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ANALYSIS OF CABLE STAYED BRIDGE USING STADD PRO

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ABSTRACT: Cable Stay type bridges have been around a lot longer than a lot of people think and can be traced back more than four centuries. Many early bridges using cable stays incorporated both cable stays and suspension cables. In this Project work, live project of cable stay bridge i.e. (Raja BhojSetu), Bhopal is considered. It is located at V.I.P. road. It has been designed, constructed considering details and hydraulic data as per site. In this study analysis of different types of pylon in cable stay bridge i.e. H-type, A-type and Y-type is presented to determine the most suitable type and compare it with the executed H-type pylon.
Keywords:Staad, Analysis, Cable stay, Pylon, Finite element analysis, IRC loading, Deflection, Bending, Forces.

I. INTRODUCTION

The Pylon moves the powers created in the links to the establishment through vertical pressure. The structure of the scaffold is make sense of to such an extent that the static level powers coming about because of dead burden are nearly adjusted to limit the stature of the arch. Link stay-spans have a low focus of gravity, which makes them skilled in restricting the impacts of tremors. Link stay extensions give exceptional engineering show because of their little distance across of links and restrictive upper piece of structure. It tends to be developed by cantilevering activity from the pinnacle for example the links demonstration both as transitory and lasting backings to the scaffold deck. The upside of link stay scaffolds is that it very well may be worked with any number of towers.

The motivation behind the arch in the Cable Stay Bridge is to help the link framework and move powers to the establishments. They are stacked with high compressions and twisting minutes that rely upon the stay link development and the deck-arch help conditions. Arches can be made of steel or cement, being the last commonly progressively monetary thinking about comparable firmness. conditions. In this way, the conduct of the arches will be molded by a few perspectives, and notwithstanding the past thought, the geometric state of the arches which relies upon the connected burdens, link stay framework and stylish conditions, is a significant angle. The conduct of the various states of the Pylon was examined by the computational investigation utilizing programming STAAD.PRO is limited component based program and is perceived by worldwide network for the examination reason. STAAD program will create the different outcomes like joint relocations, joint powers, joint responses, base responses, deck power, powers in links and arches, minutes in deck and arches, mode shapes and so on.

Problem Identification & Objectives

- In all of the previous work static analysis of bridge is considered but none of them defined the variation caused due to I.R.C. 70R loading.
- In previous studies no comparison was done on the effects of different pylon shapes for same project in Cable Stay Bridge.
- In this study comparing three different shapes of pylons to determine the most suitable shape of pylon for a live project, for analysis and designing purpose staad.pro software is used. In this study we are providing vehicle loading as per IRC class 70R loading specifications and providing same span and geometry in all structures.

The main objectives of the present study are as follows: -

- Study of Cable Stay Bridge with different pylon types under Dynamic Loading Condition.
- To determine the most suitable type of pylon for cable stay bridge located at V.I.P. Bhopal.
- To determine the effect of pylon on deck of bridge.
- To calculate vehicular load as per I.R.C. 70R.

