International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 10 Issue: 06 | Jun 2023 www.irjet.net p-ISSN: 2395-0072

Patch loading resistance of curved and straight steel plate girders with stiffened cell flanges

P Muhammed Ajmal [1], Sadic Azeez[2]

[1]Student, Dept.of Civil Engineering, ICET Mulavoor, Kerala,India
[2]Asst.Professor, Dept.of Civil Engineering, ICET Mulavoor, Kerala,India

---

Abstract - *The purpose of this article is to investigate the patch loading resistance of steel plate girders with trapezoidal, rectangular, and triangular hollow cell flanges in curve and straight configurations. When subjected to concentrated loading, this geometrical configuration significantly boosts the resistance of the web plates. The patch loading resistance is investigated in this work using the programme ANSYS 2022- analyses that take into account substantial displacements, elastoplastic material behaviour, initial geometric flaws, and an anticipated pattern of residual stress distribution. The numerical model is evaluated against published experimental results. Following that, a parametric analysis is carried out to explore the impact of various geometric characteristics such as loading position, different geometric shapes with infill, and so on..The results show that the use of trapezoidal cell flanges enhances the resistance of steel plate girders to patch loading in straight and curve*

1.I NTRODUCTION

Steel bridges are often fabricated using girders with slender webs with good flexural and shear strengths to cover long spans and to be capable to withstand heavy vertical loads during service. Some bridges are erected using the incremental launching method, the installation of the bridge is critical due to the concentrated support reaction transferred to the thin webs that may cause premature failure of the bridge girder. To prevent buckling related failures and to increase the resistance to concentrated loads the following strategies are employed: to increase the web thickness, to use a longitudinal stiffener with open or closed section adjacent to the loaded flange, to add adequately spaced vertical stiffeners, or to reinforce the loaded flange with a triangular cell flange.

From the results obtained in these works, it was found that adding triangular cells to the patch loaded flanges enhances both the critical buckling load and the corresponding resistance of steel plate girders. Comparing the performance of delta stiffened girders to the performance of longitudinally stiffened girders, which may be compared in terms of weight and welding investment, triangular cell flanges are more effective when it comes to increasing the capacity to withstand concentrated loads caused by support reactions in steel bridge girders incrementally launched.

1.1Objectives and scopes

The main objective of the study is the patch loading resistance of steel plate girders and finding the optimum thickness, patch loading distance different shapes performance in comparison with conventional reinforcement as per IS code. the output results like ultimate deflection, ultimate load, percentage of improvement in strength are evaluate and compared.

This study is focused on the analyze of the patch load resistance of curved and inclined steel plate girders to develop and reduce web buckling with stiffened cell flanges. This study mainly focusing on static analysis using patching loading testing in girders against buckling using in Ansys software .The models are done by Nonlinear static analysis in Workbench of Ansys (2022).

2. ANALYSIS OF PATCH LOADING RESISTANCE AT DIFFERENT PATCH LOADING LENGTH

This chapter is deals with the analysis of patch loading resistance at different patch loading length. Steel plate girders stiffened with triangular cell flanges are modelled. Four models are created using ANSYS software as per the AISC provision. The different models are P 200 , P 250 , P 300 , P 350. Material properties of the beams are Young's modulus 2 $\times 10^5$ Mpa, 3, Density 2400 kg/m^3 and material properties of steel tube is Young's modulus 2 $\times 10^5$ Mpa, Poisson's ratio 0.3, Density 7850 kg/m^3

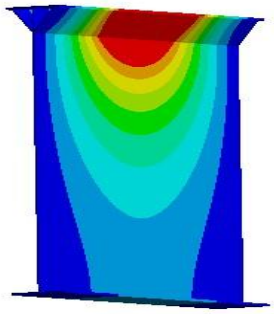
Note; P -plate load length

2.1 Modelling and loading

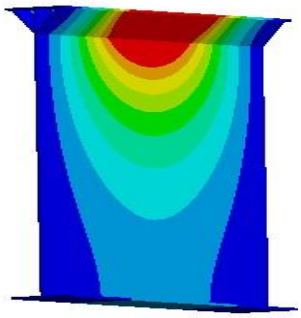
These steel plate girders are modelled with specific dimensions by changing the patch loading length like P 200 , P250 , P300, P350.

