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Eigenvalue Buckling and Static Analysis Behavior of Truss-Beam Structure

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Abstract

This study for eigenvalue buckling and the static analysis behavior of truss beam structure, where In engineering, a truss may be a structure that "consists of two-force members solely, wherever the members square measure organized in order that the assemblage as a full behaves as one object. Axial force and direct stresses and directional deformation in addition to eigenvalue buckling will be studied.

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Introduction

A truss is associate degree assembly of beams or different parts that makes a rigid structure.[1] In engineering, a truss may be a structure that "consists of two-force members solely, wherever the members square measure organized in order that the assemblage as a full behaves as one object".[2] A "two-force member" may be a structural element wherever force is applied to solely 2 points. though this rigorous definition permits the members to own any form connected in any stable configuration, trusses usually comprise 5 or additional triangular units created with straight members whose ends square measure connected at joints brought up as nodes.

In this typical context, external forces and reactions to those forces square measure thought of to act solely at the nodes and lead to forces within the members that square measure either tensile or compressive. For straight members, moments (torques) square measure expressly excluded as a result of, and solely as a result of, all the joints in an exceedingly truss square measure treated as revolutes, as is important for the links to be two-force members.

A truss consists of generally (but not necessarily) straight members connected at joints, historically termed panel points. Trusses square measure generally (but not necessarily[5]) composed of triangles owing to the structural stability of that form and style. A triangle is that the simplest geometric figure which will not change once the lengths of the edges square measure mounted.[6] as compared, each the angles and also the lengths of a multilateral figure should be mounted for it to retain its form. The joint at that a truss is intended to be supported is often mentioned because the Munter purpose.

Simple truss

The simplest kind of a truss is one single triangle. this sort of truss is seen during a framed roof consisting of rafters and a ceiling beam,[7] and in alternative mechanical structures like bicycles and craft.

Planar truss

A tabular truss lies in a very single plane.[8] tabular trusses area unit generally employed in parallel to create roofs and bridges.[9]

Space frame truss

A space frame truss could be a three-dimensional framework of members stapled at their ends. A polyhedron form is that the simplest area truss, consisting of six members that meet at four joints.[8] massive planar structures could also be composed from tetrahedrons with common edges, and that they are utilized within the base structures of huge free-standing line pylons.

Fig.1: Truss bridge

The utility of this sort of structure in buildings is that an outsized quantity of the outside envelope remains unobstructed and might be used for windows and door openings. In some applications this can be desirable to a braced-frame system, which might leave some areas stopped-up by the diagonal braces.

Fig.2: Truss bridge

N. K. Gupta, N. Mohamed peace officer, R. Velmurugan have studied the buckling of skinny conic solid below axial hundreds [17]. They performed experiments with sure specimens of conic frusta. The non1 linear material used for these specimens was metallic element. Experiments were performed by subjecting the conic shells to similar static loading. Axial compression of the shells was dispensed by pressure every specimen between 2 rigid platens. The load deflection curves were obtained from these experiments were compared with the results obtained from numerical analysis. The compressive failure mode was simulated victimisation ANSYS. Material, geometric and get in touch with non dimensionality were enclosed. the fabric non-linearity was enclosed victimisation the particular stress strain curve obtained from the experiments. The results so obtained were higher however might be compared well with the experimental ones. victimisation finite components modeling so facilitates the analysis of intermediate stages of buckling that reduces the value and time.

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A.Pica and R. D. Wood have studied the post buckling behavior of plates and shells employing a mindlin shallow shell formulation[18]. This paper presents a geometrically non-linear analysis of shallow shells victimisation finite component mindlin formulation. It provides results for post buckling behavior of sq. and circular plates subject to direct in plane loading and sq. plate subject to in plane shear loading. Analysis of shallow truss and cylindrical and spherical shells also are conferred, all exhibiting snap through behavior. For variety of post buckling solutions the nine node lagrangian component was used that demonstrates the flexibility to model ee boundaries. Chawalit Thinvongpituk and Pisit Techarungpaisarn have studied the Buckling of Axially compressed conic shells of linearly variable thickness victimisation structural model[19]. The study was conducted with a series of experiments performed victimisation conic specimens with constant thickness, that were crushed until the buckling load was recorded. For comparison atomic number 26 model was created victimisation ABAQUS to simulate the experiment. The buckling hundreds obtained from the experiment and therefore the atomic number 26 model were discovered to be in smart agreement with one another. The atomic number 26 model was any accustomed investigate the cone with non constant thickness. it absolutely was discovered that variation of thickness in axial direction ends up in the reduction of buckling load. The reduction of buckling load, thanks to the little thickness variation in axial direction is proportional to the thickness variation parameter ε, wherever wherever is that the quantitative relation of the distinction of minimum and most wall thickness to the minimum wall thickness of cone.

Huu Tai Thai and Seung Eock Kim have performed the springless post buckling analysis of area steel trusses victimisation the generalized displacement management method[20]. area steel trusses used extensively for domes or roofs. during this paper the authors have extended the appliance of Hill [21] model for springless post buckling analysis of area steel trusses. Geometric and material non dimensionality square measure thought of for the study. This paper presents AN formula which will trace the equilibrium ways of the non linear drawback with multiple limit points and snap back points. A bug is developed to predict the springless post buckling behavior of area truss structures. The paper includes variety of examples resolved to prove the accuracy of the planned procedure.

Problem Definition and Assumptions

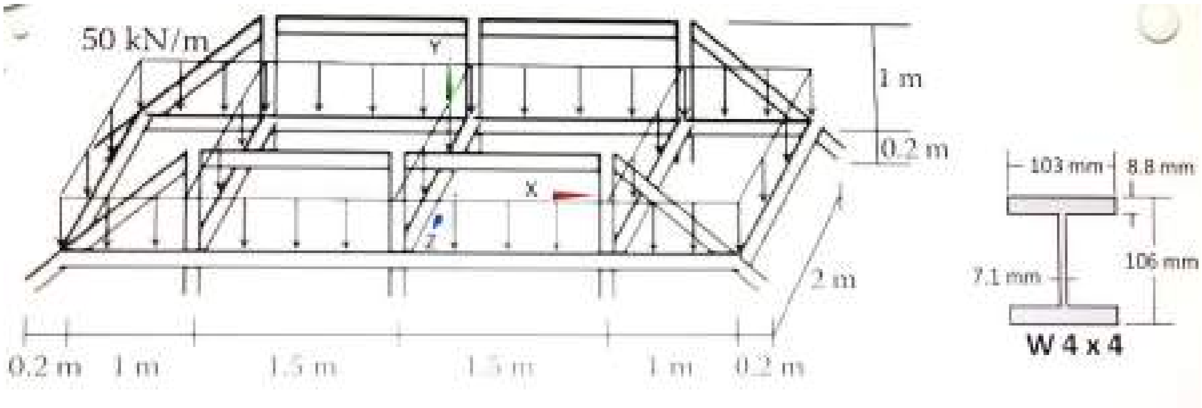

Fig.3: Truss dimensions

Three alternatives will be studied with different shapes and cross-sections, then we will compare between the three alternatives regarding the :

- Directional Deformation (mm)
- Axial Force (N)
- Direct Stress (Mpa)
- Maximum Combined Stress (Mpa)
- Eigenvalue Buckling (mm)
    - Load Multiplier
- Boundary Conditions and Loads:
    - The 10 Vertices that touching the ground for the 1st and 2nd alternative will have fixed support.
    - The 13 line edges that touching the ground for the 1st and 2nd alternative will have a line pressure with 250 N/mm.

- The 14 Vertices that touching the ground for the 3rd alternative will have fixed support.
- The 19 line edges that touching the ground for the 3rd alternative will have a line pressure with 250 N/mm.

❖ Material:

- Structural Steel

Alternative 1

Alternative 2

Alternative 3

Modeling & Analysis Setup (Alternative 1)

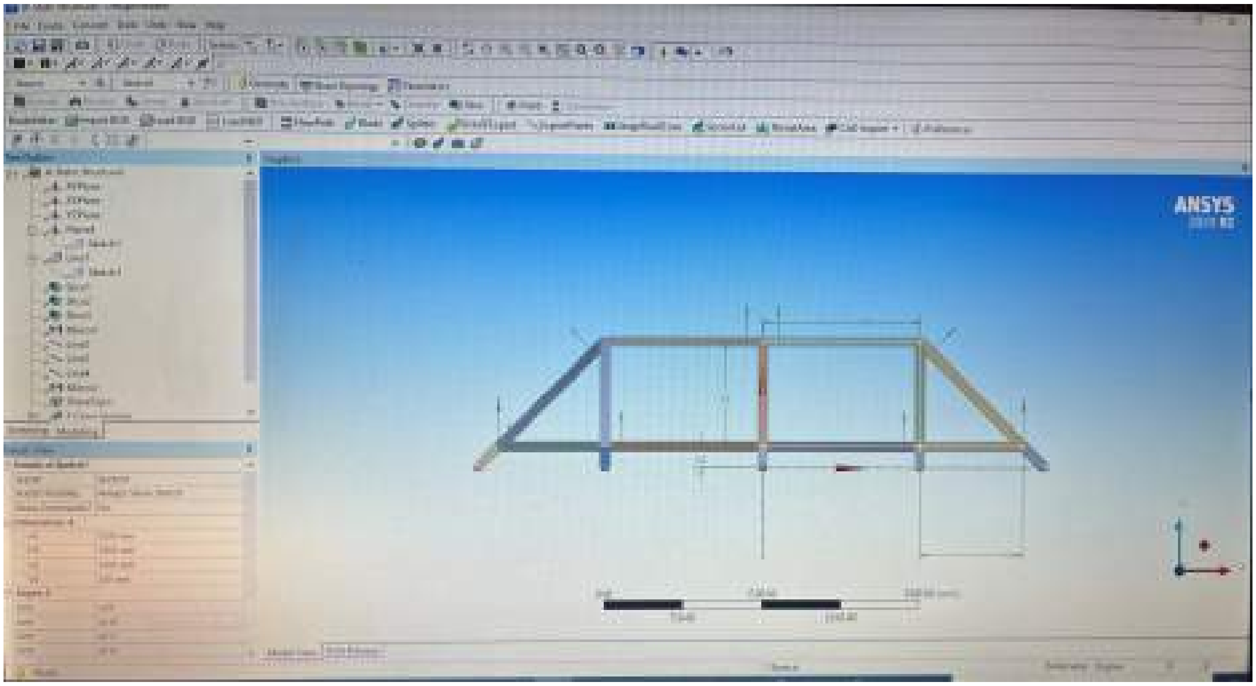

Fig.4: Dimensions of the alternative 1

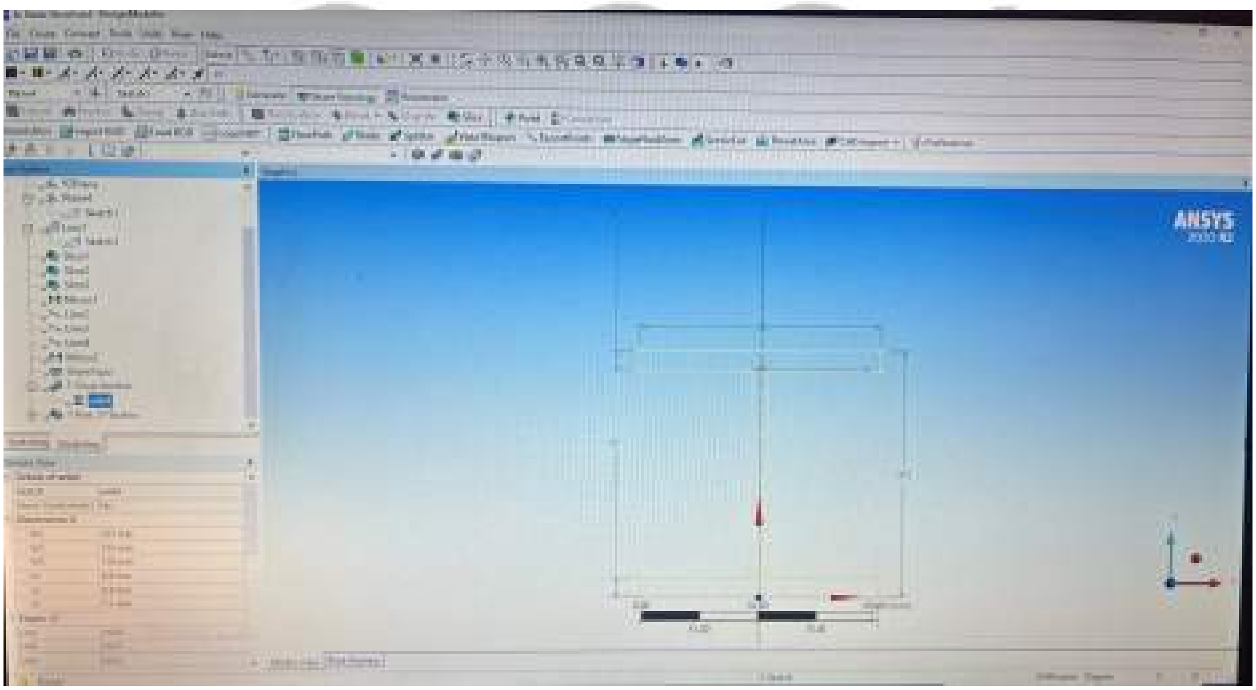

Fig.5: Dimensions of the I- beam cross section

As we can see from fig.4 and fig.5 the dimensions of the truss and the I- beam cross section in mm.

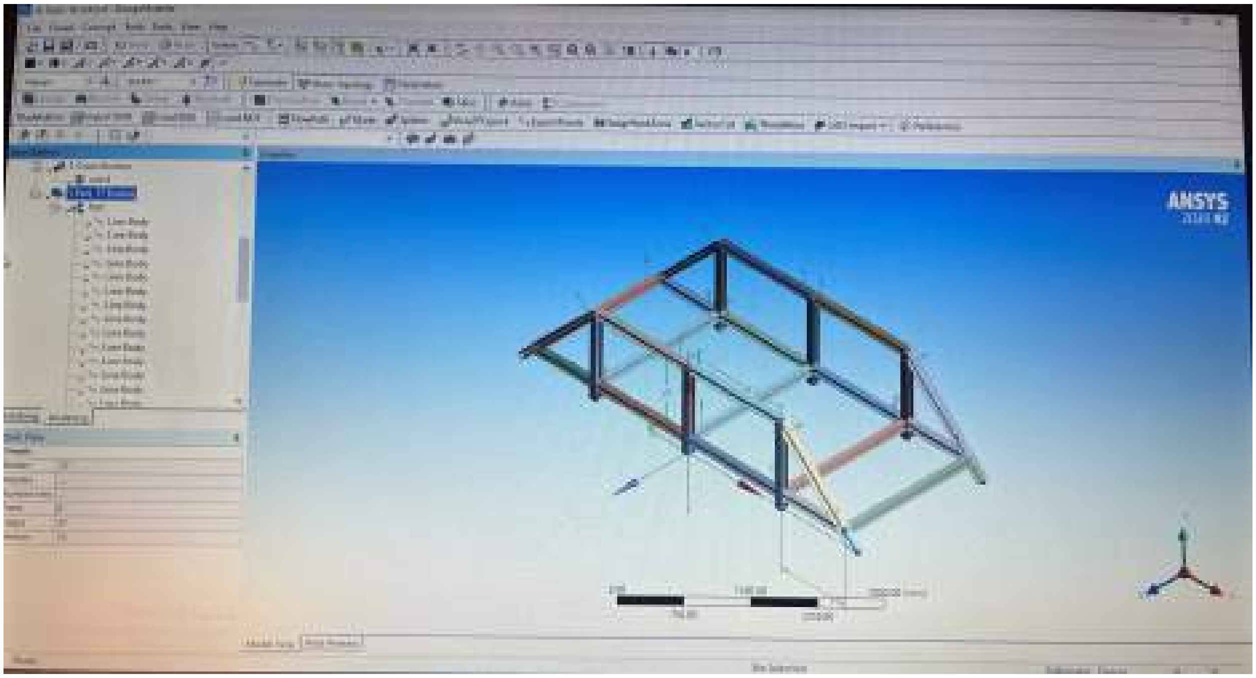

Fig.6: First alternative

Fig.6 shows us the first alternative which has 37 elements all assigned with i- beam cross-section and structural steel material.

