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OPTIMIZATION IN SUBFRAME USING SQUARE SPOT WELDED STRUCTURE

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Abstract: A subframe is a part of a car's structure, which uses a different frame, which varies within a larger body frame or body body to carry certain parts, such as an engine, steering train and / or suspension. The subframe is bolted and even welded to form a single assembly, attached to a car frame or cabinet structure. The main objectives of using the subframe, are to distribute the upper chassis loads over a wide area of the thin metal sheet of the body shell, and to distinguish vibrations and sharpness throughout the body. The weighted subframe design has many split benefits. As, it carries the engine load, suspension and steering parts of the car, it should be designed to be lightweight, but without interfering with power. This project proposed a robustness and modular modification of a small four-wheeled frame to be investigated. CATIA software was used to design the existing four-wheel frame. The existing small frame will be fixed with a square-shaped structure. to strengthen the rigidity and modal analysis of the new framed square structure will be performed using the ANSYS 19 software. The results and conclusions will be based on comparing the analysis and evaluation values of both subgroups.

***Index Terms* – STEERING ,SUBFRAME,ASSEMBLY,CATIA,CHASSIS,SUSPENSION**

I. INTRODUCTION

Weight loss will be followed by fatigue and constant tiredness. In most cases, the cost is equal to the weight. While we are trying to lose weight, the introduction of modern technology requires an increase in product costs. This situation can only be addressed by inventing new things in the design or process. In the redesigned article, square formation is proposed to build parts for the automotive system structure in order to maximize weight without increasing production costs. While cutting is empty, the use of material becomes an important factor. Typically the percentage of metal sheet use is 65% - 75. This means, ~ 30% property is lost. It shows that material use is one of the main costs. To achieve the intended purpose of firmness, braid patterns, emboss, or grip becomes a natural part of baby parts. Adding such conditions makes the process even more difficult. The number of stamping functions or in other words, the number of sections increases to form part of the complex profiles. The addition of such categories adds to the costs in the final sections. Product features of the subframe assembly are one of the difficult tasks and you will need a lot of domain information. An increase in the thickness of the panels, used in the small frame, is required to meet the targets of the rigidity. Digital analysis sometimes requires local stability but local density has increased the cost significantly and is not possible in this application, the increase of the entire panel remains the only option in most cases..

OBJECTIVES

TO EVALUATE THE PERFORMANCE, RELIABILITY AND BENEFITS OF A SQUARE BUILDING FOR METAL SHEET METAL PARTS (FRAMEWORK).

TO UNDERSTAND THE EFFECT OF A SIMPLE WELDED STRUCTURE OF SQUARE PIPES SUITABLE FOR THE CONSTRUCTION OF A PARTICULAR VEHICLE AND SOLID POINTS ARE CONSTRUCTED AND THE PERFORMANCE, WEIGHT, COST, DURABILITY AND CHARACTERISTICS OF THE PRODUCT WILL BE COMPARED TO A SMALL STANDARD FRAME.

OBTAIN AN IMPROVED MODEL OF THE EXISTING SMALL FRAME BY INSTALLING A SQUARE STRUCTURE.

DESIGN OF EXISTING AND MODIFIED MICRO FRAMEWORK USING CATIA SOFTWARE.

TESTING THE STRENGTH OF BOTH SUB-FRAMES USING ANSYS SOFTWARE AND MODAL ANALYSIS TO DETERMINE THE SHAPE AND FREQUENCY OF THE APPROPRIATE ENVIRONMENT.

DESIGN OF THE COMPONENT LOADING CONDITION IN UTM TO TEST FOR DURABILITY.

PERFORMING NEW SUB-INDEPENDENT TESTS AT UTM AND FFT TO DETERMINE NATURAL FREQUENCY.

TESTING AND ASSOCIATED OUTCOMES.COMPARING THE ANALYTICAL AND EXPERIMENTAL RESULTS OF BOTH SUB FRAMES.

II. LIMITATIONS

III. THE DESIGN OF LIGHTWEIGHT PARTS ATTRACTS HIGH PROCESS COSTS OR MATERIAL COSTS THAT ULTIMATELY INCREASE THE COST OF THE VEHICLE I.E. THE FINAL PRODUCT. THE AIM IS TO DEVELOP A DESIGN THAT BRINGS THE REQUIRED WEIGHT LOSS COMPONENT WITHOUT INCREASING THE COST OF THE PRODUCT.

IV. THE SQUARE STRUCTURE READ IN THIS PAPER CONTAINS RESEARCH RELATED TO THE STRUCTURES OF SMALL FRAMES ONLY. COMPLEX STRUCTURES SUCH AS THE BIW, THE TWIST BEAM REQUIRE FURTHER DETAILED INVESTIGATION AND IN-DEPTH ANALYSIS BEFORE FINALIZING THE APPLICATION OF A SQUARE STRUCTURE ON ALL METAL SHEET COMPONENTS IN A VEHICLE. IN ADDITION, COMPLEX PACKAGING AREAS AND UNUSUAL ATTACHMENT POINTS MAY DIFFER FROM A PRIVATE APPLICATION APPLICATION PROPOSAL.PREPARE YOUR PAPER BEFORE STYLING.