3.1 Modelling

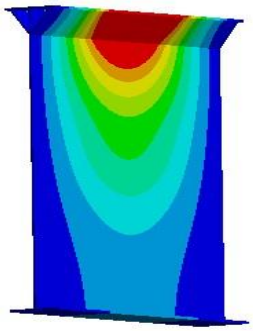
For the study of effect of web thickness on patch load resistance of plate girder with patch load length of 300 mm is carried out by considering various models. The different models are T4(thickness of 4 mm) , T4.5(thickness of 4.5 mm),T5(thickness of 5 mm),T5.5(thickness of 5.5 mm,T6(thickness of 6mm).



Deformation of T4



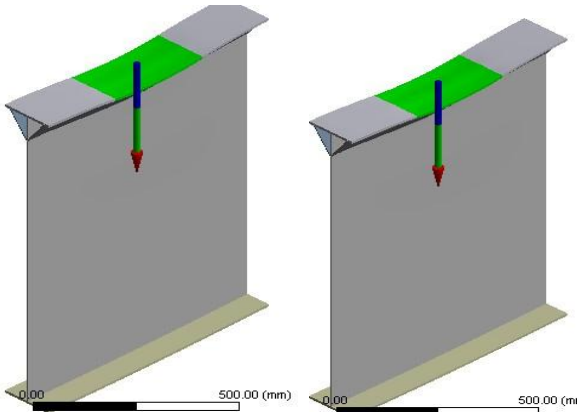
Deformation of T4.5



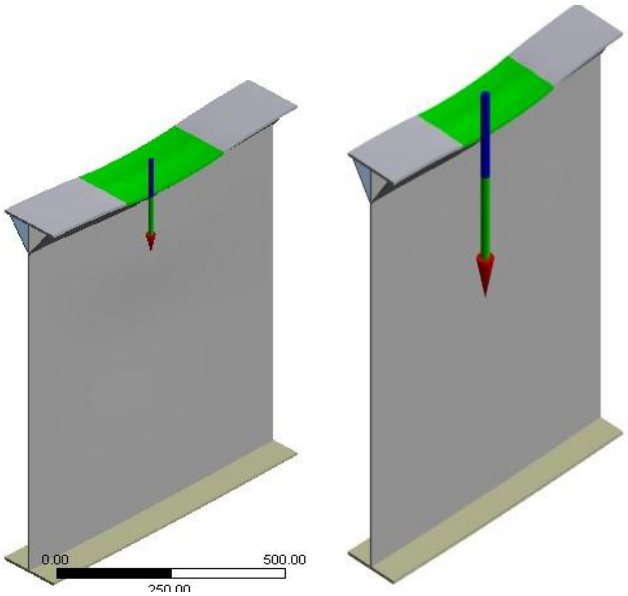
Deformation of T5

3.2 Analysis

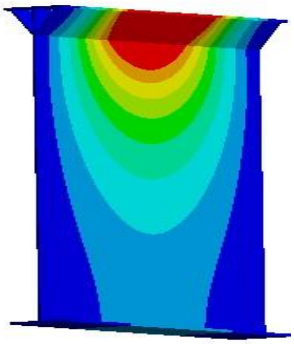
Analysis is carried out to determine the web thickness in the steel plate girders having a patch load length of 300 mm(P300). Non linear static structural analysis is carried out in ANSYS software. Deformation and load carrying capacity is studied.



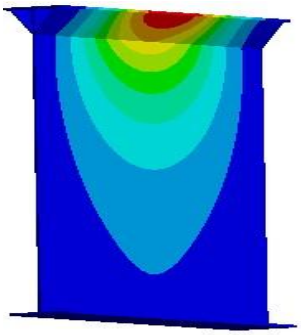
Force reaction of T4 and T4.5



Force reaction of T5 and T5.5



Deformation of T5.5



Deformation of T6

Fig -3: Deformation diagram

3.3 Result and discussion

The result obtained from the Nonlinear static structural analysis of steel plate girder P300 by changing the web thickness(T4 ,T4.5,T5,T5.5,T6). The load deformation graph is drawn for each model. The load and deformation obtained is compared. Comparison of each model are tabulated below.

