Abdullah Khan, 2023, 11:4
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

Structural Analysis of Cable Stayed Bridgewith Different Shape of Pylon Using Staad Pro

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Abstract- The need for intricate, cost-effective engineering constructions with outstanding aesthetics has increased over the past few decades, and cable stayed bridges have also seen an increase in interest in these structures This study focuses on modeling cable-stayed bridges with various pylon shapes. One of the contemporary bridges designed for longer spans is the cable stayed bridge. STAAD Pro is used in this study to design the bridge, model it, and conduct assessments for the various types of pylons. In order to determine the most effective form of pylon design, three scenarios are compared on the basis of shear force, Torsion, bending moment in terms of self weight and IRC Class 70R Loading. The findings are helpful in limiting the limitations of other pylon kinds.

Keywords- Cable Stayed Bridge, Pylons & STAAD Pro.

I. INTRODUCTION

A bridge is a building that is positioned over an obstruction to create a path through it without obstructing it. Transporting moving loads or pedestrian loads requires a total length of at least 6 metres. The passage may be for a pipeline, railway, road, valley, canal, or even another canal. A country can develop based on the infrastructure that is already in place. Highways are a crucial part of infrastructure because they allow for the movement of people and cars.

A bridge must be constructed where there is heavy traffic congestion that delays travellers. The delay will be reduced by the bridge's construction, which will also allow for continuous vehicular flow. Choosing the appropriate deck slab type for each span is also essential, keeping both cost and aesthetics in mind.

The traffic assessment and the layout and structural design are two essential aspects of the planning for these buildings IRC 92-1985 states that the bridge design is desirable when the [Passenger Car Unit] value at the intersection reaches 10,000. There are times when IRC codes are developed and used as a result of global study.

There are numerous different bridge design types, each serving a specific function. The function of a bridge, the terrain on which it is built, the materials used to create it, and the amount of financing available all influences its design.

1. Cable Stayed Bridge:

Since the last two decades of the 20th century, numerous cable stay bridge projects have been successfully built all over the world. Cable stay bridges have been regarded as one of the most common types of bridges in recent decades due to their extremely substantial appearance and uniquely appropriated structural elements.

Modern cable stay bridges are more adequate & extendable robust enough to withstand wind forces than ever before due to the lengthening of bridge spans. A conventional cable stay bridge has a deck with one or two pylons in the middle of the span that are raised by piers or walls. To offer further support, the wires are angledly attached to the girder.

The cable stays, which are under stress, support the vertical loads on the deck. The stay cables' tensile forces affect the deck's horizontal compression.
Through vertical compression, the Pylon transmits the forces generated in the cables to the foundation. The bridge's design aims to minimize the height of

International Journal of Science, Engineering and Technology

An Open Access Journal

the pylon by almost balancing the static horizontal forces brought on by dead load. Due to their low centre of gravity, cable stay-bridges can withstand the effects of earthquakes. Due to their narrow cable diameter and unique top part of the structure, cable stay bridges offer excellent architectural show.

It can be built by cantilevering from the tower, meaning that the cables support the bridge deck both temporarily and permanently. The ability to construct cable stay bridges with any number of towers is a benefit.

The Cable Stay Bridge's pylon supports the cable system and transmits stresses to the foundations as part of its design. Depending on the configuration of the stay cables and the conditions supporting the deck-pylon, they are loaded with strong compressions and bending moments Pylons can be made of steel or concrete, with concrete often being more cost-effective given conditions of equivalent rigidity.

In addition to the previously mentioned concept, another important component that will affect how the pylons perform is their geometric shape, which is influenced by the applied loads, the cable-stay system, and aesthetic concerns. Through computer analysis using the STAAD Pro, the behaviour of the various Pylon shapes was studied.

2. Objective:

- STAAD PRO was used to analyse and design a bridge, and the findings were compared to those obtained manually.
- To understand the effects of the 70R loading condition.
- In this study, the Node displacement summary, Beam end force, and Plate centre principal stresses summary that are simply supported are compared.

3. Bridge loading and design condition:

The principal forces that need to be considered in order to estimate the load-effects (moments, shears, etc.) at all important structural sections are listed below. In order to resist these pressures at the necessary stress levels and serviceability criteria (crack-widths, deflections, etc.), the structure should only be designed after accounting for these load effects. Dead load of the structure (self weight come in stages)

- Live load (on roadway)
- Impact effect (of moving load).

Dead Load –

In some circumstances, self-weight may be added gradually, as in the design of pre-stressed bridge decks, or the dead load of the structure under consideration may be taken into account at the outset of the design.

