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PARAMETRIC STUDIES FOR SUITABILITY OF STEEL BRIDGES

VIKAS GANDHE[1], PAWAN PATIDAR[2]

1. Civil Engineering Department, S.V.I.T, Indore, RGPV Bhopal, M. P., India
2. Civil Engineering Department, IES IPS Academy, Indore, RGPV Bhopal, M. P., India

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Abstract: Bridges are highly investment structures and important landmarks in any country besides being vital links in transportation system. Strength, safety and economy are the three key features that cannot be neglected before the finalization of types of bridges. While deciding the types of bridge, spans and other parameters are to be studied carefully to meet out the need of suitability to site conditions. The scope of this paper is to confine to the design aspect related to variable parameters. Depth of web, thickness of web, width of flange and span of bridges are the variable parameters considered during the design of plate Girder Bridge. The graphical representation is showing the relations between different parameters to conclude for cost effectiveness with respect to spans. Broad gauge main line loading is adapted to carry out design calculations. Bending and shear stresses are plotted against the spans to check the stability of structure. The results, summarized in this paper will be a guide line to field and budding engineers.

Keywords: d-web depth, t_w-web thickness, A_f- area of flange, b_f- flange width, D_f- flange depth.

Corresponding Author: MR. VIKAS GANDHE

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INTRODUCTION

Bridge plays a vital role to overcome the obstacles without dismantling. Plate Girder Bridge is the most common type of steel bridge used for railways. The plate girder are often used in structures having span varying from 15 to 30 m. Normally plate girders are provided with intermediate of edge stiffeners to reduce the thickness of web plate and also to resist the buckling strength of web. A plate girder is basically an 'I' sec beam, Built up from plate and angles. It is a deep flexural member. This built up beam carries maximum load as compared with rolled section beam, when the load is heavy and span is large, plate girder is the most economical structure. Plate girder provides maximum flexibility by changing the various dimensions of component, economy can be achieved. The plate girders have limit less possibilities for the optimization.

Parametric study of plate Girder Bridge is carried out for the spans of 15m, 20m, 25m and 30m. Other variable parameters are: Web thickness, Flange area and thickness. Design calculations are carried out for simply supported single span. Seismic and wind effect is not taken in to account at design stage.

The object of this paper is to investigate an economy, strength, stability etc. by plotting the graph between various parameters such as: span, weight, bending and shear stresses. Required data from IRC: 24-2000, IS-800-1984 is considered as guideline for the design and loading considerations.

II. Design parameters

For cost effectiveness of plate Girder Bridge, following parameters are considered:

1) IRC : 24-2000
2) Span : 15m, 20m, 25m & 30m
3) Boundary conditions : Simply supported
4) Depth of web : Variable
5) Loading : IRC:6-2000
6) Thickness of web : Variable
7) Design method : WSM

8) Flange area : Variable

9) Code : IS-800-1984/1988

10) Flange thickness : Variable

11) Intermediate vertical stiffeners : At equal intervals

For each span, various other parameters mentioned above, are considered. With different combinations with each span, the design of Plate Bridge is carried out.

The results thus obtained by using working stress method, is studied carefully for the conclusion of suitability of bridge.

III. Observation

All the related data regarding the design criteria of plate Girder Bridge, is compiled categorically. The observed data is shown in tabular form. Comparative charts are prepared to study the cost-effectiveness. Graphical representations are prepared, showing the curves and charts for the final conclusions. The weight cost comparison is worked out and summarized.

Table 1

Area of Flange Vs Span

Span (m) →	**15**	**20**	**25**	**30**
Depth of Web (mm) ↓	**A_f (mm^2)**	**A_f (mm^2)**	**A_f (mm^2)**	**A_f (mm^2)**
800	12444	20077	29029	39728
1000	9955	16061	23223	31782
1200	8296	13384	19352	26485
1500	6637	10708	15482	21188