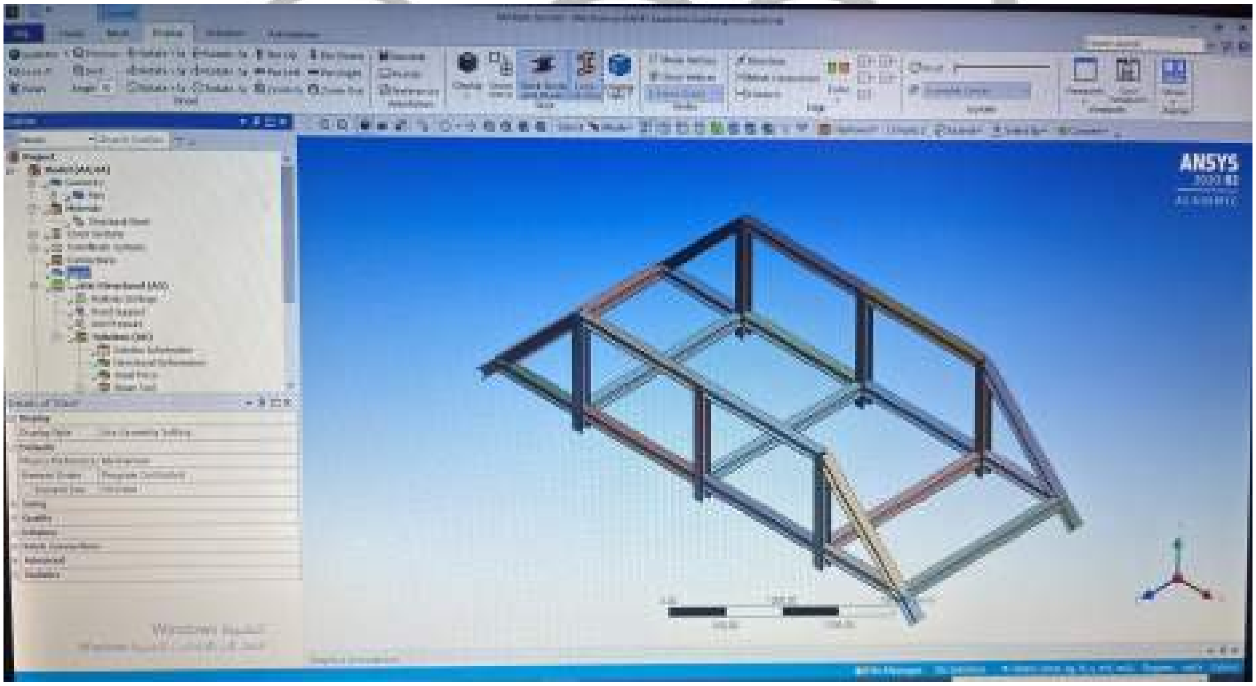

Fig.7: Meshing of First alternative

In fig.7 we use 50 mm as meshing size, which give us 1597 nodes and 804 elements.

Results and Discussion

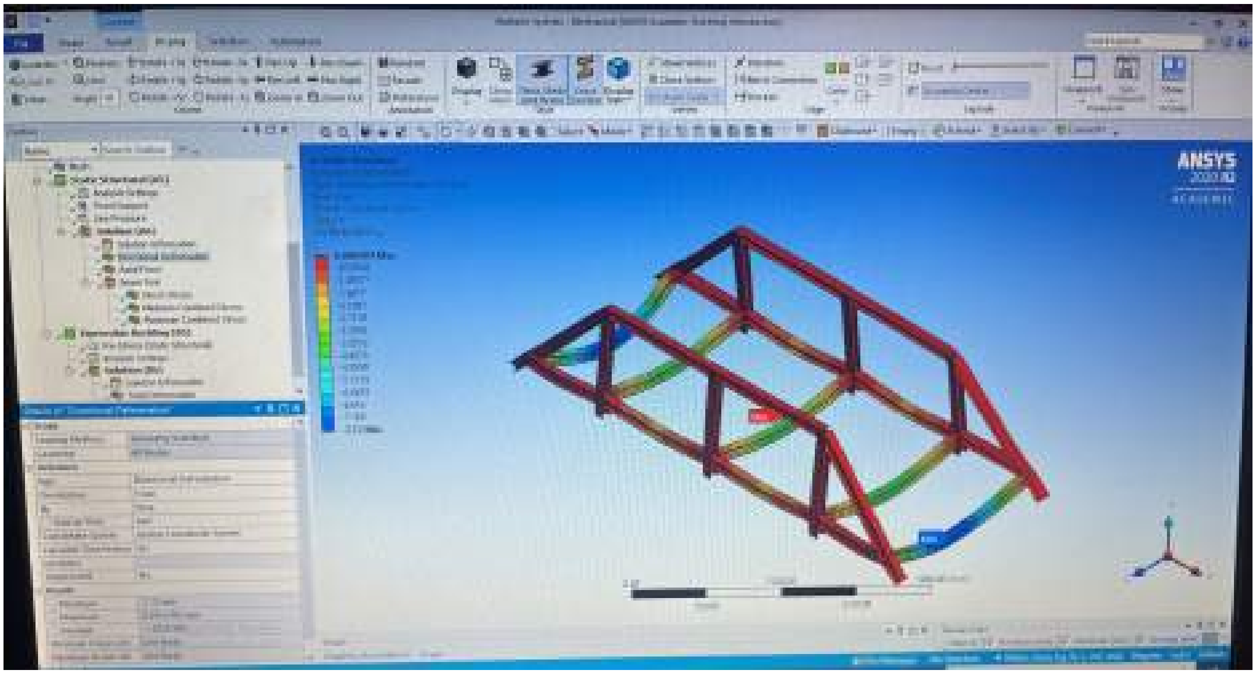

Fig.8: Directional deformation of 1st alternative

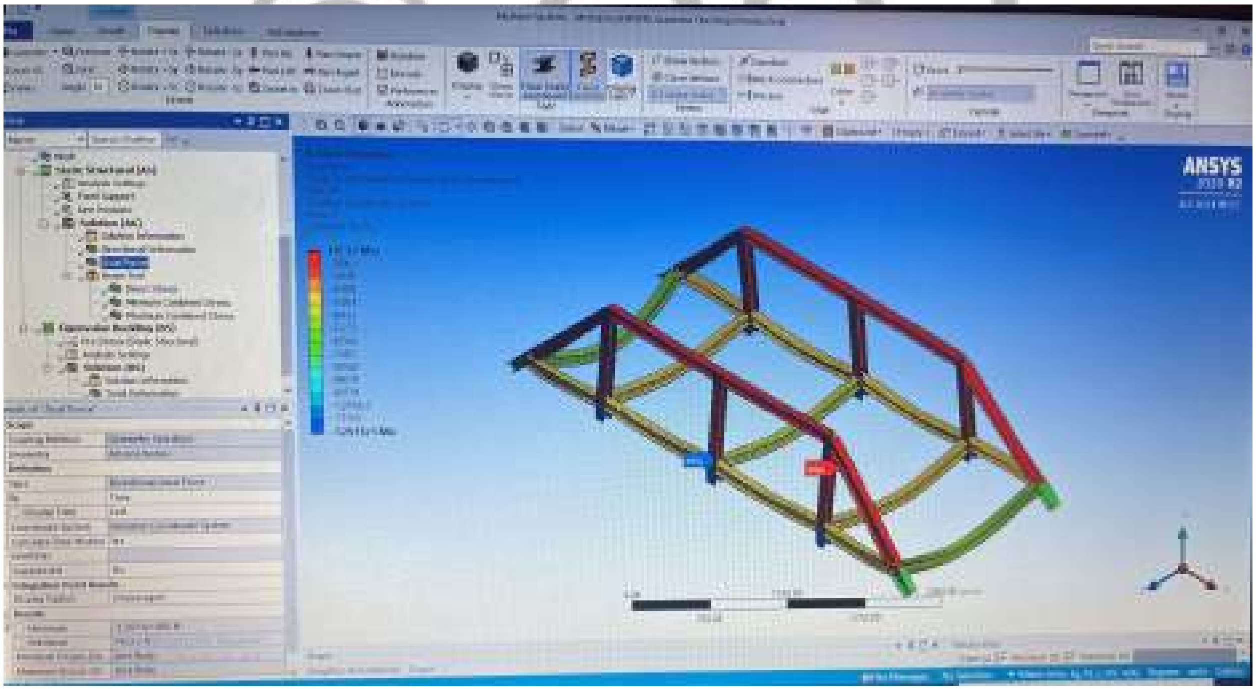

Fig.9: Axial force of 1st alternative

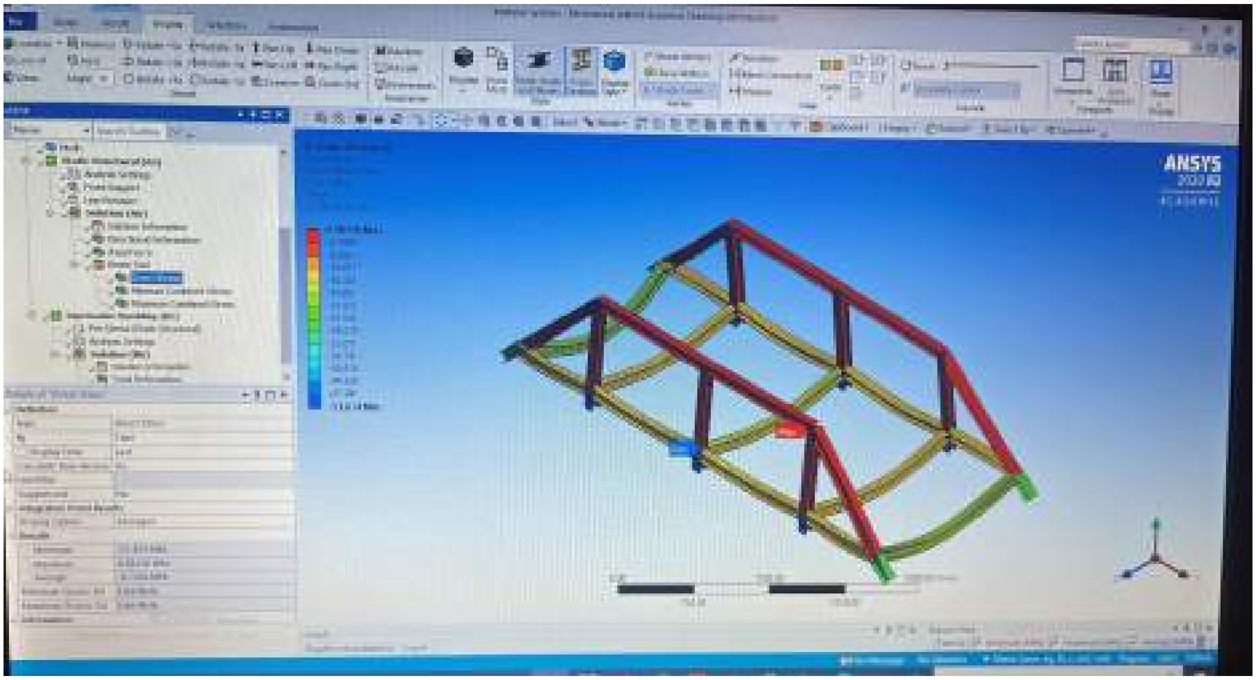

Fig.10: Direct stress of 1st alternative

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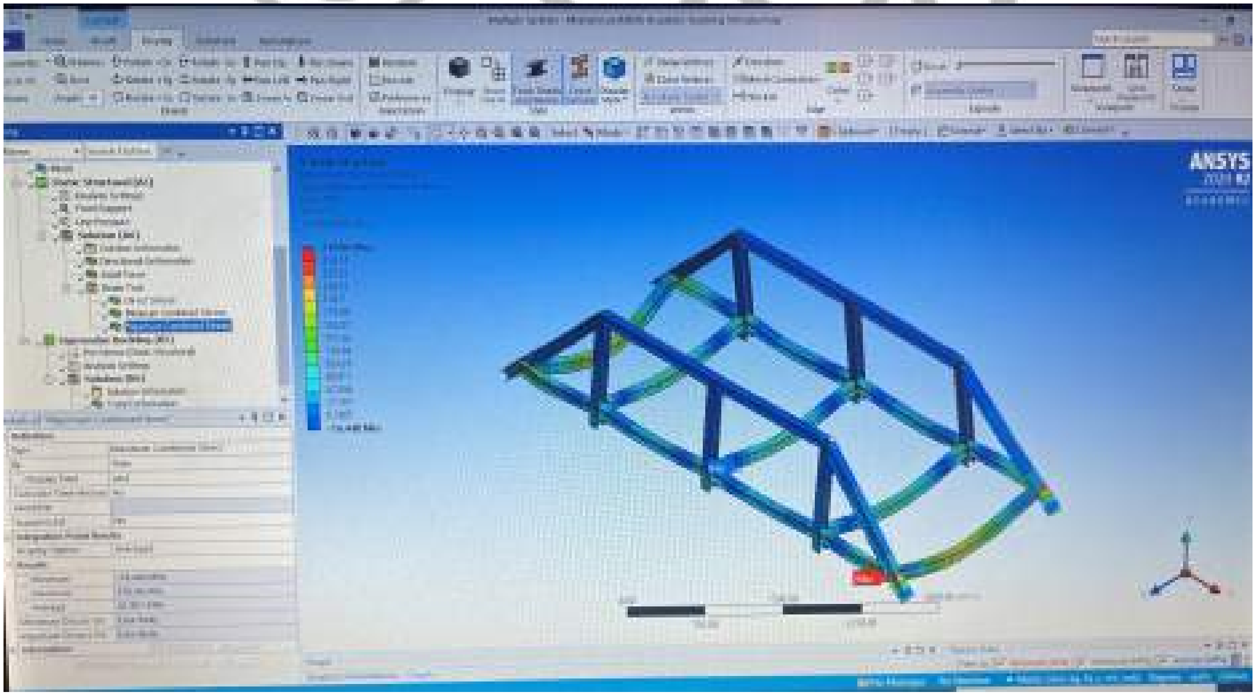

