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ANALYTICAL EVALUATION OF FOLDED PLATE GIRDER WITH CORRUGATED WEB FOR SHORT SPAN BRIDGES

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Abstract: **Folded plate girder system has been promoted as a cost-effective alternative for the design and construction of bridge superstructures due to merits such as low cost and facilitation of accelerated bridge construction. In this thesis analyzing folded plate girder system with corrugated web section in ANSYS 16.1. To investigate the performance of corrugations on web of the girders, first modelling and analyzing a simple I-beam with plane web and corrugated web. Buckling analysis is doing to find out the critical buckling load of the I-beam. Then apply the corrugations to the folded plate girder. Then modelling and analyzing the folded plate girder with plane web and corrugated web. After the analysis, compare the results the folded plate girder with plane web and corrugated web.**

Keywords: **ANSYS Software, Corrugated web, Plane web, Deformation, Critical buckling load, Stress distribution, Moment reaction, Folded plate girder.**

1. INTRODUCTION

Bridge owners and engineers focusing on bridge design, management and maintenance continue to search for more efficient ways to design, construct and maintain their bridge inventory. In the past, steel bridges are one of the most common types have been comprised of superstructures consisting of either rolled steel beams or welded steel girders. Recently, a relatively newly developed concept, which consists of what is known as a folded plate girder system, has been promoted as a cost-effective alternative for the design and construction of short span bridge superstructures. The folded plate girder system is potentially a cost-effective system due to the followings: (1) relatively low cost of plate steel; (2) cost saving. (3) Modular fabrication with a composite deck in the fabrication plant and simple installation in the field, eliminating the use of external bracing or cross-frames, reducing the construction cost and labour, and facilitating accelerated bridge construction. However the interior of the folded plate girder is inaccessible due to the narrow enclosed shape. Accordingly, it is recommended to use weathering steel or fully seal the girder interior to minimize inspection and maintenance of the girder system.

The objectives of the study are to analyse the effect of corrugated web on folded plate girders, to find out the buckling load of folded plate girder with plane web and corrugated web, to compare the performances of folded plate girder with plane web and corrugated web.

2. LITERATURE REVIEW

Yaohua Deng, brent M Phares studied **'**Experimental and numerical evaluation of a folded plate girder system for short span bridges' systematic performance evaluation of the folded plate girder system through experimental and numerical programs were studied.

Design aspects of steel I-girders with corrugated steel webs were conducted by **Ezzeldin Yazeed Sayed Ahmed.** The shear behaviour of the corrugated webs which is investigated focusing on the failure modes affecting the web design. Development of hybrid pre-stressed concrete bridges with corrugated steel web construction was conducted by **Shoji**

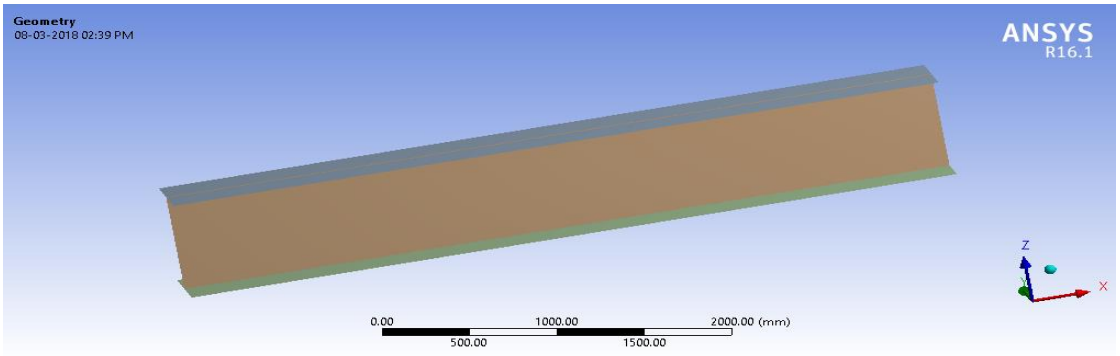
Ikeda, M Sakurada. Reducing the dead load of main girders, improving the pre-stress efficiency, and reducing the construction work and cost are principally main advantages of this structure.