The following factor affects the structure's dead load:

- Live load
- Type of design
- Working stresses employed
- Length of span

Live load-

- IRC Class 70R Loading: Culverts and permanent bridges are subject to IRC Class 70R Loading.
- IRC Class 70R Loading - On all highways when culverts and permanent bridges are built, this loading must typically be used. In some circumstances, greater pressures may occur under Class A Loading, hence bridges designed for Class 70R Loading should also be evaluated for Class A Loading.

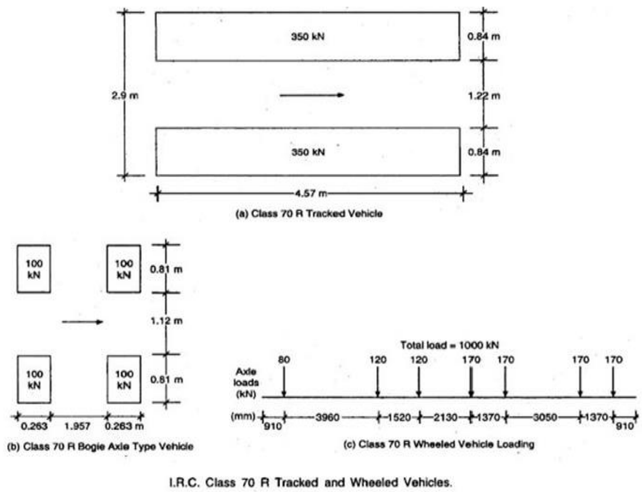

Fig1. Live Load.

II. LITERATURE SURVEY

In this chapter, some of the earlier research on the many types of cable-stayed bridges, the various loading conditions for cable-stayed bridges, and their construction is covered. Additionally, various codes of practise from Indian Standards have been researched and used in the current study.

Thomas Blesson B. and S. P. Thakkar (2011) A study was carried out to find the dynamic and aerostatic effect on different shapes of pylons of a cable stayed bridge. The different shapes of pylons considered here are H type, A type, Inverted Y type, Diamond type and Delta type. The central span of the cable stayed bridge is also varied as 100m, 200m, 300m, 400m to study the combined effects due to shape and span. The study was carried out by taking live load according to IRC 6:2000, IRreC Class A and Class 70R vehicle load along with Aerostatic wind loads was undertaken.

A Dynamic analysis in the form of Linear Time-history was also carried out using El-Centro ground motion and various response quantities such as Bending-moment, Shear force; Torsion and Axial force was represented.

The delta shape of pylon has lesser forces than others in both Linear and Dynamic case for Girder axial force while diamond performs better for shear. For Girder Torsion. A shape pylons perform better. For pylon Axial forces the Diamond shape performance has been better with the increase in span, in shear and pylon torsion both H type and A type are shaped pylons are better while in Pylon moment the Inverted Y type along with H type and A type shows better performance.

Praveen kumar M et.al (2017) The objective of the research paper was to create the model of Cable stayed bridge using SAP2000 software and investigate the displacement of cable stayed bridge, deck slab and pylon under the combined action of seismic loads, imposed loads and moving loads.

The displacement of the cable-stayed bridge deck slab under the action of the imposed and seismic loads was observed to be 28.3mm whereas the allowable displacement as per AASHTO code is 50mm, Hence the bridge performs safely under the action of imposed and seismic loads.

The displacement of the cable-stayed bridge deck under the action of moving traffic loads was observed to be 2.428mm which is very less compared to the allowable displacement 250mm. Hence the bridge remains safe under the action of daily traffic loads.

Hussain Hararwala and Savita Maru (2017) The research paper dealt with the linear static analysis of Cable Stayed Bridges with different shapes of pylons under its own weight. The different shapes of Pylons considered for Cable Stayed Bridge were A type, H type, inverted Y type, Single pylon, Diamond shaped, Pyramid Shaped, U-Shaped & Hexagonal Shaped. The height of the pylon remains same for all the models of Cable Stayed Bridge with different shapes of Pylons.

The modelling of bridge was prepared using SAP 2000 software. Results stated that the Pyramid Shaped Pylon having the minimum value of axial forces, bending moment, shear force & deflection in such conditions for Cable Stayed Bridge.

