International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 06 Issue: 05 | May 2019 www.irjet.net p-ISSN: 2395-0072

Finite Element Analysis of Corrugated Web Beams, Column and Slab Connection Under Loading Condition

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Abstract - *Beam, column and slab with corrugated shapes have been extensively used in structural application such as building and bridges. Commonly used Corrugated shapes are trapezoidal, sinusoidal and rectangular. Corrugated shapes show large resistance to shear buckling and has large load carrying capacity and control the bending moment of the member. The aim of this study is to determine the maximum load carrying capacity of connection with corrugated beam, column and slab. Corrugated shape decreases the buckling of the column and bending of slab. The beam, column and slab load carrying capacities are different in different corrugated shapes. Connection of sinusoidal corrugated beam, trapezoidal corrugated column and rectangular corrugated slab can be better for construction purpose than any other combination of beam, column and slab. It is found better in providing different corrugated shapes for the connections of beam, column and slab than same corrugated shapes. Which provides good load carrying capacity.*

Key Words**: Load carrying capacity, Rectangular corrugated beam, trapezoidal corrugated beam, sinusoidal corrugated beam, ANSYS, Rectangular corrugated column, Trapezoidal corrugated column, Sinusoidal corrugated column…**

1. INTRODUCTION

1.1 General Background

Buildings are composed of various structural elements such as slabs, beams and columns. Corrugated web profile can be more economical than conventional plate and improve in the structure. Beam, column and slab with corrugated shapes have been extensively used in structural application such as building and bridges.Commonly used Corrugated shapes are trapezoidal, sinusoidal and rectangular .Corrugated shapes shows large resistance to shear buckling and has large load carrying capacity.

The aim of this study is to determine the maximum load carrying capacity of connection with corrugated beam, column and slab. Now a day's building and civil infrastructures are becoming larger and higher, the demand for horizontal structure members, which are suitable for long spans so structural steel require high strength but steel member also have many weaknesses, such as less resistance to bucking, excessive deflection, fatigue strength, vibration. To overcome these disadvantages various types corrugated shapes are developed. corrugations can be applied to strengthen the beams, columns, and slabs of buildings and bridges. It is possible to increase the strength of structural members. The main scope of this study is: to control the bending moment of member, to avoided shear buckling, to implement economic and safety construction, to improve the load-bearing efficiency. The main objectives of this study are follows:Comparative study of load carrying capacity of three different types of cross sections of corrugated beam and column,Comparative study of buckling behavior of three different types of corrugated columns,To create corrugated beam column joint by finding the best load carrying capacity of corrugated beam and column,Comparative study of load carrying capacity different types of beam column joint and finding the best among that,Comparative study of the best load carrying capacity of corrugated beam column joint with three different types of cross section of corrugated slabs,To determine the maximum load carrying capacity of connection with corrugated beam ,column and slab joint.

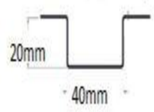
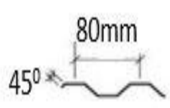
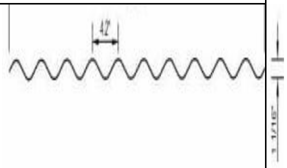
Rectangular corrugated shape	trapezoidal corrugated shape	Sinusoidal corrugated shape
		

Fig -1: Common corrugated shapes

2. NUMERICAL INVESTIGATION USING ANSYS WORKBENCH 16.1

2.1 Base Model

Numerical modelling of corrugated shape with different sections were done using ANSYS 16.1 WORKBENCH, a finite element software for mathematical modelling and analysis. The dimensions and material properties of all models are same and is given in Table 1 and Table 2 respectively.

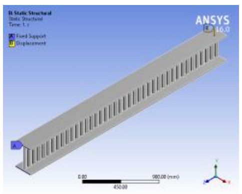
Boundary conditions are(a) beam ,column case one end fixed and other end is displaced in downward direction .(b)Beam-column joint with two end is fixed and other end is displaced in downward direction.

Table -1: Geometry of Sections

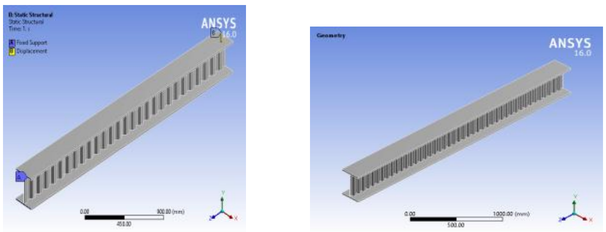
Descriptions	Dimensions
Depth of web	3254mm
Web thickness	363mm
Flange width	3254mm
Flange thickness	363mm
Length of slab	3254mm
Width of slab	3254mm

Table -2: Material Properties of Steel.

