment is more in harp and least in radial arrangement
3. Deflection is more in harp and least in radial arrangement
4. The results indicated that the radial arrangement is more efficient then three other arrangement

Y shape tower

1. The shear force is more in Fan and least in star arrangement
2. The bending moment is more in Fan and least in radial arrangement
3. Deflection is more in harp and least in radial arrangement
4. The results indicated that the radial arrangement is more efficient then three other arrangement

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Based on shape of the tower:

Among all the pylons (i.e. one axial layer of stay and two lateral of stays) the circular and the H shape pylon can has low amount of sag and moment in the cables and the deck because of having the more number of joints comes under non-homogeneity so that the concentration of stress and tension carrying capacity of the cables was not effectively to the other parts of the cable which may lead to maximum concentration in some cables, when compared to circular which has homogeneous member.

Based on cable configuration to the tower and the deck

The harp and the fan shape configuration is more suitable than star and radial configuration. Because, harp configuration which has evenly spaced to the tower and deck can reduced the sag in the cables .Whereas the fan shape configuration has more less amount of sag when compared to harp shape but the outer cables in the fan configuration may attain more stress concentration, unless providing some dampers to the outer cables (i.e. far away from the tower) is the most suitable configuration. The star and radial configuration may have more sag when compared to other types.

Finally, among all these study the pylons (i.e. one axial layer of stay and two lateral of stays) the circular and the H shape with harp and the fan shape configuration is the best configuration.

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