A.Annie Pauline sarah, Priya A Jacob studied optimization of plate girders with corrugated webs. Various methods of optimization suitable for the optimization of plate girders are discussed based on various literatures.

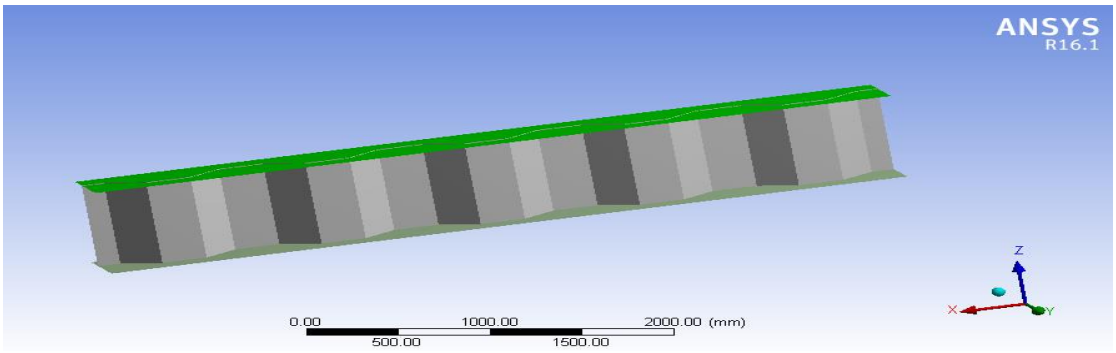
3. MODELLING AND ANALYSIS

A. Modelling of I-beam

A simple I-beam with plane web and corrugated web is modelled by using AutoCAD 2013 software. The length of the I-beam is 4.5 m and height is 0.7 m. Width of the flange is 0.25 m. Then exporting the geometry into ANSYS 16.1. and assigning the material properties, supports, loading condition, meshing the structure and solving the structure. Models of I-beam with plane web and corrugated web are shown in fig, 1 and fig, 2.