Table -2: Comparison of load

Model	Deflection (mm)	Load (kN)	%increase of load
Thickness 4mm	1.8111	839.24	1
Thickness4.5mm	1.4853	889.15	5.947047
Thickness5mm	1.8952	1021.3	21.69344
Thickness 5.5m	m1.8318	1090.5	29.93899
Thickness 6mm	4.4553	912.35	8.711453

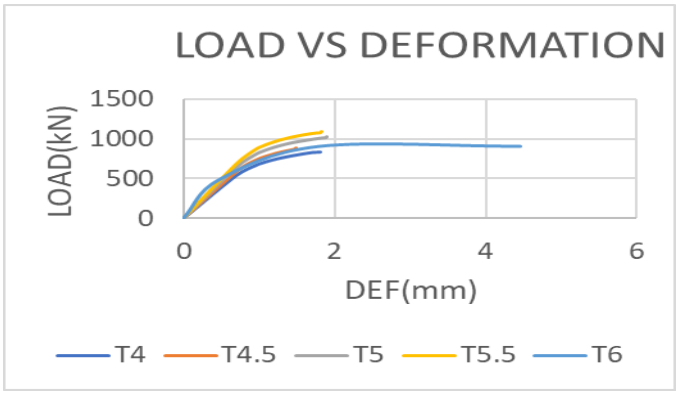


Chart -2: Load deflection comparison

From the above analysis carried out on the steel plate girders by varying the web thickness. The specimen analyzed are T4 T4.5 T5 T5.5 T6. The load value obtained for steel plate girder with web thickness of 5mm gives a load of 1020.3 KN which is greater than other specimen. So plate girder with web thickness of 6mm gives the better performance.

3. Study the effect of flange cases with hollow triangular, rectangular, and trapezoidal cell flanges(both straight and curve) and their comparison

Effect of flange cases such as hollow triangular , rectangle and trapezoidal cell flanges both straight and curved and their comparison. Three models are created by using ANSYS software by changing the flange cases as per EI provisions. The different models are ST-HT(straight hollow trapezoidal),ST-HR(straight hollow rectangular),ST-TRI (straight hollow triangular).

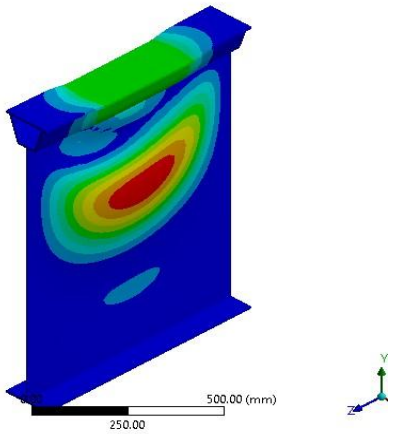
4.1 Modelling

Analysis on the patch load resistance of steel plate girders with different flange case conditions. Analysis is carried

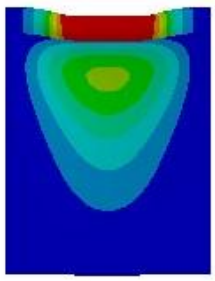
out to determine the effect of flange cases by providing different flange cases and their comparison. Nonlinear static structural analysis is carried out in ANSYS software. Deformation and load carrying capacity is studied. Models analyzed are ST-HT(straight hollow trapezoidal),STHR(straight hollow rectangular),ST-TRI (straight hollow triangular).