Young's modulus of Steel (GPa)	200
Poisson's ratio of Steel (ν)	0.3
Yield stress (MPa)	375

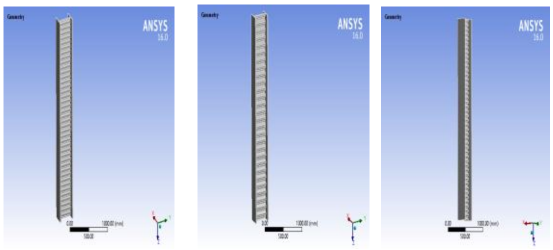


(a)



(b) (c)

Fig -2: Finite element modell of (a)rectangular (b)trapezoidal (c) sinusoidal corrugated beam



(a) (b) (c)

Fig -3: Finite element modell of (a)rectangular (b)trapezoidal (c) sinusoidal corrugated column

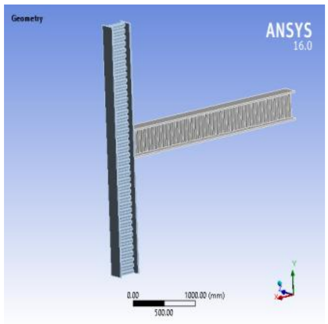
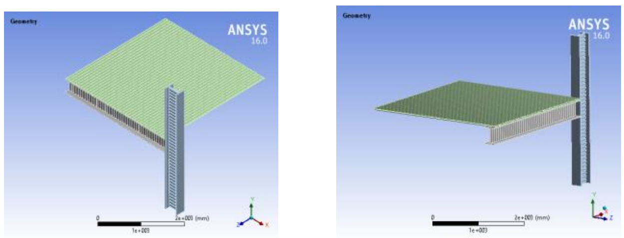
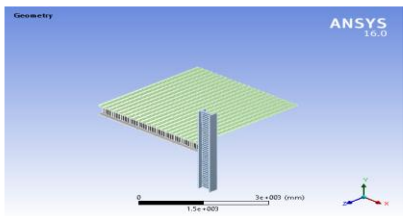


Fig -4: Finite element model of connection of sinusoidal beam and trapezoidal column joint

In the finite element analysis fine mesh was adopted for accuracy. The whole model was meshed using 20 node solid 186.



(a) (b)



(c)

Fig -5: (a) Finite element model of connection of sinusoidal beam, trapezoidal column and rectangular slab(b) Finite element model of connection of sinusoidal beam, trapezoidal column and sinusoidal slab(c) Finite element model of connection of sinusoidal beam, trapezoidal column and trapezoidal slab.

3. RESULTS AND DISCUSSIONS

Maximum value for load carrying capacity and less stress is obtained for sinusoidal corrugated beam compared to trapezoidal corrugated beam and rectangular corrugated beam.Maximum value for load carrying capacity and buckling load carrying capacity is obtained for trapezoidal corrugated column compared to sinusoidal corrugated column and rectangular corrugated column. Connection of sinusoidal corrugated beam, trapezoidal corrugated column and rectangular corrugated slab has maximum load carrying capacity compared with other two types.

Table -3: Maximum load values

models	Sinusoidal corrugated		Trapezoidal corrugated		Rectangular corrugated	
	beam	column	Beam	Column	Beam	Column
Load (N)	42×10^4	361×10^4	34×10^4	366×10^4	25×10^4	356×10^4

Table -4: Maximum load values

models	Sinusoidal corrugated beam,trapezoidal corrugated column and rectangular corrugated slab	Sinusoidal corrugated beam,trapezoidal corrugated column and sinusoidal corrugated slab	Sinusoidal corrugated beam,trapezoidal corrugated column and trapezoidal corrugated slab
Load (N)	474×10^5	388×10^5	484×10^5

Figure 6 to Figure 9 shows the force -displacement graph. Figure 10 to Figure 13 shows the deformation of models from ansys.

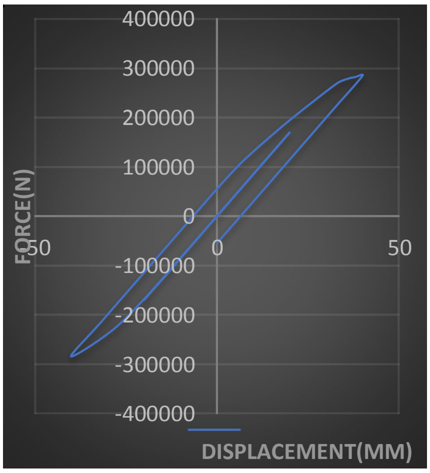


Fig -6: Force-displacement curve of connection with sinusoidal corrugated beam and trapezoidal corrugatedcolumn joint