Flow Chart Diagram

Flow chart of proposed method of the analysis shown in the Figure: 4.7

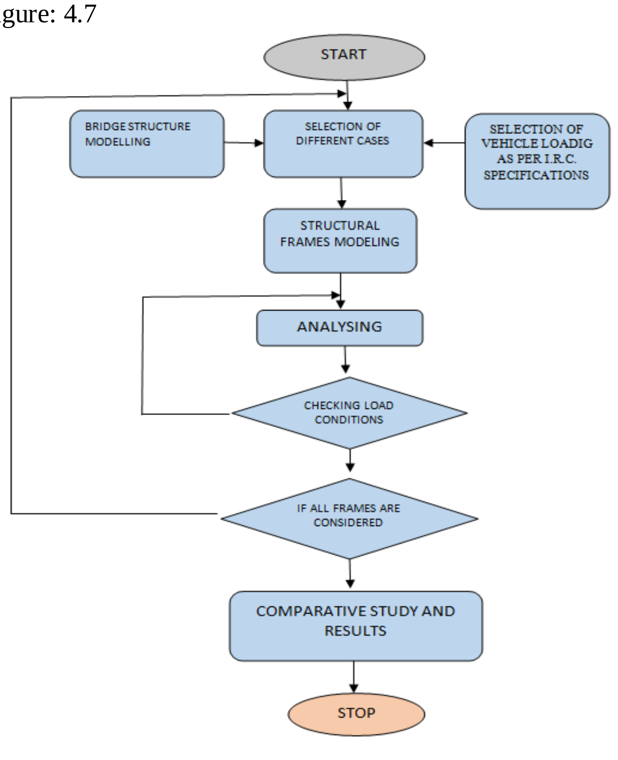

Fig: 4.7 Flow chart of methodology

Modeling of bridge frames

Here R.C.C. bridge frame is modeled in analysis tool staad pro in which bridge is analyzed and optimized, and vehicle loading (70R+A class) is considered as per I.R.C. Specifications, dead load as per 875 part-1 and superimposed live load as per 875 part-2 is calculated and applied.

Three caseshave been considered for comparative analysis:

- First Cable stay bridge with H-type pylon.
- Second Cable stay bridge with A-type pylon.
- Third Cable stay bridge with Y-type pylon.

STAAD.Pro is a multipurpose program for analyzing the different forms of structures. The following three activities must be performed to achieve that goal –

- Modeling of the frame using STAAD.Pro.
- The calculations to decide the explanatory results.
- Result check is all empowered by devices contained in the framework's graphical environment.

Geometrical properties

The bridge configuration selected is a representative of practical R.C.C.bridge that is common in Indian region as per Indian specifications and standards. The bridge is designed to bear Class A load. Hence, it needs to be strengthened. Therefore we considered here same loading as per I.R.C. standard code and same length to determine the best type of bridge structure in terms of force and deflection resistance also in terms of economy.

Following geometrical properties has been considered with materials in modeling: -

The total length of the bridge is 262 m out of which the length of the cable stay portion is nearly 200 m. the deck girder is a reinforced concrete section of 15.90 overall width catering for 2 lanes. Along the length of the bridge. The overall depth of the girder is 1.45 m and width 0.55.

A pylon frame of solid section is provided with an overall height of about the cross-section dimension of each leg varies from 4.6 m x 3.2 m at base to 2.6 m x 3.2 m at top. The pylon height is 32 m bridge. Here it is proposed to study the effect on the structural response 32 m.

Geometrical Details

Table 4.1 Description of Structure

S.No.	Description	Value
1	Length of Bridge	262 m.
2	Number of bays in X direction	52
3	Number of bays in Z direction	32 m
4	Width of the bridge section	15.90 m
5	Bay width in Z direction	3 m
6	Support type	Fixed support

The Bridge is of structural plan in X direction is 262 m and in Z it is 15.9 m.

Technical Specifications

In this problem standard material properties are considered which is given below table:

Table 4.2 Property of material

S.No.	Description	Value
1	Sections	Standard
2	Young's modulus of steel, Es	2.17×10^4 N/mm^2
3	Poisson ratio	0.17
4	Tensile Strength, Ultimate Steel	505 MPa
5	Tensile Strength, Yeild Steel	215 MPa
6	Elongation at Break Steel	70 %

II. RESULTS AND ANALYSIS

F.E.M. Analysis

Parameters on which study done are-

1. Shear force in KN.
2. Axial Force in KN.
3. Bending Moment in KN-m
4. Maximum deflection due to vehicle loadings.
5. Reaction at Deck.

- This chapter presents the results of comparative study prepared on a R.C.C. bridge where vehicle loading for lanes is assigned as per I.R.C. specifications to compute which type of bridge will be better in all aspects. For modelling, analysis and optimized designing of all the cases analysis tool staad.pro v8i. with fixed support is considered.
- These are the following forces acting due to vehicles moving load and behaviour of structures show in the values andfigures.