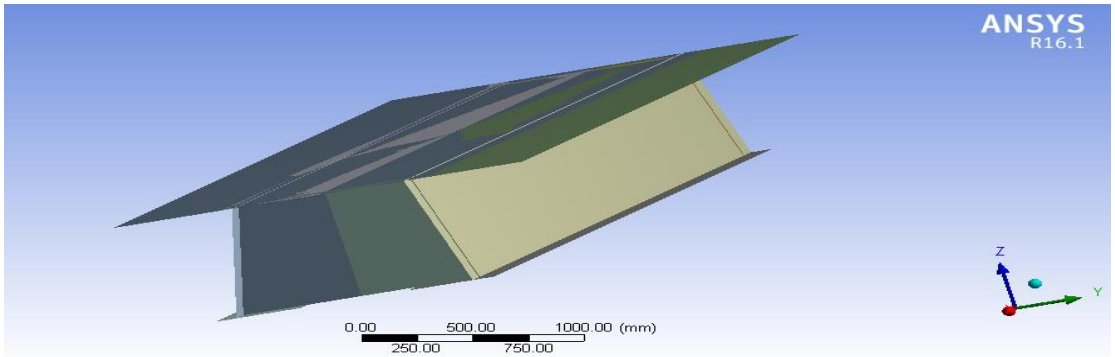
Fig, 1: Model of I-beam with plane web



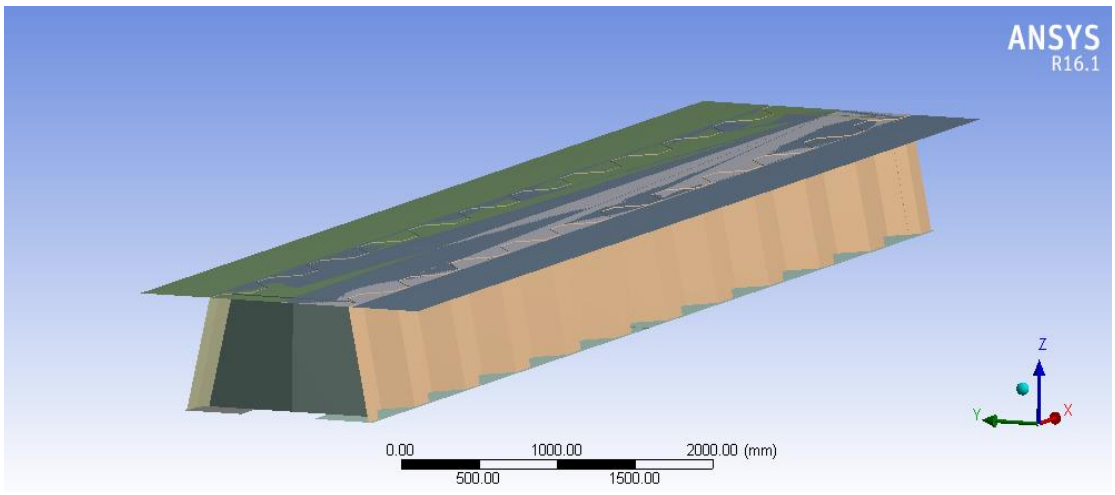
Fig, 2: Model of I-beam with corrugated web

B. Modelling of folded plate girder

The total length of the folded plate girder is 10 m. Width of one folded plate girder is 2.3 m. Thickness of concrete deck slab is 220 mm. Thickness of the plate is 12 mm. Modulus of elasticity is 2.1×10^5 N/mm^2. Poisson's ratio is 0.3. Tensile yield strength of steel plate is 345 MPa.