4.1 Analysis

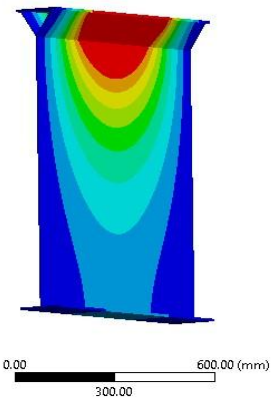
Analysis is carried out to determine the effect of flange cases by providing different flange cases and their comparison. Nonlinear static structural analysis is carried out in ANSYS software. Deformation and load carrying capacity is studied.



deformation and force reaction of ST-HT



deformation and force reaction of ST-HR



deformation and force reaction of ST-HTR

4.3 Result and discussion

The result obtained from the Nonlinear static structural analysis of steel plate girder by changing the flange cases (,ST-HT, ST-HR, ST-TRI). The load deformation graph is drawn for each model. The load and deformation obtained is compared.

Table -2: Comparison of load

Models	Deflection (mm)	Load (kN)	% increase of load
ST-HT	4.6446	986.69	1
ST-HR	20.721	801.99	18.719
ST-HTR	3.7933	778.39	21.1109

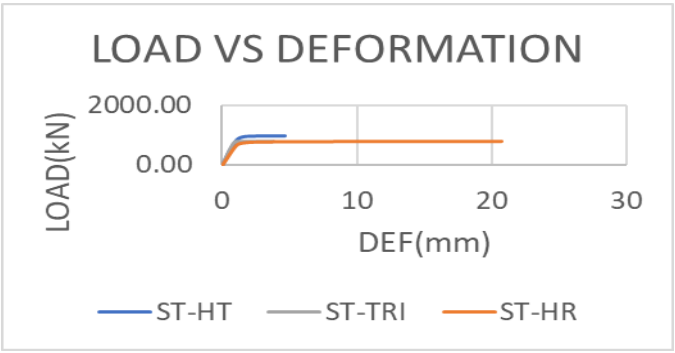


Chart -3: Load deflection comparison

From the analysis conducted on the steel plate girders having different flange cases it is found that the Optimum shape is hollow trapezoidal. Models analyzed are STHT(straight hollow trapezoidal),ST-HR(straight hollow rectangular),ST-TRI (straight hollow triangular) are analyzed. ST-HT gives a load of 986.89 KN which is greater

than other two conditions. Optimum size hollow trapezoidal (straight)

4. CONCLUSIONS

Patch load resistance of steel plate girders have been conducted by considering various factors .Certain number of numerical model was elaborated considering initial geometric imperfections, residual stresses, and elastoplastic material behaviour.It was demonstrated that residual stresses have a diminished effect on the resistance of the stiffened girders

- Compared to the standard plate girders , the plate girders with a patch load length of 300 mm gives a better performance.. Since the specimen P 300 achieved the ultimate load and deflection. The ideal deflection value is 1.682 mm, and the ideal load is 836kN.
- For a plate girder with web thickness of 5 mm give more strength.it gives a load of 1021 KN and deflection of 1.89mm.
- Steel plate girders with different flange conditions analyzed like hollow trapezoidal, hollow rectangular , hollow triangular. From this hollow trapezoidal gives a load of 986.69kN and deflection of 4.64 mm
- By changing the patch load distance from 200 mm to 350mm,optimum patch loading distance is found as 300mm

REFERENCES

[1] Euro Casanova “Patch loading resistance of steel plate girders stiffened with triangular cell flanges” (2022)

[2] Fayaz A. Sofi “Using committees of artificial neural networks with finite element modeling for steel girder bridge load rating estimation”” (2021)

[3] Ying Guo “Testing and evaluation of web bearing capacity of corroded steel bridge “ (2022)

[4] Carlos Graciano “Elastic buckling analysis of plate girders stiffened with triangular cell flanges under patch loading” (2021)

[5] Gonçalo Ferraz a, “Lifecycle cost assessment of high strength carbon and stainless steel girder bridges” (2021)

[6] Ben Young “Ultimate resistances of memberrotated cold-formed high strength steel tubular T-joints under compression loads” (2022)

[7] Amedeo Gregori , Chiara Castoro “Modelling mechanical properties and bond behaviour of rubbercrete”(2021)

[8] P. Kaliyappan , M. Dhananchezian , K. Rajkumar “Utilization of waste tyre rubber and carbon black to develop a neoprene rubber hybrid composite”(2022)