5Shear Force

Table 5.1 Shear force

Max. Shear Force kN		
A-type	H-type	Y-type
345.34	353.56	357.12

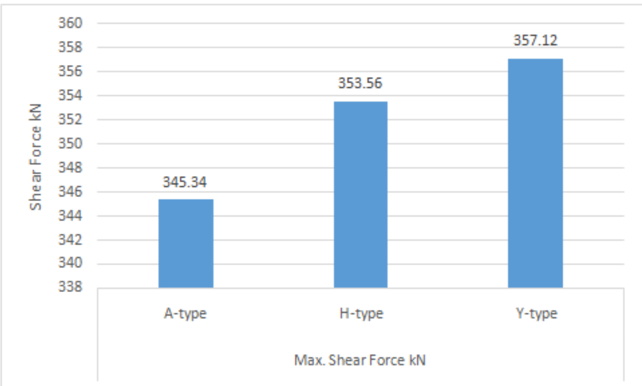

Fig: 5.1 Shear Force

Inferences: In the above fig 5.1, it is clearly observed that A-type pylon is observing less unbalance forces in comparison, whereas Y type pylon shows worst result in balancing forces.

Axial Force

Table 5.2 Axial force

Max. Axial Force kN		
A-type	H-type	Y-type
1024.15	1282.5	1376.19

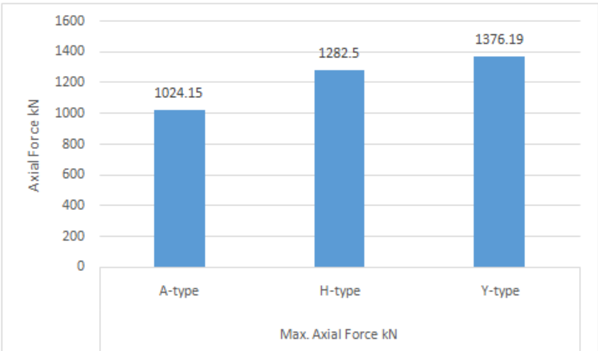

Fig: 5.2 Axial Force

Inferences: An axial force is any force that directly acts on the center axis of an object. These forces are typically stretching force or compression force, depending on direction. In addition, when the force load is even across the form's geometric center, it is concentric, and when it is uneven, it is eccentric. Unlike many acting forces, an axial force is often its own counter; an object pulled or pushed evenly in opposing directions doesn't move. In above figure it is clearly observed that A-type pylon is observing less resultant in distributing axial force, hence this will be stable one.

Deck Analysis

Table 5.5 Reactions at Deck (A-type)

Reactions at Deck A-type						
OutputCase	GlobalFX	GlobalFY	GlobalFZ	GlobalMX	GlobalMY	GlobalMZ
Unit	KN	KN	KN	KN	KN-m	KN-m
NODAL	13.45	18.45	8.7607	-15.123	2.45	26.33
NODAL	12.56	17.45	0.033	-17.54	2.87	26.87
NODAL	18.65	16.45	-1.54905	28.65	3.29	26.61
NODAL	20.12	15.45	-9.561	54.357	3.71	24.56
NODAL	20.06	14.45	-339.059	25.7	4.13	22.51
NODAL	19.45	13.45	2.082	-12.54	4.55	20.46
NODAL	17.56	12.45	-0.011	18.34	4.97	18.41
NODAL	15.67	11.45	1742.263	13.2	5.39	16.36
NODAL	13.78	10.45	-34.765	-26.87	5.81	14.31
NODAL	11.89	9.45	-279.003	-20.98	6.23	12.26
NODAL	10	8.45	0.001781	43.33	6.65	10.21
NODAL	8.11	7.45	-59621.168	-44.32	7.07	8.16

Table 5.6 Reaction at Deck (H-type)

Reactions at Deck H-type						
OutputCase	GlobalFX	GlobalFY	GlobalFZ	GlobalMX	GlobalMY	GlobalMZ
Unit	KN	KN	KN	KN	KN-m	KN-m
NODAL	19.67	20.98	8.7607	-15.123	3.2006	38.34
NODAL	28.95	22.65	0.033	-17.54	3.56	34.65
NODAL	17.87	29.04	-1.54905	28.65	3.9194	31.04
NODAL	27.54	28.65	-9.561	54.357	4.2788	27.32
NODAL	28.05	26.54	-339.059	25.7	4.6382	21.45
NODAL	19.45	24.43	2.082	-12.54	4.9976	18.76
NODAL	17.56	22.32	-0.011	18.34	5.357	15.45
NODAL	15.67	20.21	1742.263	13.2	5.7164	12.34
NODAL	13.78	18.1	-34.765	-26.87	6.0758	9.03
NODAL	11.89	15.99	-279.003	-20.98	6.4352	6.43
NODAL	13.45	13.88	0.001781	43.33	6.7946	3.67
NODAL	11.23	11.77	-59621.168	-44.32	7.154	2.32