The cross section of Pylon must be kept rectangular as the stresses in circular sections are greater than rectangular. And also for ease in construction of complex forms of Pylons such as Diamond shaped, Pyramid Shaped, A-shaped, Inverted-Y shaped rectangular pylon proves economical and can easily be constructed. The moments, forces & deflections developed in Hexagonal Shaped Pylon and U-shaped Pylon are not as much higher than other suitable shapes of pylons. Hence both shapes can be implemented in actual practice after the proper experimental verification on such shapes in severe conditions.

Pratiksha Singh and Rajendra Kumar Srivastava (2019) The research paper presented analysis of different shapes of pylon like A-Shape, H-Shape, and inverted Y- Shape on Extra dosed bridge under static and dynamic loading. The CSI BRIDGE software has been used for modeling and analysis. Analysis of static load, dead load, and moving a vehicular load on the bridge was done.

The results have shown that most of the response quantities for inverted Y pylon shape are less as compared to other pylon shapes considered in this study. Hence it was concluded that inverted-Y pylon shape was statically and dynamically stronger than any other pylon shapes under the action of loads.

Rinki Verma and Vinay Kumar Singh (2019) The research paper focused on the behavior of the cable-stayed bridge for earthquake load and traffic load in seismic zone IV with hard soil condition. Study was done on the displacement of bridge deck and pylon under vehicular load and seismic load combination and forces developed in various components of the bridge.

Results stated that the maximum displacement, bending moment, shear force, axial force will occur at the center of main span at 156 m on the bridge deck in case when the combined load action (vehicular and earthquake). The maximum bending moment occur at the main span when the moving loads at the main span 33627.78KN-m at the centre of the main span. The maximum axial force occurs at the 81m and 240 m from the left end of the bridge when the moving loads at the main span compress 19747.47 KN, 19491.139 KN and zero at the center of the main span.

Aniruddha Sharma and Dr J N Vyas (2019) The research paper dealt with the linear static analysis of Cable Stayed Bridges with different shapes of pylons under its own weight, vehicular load and wind load. The different shapes of Pylons considered for Cable Stayed Bridge were A type, H type, inverted Y type, Single pylon and Diamond shaped. The height of the pylon remains same for all the models of Cable Stayed Bridge with different shapes of Pylons. The modelling of bridge was prepared using SAP 2000 software. For this study, the arrangement of cable stay was taken as semi fan type. The study reveals the following points regarding to the behaviour of Pylons such as the Axial Force in Pylon, Bending Moment in Pylon, and Shear Force in Pylon & Deflection at the top of Pylon.

Results stated that values of axial forces in diamond shaped pylon having semi fan arrangement are 31% higher than the values in single shaped Pylon. The values of axial forces in H-shaped pylon having semi fan arrangement are 37% higher than the values in single shaped Pylon. The values of axial forces in A-shaped pylon having semi fan arrangement are 6% lesser than the values in single shaped Pylon.

The values of axial forces in Inverted-Y shaped pylon having semi fan arrangement are 2% higher than the values in single shaped Pylon.

Govardhan Polepally et.al (2020) This research paper focused on the effect of the shape of the pylon on the seismic response of cable-stayed bridge. The bridge span dimension and other parameters are kept constant, and the only shape of the pylon is varied viz. A type, H type, inverted Y shapes.

The height of the pylon was kept constant for all the numerical models for comparison purposes. The 3D bridge model was modelled using SAP 2000 software and analyzed for three earthquake ground motions Bhuj 2001, Loma Prieta 1989 and El Centro earthquake 1940.

Results stated that the time period of the bridge with A-shaped pylon was less when compared to other two pylon shapes and inverted-Y shaped pylon have a larger time period.

The Inverted-Y shape pylon bridge has less response for Loma and Bhuj ground motion, whereas A-shape Pylon Bridge has less response for Elcentro earthquake when compared to other pylon-shaped bridges.

Mithilesh Kumar and Kapil Soni (2020) The objective of this research paper was to investigate cable stay bridge with different pylon types namely H-type, A-type and Y-type under dynamic loading conditions. The modeling and analysis was done using analytical application STAAD.Pro.

Results stated that maximum bending was 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 was comparatively most economical in comparison as bending moment is directly proportional to reinforcement requirement.

Maximum axial force was 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.

Joseph Vianny X et.al (2020) The objective of this research paper was to investigate the behaviour of asymmetric cable stayed bridges for different loading conditions. The model of long span conventional and asymmetric Cable stayed bridge for two cable plane and four cable plane arrangements was done using SAP2000 software and investigated the response of asymmetric cable stayed bridge under all condition of loads mainly in moving loads and the comparative study was conducted between conventional and asymmetric cable bridges. The percentage of reinforcements in pylon for conventional and asymmetric cable bridge is changed. The change in percentage of reinforcement is due to a reduced in number of cables. The numbers of cables are partially reduced in asymmetric cable bridge than conventional cable bridge. Therefore the weights of the cables are greatly reduced along the length of the bridge.

