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# Analysis of Load Optimization in Cable Stayed Bridge using CSI Bridge Software

**Thippeswamy A O**
*Research Scholar, Department of Civil Engineering,*
*REVA University,*
*Bengaluru, Karnataka, India.*

**Dr. Sunil Kumar Tengli**
*Professor, Department of Civil Engineering,*
*REVA University*
*Bengaluru, Karnataka , India.*

## Abstract
This paper deals with the analysis of load optimization with different cable arrangement in cable stayed bridges. There are many types of cable arrangements among that Harp and Fan Shape cable arrangement is chosen for our study. The cable stayed bridge is analysed for these types of cable arrangements by using CSI Bridge software. The efficient cable arrangement proposed after analysis among these two cable arrangement. Load optimization applied for different cable arrangement in static and staggered load condition. Load Optimization is a method of determining an group of loads, including tensioning of cables, to achieve less displacement. Comparison made for displacement, shear force and bending moment. Conclusion is made for any type of cable arrangement can be adopted by applying load optimization. This avoids drawback of other type of arrangement. This work provides any type of cable arrangement makes efficient.

**Keywords:** Cable Arrangement, CSI Bridge, Fan, Harp, Load Optimization.

## Introduction
In this study, the comparative analysis of different cable arrangement and determine the effective cable arrangement. The cable stayed bridge gives more stiffness and high flexible in nature when compared to other conventional normal bridges and suspension bridges. This study gives most efficient cable arrangement and the behavior of cable after applying the load optimization.

## Load Optimization in Cable Stayed Bridge
Load Optimization is a method of determining an group of loads, including tensioning of cables, to achieve less displacement in a model. The optimized load can be appeal in any static load case, weather it is any type linear, nonlinear, or staged-condition. The cable tensioning is leads to achieve a specific value to acknowledgment for quantities such as displacement, reaction, member forces or moments. Load optimization consist of finding the scale factors of different loads in the static loads cases to reach the aim.
In load optimization there are three types of problems can be solved, its depending on the relation between the number of fluctuating loads and the number of aim to achieve.

1) Number of fluctuation loads is greater than number of goals, Optimization problem.
2) Number of fluctuation loads is equal to number of goals, determinate problem.
3) Number of fluctuation loads is smaller than number of goals, Best-fit problem

## Analysis:
Cable stayed bridge analysis carried out using CSI Bridge software. The main aim of this analysis minimizes the displacement. Comparison is made for two kinds of cable arrangement, harp and fan kind of cable arrangement. Comparison made for stresses, bending moment and shear force. Load optimization is applied for the one of the cable arrangement.

**i. Loads to be Considers**
- Dead load
- Live load:- Vehicle load as per IRC6
- Staggered load

**ii. Details about Bridges**

The analysis is carried out for cable stayed bridge having span of 600m. The width of the deck is 30m. Here the box girder will be considered for analysis. The single leg pylon is used. The total height of the pylon is 135m. The harp shape and fan shape cable arrangement can be considered. There is no earthquake and wind load to be considered. Here only static and staggered load considered. This paper limited to displacement, bending moment and shear force. The following Fig1 shows details of cable stayed bridge.

