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Comparative Study of Prestressed Concrete Girder and Steel Plate Girder of Integral Abutment Bridge

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Abstract : This project compares the use of steel plate girders and prestressed concrete girders in urban locations. PSC Girders and Steel Plate Girders have been utilised over piers and abutments in India for a very long period. There are some issues with PSC Girder, including as its extremely high self weight, which makes it challenging to launch and cast at the location. There are some issues with PSC Girder, including as its extremely high self weight, which makes it challenging to launch and cast at the location. In PSC Girder, there is a higher likelihood of operational issues; accidents frequently happen. To solve these issues It has been suggested to compare the superstructure of PSC and steel girders. The study comprises the design of PSC and Steel Plate Girders for a 30 m span. The analysis is performed using the CSI BRIDGE programme. Calculations of the bending moment, shear force, axial force, longitudinal displacement, vertical displacement, and deflection are all part of the study. For both girders, the aforementioned estimated characteristics are compared. The most advantageous alternative from the two listed above will be chosen as the subject of this study.

***IndexTerms* - CSI Bridge, Prestressed Concrete Girder, Steel Plate Girder, Vertical, Displacement**

I. INTRODUCTION

To prevent level crossings, crossing any kind of impediment in urban environments requires elevated access. Rail level crossings are avoided via the provision of elevated highways. In India, these regulations are specifically found in the UP system. Over piers and abutments, a pre-stressed, steel, and composite girder is supported. For the local traffic, service lanes are suggested the system mentioned above has the some issues. PSC Girder is very heavy, making it challenging to launch and cast at the site. Because of the weight, the size and depth of the foundation increase, making the building unprofitable. The likelihood of working issues is higher, and accidents frequently happen. Take Varanasi (UP) in May 2018 as an example. To solve these issues It has been suggested to compare the superstructure of PSC and steel girders.

1.1 Prestressed Concrete Girder

Construction with prestressed concrete is the most popular type. By using girders that are constructed off-site, transported, and then put into place at the job site, prestressed concrete girders enable quick bridge construction. As the technology is now available in all industrialized and many developing countries, it has established itself as a reliable way of construction. Precast concrete has seen widespread use in the construction of large span bridges ever since it was first developed. Precast girders with cast-in-place slabs are one of the superstructure types that are most frequently utilized in concrete bridges. Typically, this kind of superstructure is employed for spans between 20 and 40 meters. The most typical examples are bridges with T or I girders and box girders. It is important to dispel the misconception that PSC Girder is a cheap choice.

1.2 Plate girder

In essence, a plate girder is an I beam constructed from plates utilizing bolting or welding. It is a deep flexural element that rolls beams may support. Plate girders are not constrained to standard designs and can be taller than rolled steel girders. The bridge design can be more effective since girders can be made to fit the precise load conditions. PSC Girder is heavier than Plate Girder, which is lighter. On rare occasions, stiffeners are welded between the compression flange and the web to strengthen the girder. The designer is free to choose the most cost-effective girder for the construction because plate girders, rather than rolling beam sections, are used for the two major girders. In structures up to 40 meters, plate girders are frequently employed.

II. METHODOLOGY

To start, the PSC Girder was manually designed based on IS 456:2000, IS 1343:2012, IRC 112:2011, and IRC 18:2000. A MS Excel design programme was created based on the procedures and calculations used. By initially utilising the programme to design the manually designed girder and comparing the results, the program's validity was examined. On CSI BRIDGE, the output from the programme and the manual computations were also checked.,etc.

Additionally, the Steel Girder was initially created utilising the limit state method based on the IRC 112:2011, IRC 24:2010, and IS 800:2007 standards. A design programme was created in MS Excel based on the formulas and steps that were used. By initially utilising the programme to design the manually designed girder and comparing the outcomes, the program's validity was examined. On CSI BRIDGE, the output from the programme and the manual computations were also checked.The span length taken into consideration for both girders is 25 m, which is subject to the same vehicular loading. For the specified length of the span, four longitudinal and six cross girders have been installed. Class 70 (R) for two lanes and Class (A) for one lane vehicles are loaded into the system. When developing the girder, all the guidelines from IRC: 24-2010, IS:800-2007, and IS:1343-2012 were taken into consideration. The girder layout was also created on AUTO CAD for greater comprehension.