Abhishek Pandey and Nitesh Kushwah (2020) This research paper dealt with the design and analysis for different cables arrangement with the different shapes of pylons using STAAD Pro. And for conscious minds arrangements with both the H, Both a Y shape tower, those who regarded multiple cases together with dead load & live load for analysis using Stand-Pro software.

Results stated that the circular or the H shape pylon can have a small amount of sag and moment in the cables or the deck among all of the pylons (i.e. one axial layer of stay and two lateral of stays) also because greater number with joints was n't homogeneous such that the composition with pressure and anxiety carrying capacity of both the cables wasn't really efficient towards the other parts of both the cable which might lead with sec, In comparison with a circular with a homogeneous member.

Neel Shah et. al (2021) This study was carried out to find the dynamic effect on different configurations of pylons of a cable-stayed bridge. A pylon was inclined at 5o , 10o, 15o, 20o, 25o and 30o with vertical and horizontal axis both and compared with vertical pylon to study the dynamic response of the bridge. The 3D bridge models were prepared on CSI BRIDGE software and the bridge was analyzed seismically by Imperial Valley 1947, Earthquake. The bridge response in terms of Pylon, Girder and Cable axial force, moment and torsion was obtained.

Results stated that minimum axial force was obtained at 10o in Cable at main span near pylon in X - Direction and Y - Direction both. Minimum axial force we got in girder at 10o at main span and side span both in X – Direction. Minimum axial force we got in pylon at 10o in X – Direction and at 15o for Y – Direction. Minimum moment in pylon we got at 10o and minimum torsion in pylon at 5o.

Priyanka Singh et.al (2021) In the research paper, the bridge design, model, and analyses for different types of pylons namely, H-type pylon, A-type pylon and inverted Y-type pylon was done using STAAD Pro. The comparison for three cases was done on the basis of shear force and bending moment in terms of self weight to obtain the most efficient type of pylon design. Maximum shear force is observed in A-type pylon i.e., 605.876kN, 468.210kN for inverted Y-type and H-type pylon design i.e., 508.93kN.

In terms of bending moment, it is observed that maximum bending is in inverted Y-type pylon i.e., 444.329kN-m, 271.430kN-m for H- type pylon whereas minimum is observed in A-type pylon i.e., 213.8kN-m which shows that this pylon design is more economical in comparison to other types as bending moment is directly proportional to the amount of reinforcement requirement.

In case of deflection, it was observed that pylon type H has maximum deflection i.e., 172.5mm, followed by inverted Y- type pylon design i.e., 149.8mm,whereas it minimum in A-type pylon design, i.e., 76.9mm, which concludes that A-type pylon is most suitable and stable section in comparison.

N. Sonjoh Chebelem and Hakan Erdogan (2021) This research paper focused on the effect of A and H shape reinforced concrete pylons on the seismic behavior of a long span steel triple box-girder cable-stayed bridge that was presumed to be located in an earthquake-prone region in Turkey. The 3D models of the bridge were constructed using SAP2000 software and the time history analysis was carried out considering cable sag, large displacement effects. The seismic responses of the bridges were compared in terms of axial force on cables, deflections on the pylons and the deck.

Results stated that the pylon vibration became dominant in the earlier modes for H shape pylon with respect to A shape pylon. This behaviour possibly led to almost two fold difference among the maximum pylon top transverse displacements of the two different pylons, namely H shape pylon experienced greater displacement.

On the contrary, the maximum deck midspan transverse displacement was observed in cable stayed bridge model with A shape pylon.

Mohamed Naguib et.al (2022) In the research paper, bridges' static analysis was carried out using a FORTRAN finite element program based on the minimization of Total Potential Energy "TPE" applying the method of conjugate gradient. The analysis is carried out for five spans CSBs with three shapes of pylons H, A and Y shape. Four popular connection cases have been shown to describe the effect of connections between pylons and floor beams. The effect of initial tension in cables and various heights of pylons are taken into consideration as parametric study.

Results stated that radiating shape decreases the lateral displacement of the pylon by 5% and the maximum deflection of the floor beam by 7%, but it has the maximum normal force along the pylon height.

The A-tower is more effective in decreasing both the lateral displacement of the pylon by 17% and the vertical deflection of the floor beam by 57%. Increasing the pretension forces in cables decreases the lateral displacement of pylons, vertical deflection and bending moment of floor beam but increases the normal force along floor beam. Also, the normal force and bending moment of the pylon increases.