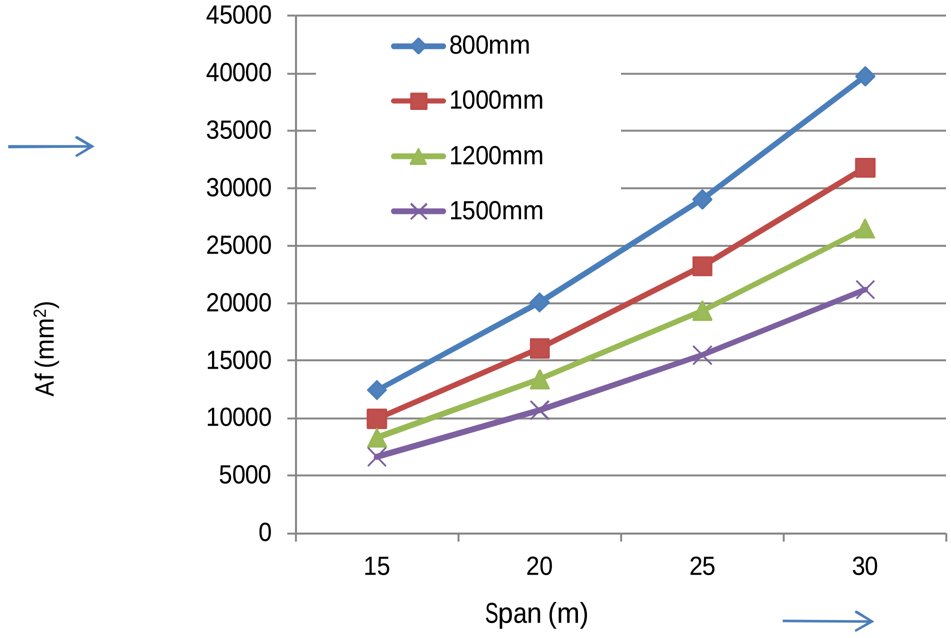

FIG 1: Area of Flange Vs Span

Table 2 : Depth of Web Plate Vs Thickness of web

d/t_w →	86	100	150	200
Depth of Web (mm) ↓	t_w (mm)	t_w (mm)	t_w (mm)	t_w (mm)
800	9	8	5	4
1000	11	10	6	5
1200	14	12	8	6
1500	17	14	10	7

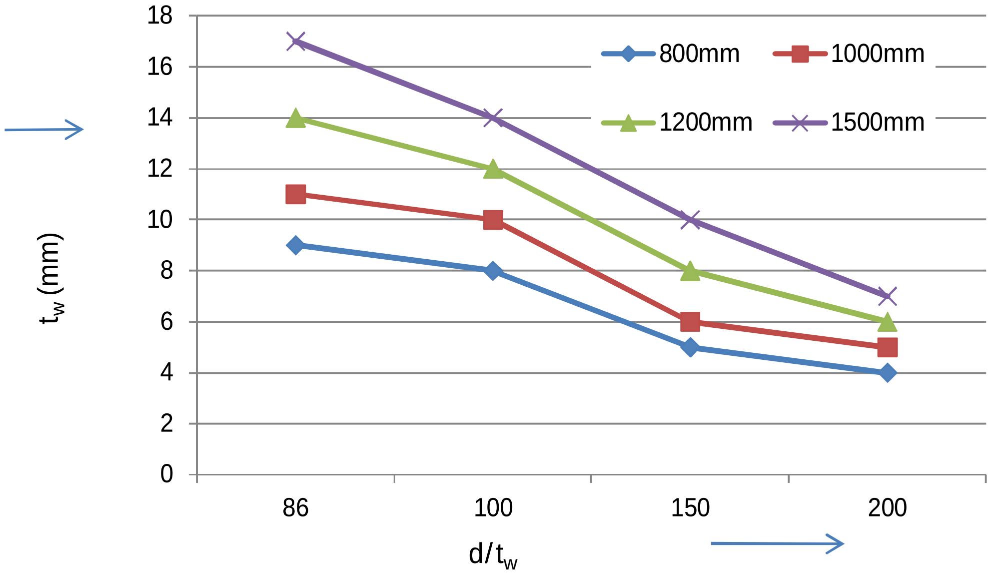

FIG 2: Depth of Web Plate Vs Thickness of web

TABLE 3

Relation b/w Area of Flange to Bending Moment Vs Span

Span (m) →	15	20	25	30
Depth of Web (mm) ↓	A_f/BM	A_f/BM	A_f/BM	A_f/BM
1100	3.30	3.30	3.30	3.30
1200	3.04	3.04	3.04	3.04
1300	2.80	2.80	2.80	2.80
1400	2.60	2.60	2.60	2.60
1500	2.43	2.43	2.43	2.43

