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Generation and Optimization of Lattice Structure on I beam

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***Abstract*: This paper deals with the generation and optimization of lattice structure on an I beam considering weight reduction of the beam as primary objective within defined displacements and stresses. A finite element model of I beam is considered for analysis. It is optimized for a given tangential force acting on the beam. Honeycomb lattice structures are generated and the structure is optimized based on the finite element analysis. Stresses and displacements of the optimized I beam are compared with fully solid part. The obtained values of displacement for solid and optimized parts are nearly comparable.**

***Keywords*: Lattice structure, Weight reduction, Honeycomb Structure, Optimization**

1. Introduction

Periodic arrangement of cells possessing varying sizes and shapes ensures optimal use of material to with stand imposed stresses. Nature tailor's cellular materials for a specific loading condition by removing material from regions susceptible to low stresses. The use of lattice structures allows the simultaneous optimization of stiffness, strength, energy absorption and are ideal for lightweight parts which finds high potential in aerospace, automotive, and various engineering applications,

A. Problem statement

Determine the stresses and deflection for different material of I beam having fixed supported in both side which are given are having given data:

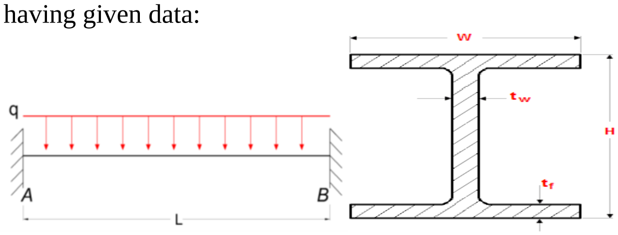

Fig. 1. I beam

Where

W=width of web=2000mm
T_w=thickness of web=500mm
T_f =thickness of web=500mm
H=height of flange=300mm
L=length of beam=50000mm
q =load on beam=49050 N/mm

B. Objective

- Reduce the amount of material utilized in the manufacturing process.
- Reduce the amount of time taken to produce an object.
- Reduce the amount of energy utilized in the manufacturing process.
- Optimize the strength of the produced object while minimizing the weight

2. Methodology

First of all we have measure the dimension of I beam, then we calculate the analytical result for different types of materials of I beam. After that we calculate ansys calculation in ansys 19.2 and last we compare both analytical and ansys software.

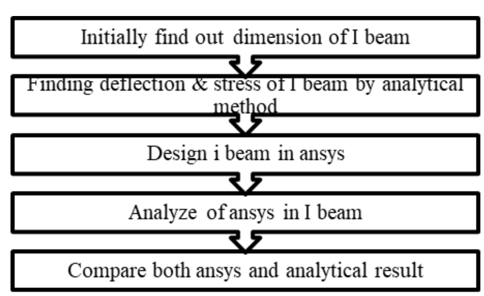

Fig. 2. Flow chart

Table 1
Literature review

S. No.	Paper title	Author	Conclusion
1	Design of lattice structures with controlled anisotropy(2016)	• ShanqingXu • JianhuShen	Conventional design of lattice structures, bone implants, mechanical properties, anisotropic properties,
2	Design, analysis and manufacturing of lattice structures: an overview (2017)	• MarkHelo • Sami Kara	Lattice Structures. Traditional manufacturing methods
3	Generation and Optimization of Lattice Structure on a Spur Gear(2018)	• Arun Kulangaraa • C. S. P. Raob • Subhash Chandra Bose	Solid structure, spur gear, honeycomb lattice structure, volume reduction, displacements, stresses as constraints.

A. Analytical calculation

For structural steel

$$\delta = \frac{5qL}{384EI}$$

$$= \frac{5*49050*50000*4}{384*210*10*3*3.5*10*6}$$

$= 0.0179$mm

$$\sigma = \frac{q*L*L}{8Z}$$

$$= \frac{49050*50000*2}{8*2.333*10*6}$$

$\sigma = 0.148$MPA

For cast iron

$$\delta = \frac{5qL}{384EI}$$

$$= \frac{5*49050*50000*4}{384*170*10*3*3.5*10*6}$$

$= 0.0169$mm

$$\sigma = \frac{q*L*L}{8Z}$$

$$= \frac{49050*50000*2}{8*2.333*10*6}$$

$\sigma = 0.148$MPA

B. Ansys Calculation

For structural steel:

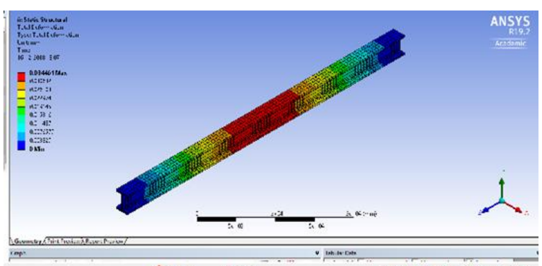

Fig. 3. Deformation

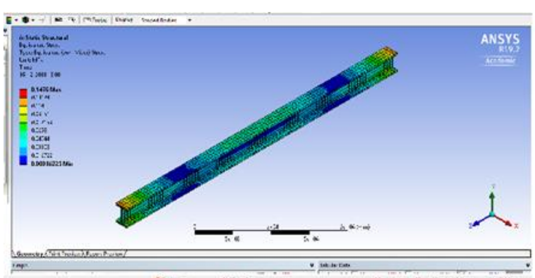

Fig. 4. Stress

For cast iron:

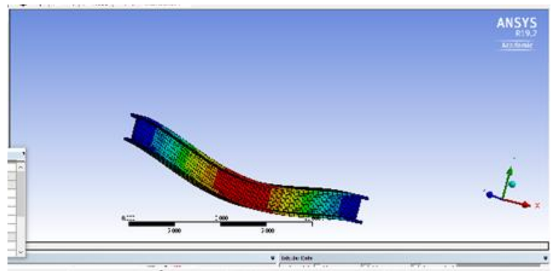

Fig. 5. Deformation

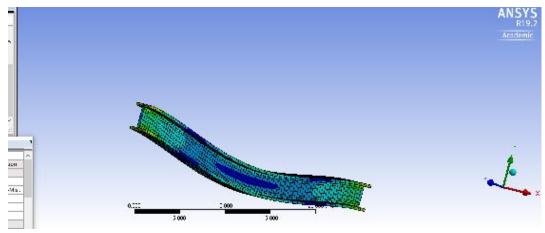

Fig. 6. Stress

3. Future scope

Here we found the results of I beam in both analytical and ansys results. After comparing both results we does not found any error.

After that we built lattice structure on I beam and we found deflection and stress.

4. Summary

At this stage we calculate the deflection and stress of I beam with different material and comparison between analytical and ansys calculation are as follows,

Table 2
Result

	Analytical result	Ansys result	Analytical result	Ansys result
Material	Structural steel		Cast iron	
Deflection (δ)	0.0179	1.8881e-002	0.0169	1.8881e-002
Stress (σ)	0.148	0.1476	0.148	0.1476

5. Conclusion

This paper presented Generation and Optimization of Lattice Structure on I beam.

References

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