Atheela Mehaboob and Athira Suresh (2022) This research paper presented modelling and analysis of a curved cable-stayed bridge using SAP 2000 subjected to dynamic time history loads considering the effect of inclination of pylon on response of mode shape of pylon. Inclinations provided were 0 degree, 5 degree, 15 degree and 20 degree.

Results concluded that 5 degrees was the most accurate inclination over other inclinations. Since in the case of deflection analysis 5 degree inclination gives the best result, only height of 5 degree inclination varied. Actual height of the tower was 36.87m. It was reduced to 33.86m and 39.87m. Changes in longitudinal and transverse direction were found and a graph was drawn.

Ahmed M. Fawzy et.al (2022) In the research paper, the shape of pylons; the performance of many shapes was investigated after being exposed to an earthquake. The effect of changing deck width of an inverted Y-shaped pylon with variation in main span length was investigated. The numerical study was performed using MIDAS civil software. Conclusion stated that the most efficient pylon shape in terms of seismic performance was that of pyramid shape followed by a delta shape. In addition, it was found that changing deck width for the same main span gives a negligible difference to normalized shear force.

III. ANALYSIS AND RESULTS

Table 1. Maximum node displ cement for H type pylon condition in IRC 70R loading.

Node Displacement Summary

	Node	L/C	X (mm)	Y (mm)	Z (mm)	Resultant (mm)	rX (rad)	rY (rad)	rZ (rad)
Max X	7	5:IRC: SLS CL	**14.5E+3**	-10.601	-2.906	14.5E+3	-0.000	0.000	-0.263
Min X	6	8:IRC: SLS CL	**-14.9E+3**	-10.746	-2.216	14.9E+3	-0.000	-0.000	0.278
Max Y	2	3:IRC: SLS CL	-49.185	**28.1E+3**	-18.444	28.1E+3	0.021	0.000	0.308
Min Y	1	8:IRC: SLS CL	-270.429	**-31.6E+3**	-36.845	31.6E+3	-0.093	-0.001	0.383
Max Z	7	1:DEAD	461.781	-51.586	**304.221**	555.386	0.008	-0.000	-0.010
Min Z	342	1:DEAD	461.781	-51.586	**-304.221**	555.386	-0.008	0.000	-0.010
Max rX	1	10:IRC: SLS Cl	-322.987	-29.9E+3	36.363	29.9E+3	**0.095**	0.000	0.345
Min rX	22	8:IRC: SLS CL	-275.125	-30.8E+3	-36.657	30.8E+3	**-0.099**	-0.000	0.379
Max rY	2	5:IRC: SLS CL	307.320	-30.8E+3	-36.610	30.8E+3	-0.090	**0.001**	-0.355
Min rY	1	8:IRC: SLS CL	-270.429	-31.6E+3	-36.845	31.6E+3	-0.093	**-0.001**	0.383
Max rZ	116	8:IRC: SLS CL	-274.827	10.9E+3	2.536	10.9E+3	0.015	-0.000	**0.463**
Min rZ	216	5:IRC: SLS CL	311.649	10.8E+3	2.519	10.8E+3	0.015	0.000	**-0.457**
Max Rst	1	8:IRC: SLS CL	-270.429	-31.6E+3	-36.845	**31.6E+3**	-0.093	-0.001	0.383

Table 2. Maximum Axial force, Shear, Torsion, and Bending moment for H-shape pylon condition in IRC 70R loading.

Beam End Force Summary

The signs of the forces at end B of each beam have been reversed. For example: this means that the Min Fx entry gives the la value for an beam.