3.1 Problem Description

You need to upgrade the lower frame to get a fuller weight, with a smaller number of parts, with less heat, without compromising its strength. It requires a thorough study of the current design, areas of failure and critical design considerations. In the Automotive Sector there is an ongoing need for low weight, fuel efficiency and high component connections to shorten the product life cycle cycle. This project involves the construction of a small standard pre-existing commercial vehicle suspension system and is unique.

3.2 LITERATURE REVIEW

Spot-welds Development on Patchwork Blank for Thermal Processing Process, M. A. Ahmad and A. Zakaria, Applied Mechanics and Materials Vol. 606 (2014) pages 177-180
In this study paper it is revealed that the patchwork blank usually contains two different thicknesses of the HSS sheet metals spot burned on top of each other. Designed to provide an increase in durability, it is widely used in many structural components. The right number of spot-welds is important in terms of cost and safety. In this study, the effects of spot-weld areas on a B-Pillar vehicle with a hollow patchwork design were investigated by numerical simulations of thermal formation. Welding is modeled as a solid link between parental void and additional void. Throughout the composition of the mold, maximum stress and component formation were considered. The same process has been repeated with a different number of spot-weld and area. A large number of spot-weld was then determined by the onset of the disappearance of wrinkles. The performance of the prepared spot-weld section was confirmed by the actual part. Imitation tests have shown that the improved number of spot-welds can be accurately determined using a limited element method. Compared to the real part, it also suggests that the area of the weld area can be reduced from 43 to about 30. This is yet to be confirmed by actual testing. In the event of an intervention test then a solid spot-weld model is probably the next step that should be investigated. And this will require physical examination to be performed to detect spot-weld flow curves.

Development of a Rapidly Independent Truck Designer Program with UG Secondary Development Framework, Liu Xinhua, Li Qi, Liu Youhui, Yin Jilin, Procedia Engineering (2011) 2961 - 2965
These books provide information on improving the efficiency of the air transport truck framework, analysis of the geometric features of the submarine truck, the process of matching the subframe parameters of the air transport truck proposed, and the rapid airport design prototype system. the lower frame of the work truck based on UG Secondary development platform and the integrated environment VC 6.0 was developed. In recognition of the rapid design of a small-scale air-duty truck design, this paper sets out how to create a wizard-based parameter model and develop a prototype system based on the UG development platform and VC 6.0 integration environment. The example shows that the system can significantly improve the efficiency of subframe design, shorten the design cycle and provide a 3D model for tracking measurement analysis.

Finite Element Analysis and Yj3128 Genre Disposal Truck Development Project Development Plan based on ANSYS, Chen Yanhong, Zhu Feng Procedia Earth and Planetary Science 2 (2011) 133 - 138
The article mainly reads for trucks under the YJ3128 type, due to the exhaustion of the fatigue caused by the Subframe wizard operating in poor condition for 3 to 5 months, truck operating conditions and load characteristics are investigated, and ANSYS is used to analyze sub-pressure frame. Finally the development and improvement of frame structures is provided. With the pressure of the YJ3128 dump truck there are no advanced research methods and theoretical support,

so the analysis in this paper and the proposed development plan is worth a reference. Because the frame is their most important part of the load, the quality of the frame is directly related to the performance of the heavy trucks. In this article, the sub-frame is analyzed by ANSYS, and the reason for the fracture is found, and the development method is shown to the Company. A theater foundation has been provided to improve the design of the frames, and an important reference has been provided to improve truck design designs.

Parametric Study for Ladder Frame Chassis Stiffness, Praneeth Kurisetty and Naveen Sukumar, SAE International presented to you by the University of Kansas (Technical Reports: 1998 to date), Saturday, August 25, 2018

In this study showing the competitiveness of current market conditions, there is a constant need to develop cost-effective frame designs to meet customer needs. During the development of new vehicles, with a strong focus on weight loss, in order to improve the load capacity and fuel efficiency. Due to the introduction of new high-strength materials, static energy conditions can be met through the use of thin frames, but the dynamic behavior of the frame deteriorates. Flexible behaviors such as riding and gripping, comfort are affected by the durability of the car frame. The stiffness of a frame is defined primarily by its vertical stiffness, lateral stiffness and torsional stiffness. The vertical stiffness of the frame plays a major role in separating the vibration of the road into an integrated frame. Side stability plays a very important role in car management and the ability to turn a corner of a car. Torsional stiffness affects the load distribution and the distribution of the lateral load. In this study we look at the impact of various independent parameters such as wheelbase, spring track width, stiffener extension and section width, length and stiffness of the long limb. The weight of these parameters in each strength factor is calculated. By using these weights the frame can be designed to provide the required durability accordingly. Increasing the wheel base reduces direct, lateral and torsional stiffness. Increased long limb thickness increases direct, lateral and torsional stiffness. Therefore, high density helps to achieve good.