Table 1 Data About PSC Girder

General Data	Values
Grade of concrete	M 35
Reinforcement	Provided HYSD 500
Tendons Provided	7ply, 12.7 mm diameter

Table 2 Data About Steel Girder

General data	Values
Total Depth	1200 mm
Total Flange Width	400 mm
Web Thickness	13 mm
Bottom Flange Width	250 mm
Bottom Flange Thickness	25 mm
Grade of Steel	Fe 410
Welded Connection is to be provided	Fillet welding
Weight of Girder per m run	10KNM

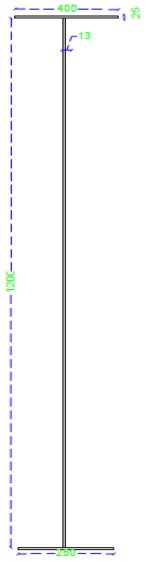

Figure 1 I-section of PSC Girder

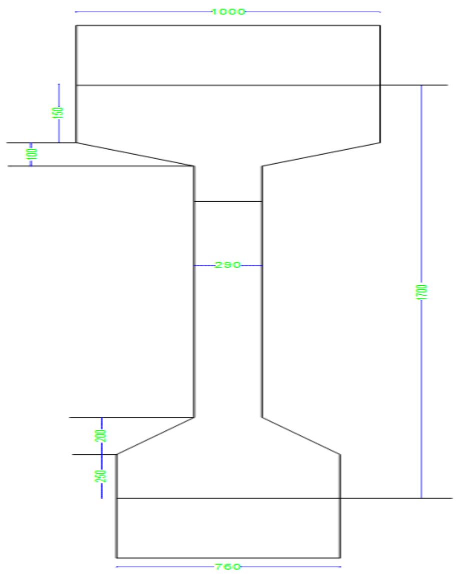

Figure 2 Details of PSC Girder

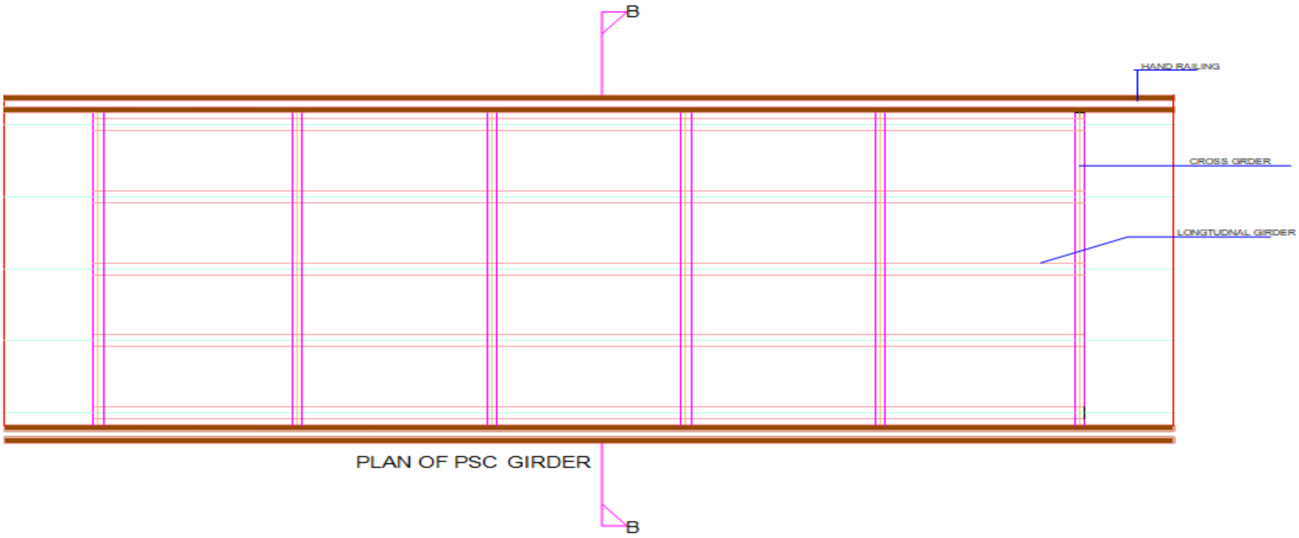

Figure 3 Plan of PSC Girder

III. Analysis and Comparison of results

The analysis of both the girders was carried out on CSI bridge software. The parameters for analysis are: -.

a) Shear Force
b) Bending Moment
c) Vertical Displacement
d) Axial Force

3.1 Shear Force

Table 3 Shear Force

Span	PSC Girder	Plate Girder
0.00	-1581.023	-1253.239