Fig.11: Maximum combined stress of 1st alternative

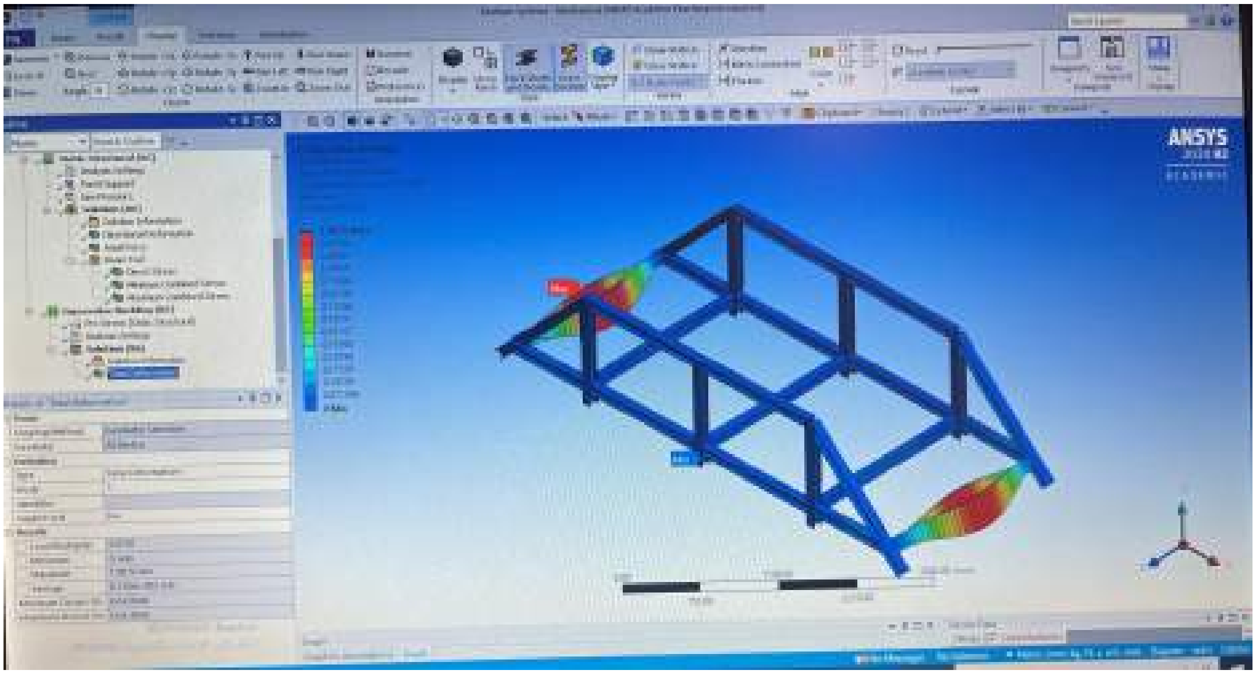

Fig.12: Eigenvalue buckling of 1st alternative

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As we can see from fig.8 – fig.12 are the output for alternative 2, will be shows clarify in the below table:

Table.1: Results for 1st alternative

No.	Output	Value	Unit
1	Directional Deformation	8.393 X 10-3	mm
2	Axial Force	1423.2	N
3	Direct Stress	0.58316	Mpa
4	Maximum Combined Stress	276.96	Mpa
5	Eigenvalue Buckling	1.0079	mm
		Load Multiplier: 5.0701	

Modeling & Analysis Setup (Alternative 2)

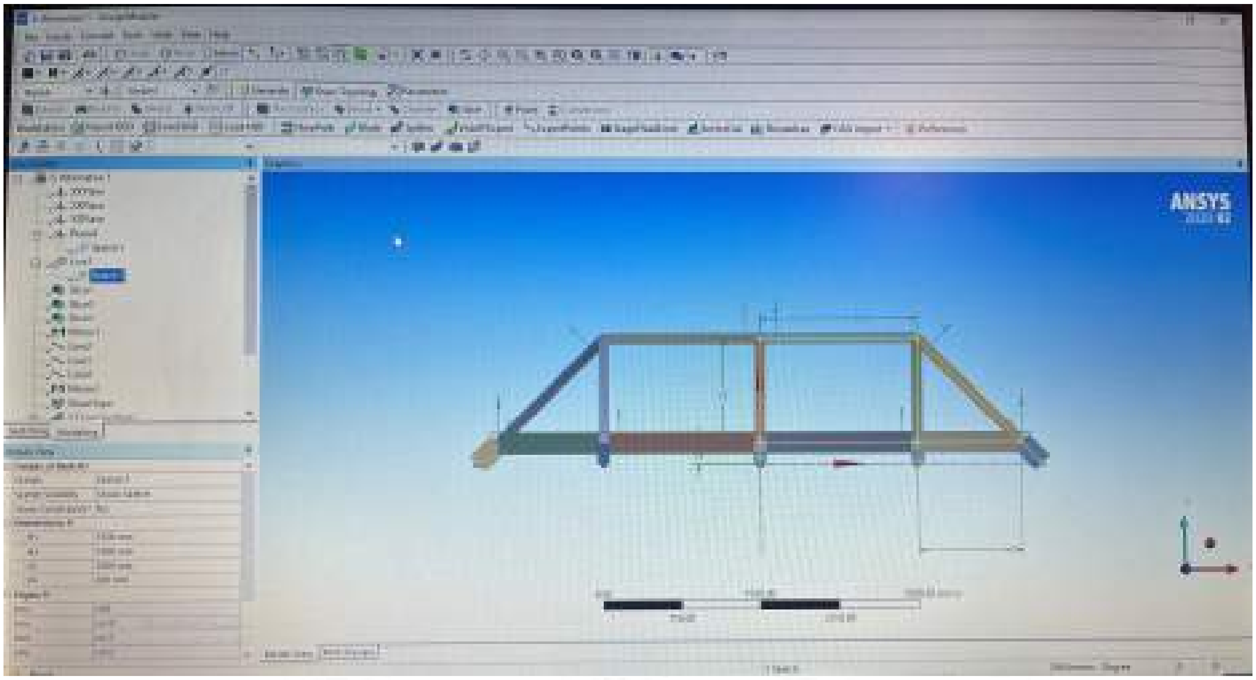

Fig.13: Dimensions of the alternative 2

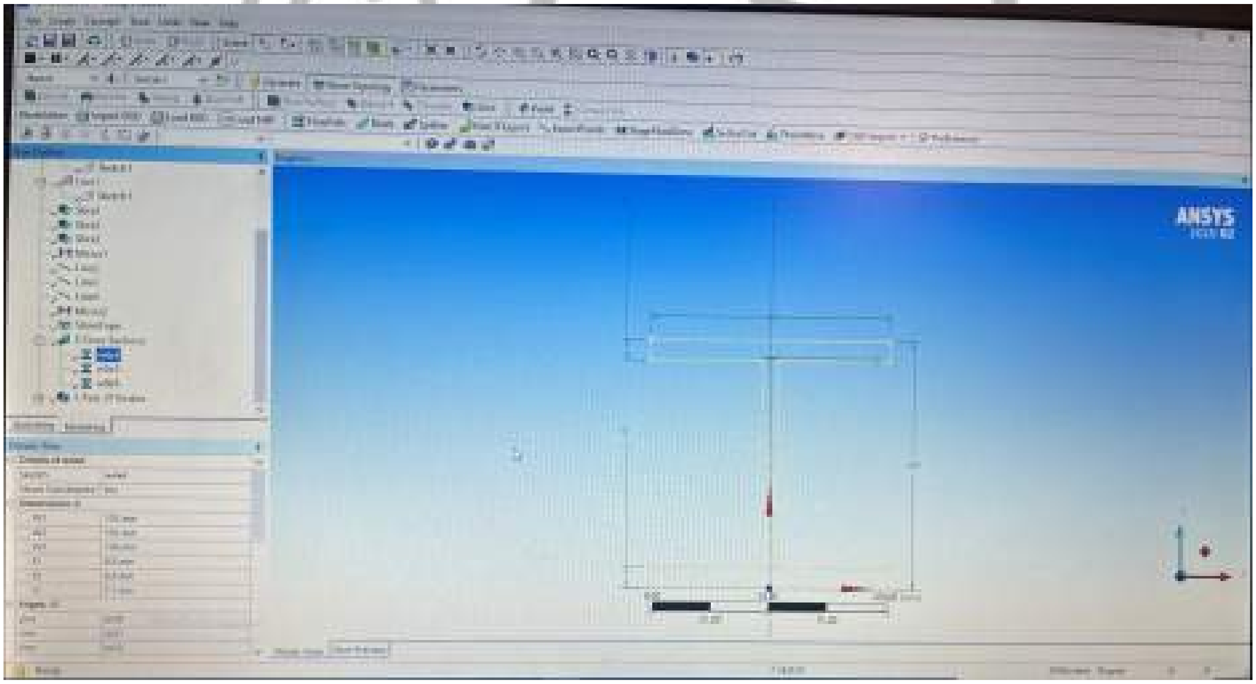

Fig.14: Dimensions of the 1st I- beam cross section

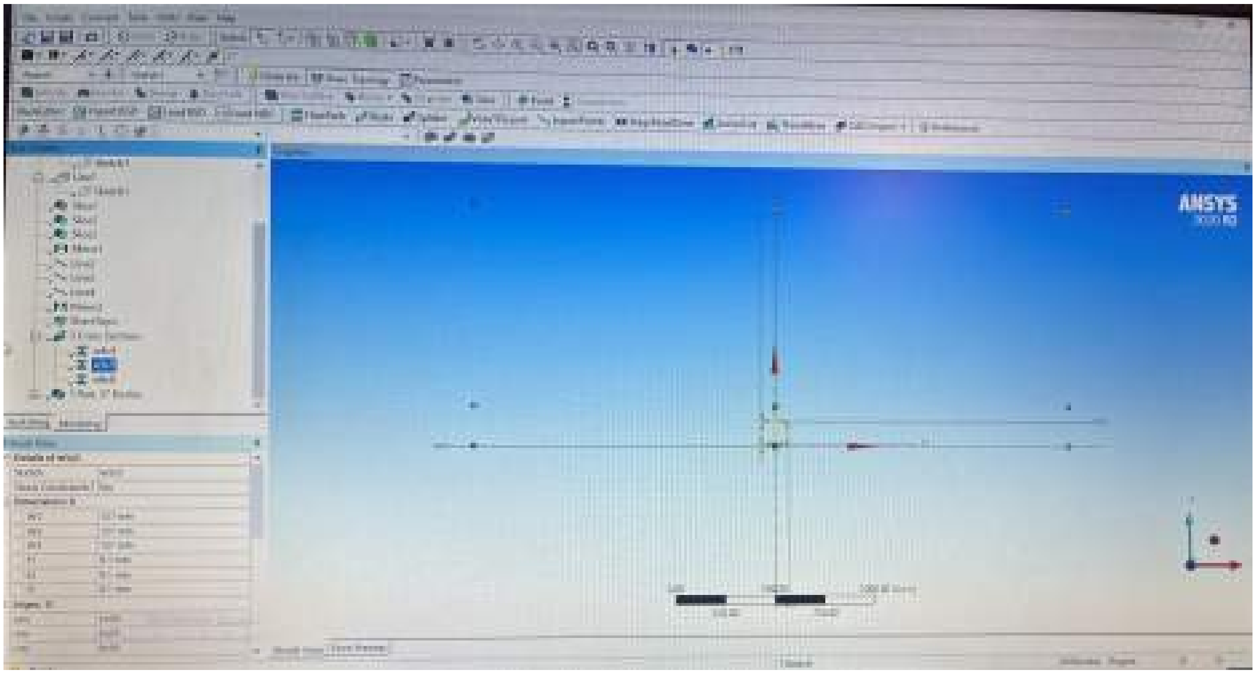

Fig.15: Dimensions of the 2^{nd} I- beam cross section

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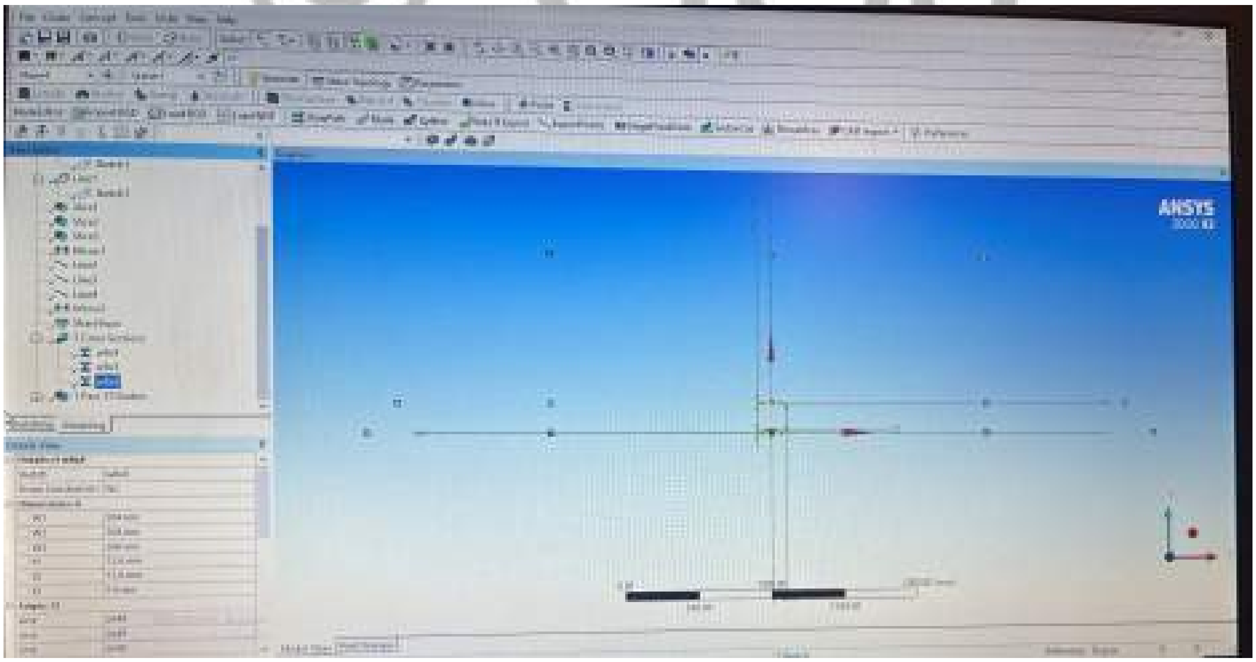

Fig.16: Dimensions of the 3^{rd} I- beam cross section

As we can see from fig.13 to fig.16 the dimensions of the truss and the three I- beam cross sections in mm.

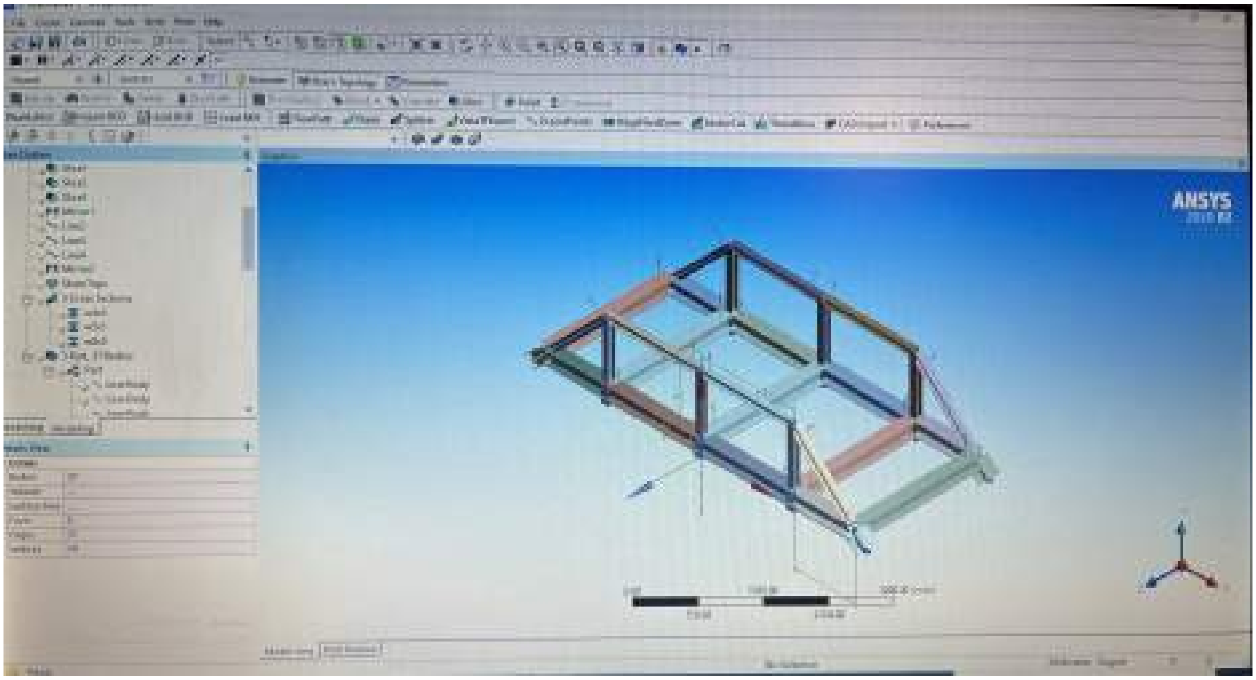

Fig.17: Second alternative

Fig.17 shows us the second alternative which has 37 elements all assigned with different i- beam cross-section and structural steel material.