Fig, 3: Model of folded plate girder with plane web

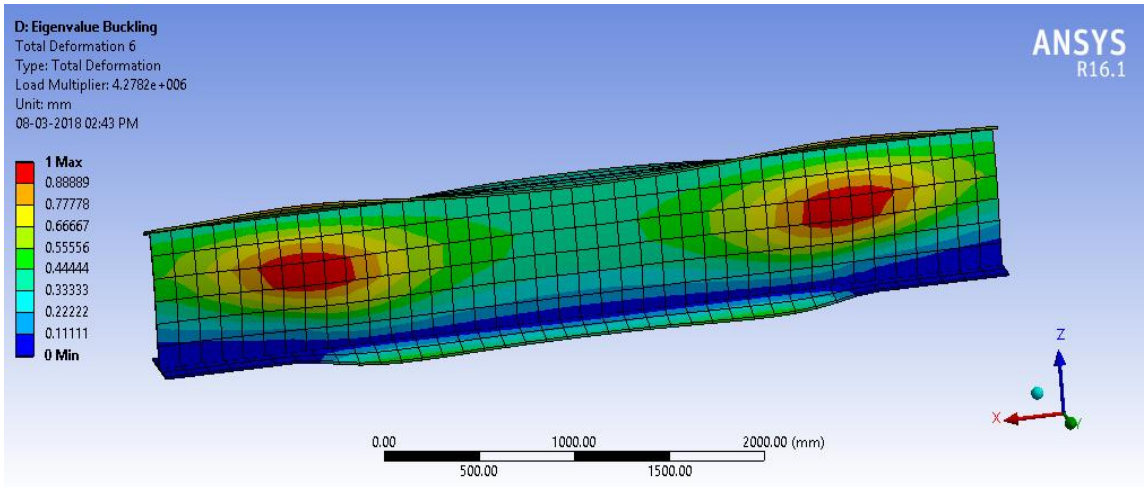


Fig, 4: Model of folded plate girder with corrugated web

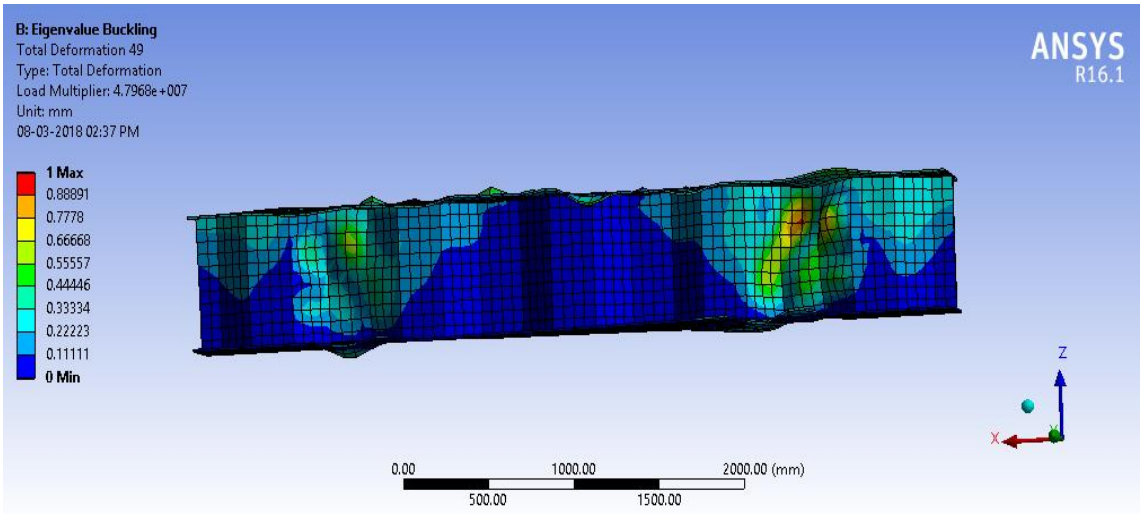
4. RESULTS AND DISCUSSION

A. I-Beam

The buckling modes of I-beam with plane web and corrugated web are shown in fig, 5 and fig, 6.



Fig, 5: Buckling mode of I-beam with plane web



Fig, 6: Buckling mode of I-beam with corrugated web

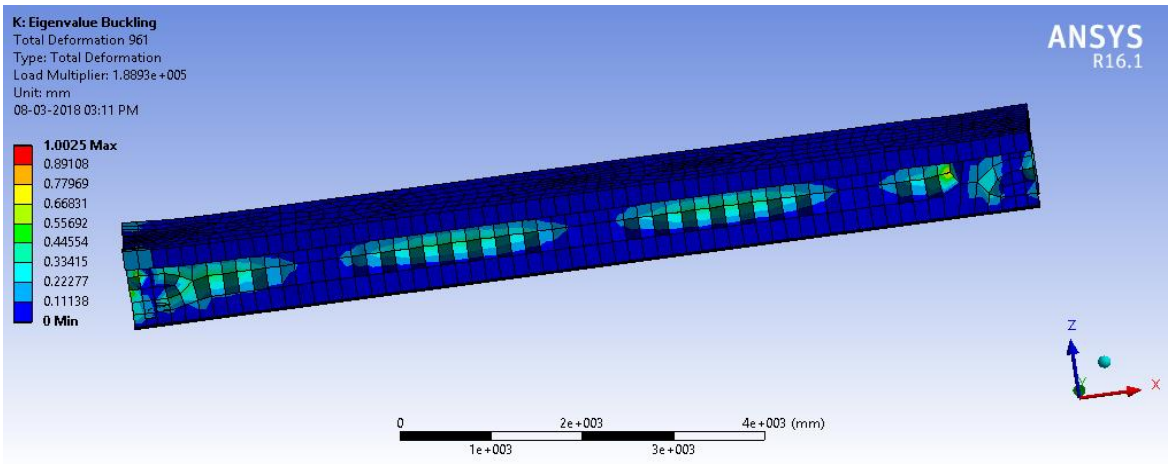
TABLE I: CRITICAL BUCKLING LOADS OF I-BEAMS