				Axial	Shear		Torsion	Bending	
	Beam	Node	L/C	Fx (kN)	Fy (kN)	Fz (kN)	Mx (kNm)	My (kNm)	Mz (kNm)
Max Fx	7	8	1:DEAD	**7.12E+3**	12.703	-8.264	-0.003	-68.876	-108.690
Min Fx	595	166	8:IRC: SLS CL	**-878.923**	0.001	-0.000	-0.001	0.001	0.036
Max Fy	7	4	8:IRC: SLS CL	1.09E+3	**395.538**	-0.167	0.749	2.063	6.69E+3
Min Fy	8	5	8:IRC: SLS CL	-287.398	**-393.090**	-0.242	0.074	3.891	-6.45E+3
Max Fz	643	25	1:DEAD	6.97E+3	-12.703	**8.264**	-0.003	-137.734	-208.892
Min Fz	8	5	1:DEAD	6.97E+3	-12.703	**-8.264**	0.003	137.734	-208.892
Max Mx	154	20	8:IRC: SLS CL	1.954	-6.397	-1.057	**130.605**	1.272	-4.115
Min Mx	419	21	5:IRC: SLS CL	1.948	-6.269	1.049	**-129.250**	-1.264	-3.672
Max My	8	5	1:DEAD	6.97E+3	-12.703	-8.264	0.003	**137.734**	-208.892
Min My	643	25	1:DEAD	6.97E+3	-12.703	8.264	-0.003	**-137.734**	-208.892
Max Mz	7	4	8:IRC: SLS CL	1.09E+3	395.538	-0.167	0.749	2.063	**6.69E+3**
Min Mz	8	5	5:IRC: SLS CL	1.09E+3	-390.076	-0.145	-0.743	1.717	**-6.62E+3**

Table 3. Maximum Principal, Von Mis, Tresca for H-shape pylon condition in IRC 70R loading.

Plate Centre Principal Stress Summary

			Principal		Von Mis		Tresca	
	Plate	L/C	Top (N/mm^2)	Bottom (N/mm^2)	Top (N/mm^2)	Bottom (N/mm^2)	Top (N/mm^2)	Bottom (N/mm^2)
Max (t)	858	8:IRC: SLS CL	**84.456**	-0.509	84.206	84.737	84.456	84.991
Max (b)	862	3:IRC: SLS CL	-1.427	**88.769**	88.120	88.070	88.825	88.769
Max VM (t)	862	3:IRC: SLS CL	-1.427	88.769	**88.120**	88.070	88.825	88.769
Max VM (b)	862	3:IRC: SLS CL	-1.427	88.769	88.120	**88.070**	88.825	88.769
Tresca (t)	862	3:IRC: SLS CL	-1.427	88.769	88.120	88.070	**88.825**	88.769
Tresca (b)	862	3:IRC: SLS CL	-1.427	88.769	88.120	88.070	88.825	**88.769**

Table 4. Maximum node displacement for A-shape pylon condition in IRC 70R loading.

Node Displacement Summary

	Node	L/C	X (mm)	Y (mm)	Z (mm)	Resultant (mm)	rX (rad)	rY (rad)	rZ (rad)
Max X	7	1:d	**5.86E+3**	-50.553	916.289	5.93E+3	0.023	0.001	-0.166
Min X	6	1:d	**-5.86E+3**	-50.553	916.284	5.93E+3	0.023	-0.001	0.166
Max Y	96	1:d	10.200	**172.750**	-16.574	173.843	0.013	-0.001	-0.007
Min Y	22	1:d	5.247	**-28E+3**	-175.459	28E+3	0.006	-0.002	0.378
Max Z	7	1:d	5.86E+3	-50.553	**916.289**	5.93E+3	0.023	0.001	-0.166
Min Z	341	1:d	-5.77E+3	-745.639	**-3.97E+3**	7.04E+3	-0.125	0.011	0.164
Max rX	5	1:d	-11.841	-32.809	-21.863	41.166	**0.023**	0.001	-0.095
Min rX	342	1:d	5.77E+3	-745.639	-3.97E+3	7.04E+3	**-0.125**	-0.011	-0.164
Max rY	341	1:d	-5.77E+3	-745.639	-3.97E+3	7.04E+3	-0.125	**0.011**	0.164
Min rY	342	1:d	5.77E+3	-745.639	-3.97E+3	7.04E+3	-0.125	**-0.011**	-0.164
Max rZ	65	1:d	3.629	-11.8E+3	-83.309	11.8E+3	0.004	-0.002	**0.428**
Min rZ	275	1:d	-3.637	-11.8E+3	-83.306	11.8E+3	0.004	0.002	**-0.428**
Max Rst	22	1:d	5.247	-28E+3	-175.459	**28E+3**	0.006	-0.002	0.378

Table 5. Maximum Axial fo ce,Shear,Torsion, and Bending moment A-s ape pylon condition in IRC 70R loading.

Beam End Force Summary

The signs of the forces at end B of each beam have been reversed. For example: this means that the Min Fx entry gives the l value for an beam.