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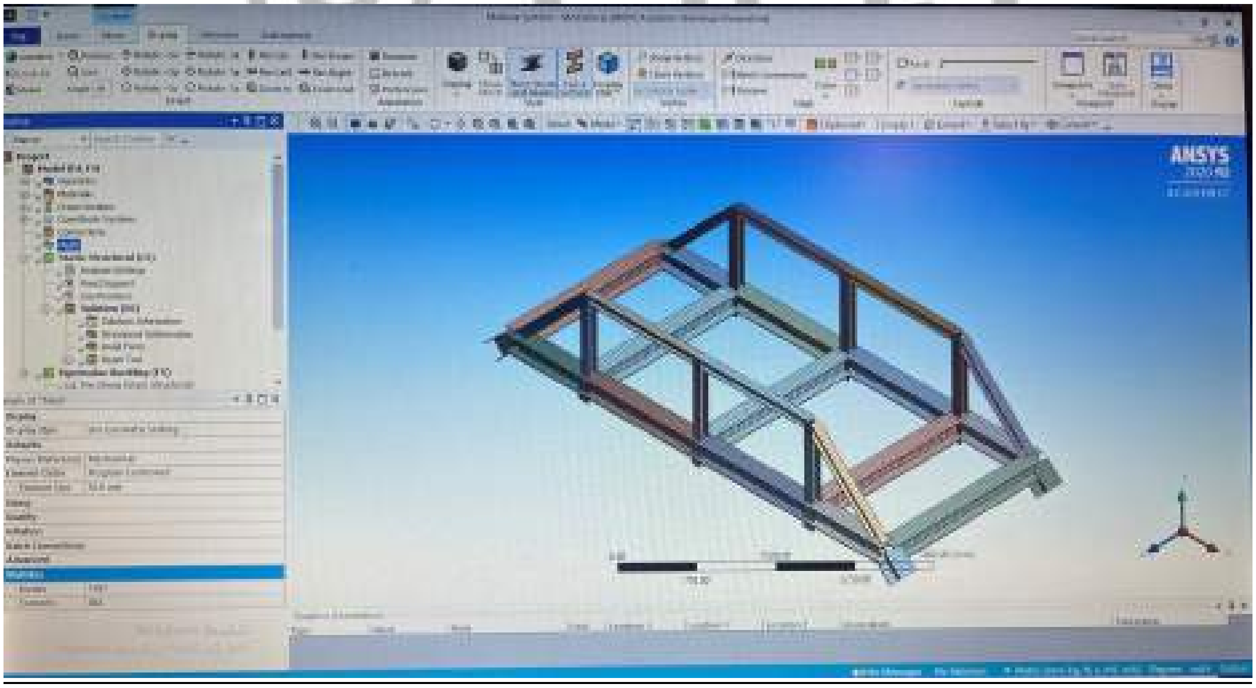

Fig.18: Meshing of second alternative

In fig.18 we use 50 mm as meshing size, which give us 1597 nodes and 804 elements.