MODEL TYPE	CRITICAL BUCKLING LOAD (N)
Plane web	4.27×10^{6}
Corrugated web	4.79×10^{7}

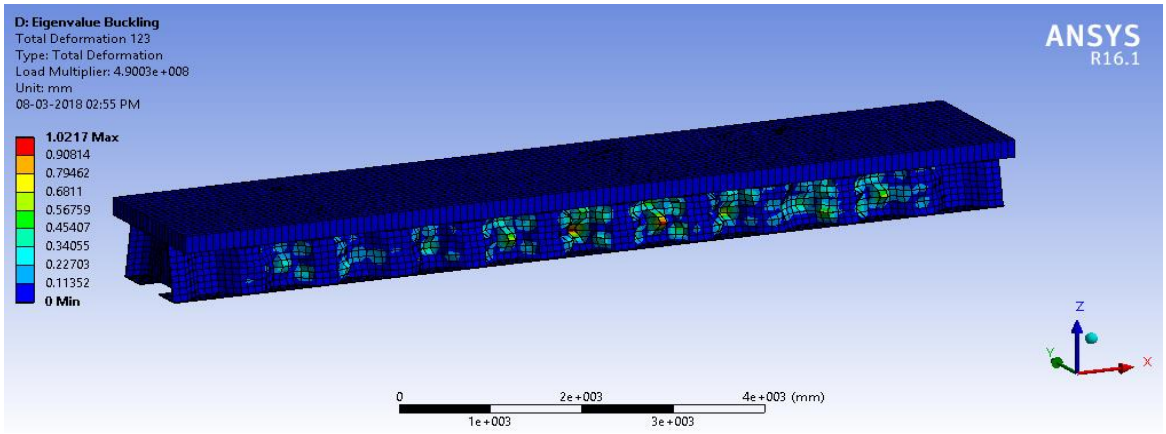
From the above results it is clear that critical buckling load value is higher for I-beam with corrugated web. So adopt the corrugated web to folded plate girder and compare the results of folded plate girder with plane web and corrugated web.

B. Folded plate girder

The buckling modes of folded plate girder with plane web and corrugated web are shown in fig, 7 and fig, 8.



Fig, 7: Buckling mode of folded plate girder with plane web



Fig, 8: Buckling mode of folded plate girder with corrugated web

TABLE II: CRITICAL BUCKLING LOADS OF FOLDED PLATE GIRDERS

MODEL TYPE	CRITICAL BUCKLING LOAD (N)
Plane web	1.89×10^{5}
Corrugated web	4.90×10^{8}

TABLE III: RESULTS FROM ANALYSIS OF FOLDED PLATE GIRDER

	Plane web	Corrugated web
Total deformation (mm)	2.726	2.663
Stress (N/mm^2)	103.22	79.79
Moment reaction (N-mm)	3.76×10^{8}	3.08×10^{8}

From comparison of results, it is concluded that the folded plate girder with corrugated web have high critical buckling load and the values of deformation, stress and moment reaction are small compared to folded plate girder with plane web. So folded plate girder with corrugated web shows better performance.

5. CONCLUSIONS

A simple I-beam with plane web and corrugated web was modelled analyzed. Buckling analysis was done to find out the critical buckling load of the I-beam. Then corrugations were applied to the folded plate girder. Then folded plate girder with plane web and corrugated web were modelled and analyzed. From the analysis following conclusions can be recorded.

- Critical buckling load value of simple I-beam with corrugated web is higher.
- Load carrying capacity is more when corrugations are applied.
- Critical buckling load value of folded plate girder with corrugated web is higher.
- Folded plate girder with corrugated web has high load carrying capacity.
- Values of deformation, stress and moment reaction are small for folded plate girder with corrugated web.
- Thickness of the steel plate can be reduced by providing corrugations.
- Aesthetic beauty is improved by providing corrugations to web.
- Folded plate girder with corrugated web shows overall better performance compared to plane web.

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