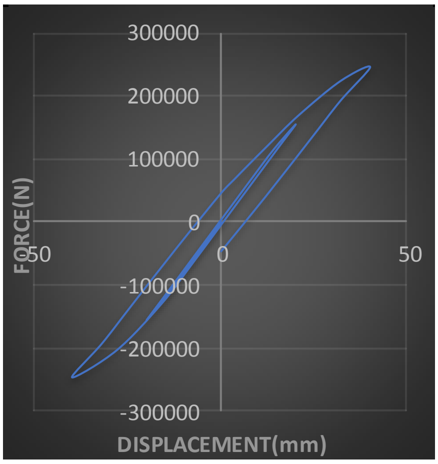


Fig -7: Force-displacement curve of connection with sinusoidal corrugated beam column joint

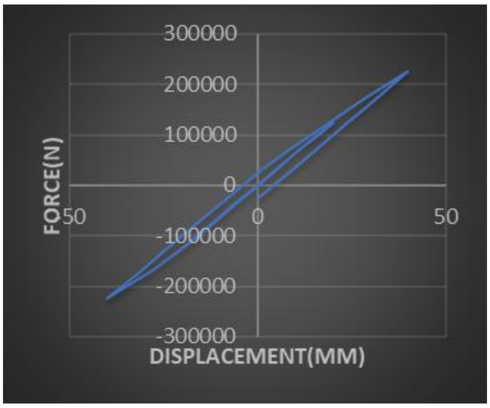


Fig -8: Force-displacement curve of connection with rectangular corrugated beam column joint

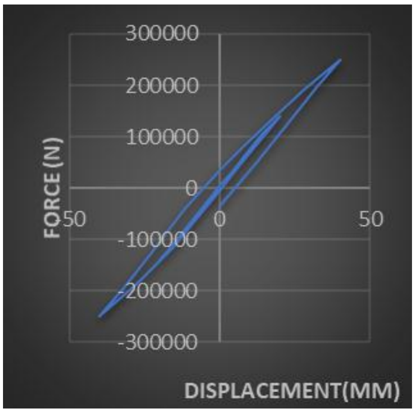


Fig -9: Force-displacement curve of connection with trapezoidal corrugated beam column joint

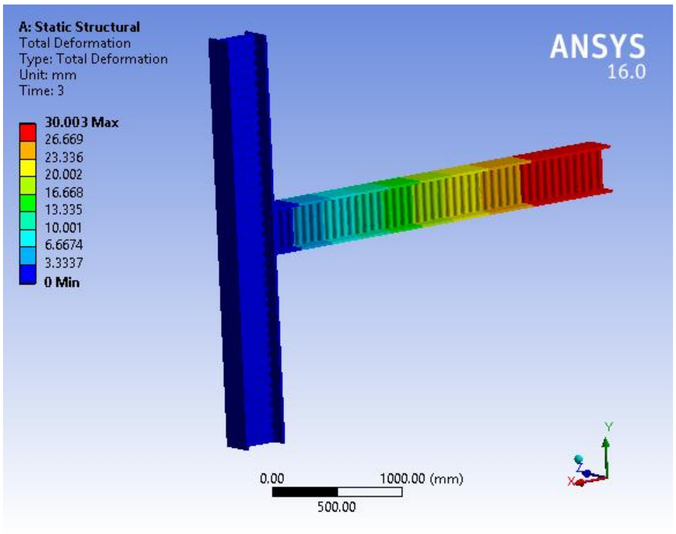


Fig -10: Total deformation of connection with sinusoidal corrugated beam and trapezoidal corrugatedcolumn joint

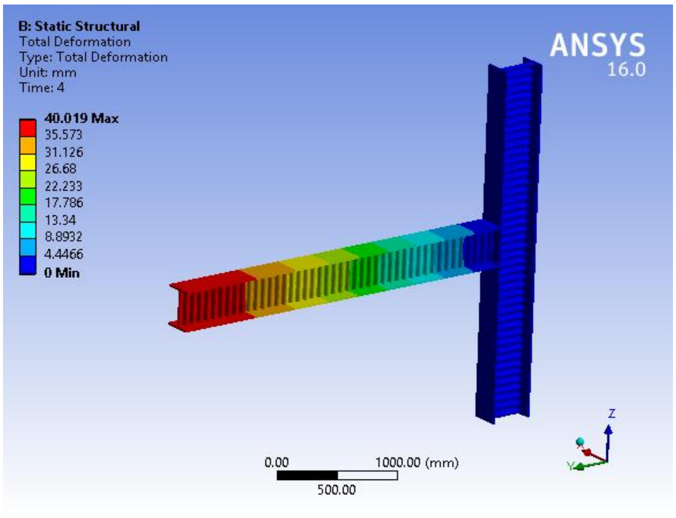


Fig -11: Total deformation of connection with sinusoidal corrugated beam column joint