Results and Discussion

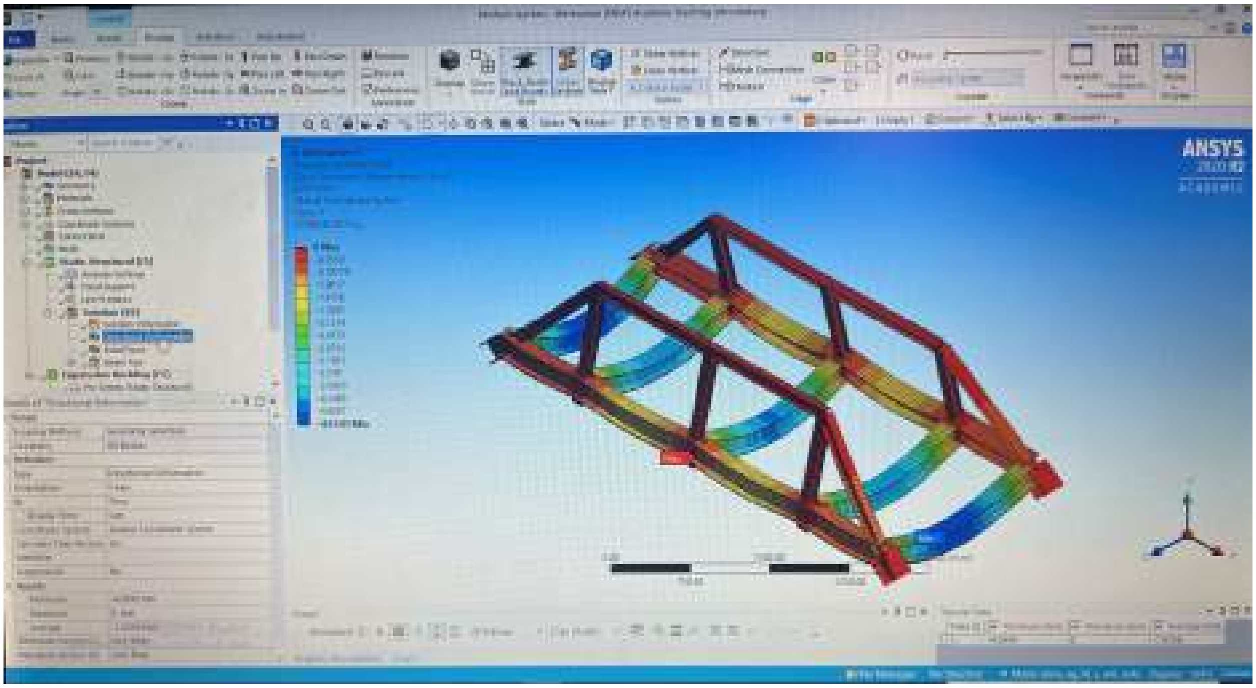

Fig.19: Directional deformation of 2nd alternative

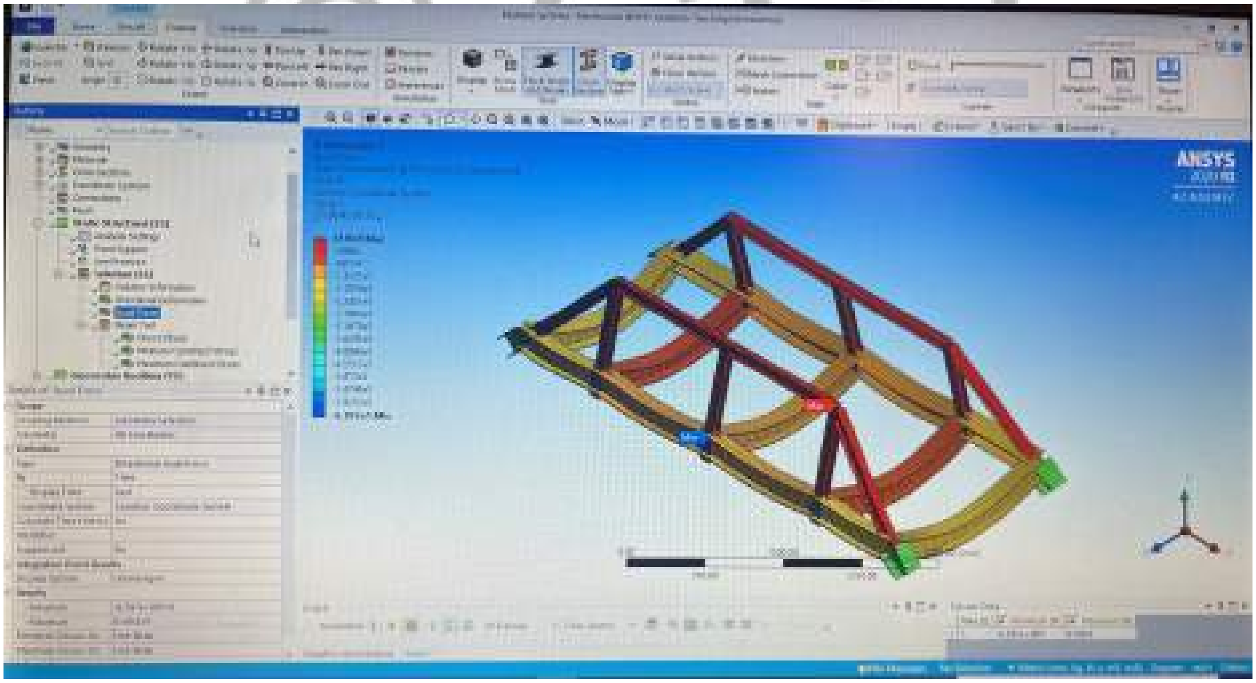

Fig.20: Axial force of 2nd alternative

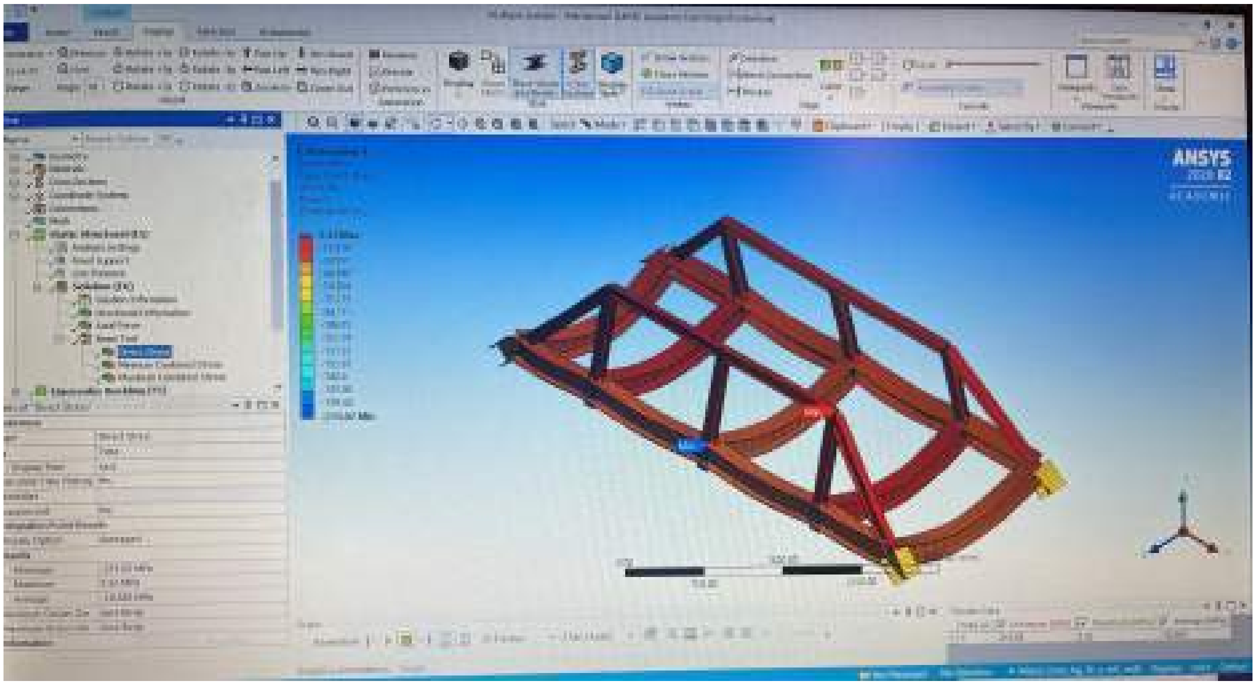

Fig.21: Direct stress of 2nd alternative

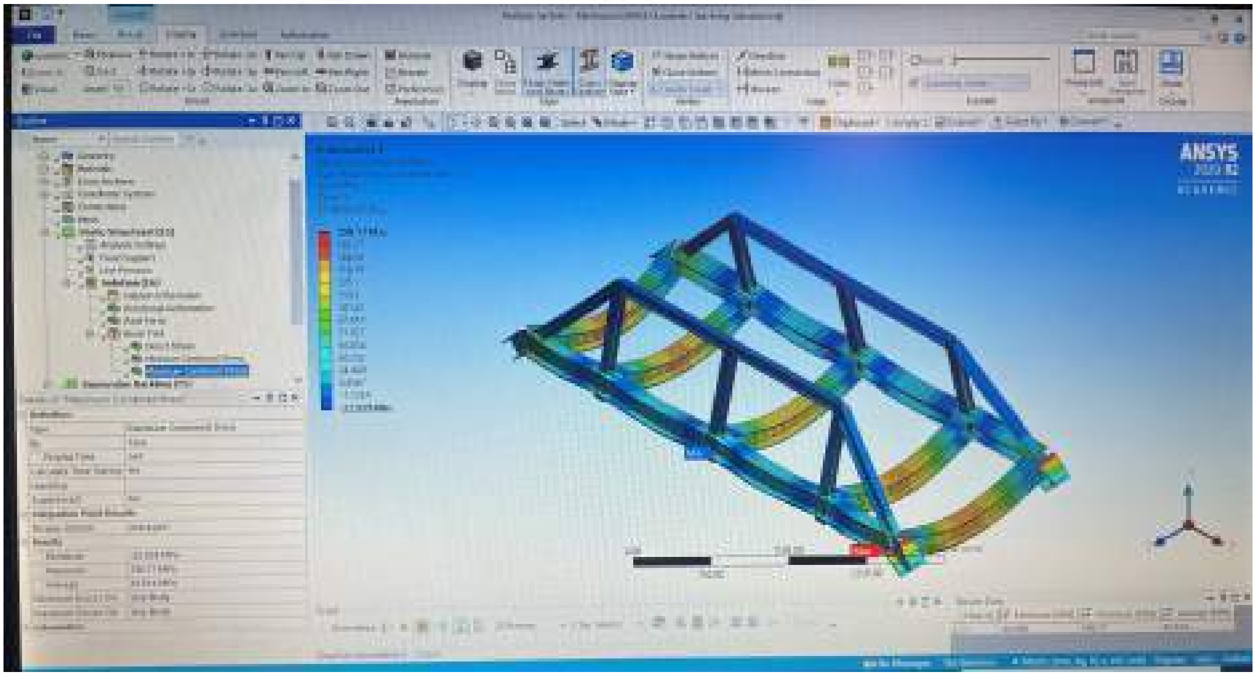

Fig.22: Maximum combined stress of 2nd alternative

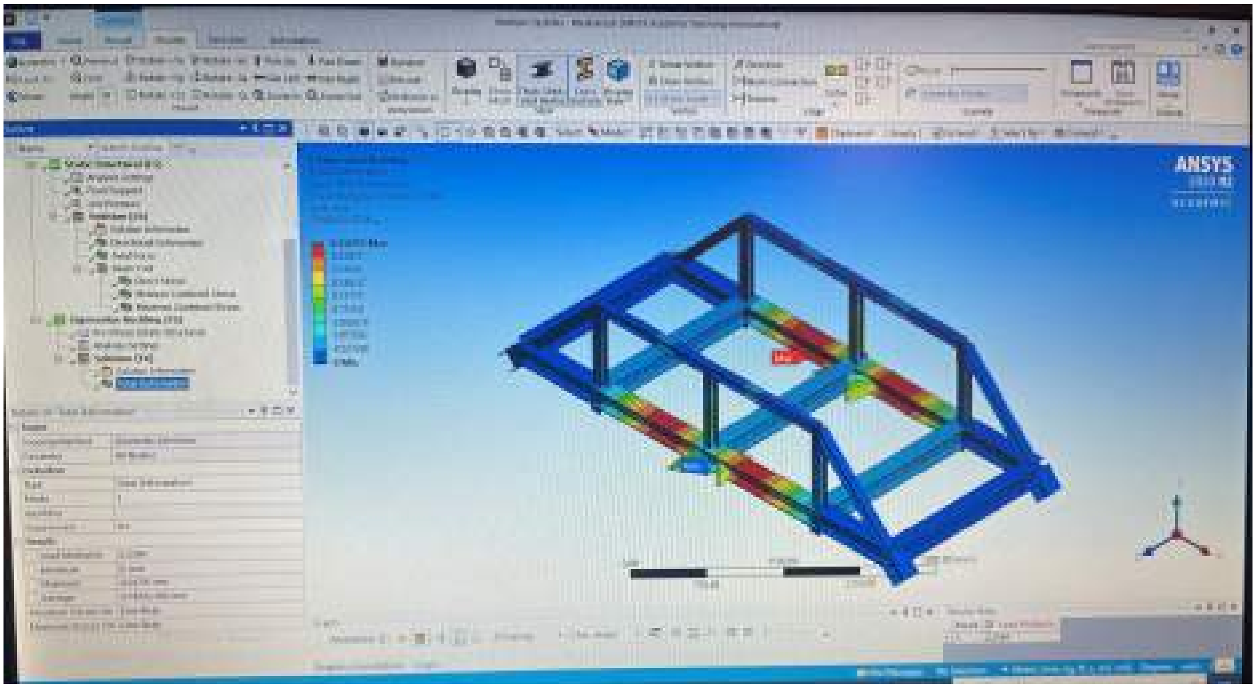

Fig.23: Eigenvalue buckling of 2nd alternative

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As we can see from fig.19 – fig.23 are the output for alternative 2, will be shows clarify in the below table:

Table.2: Results for 2nd alternative

No.	Output	Value	Unit
1	Directional Deformation	0	mm
2	Axial Force	6149.8	N
3	Direct Stress	2.52	Mpa
4	Maximum Combined Stress	198.17	Mpa
5	Eigenvalue Buckling	0.24791	mm
		Load Multiplier: 2.2384	

Modeling & Analysis Setup (Alternative 3)

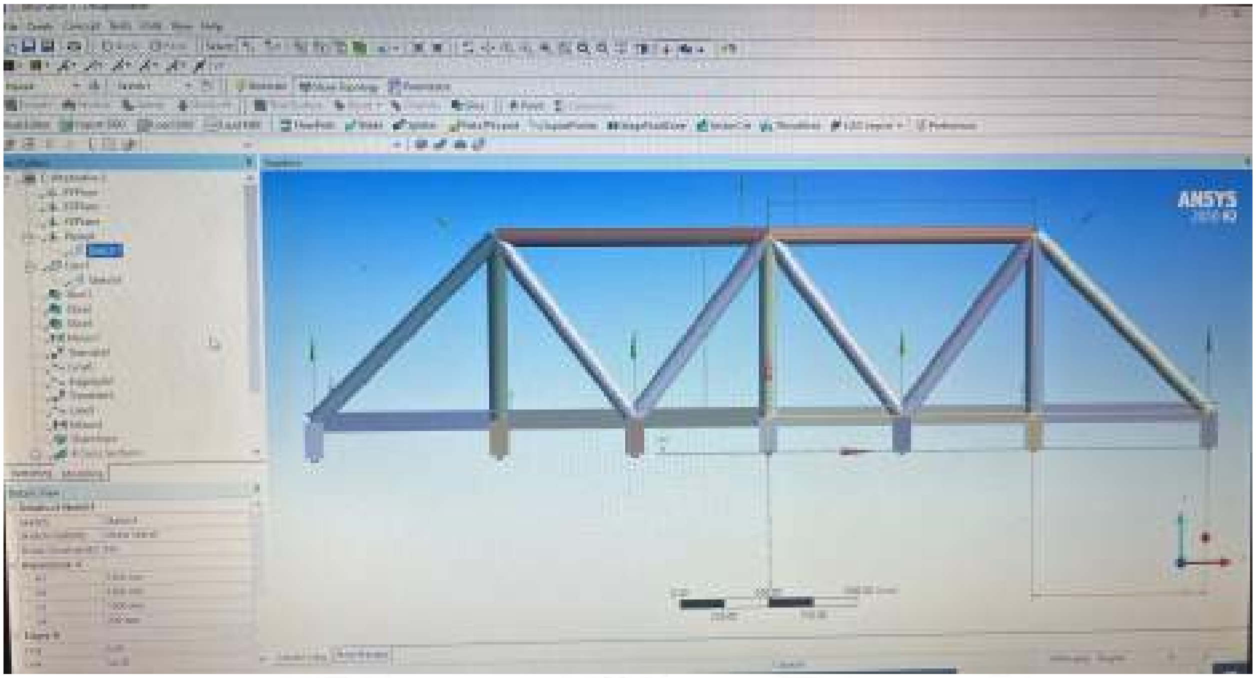

Fig.24: Dimensions of the alternative 3

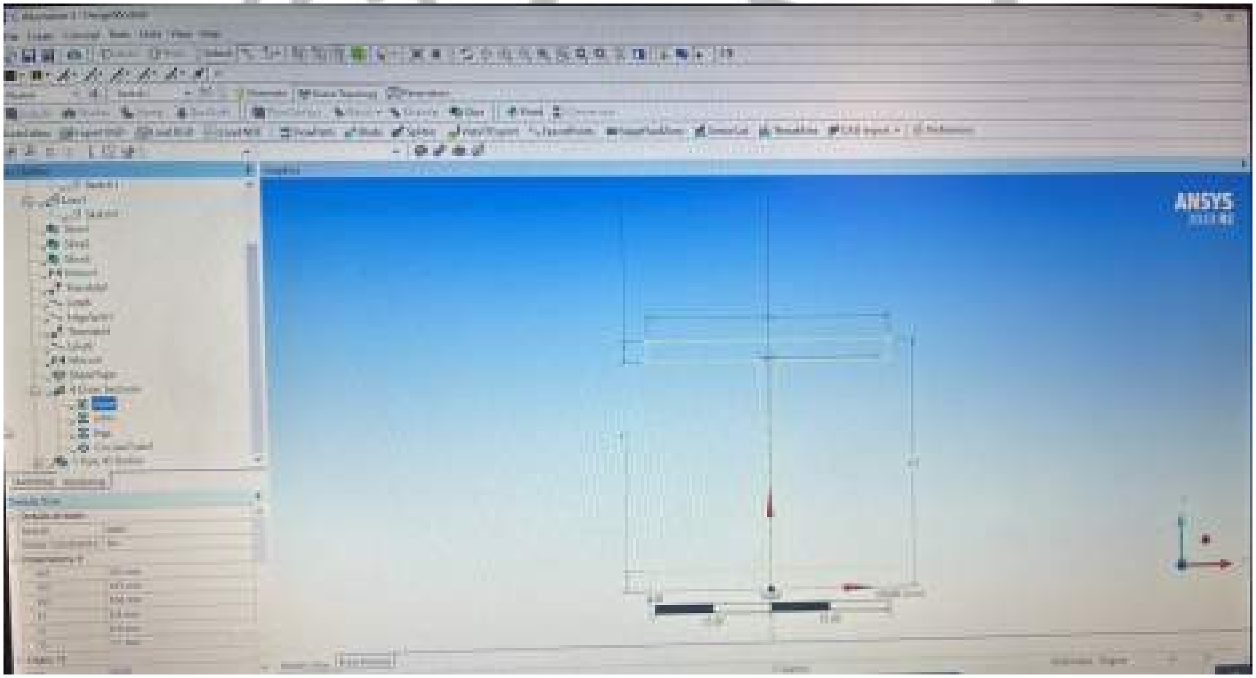

Fig.25: Dimensions of the 1st I- beam cross section

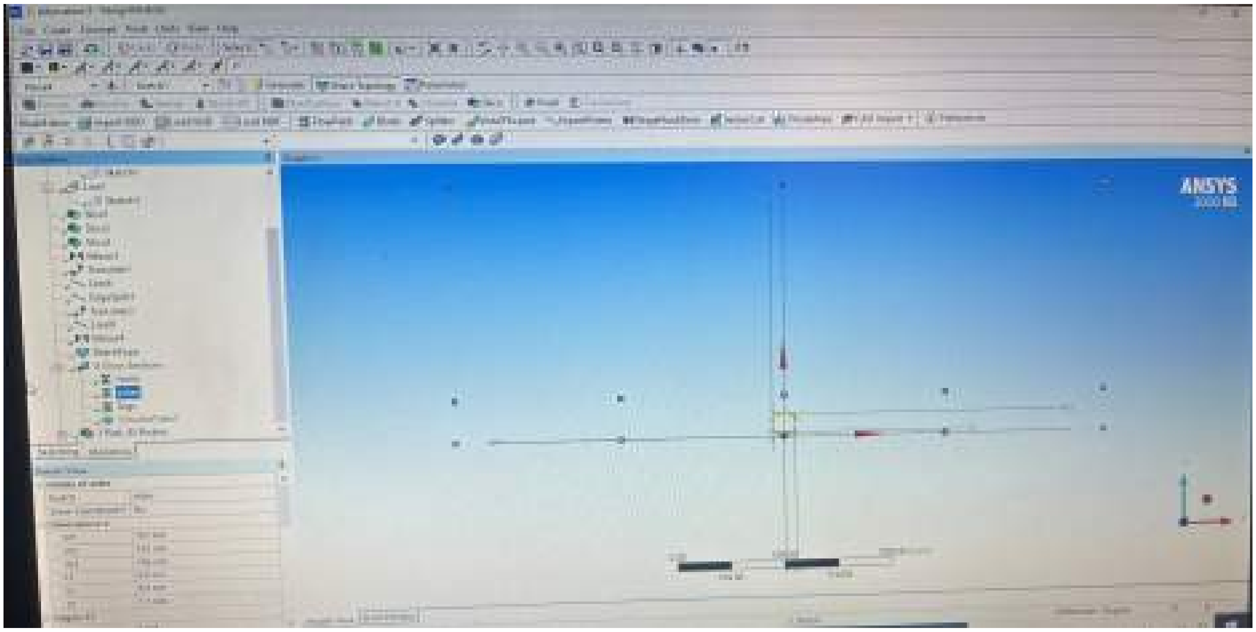

Fig.26: Dimensions of the 2nd I- beam cross section

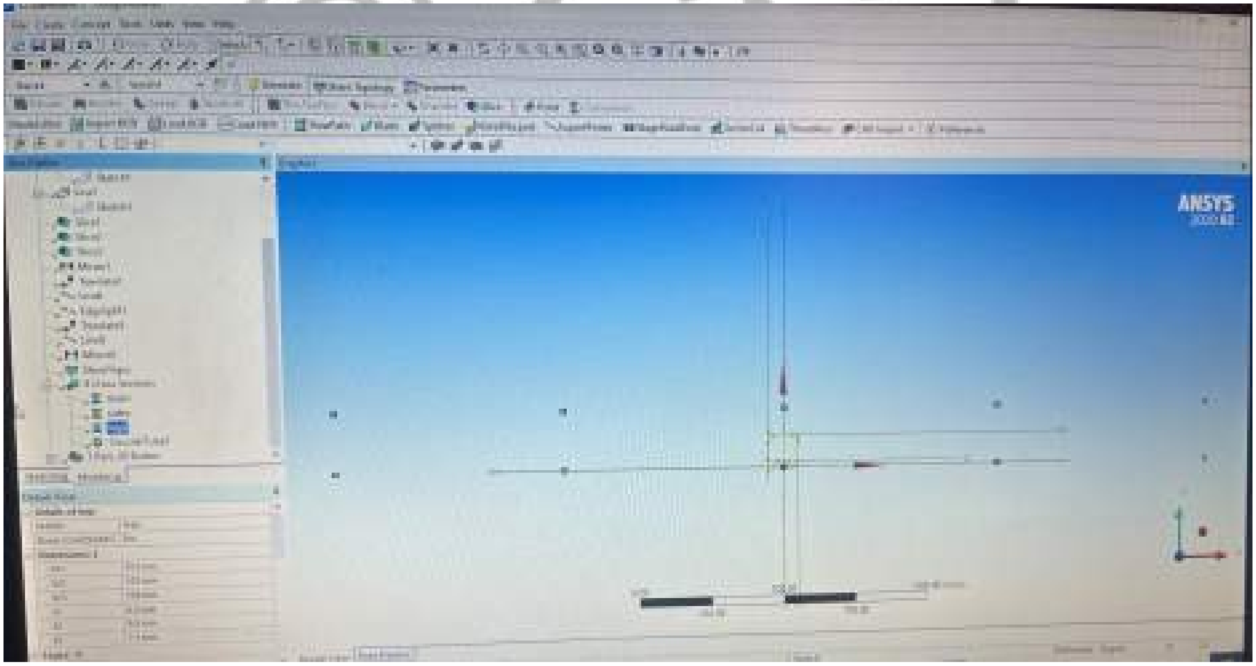

Fig.27: Dimensions of the 3rd I- beam cross section

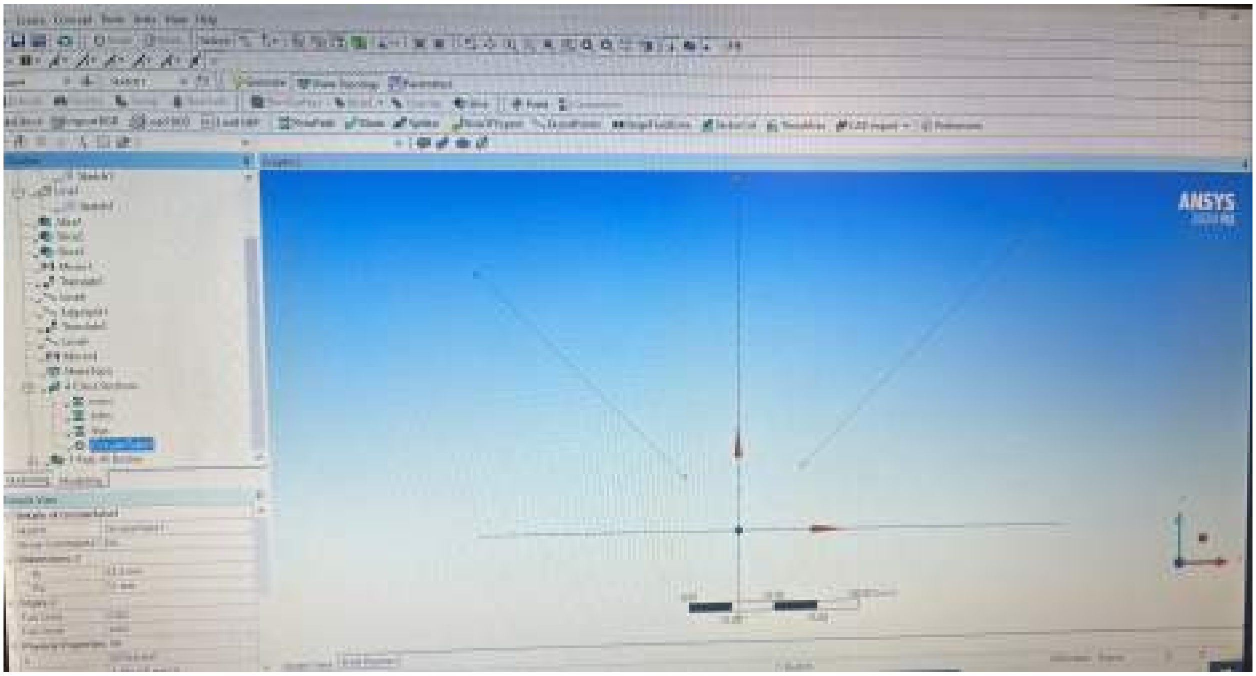

Fig.28: Dimensions of the Circular tube cross section

As we can see from fig.24 to fig.28 the dimensions of the truss and the three I- beam and circular tube cross section in mm.