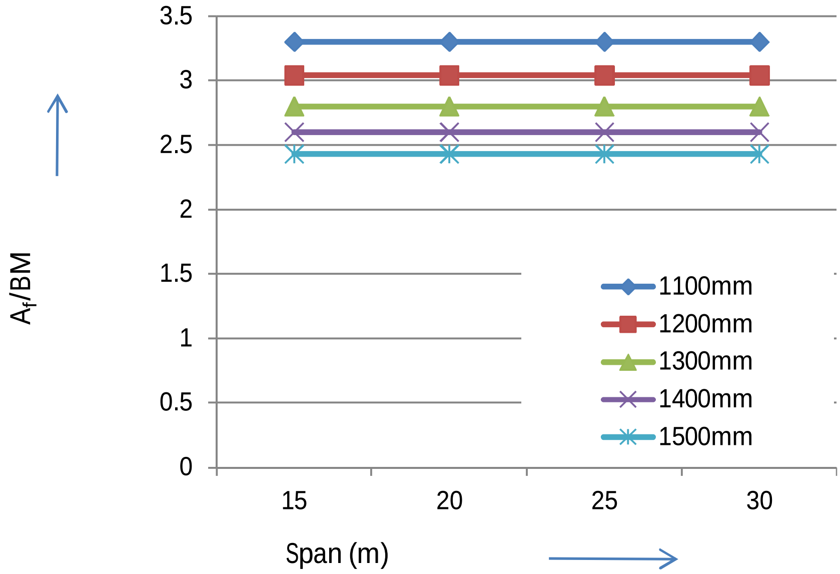

FIG 3: Relation b/w Area of Flange to Bending Moment Vs Span

TABLE 4

Shear Stress Vs Span

Span (m) →	15	20	25	30
Thickness of Web (mm) ↓	**Shear Stress N/mm^2**	**Shear Stress N/mm^2**	**Shear Stress N/mm^2**	**Shear Stress N/mm^2**
10	148	137	131	127
14	125	116	111	107
18	110	102	98	94
22	100	93	88	85

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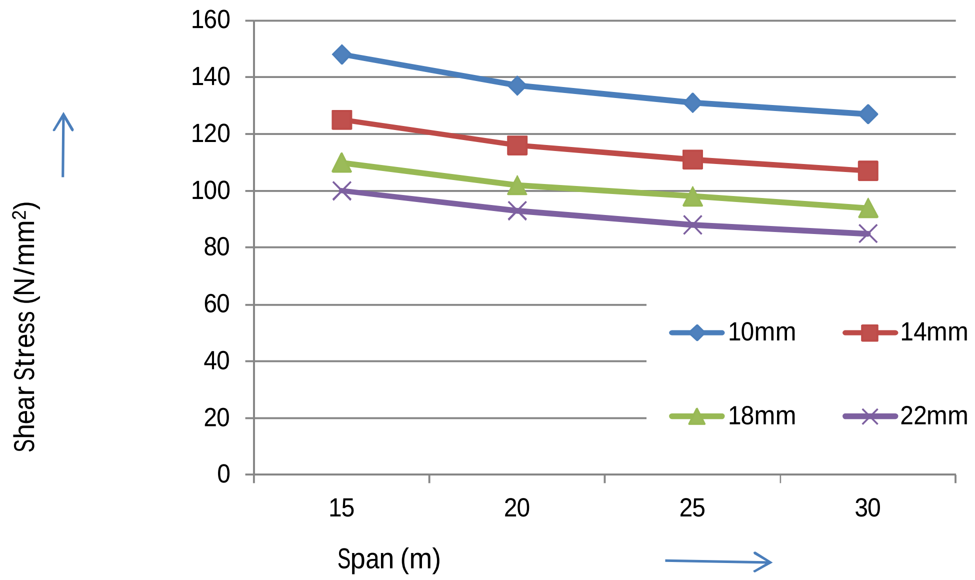

FIG 4: Shear Stress Vs Span

TABLE 5

Weight Vs Span

Span (m) →	15	20	25	30
Depth of Web (mm) ↓	Weight **(N)**	Weight **(N)**	Weight **(N)**	Weight **(N)**
800	1405.69	2136.60	3202.6	4495.56
1000	1169.29	1755.20	2651.2	3740.85
1200	1035.19	1500.94	2283.5	3237.71
1500	1180.37	1274.08	1952.1	2774.28