**Figures and Tables**

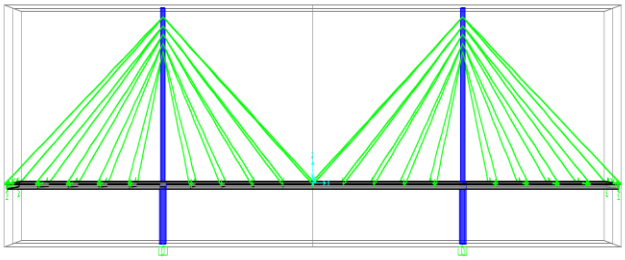


**Fig 1:** Details of Cable Stayed Bridge of Harp Shape Cable Arrangement

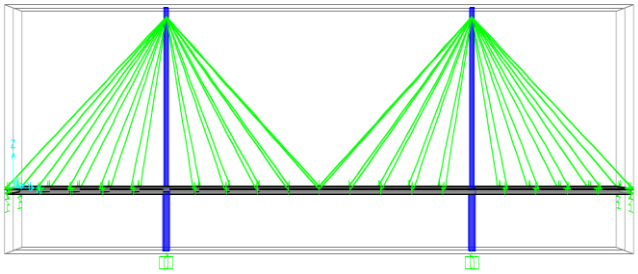


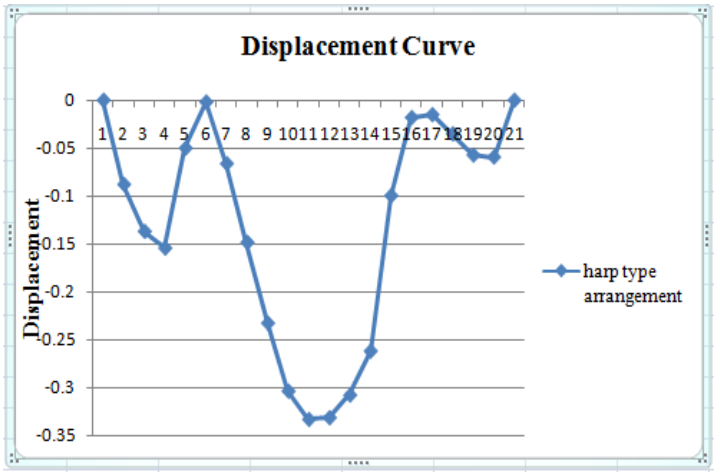
**Fig 2:** Details of Cable Stayed Bridge of Fan Shape Cable Arrangement

**Table1:** Bending Moment and Shear Force and Stresses for Harp and Fan Shape Cable Arrangement

| **Maximum and Minimum Bending Moment, Shear Force and Stresses in Harp and Fan Shape Cable Arrangement (Dead and Live)** | | | | | |
|---|---|---|---|---|---|
| Sl. No | Force and Stresses | Harp Shape Cable Arrangement | | Fan Shape Cable Arrangement | |
| | | Max | Min | Max | Min |
| | | 0.994 | -0.744 | 0.824 | -0.652 |
| | | 15112.24 | -12530.24 | 13225.2 | -11250.5 |
| | | 5881.94 | -15790.38 | 5443.48 | 14290.42 |

**Table2:** Displacement for Harp and Fan Shape Cable Arrangement

| **Maximum and Minimum Displacement in Harp and Fan Shape Cable Arrangement (Dead and Live)** | | | | | |
|---|---|---|---|---|---|
| Sl. No | Parameter | Harp Shape Cable Arrangement | | Fan Shape Cable Arrangement | |
| | | Max | Min | Max | Min |
| 1 | Displacement | 0.3326 | 0.0877 | 0.1325 | 0.0437 |