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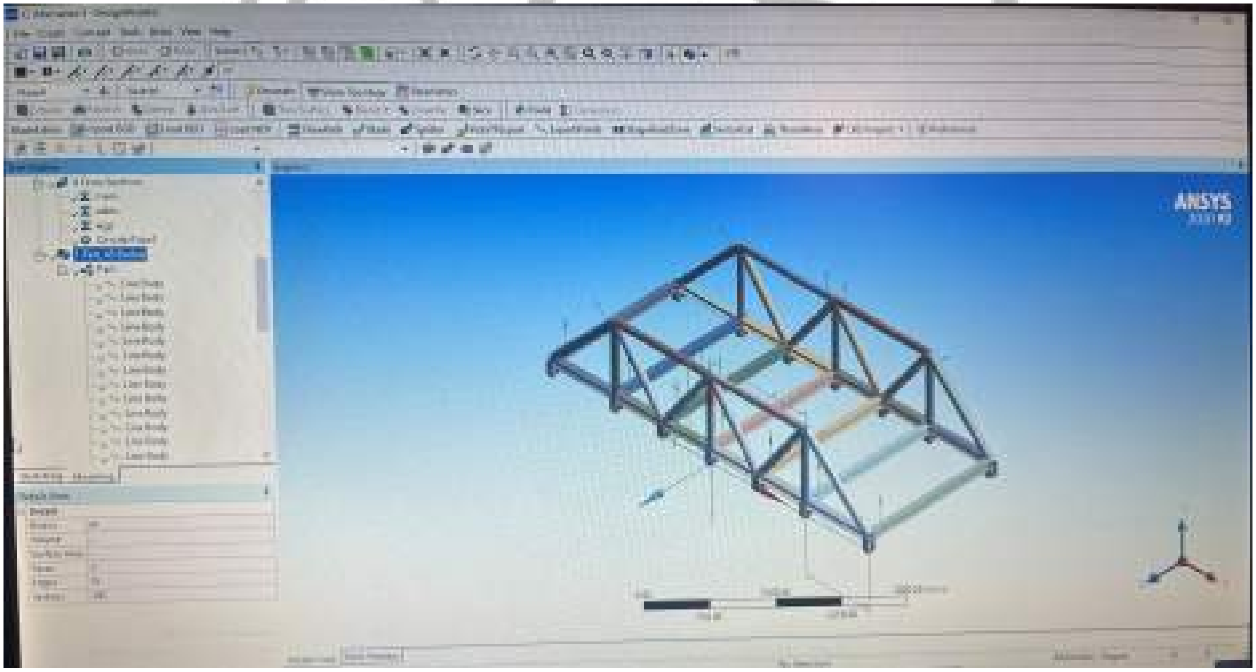

Fig.29: Third alternative

Fig.29 shows us the third alternative which has 45 elements all assigned with i- beam and circular tube cross-section with structural steel material.

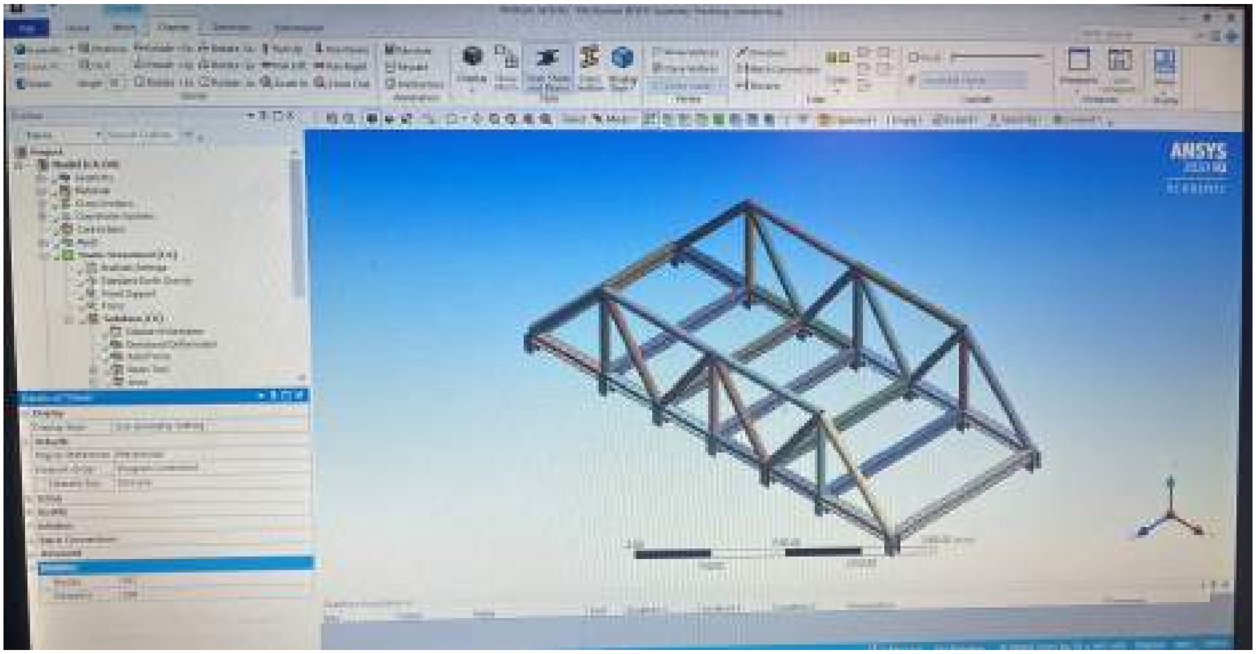

Fig.30: Meshing of Third alternative

In fig.30 we use 50 mm as meshing size, which give us 567 nodes and 294 elements.