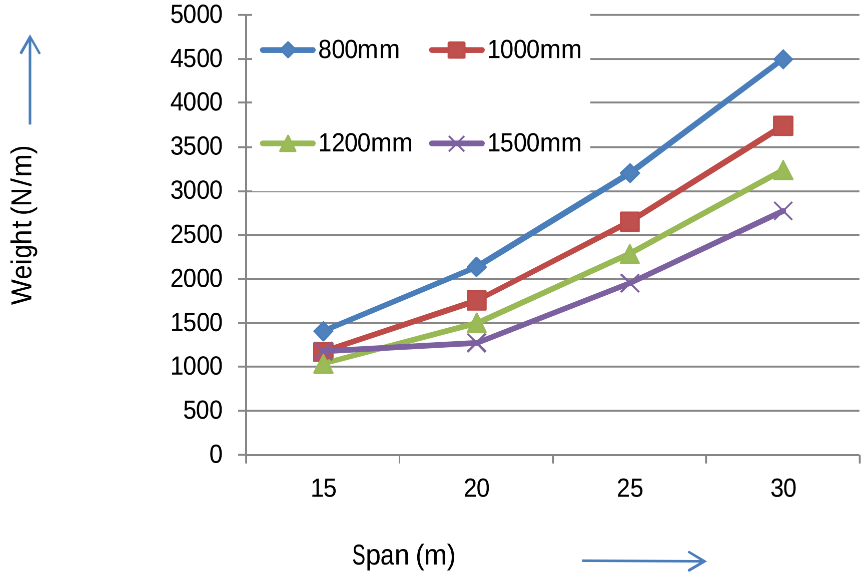

FIG 5: Weight Vs Span

TABLE 6

Bending Stress Vs Span

span (m) →	15	20	25	30
Depth of Web (mm) ↓	**Bending Stress n/mm^2**	**Bending Stress n/mm^2**	**Bending Stress n/mm^2**	**Bending Stress n/mm^2**
800	240	210	235	263
1000	262	256	235	232
1200	272	265	273	255
1500	182	259	265	241

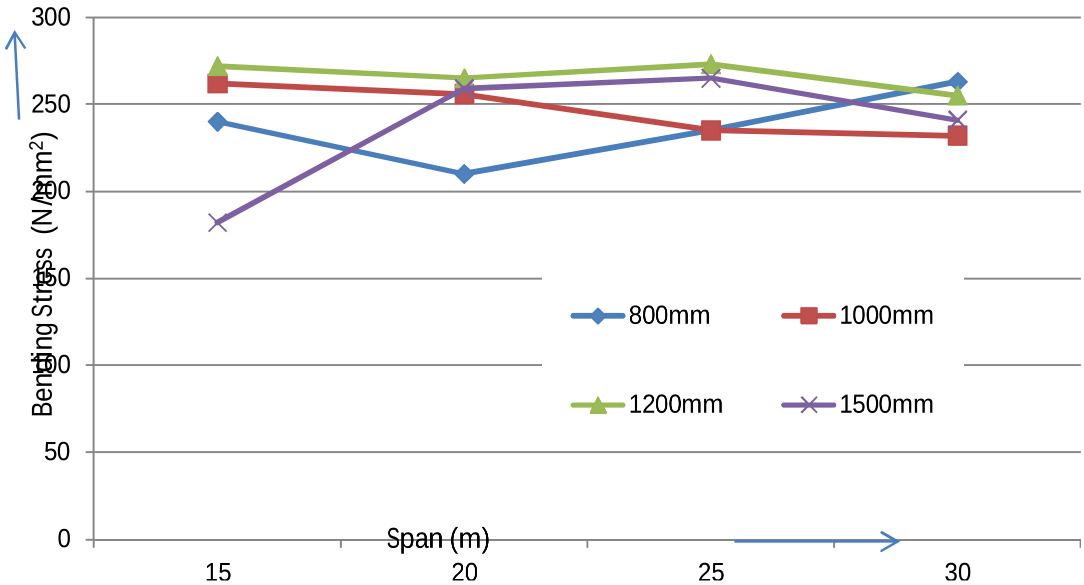

FIG 6: Bending Stress Vs Span

IV. Conclusion

- It is the most economical bridge in terms of construction and cost.
- Relation for Area of Flange to Bending Moment V/s Span bears a constant ratio.
- Thickness of Web varies linearly with Span for the constant Web depth.
- Keeping the depth of web constant, Shear and Bending Stress increases with increase in Span length.
- With depth of web to thickness of Web ratio remains the same, flange area varies as per the variation of span.
- Using the vertical stiffeners, the Wt. of Girder is controlled with span variation.
- The thickness of Web plate varies linearly for depth to thickness ratio of Web.

V. RESULTS

- From the graphs shown, for a given span, other parameters of Plate Bridge can be easily traced out.

- These results are the guide line for design engineers, contractors and for budding engineers.

- The observations incorporated above will act as ready reckoner for engineers working in field.

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