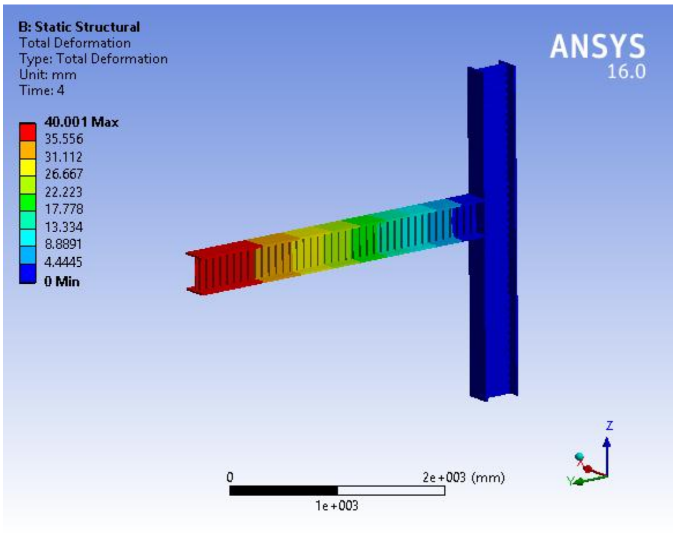


Fig -12: Total deformation of connection with rectangular corrugated beam column joint

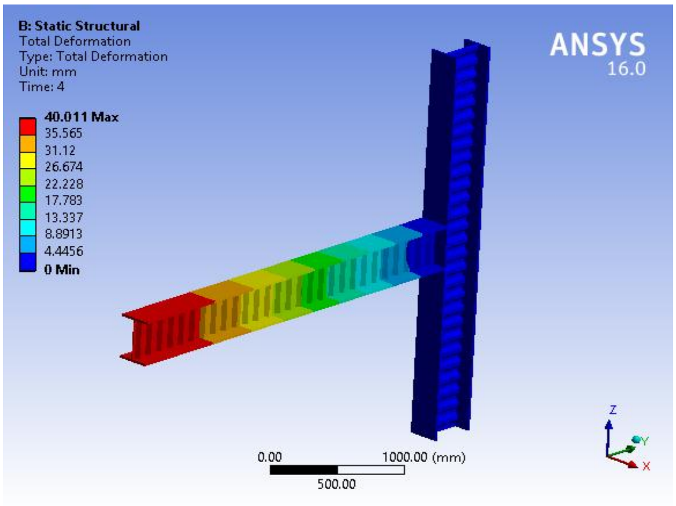


Fig -13: Total deformation of connection with trapezoidal corrugated beam column joint

Rectangular corrugated beam column joint and connection of sinusoidal corrugated beam and trapezoidal corrugated column joint has approximately same stress characteristics compared to other two types. Connection of Sinusoidal corrugated beam and trapezoidal corrugated column joint has maximum load carrying capacity compared with other three types and it is more suitable for construction purpose.

4. CONCLUSIONS

- Maximum value for load carrying capacity and less stress is obtained for sinusoidal corrugated beam compared to trapezoidal corrugated beam and rectangular corrugated beam.
- Maximum value for load carrying capacity and buckling load carrying capacity is obtained for trapezoidal corrugated column compared to

sinusoidal corrugated column and rectangular corrugated column.

- Connection of Sinusoidal corrugated beam and trapezoidal corrugated column joint has maximum load carrying capacity compared with fully corrugated sinusoidal beam column joint, trapezoidal beam column joint and rectangular beam column joint.
- Connection of sinusoidal corrugated beam, trapezoidal corrugated column and rectangular corrugated slab has maximum load carrying capacity compared with other two types.
- The beam, column and slab load carrying capacities are different in different corrugated shapes.
- Connection of sinusoidal corrugated beam and trapezoidal corrugated column and rectangular corrugated slab can be better for construction purpose than any other combination of beam, column and slab.
- It is found better in providing different corrugated shapes for the connections of beam, column and slab than same corrugated shapes. Which provides good load carrying capacity.

ACKNOWLEDGEMENT

I wish to thank the Management, Principal and Head of Civil Engineering Department of Ilahia College of Engineering and Technology, affiliated by Kerala Technological University for their support. This paper is based on the work carried out by me (Hafsamol S), as part of my PG course, under the guidance of Mr. Ranjan Abraham (Assistant Professor, Ilahia College of Engineering and Technology, Muvattupuzha, Kerala). I express my gratitude towards her for her valuable guidance.

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