				Axial	Shear		Torsion	Bending	
	Beam	Node	L/C	Fx (kN)	Fy (kN)	Fz (kN)	Mx (kNm)	My (kNm)	Mz (kNm)
Max Fx	7	8	1:d	**7.2E+3**	103.837	-27.339	3.789	-235.611	-869.118
Min Fx	599	323	1:d	**-550.169**	-0.204	0.000	0.000	0.000	2.012
Max Fy	20	25	1:d	5.711	**170.750**	1.128	-69.363	-3.649	2.03E+3
Min Fy	146	24	1:d	5.710	**-170.755**	-1.128	69.363	-3.649	2.03E+3
Max Fz	643	25	1:d	6.85E+3	-103.012	**27.339**	-3.694	-463.561	-1.72E+3
Min Fz	7	4	1:d	7.05E+3	103.837	**-27.339**	3.789	447.854	1.73E+3
Max Mx	19	25	1:d	-11.771	126.252	-0.301	**82.652**	1.456	1.69E+3
Min Mx	159	100	1:d	-11.772	-108.586	0.301	**-82.652**	-0.051	1.11E+3
Max My	7	4	1:d	7.05E+3	103.837	-27.339	3.789	**447.854**	1.73E+3
Min My	643	25	1:d	6.85E+3	-103.012	27.339	-3.694	**-463.561**	-1.72E+3
Max Mz	146	24	1:d	5.710	-170.755	-1.128	69.363	-3.649	**2.03E+3**
Min Mz	8	5	1:d	7.05E+3	-103.837	-27.338	-3.789	447.853	**-1.73E+3**

Table 6. Maximum Principal, Von Mis, Tresca A-shape pylon condition in IRC 70R loading.

Plate Centre Principal Stress Summary

			Principal		Von Mis		Tresca	
	Plate	L/C	Top (N/mm^2)	Bottom (N/mm^2)	Top (N/mm^2)	Bottom (N/mm^2)	Top (N/mm^2)	Bottom (N/mm^2)
Max (t)	805	1:d	**77.233**	4.857	79.582	81.421	81.739	83.741
Max (b)	736	1:d	0.290	**82.157**	94.866	82.421	95.011	82.682
Max VM (t)	736	1:d	0.290	82.157	**94.866**	82.421	95.011	82.682
Max VM (b)	745	1:d	3.594	87.852	91.484	**89.510**	93.229	91.081
Tresca (t)	739	1:d	5.754	81.580	93.448	84.640	**96.192**	87.400
Tresca (b)	745	1:d	3.594	87.852	91.484	89.510	93.229	**91.081**

Table 7. Maximum node displacement for Y-shape pylon condition in IRC 70R loading.

Node Displacement Summary

	Node	L/C	X (mm)	Y (mm)	Z (mm)	Resultant (mm)	rX (rad)	rY (rad)	rZ (rad)
Max X	7	5:IRC: SLS CL	**31.8E+3**	-82.401	-142.180	31.8E+3	-0.004	-0.047	-0.868
Min X	6	5:IRC: SLS CL	**-32.8E+3**	-84.036	-142.761	32.8E+3	-0.004	0.034	0.880
Max Y	2	3:IRC: SLS CL	-3.609	**55.9E+3**	-12.065	55.9E+3	0.011	0.000	0.726
Min Y	22	5:IRC: SLS CL	-213.236	**-84.4E+3**	24.449	84.4E+3	0.138	0.001	1.258
Max Z	341	1:D	-6.96E+3	-8.18E+3	**8.11E+3**	13.5E+3	0.386	-0.065	0.217
Min Z	6	1:D	-8.55E+3	-4.08E+3	**-6.98E+3**	11.8E+3	-0.272	0.057	0.250
Max rX	341	1:D	-6.96E+3	-8.18E+3	8.11E+3	13.5E+3	**0.386**	-0.065	0.217
Min rX	6	1:D	-8.55E+3	-4.08E+3	-6.98E+3	11.8E+3	**-0.272**	0.057	0.250
Max rY	366	5:IRC: SLS CL	7.68E+3	-24.588	9.426	7.68E+3	0.002	**0.103**	-0.893
Min rY	352	5:IRC: SLS CL	-8.39E+3	-24.478	7.417	8.39E+3	0.002	**-0.098**	0.923
Max rZ	35	5:IRC: SLS CL	-213.387	-71.8E+3	19.255	71.8E+3	0.132	0.001	**1.264**
Min rZ	310	5:IRC: SLS CL	-222.167	-75.6E+3	22.151	75.6E+3	0.138	-0.001	**-1.250**
Max Rst	22	5:IRC: SLS CL	-213.236	-84.4E+3	24.449	**84.4E+3**	0.138	0.001	1.258

Table 8. Maximum Axial force,Shear,Torsion, and Bending moment for Y-shape pylon condition in IRC 70R loading.