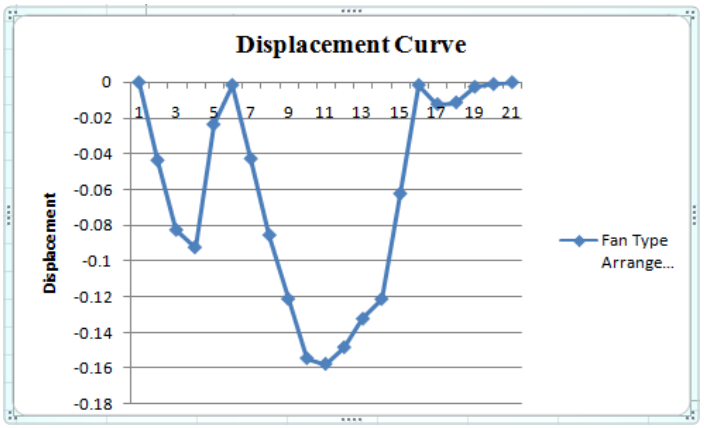




**Fig 4:** Displacement Curve of Fan Shape Arrangement

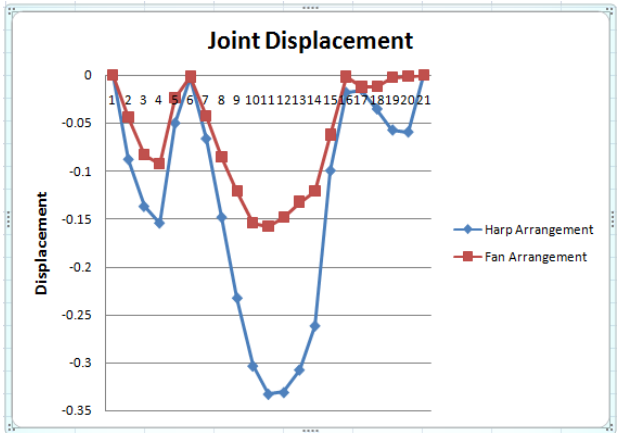



**Fig 5:** Comparison of Harp and Fan Shape Arrangement

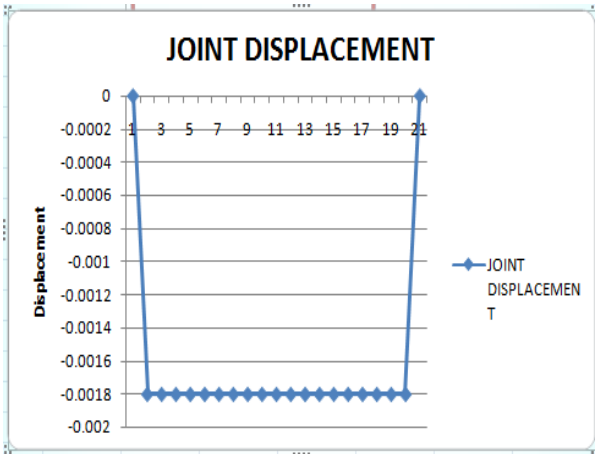



**Fig 6:** Displacement Curve after Load Optimization in Harp Shape Arrangement

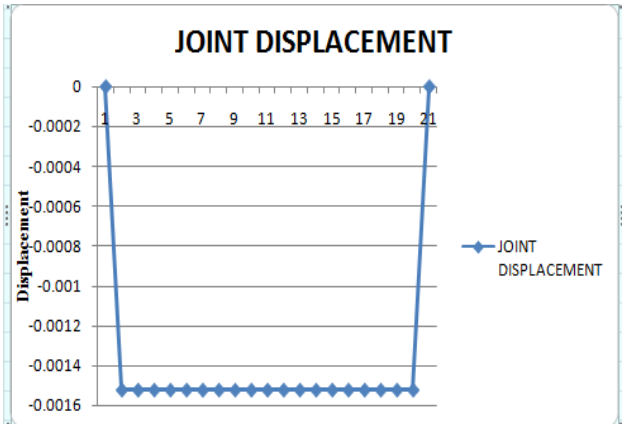



**Fig 7:** Displacement Curve after Load Optimization in Fan Shape Arrangement.

## Conclusion:

The joint displacement of cable stayed bridge in Fan shape cable arrangement gives less than that of Harp shape cable arrangement. We concluded that fan shape cable arrangement gives more efficient than the harp shape cable arrangement.

The bending moment in Fan shape cable arrangement is less compared to Harp shape arrangement. That indicated the due to less moment it reduce the displacement and gives better stiffness to the cable stayed bridge.

The shear force in Fan Shape cable arrangement is less when compared to Harp Shape arrangement. After load optimization, the joint displacement can be minimized in both harp and fan shape to least minimum value. So, it can be concluded that any type of cable arrangement can be adopted.

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