3.33	-1208.482	-974.742
6.67	-858.904	-696.244
10.00	-513.136	-417.746
13.33	-170.831	-139.249
16.67	170.831	139.249
20.00	513.296	417.746
23.33	859.064	696.244
26.67	1208.641	974.742
30.00	1579.285	1253.239

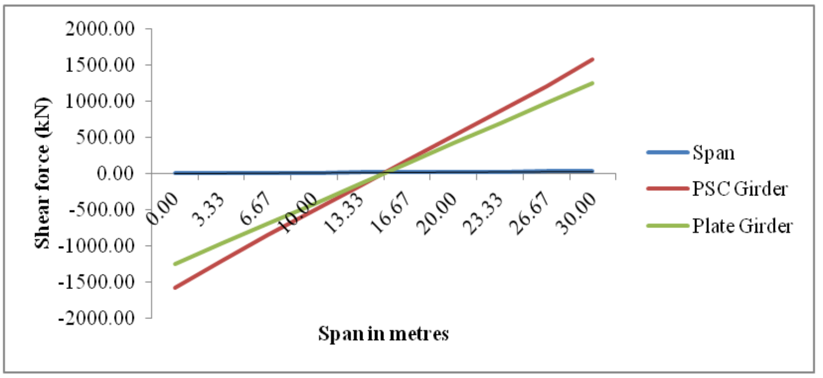

Figure 4 Comparison of Shear Force

3.2 Bending Moment

Table 4 Bending Moment

Span	PSC Girder	Plate Girder
0.00	0	0
3.33	4846.5319	3094.4176
6.67	8481.4308	5415.2309
10.00	10904.6968	6962.4397
13.33	12116.3298	7736.0441
16.67	12116.3298	7736.0441
20.00	10904.7	6962.4397
23.33	8481.431	5415.2309
26.67	4846.5319	3094.4176
30.00	0	0

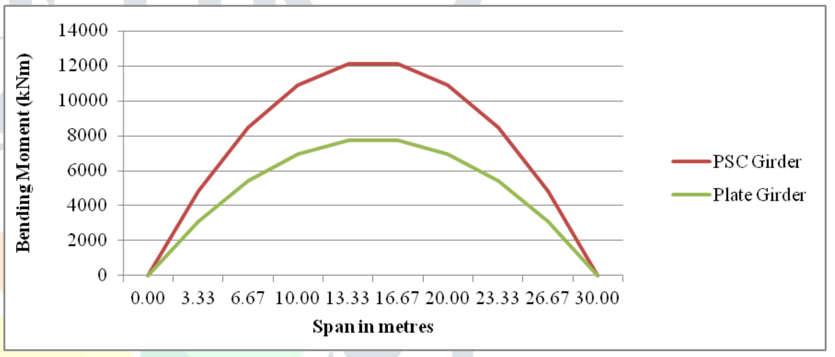

Figure 5 Comparison of Bending Moment

3.3 Vertical Displacment

Table 5 Vertical Displacment

Span	PSC Girder	Plate Girder
0.00	0	0
3.33	-0.003196	-0.005639
6.67	-0.005862	-0.010381
10.00	-0.007771	-0.013805
13.33	-0.00876	-0.015586
16.67	-0.008749	-0.015564
20.00	-0.007742	-0.013745
23.33	-0.005825	-0.010298
26.67	-0.003165	-0.005566
30.00	0	0