Table 5.7 Reaction at Deck (Y-type)

Reactions at Deck Y-type						
OutputCase	**GlobalFX**	**GlobalFY**	**GlobalFZ**	**GlobalMX**	**GlobalMY**	**GlobalMZ**
Unit	**KN**	**KN**	**KN**	**KN**	**KN-m**	**KN-m**
NODAL	20.04	21.54	9.07	-15.123	3.2006	34.87
NODAL	19.05	23.45	-4.54	-17.54	3.56	34.65
NODAL	18.56	28.05	1.65	28.65	3.9194	42.87
NODAL	32.01	32.34	9.765	54.357	4.2788	28.09
NODAL	29.55	23	-7.87	25.7	4.6382	22.32
NODAL	32.45	26.43	2.082	-12.54	4.9976	19.05
NODAL	18.05	23.09	-0.011	18.34	5.357	16.78
NODAL	16.65	21.5	10.09	13.2	5.7164	13.43
NODAL	15.54	19.05	-21.07	-26.87	6.0758	10.54
NODAL	10.05	16.87	-2.08	-20.98	6.4352	7.98
NODAL	11.23	14.55	0.56	43.33	6.7946	5.45
NODAL	16.43	18.76	-5.76	-44.32	7.154	3.23

Table 5.8 Reaction at Deck

S. No.	Top Deck Slab Analysis		
	A-type	H-type	Y-type
B.M. (KN-m)	26.87	38.34	42.87
S.F. (KN)	18.45	29.04	32.34
A.F. (KN)	20.12	28.95	32.45

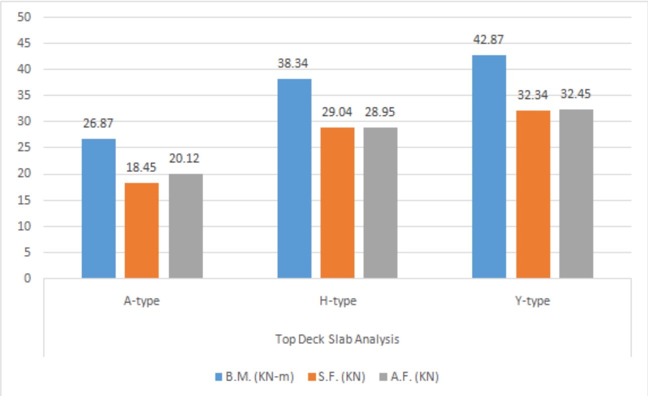

Fig: Deck slab analysis

Inferences: As deck will be the portion open to the vehicular load thus it is mandatory to have a deck which can distribute the load evenly. Here results shows that A type pylon will help the deck more to resist and distribute load properly.

III. CONCLUSIONS

As the aim of this study is to compare these three types of pylon for a live project. It is determined that A type pylon is most suitable, stable and resistible whereas H-type pylon is second best and Y type is observed as third best.

Following are the salient conclusions of this study-

In this study linear analysis of cable stayed bridge is done using FEA tool Staad-ProShear force in known as the unbalance force observed due to transmission of load from beam to column, in our study maximum value is observed in Y-type pylon i.e. 357.12 kN, whereas minimum in A-type pylon i.e. 345.34 kN.

Axial force is known as the vertical force observe in piers, this force is meant to distribute load from pier to earth. In our study maximum axial force is observed in Y-type i.e. 1376.19 kN, whereas minimum in A-type pylon i.e. 1024.15 kN, thus A-type pylon requires minimum cross sectional piers for load distribution.

In terms of bending moment, it is observed that maximum bending is in Y-type pylon i.e. 148.93 kN-m, whereas minimum is observed in A-type pylon i.e. 138.04 kN-m which shows that A-type pylon is comparatively most economical in comparison as bending moment is directly proportional to reinforcement requirement.

Future Scope of Work

In this analysis three different types of pylon are considered whereas in future following further steps can be considered.

- In future different spans can be compared for same loading conditions.
- In future different type of suspension bridges can be consider for different type of pylons analysis.
- In future other methods of analysis can be consider as in this study F.E.M. is considered.
- In future cost analysis can be done using schedule of rates.

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