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Results and Discussion

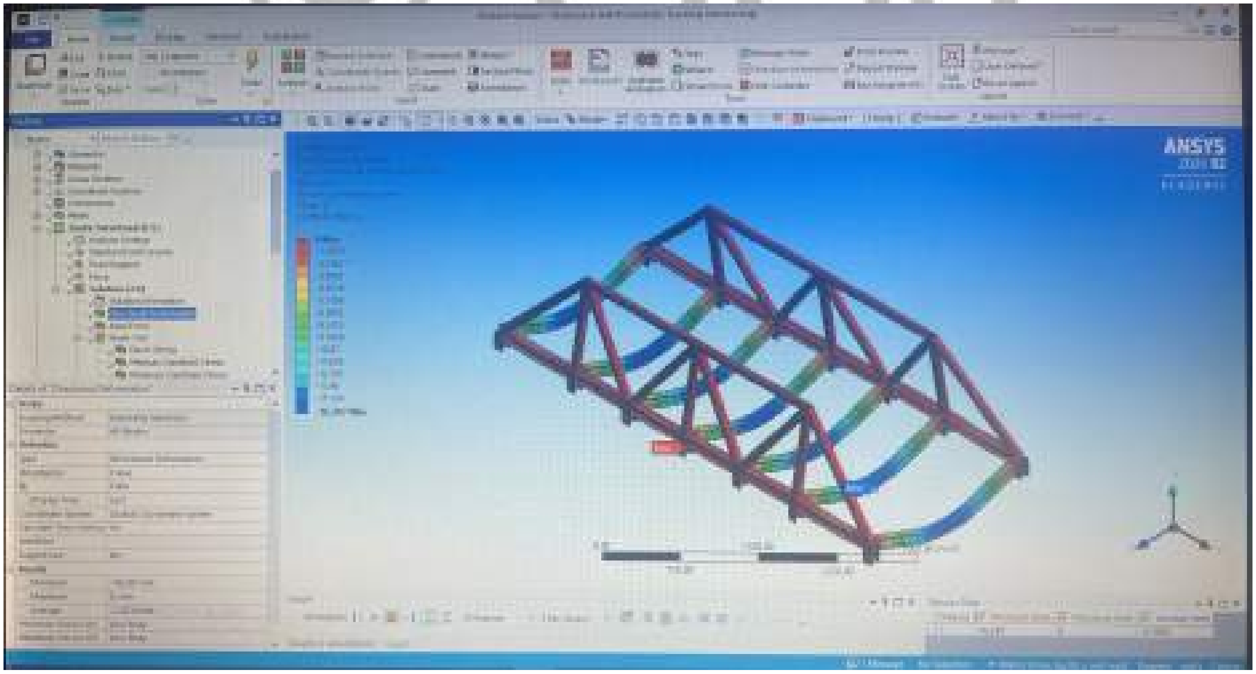

Fig.31: Directional deformation of 3rd alternative

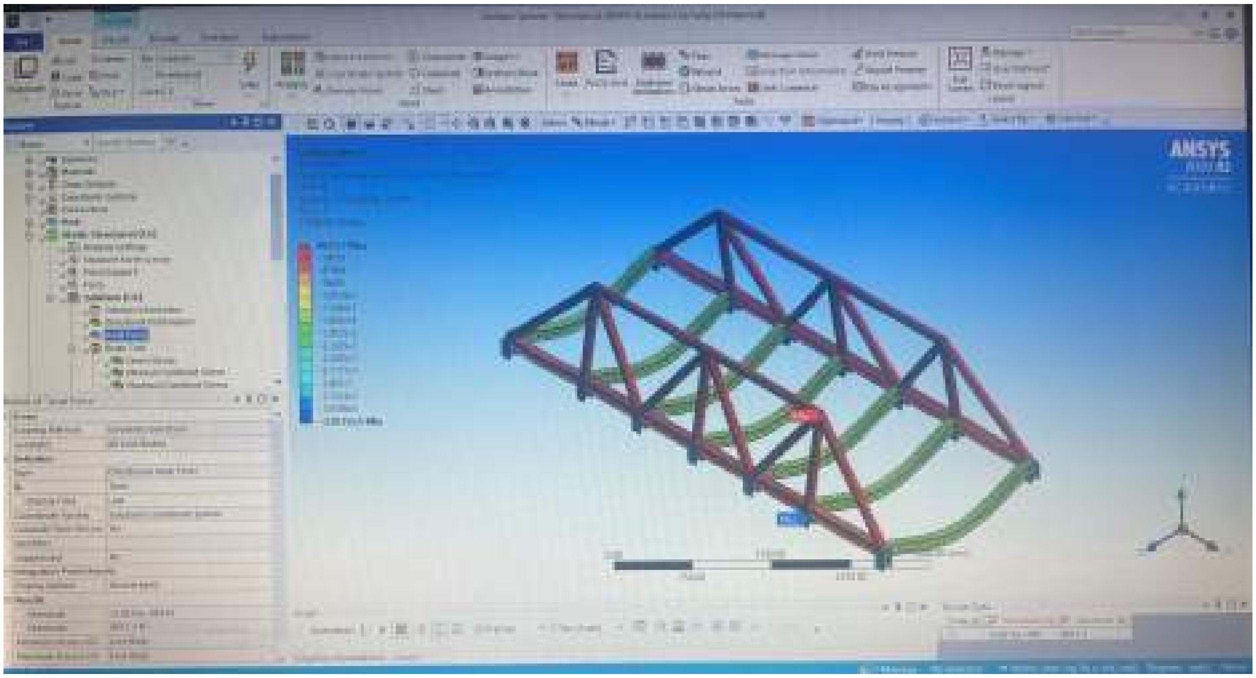

Fig.32: Axial force of 3rd alternative

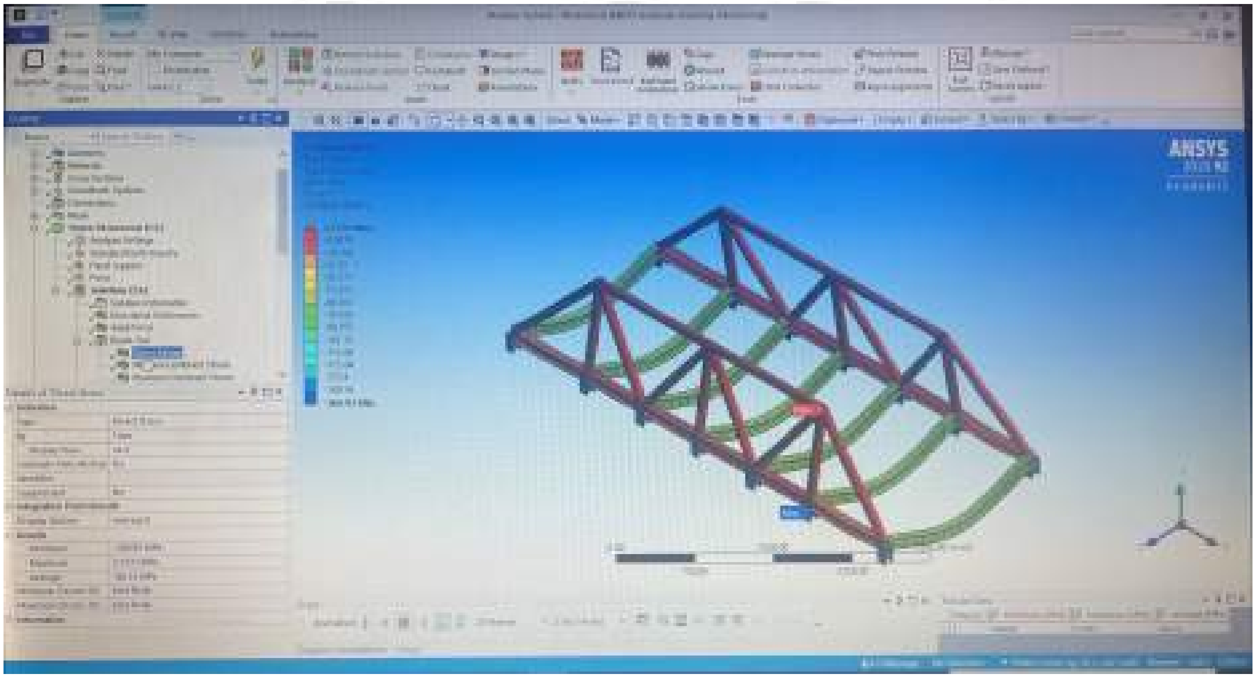

Fig.33: Direct stress of 3rd alternative

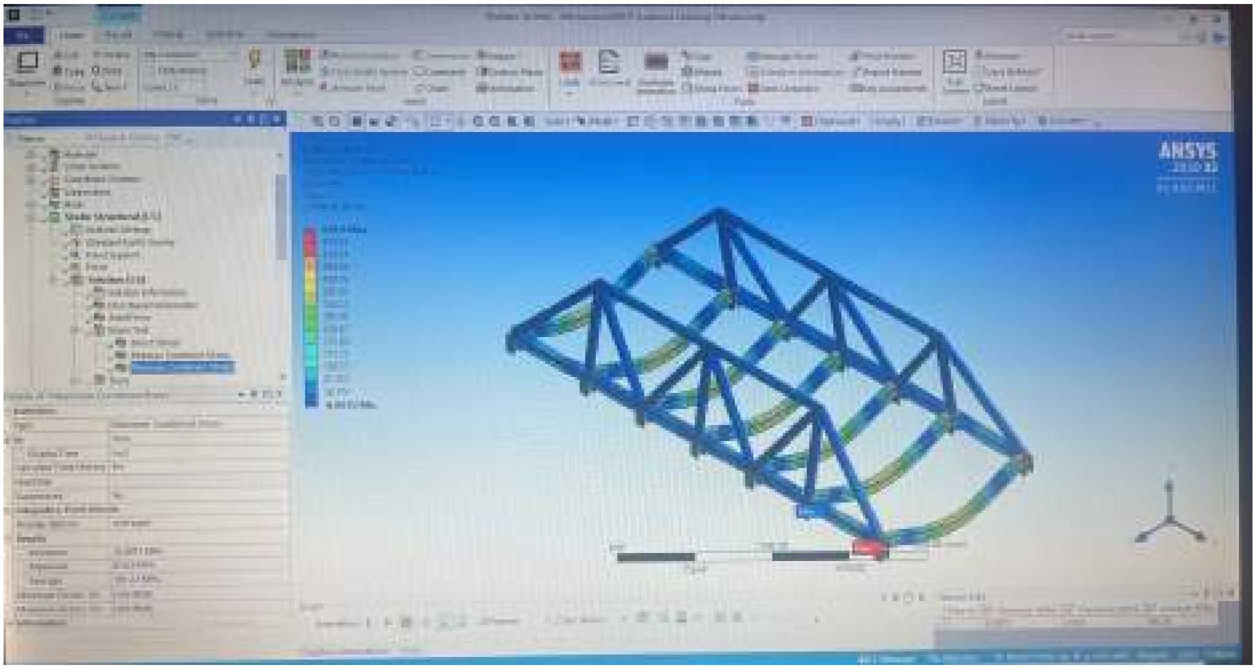

Fig.34: Maximum combined stress of 3rd alternative

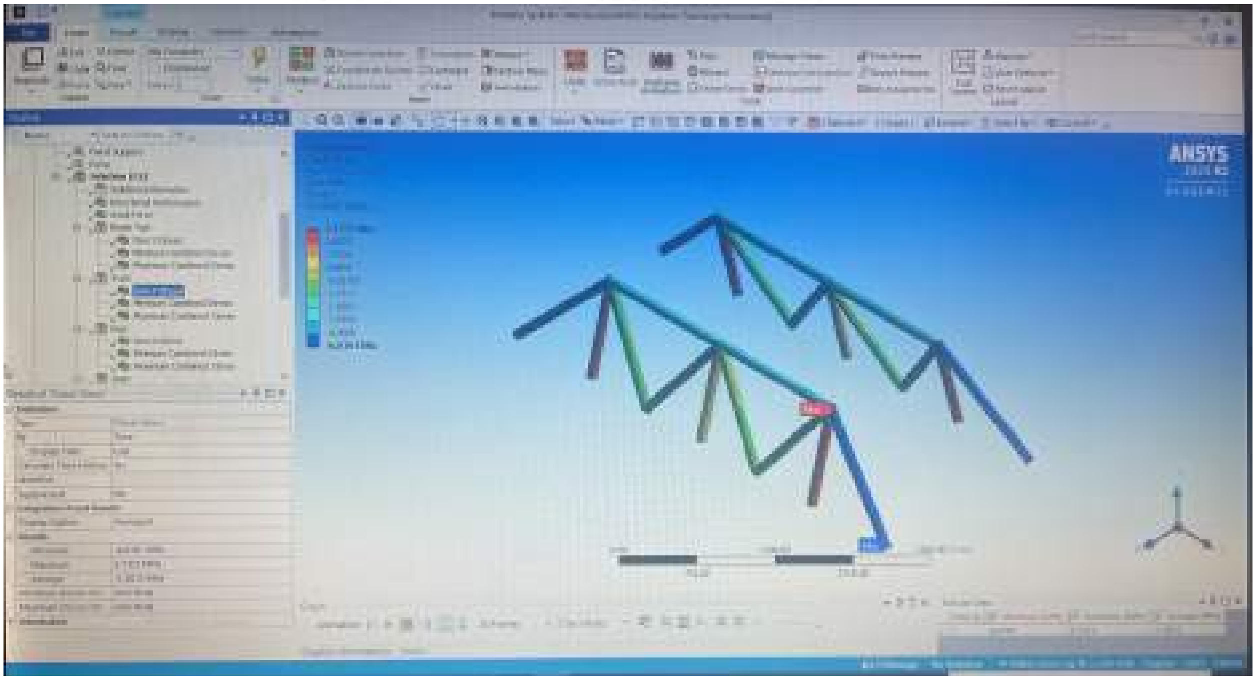

Fig.35: Direct stress of upper truss

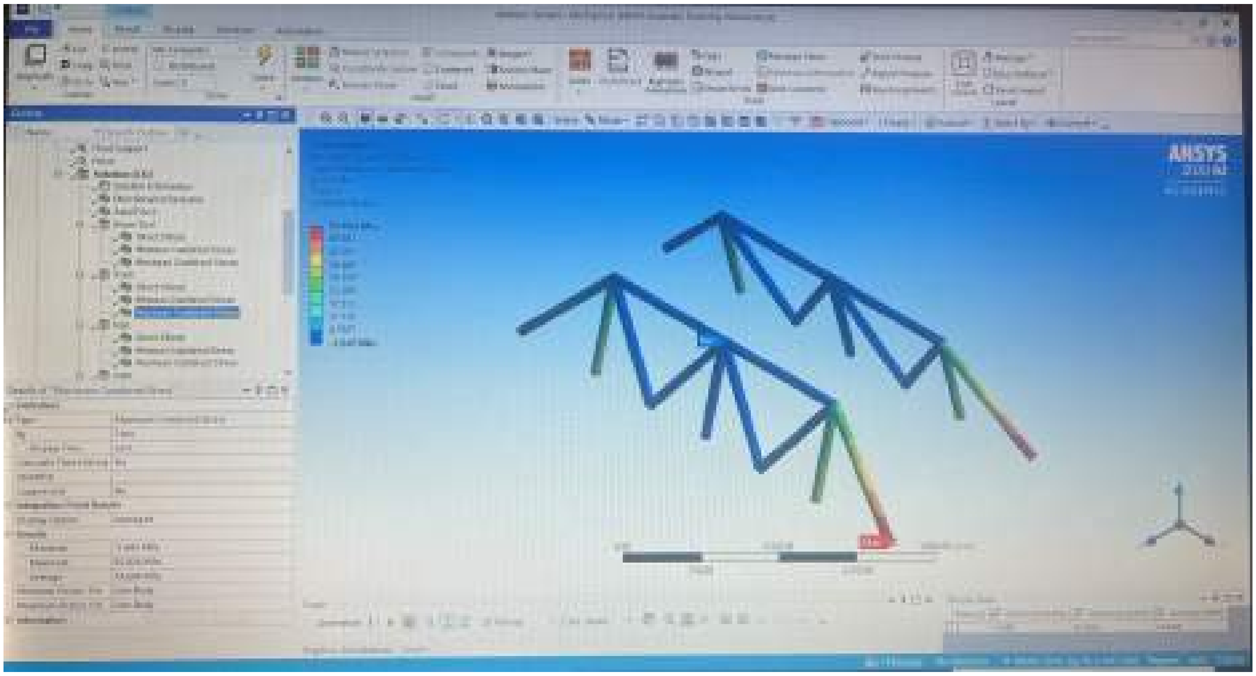

Fig.36: Maximum combined stress of upper truss

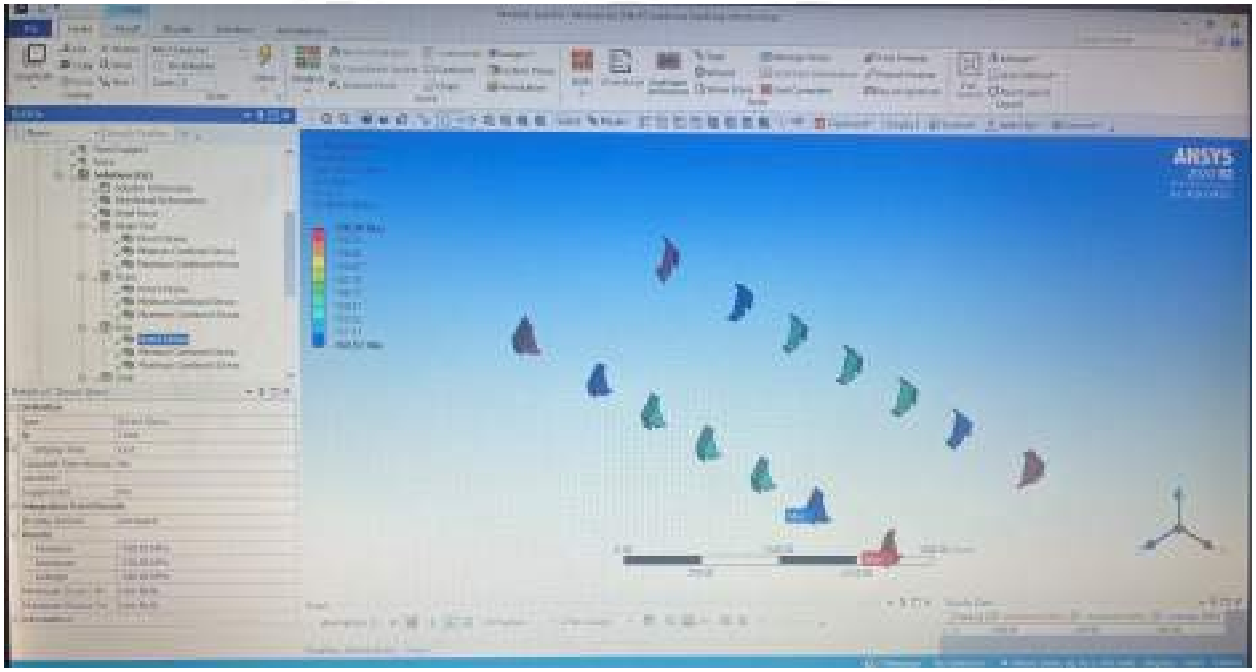

Fig.37: Direct stress of legs

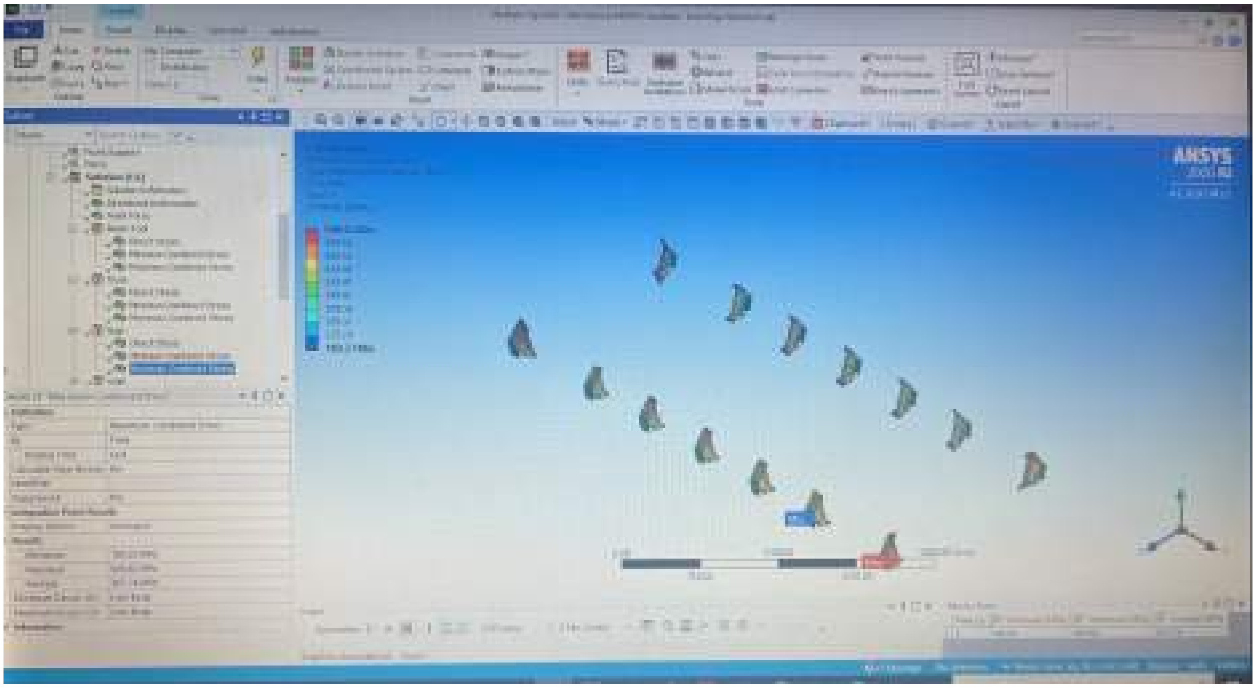

Fig.38: Maximum combined stress of legs

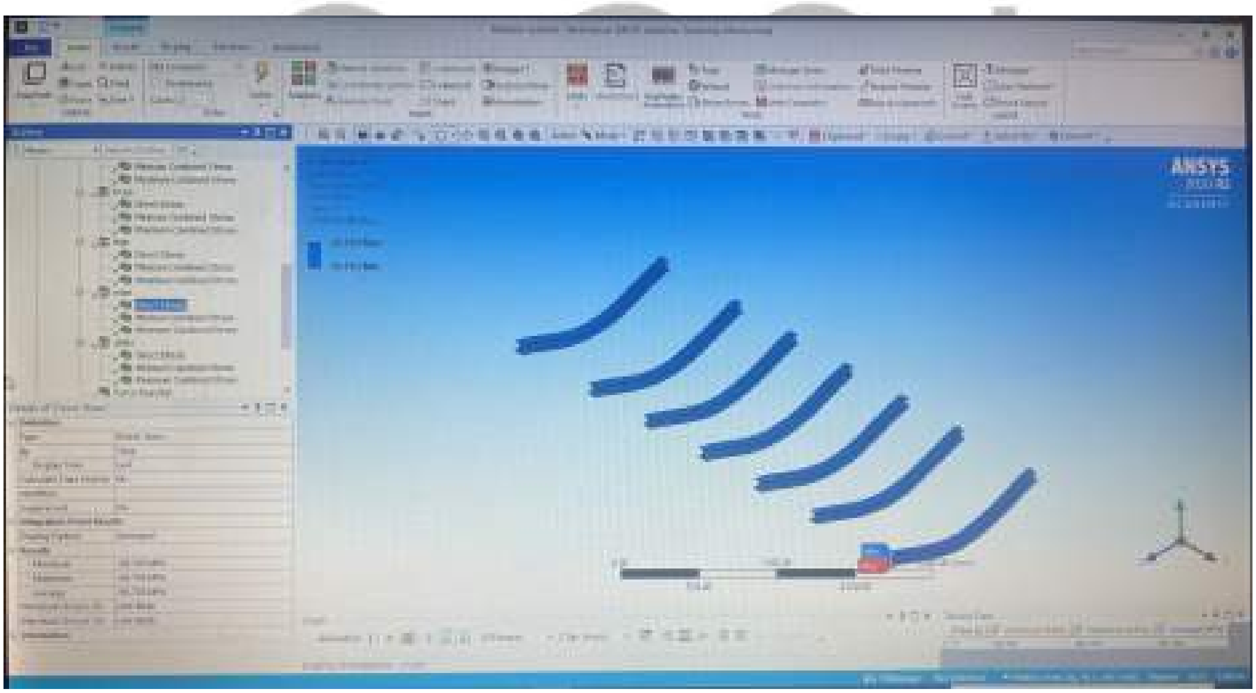

Fig.39: Direct stress of main

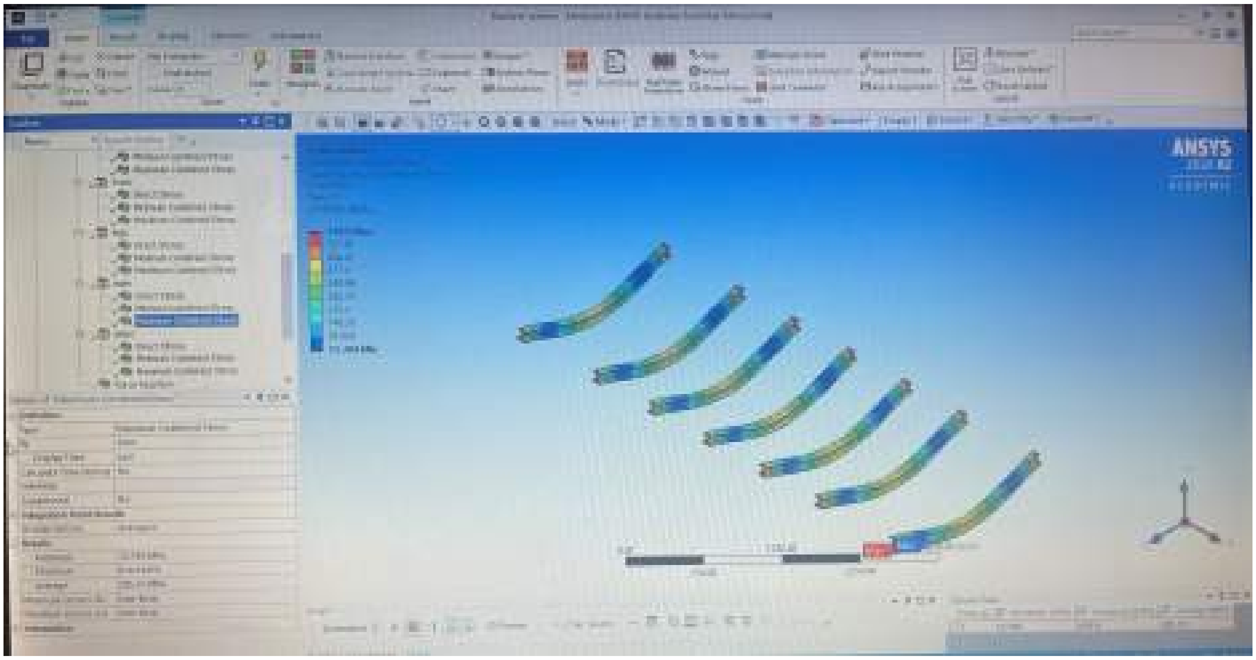

Fig.40: Maximum combined stress of main

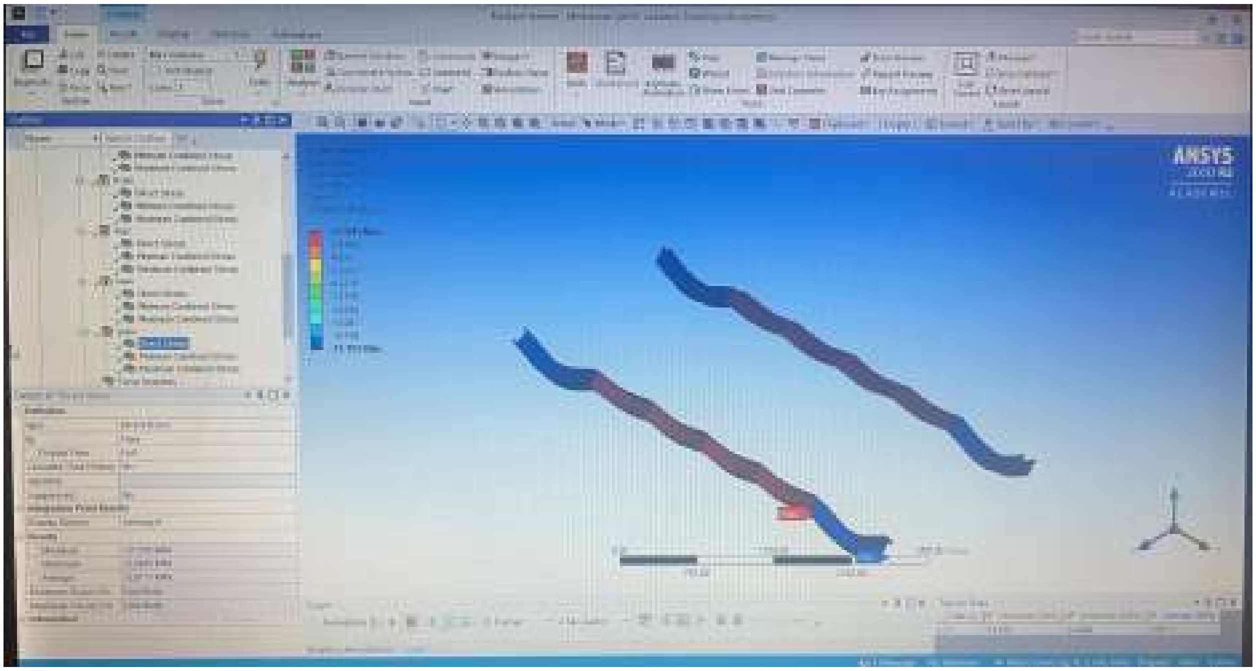

Fig.41: Direct stress of sides

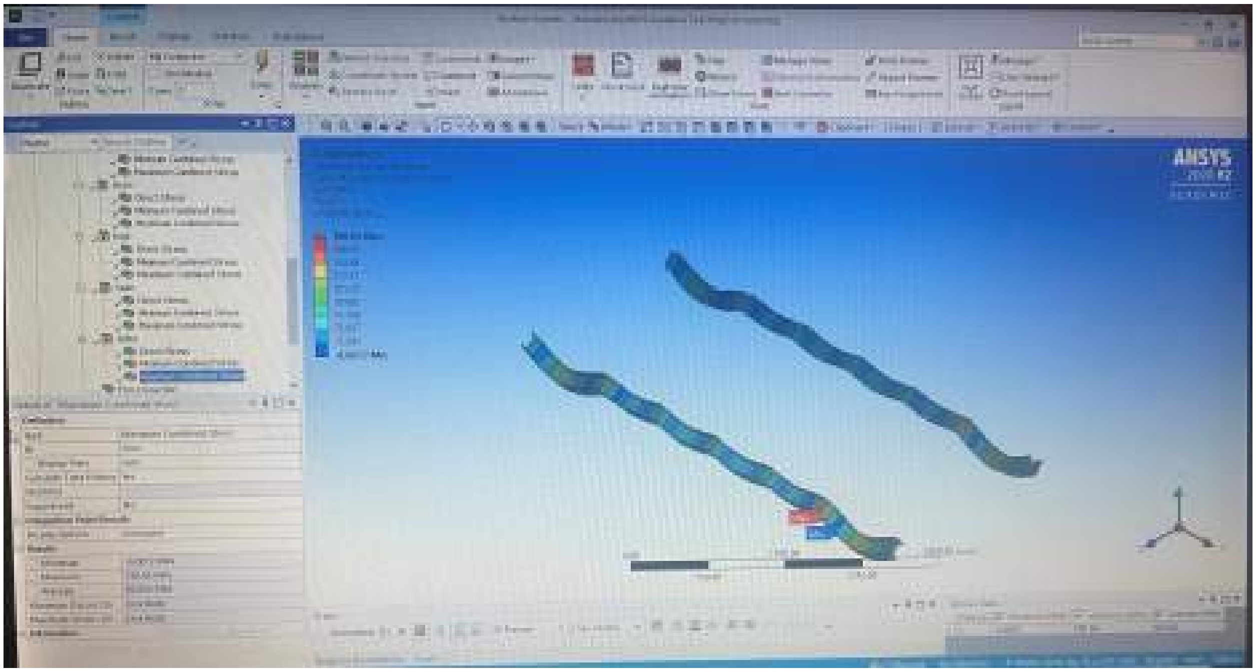

Fig.42: Maximum combined stress of sides

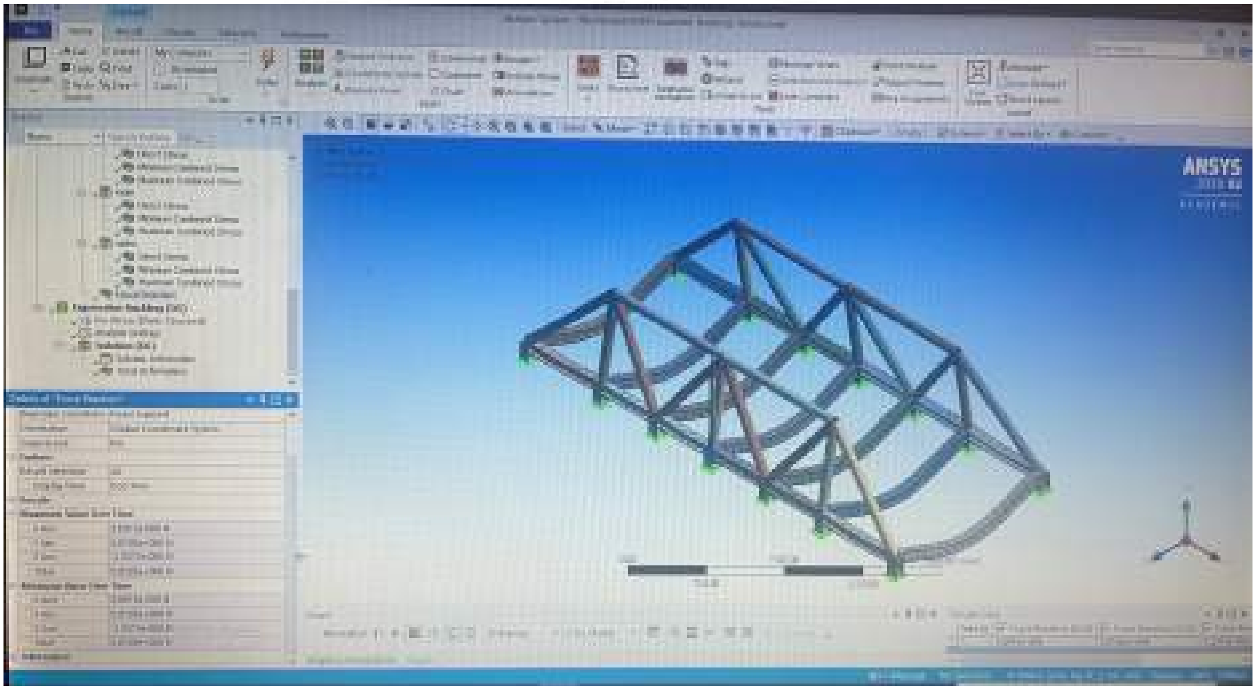

Fig.43: Force reactions of 3rd alternative

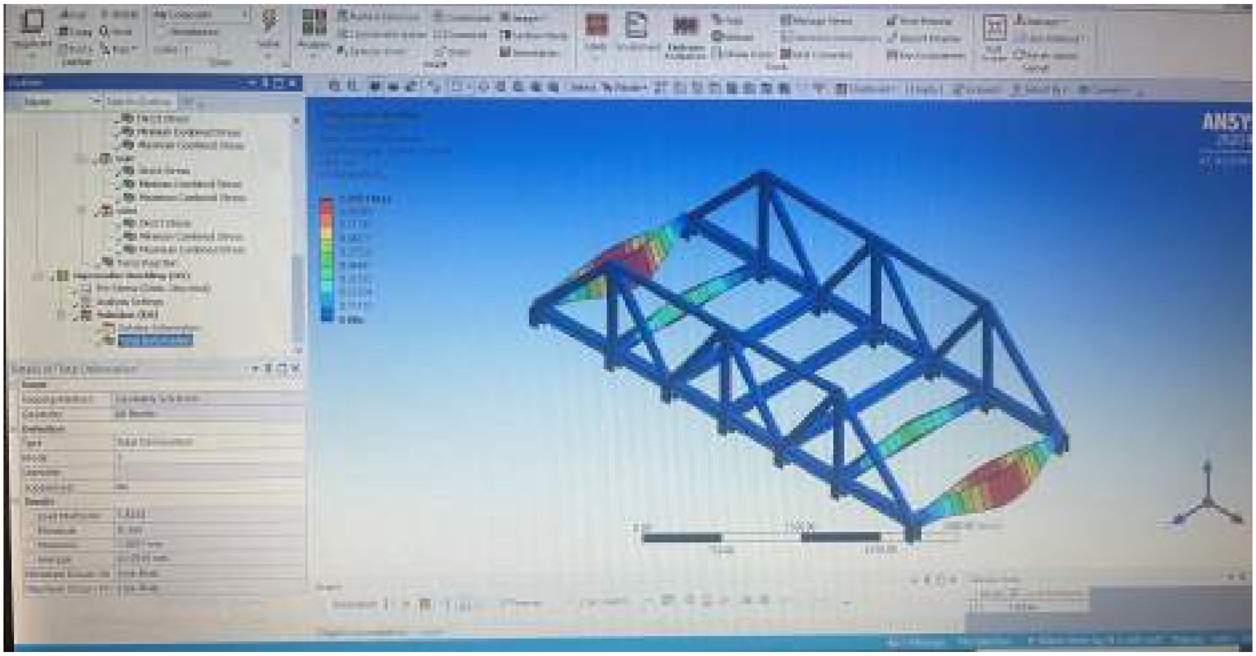

Fig.44: Eigenvalue buckling of 3rd alternative