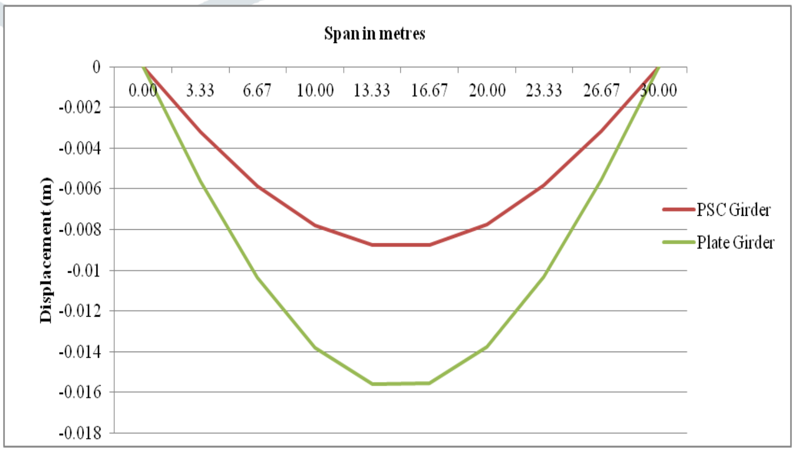

Figure 6 Comparison of Vertical Displacment

3.4 Axial Force

Table 6 Axial Force

Span	PSC Girder	Plate Girder
0.00	-1546.48	0
3.33	-1574.297	0
6.67	-1604.139	0
10.00	-1629.368	0
13.33	-1639.55	0
16.67	-1639.55	0
20.00	-1639.55	0
23.33	-1604.139	0
26.67	-1574.297	0
30.00	-1545.454	0

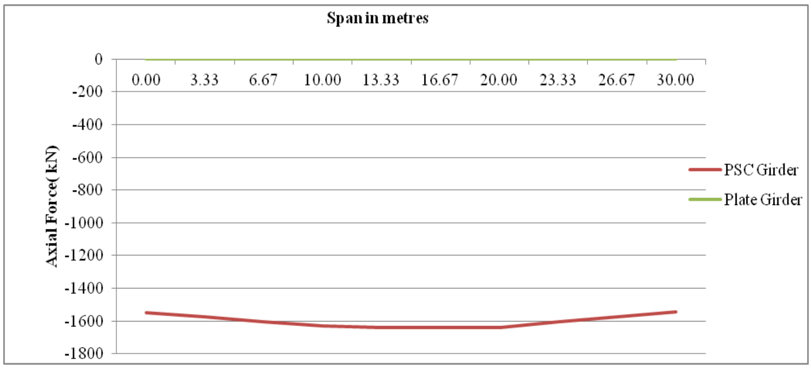

Figure 7 Comparison of Axial Force

IV. RESULTS AND CONCLUSION

The girders' bending moments varied by 56% as a percentage.PSC girders have a mid-span maximum bending moment of 12116 KNm, while plate girders have a maximum bending moment of 7736 KNm. Shear force differs by 26% as a percentage. Maximum shear forces for PSC and Steel Plate Girders are respectively 1581 KN and 1253 KN. Plate girders have a 45% larger vertical displacement than PSC girders.

For the analysis of PSC Girder and plate girder, a 25 m length of span is taken into account, and for both girders, displacement and stresses are within the permitted range. The figures make it evident that the PSC Girder's bending moment and shear force are significantly higher than those of Steel Plate Girders. This increase is due to the PSC Girder's self-weight, which produces a significant bending moment and shear force.

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