Beam End Force Summary

The signs of the forces at end B of each beam have been reversed. For example: this means that the Min Fx entry gives the lar value for an beam.

				Axial	Shear		Torsion	Bending	
	Beam	Node	L/C	Fx (kN)	Fy (kN)	Fz (kN)	Mx (kNm)	My (kNm)	Mz (kNm)
Max Fx	642	343	1:D	**7.22E+3**	165.578	11.208	-0.687	89.713	-1.38E+3
Min Fx	580	311	1:D	**-725.240**	0.283	-0.000	0.000	0.000	3.813
Max Fy	642	24	5:IRC: SLS CL	769.070	**876.940**	-3.361	2.990	52.314	14.7E+3
Min Fy	643	25	5:IRC: SLS CL	645.856	**-876.915**	-3.416	-2.947	53.504	-14.5E+3
Max Fz	6	5	3:IRC: SLS CL	516.344	0.001	**431.076**	0.031	-2.82E+3	0.011
Min Fz	5	4	3:IRC: SLS CL	510.385	0.001	**-426.108**	-0.031	2.78E+3	0.011
Max Mx	154	20	5:IRC: SLS CL	84.002	42.325	46.587	**297.387**	-36.779	58.427
Min Mx	151	4	5:IRC: SLS CL	94.360	2.325	-36.167	**-295.058**	44.505	81.023
Max My	6	5	5:IRC: SLS CL	838.931	-0.001	-350.580	-0.030	**3.5E+3**	-0.014
Min My	5	4	5:IRC: SLS CL	1.06E+3	-0.001	369.689	0.030	**-3.53E+3**	-0.014
Max Mz	642	24	5:IRC: SLS CL	769.070	876.940	-3.361	2.990	52.314	**14.7E+3**
Min Mz	643	25	5:IRC: SLS CL	645.856	-876.915	-3.416	-2.947	53.504	**-14.5E+3**

Table 9. Maximum Principal, Von Mis, Tresca for Y-shape pylon condition in IRC 70R loading.

Plate Centre Principal Stress Summary

			Principal		Von Mis		Tresca	
	Plate	L/C	Top (N/mm^2)	Bottom (N/mm^2)	Top (N/mm^2)	Bottom (N/mm^2)	Top (N/mm^2)	Bottom (N/mm^2)
Max (t)	858	5:IRC: SLS CL	**127.672**	-2.231	126.489	125.988	127.672	127.088
Max (b)	745	1:D	-13.573	**125.396**	130.896	120.114	137.153	125.396
Max VM (t)	745	1:D	-13.573	125.396	**130.896**	120.114	137.153	125.396
Max VM (b)	858	5:IRC: SLS CL	127.672	-2.231	126.489	**125.988**	127.672	127.088
Tresca (t)	745	1:D	-13.573	125.396	130.896	120.114	**137.153**	125.396
Tresca (b)	858	5:IRC: SLS CL	127.672	-2.231	126.489	125.988	127.672	**127.088**

IV. CONCLUSION

Many different cable stayed bridge pylon types have their designs and analyses completed using the tool STAAD Pro. Pylons of the H-type, A-type, and inverted Y-types are among the different types that are taken into consideration. Shear force, bending moment, and deflection measurements between three different types of cable-stayed bridge pylons are made, with the results of these comparisons being recorded. The effect of these alternative pylon designs on the strength and efficiency of the bridge is then evaluated and contrasted.

A force known as shear, also referred to as unbalance, is produced when a load is transferred from a beam to a column. The A-type pylon, with a shear force of (170.750 KN), the Y-type pylon, with a shear force of (875.950 KN), and the H-type pylon, with a shear force of (395.538 KN), are those with the highest shear forces, per our analyses. The A-type pylon bends at a minimum of (2.03E+3 kN-m) while the Y-type and H-type pylons bend at maximums of (14.7E+3) and (6.69E+3 kN-m), respectively, showing that this pylon design is more cost-effective than other types because bending moment is directly proportional to the amount of reinforcement required.

We discovered that pylon type Y has the highest Torsion, or primary stress at the centre of the plate, followed by the Y-type pylon design. The torsion and principal stress at the centre of the plate for the Y type pylon are (297.387 kN-m) and (127.672 N/MM2), respectively, and the torsion and principal stress at the centre of the plate for the A type pylon are (82.652 kN-m) and (77.233 N/MM2), respectively, indicating that the A-type pylon is the most suitable and stable section in comparison.

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