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As we can see from fig.31 – fig.44 are the output for alternative 3, will be shows clarify in the below table:

Table.3: Results for 3rd alternative

No.	Output	Value	Unit
1	Directional Deformation	0	mm
2	Axial Force	9611.3	N
3	Direct Stress	3.7331	Mpa
4	Maximum Combined Stress	618.9	Mpa
5	Direct Stress of truss	3.7331	Mpa
6	Maximum Combined Stress of truss	55.826	Mpa
7	Direct Stress of legs	-128.98	Mpa
8	Maximum Combined Stress of legs	549.62	Mpa
9	Direct Stress of main	-59.703	Mpa
10	Maximum Combined Stress of main	618.9	Mpa
11	Direct Stress of sides	-2.2445	Mpa

12	Maximum Combined Stress of sides	188.66	Mpa
13	Force Reactions	F_x= 3.6915 e-008	N
		F_y= 5.0105 e+006	
		F_z= -1.2573 e-008	
		F_{total}= 5.0105 e+006	
13	Eigenvalue Buckling	1	mm
		Load Multiplier: 1.8334	

Conclusion

The main objective of the study is to investigate the eigenvalue buckling of structural components that are bound to be subjected to heavy loads. Their complex equilibrium paths are explained to inform engineers of possible nonlinear behavior in designs and that instability may occur before a design bifurcation limit is reached. Understanding the large elastic displacement of these types of structures can prevent sudden buckling failures from applied operational and construction loads

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