3.3 SKILL CONSTRUCTION

Concerns about common designs in terms of weight and rising costs

In the case of a square structure, hexagonal tubes are cut to the required length and the number of pieces connected to each other to form a larger structure. This process allows us to use high quality content from downloads. In other words, the use of the proposal is close to 95%.

Ribbing, Emboss, Bidding: Although a small standard frame achieves local strength, a square proposal has the natural advantage of the straight walls of each connecting cell. These walls give a double thickening effect and improve the overall strength of the structure. In the proposed method, spot welding is used between the two walls to avoid the need for MiG welding. As a result, a single straight-walled structure is constructed that provides the required durability in the structure. In addition, it removes the requirement for a separate bid or emboss in various locations. The need for different flanging required for conventional construction, is not required here as visibility is made between the available flat areas of straight walls. This helps to reduce the weight of the structure. The proposed square structure has the natural advantage of lateral and longitudinal direction. Hexagonal cells can be added in the center to expand the profile accordingly.

The square structure provides options for adding local seals in accordance with CAE recommendations. The figure below shows the strength of the sidebar and the lengths provided to achieve the intended values of the product specifications. As a result, the need for increased panel durability is removed, which greatly adds weight to conventional designs).

Computer-aid design (CAD) is the use of computer systems (or workstations) to assist in the creation, editing, analysis, or development of a project. CAD software is used to increase designer productivity, improve design quality, improve textual communication, and create a production website. CAD output is usually in the form of electronic files for printing, machine, or other production operations. The term CADD (Computer Aided Design and Planning) is used.

Its use in designing electrical systems is known as electronic design automation (EDA). In mechanical engineering it is known as mechanical design automation (MDA) or computer-aid drafting (CAD), which involves the process of creating a technical drawing using computer software.

The CAD software for machine design uses vector-based images to display traditional draft objects, or it may also produce images that show the appearance of all the designed objects. However, there is more to it than that. As in the written text of technical and engineering drawings, the CAD output must convey information, such as materials, processes, sizes, and tolerances, subject to application-specific agreements.

CAD can be used to design curves and figures in a two-dimensional (2D) environment; or curves, tops, and solid objects in a three-dimensional (3D) space.

CAD is an important industrial art that is widely used in many applications, including automotive, shipbuilding, and aerospace, industrial and architectural design, architecture, and much more. CAD is also widely used to produce computer animation for special effects in movies, advertising and technical manuals, commonly referred to as DCC digital content creation. The advent of modern technology and the power of computers means that even perfume bottles and shampoos are designed using techniques that were unheard of by the 1960s engineers. Because of its great economic value, CAD has become a major force in conducting computer geometry research, computer graphics (both hardware and software), and a unique geometry.

The design of geometric models, in particular, is sometimes called computer-aid geometric design (CAGD)

APPLY:

Computer-assisted design is one of the many tools used by engineers and designers and is used in many ways depending on the expertise of the user and the type of software in question.

CAD is part of all Digital Product Development (DPD) work within the Product Life Cycle Management System (PLM), and is therefore used in conjunction with other tools, which are integrated modules or standalone products, such as:

- ***Computer-aided engineering (CAE) and Finite element analysis (FEA)***
- ***Computer Aided Production (CAM) which includes Computer Numerical Control (CNC) machine instructions.***
- ***Photorealistic Provision and Movement Alignment.***

- *Document management and review management using Product Data Management (PDM).*

CAD is also used for the precise design of the simulations that are often required in the preparation of Environmental Impact Reports, where computer-based designs of targeted buildings are placed on top of existing landscapes to represent what the area will look like, where the proposed sites are allowed to be constructed. Possible blockage of viewing passages and shadow subjects is also often assessed using CAD.

CAD has proven to be useful even for engineers. Four historical features, features, parameters, and high-level issues are used. The construction history can be used to look back on the individual features of the model and work in one place instead of the whole model. Parameters and limits can be used to determine the size, shape, and other features of different modeling items. Features in the CAD system can be used for a variety of measurement tools such as solid strength, yield strength, electrical or electrical properties. Also pressure, difficulty, time or how the element is affected at certain temperatures, etc.

TYPES:

There are several different types of CAD, each requiring operators to think differently about how to use it and design their visual components in each way.

There are many manufacturers of low-cost 2D programs, including a number of free and open source programs. This provides a way of drawing process without any controversy about the scale and placement of the corresponding drawing sheet as this can be adjusted as needed during the final frame construction.

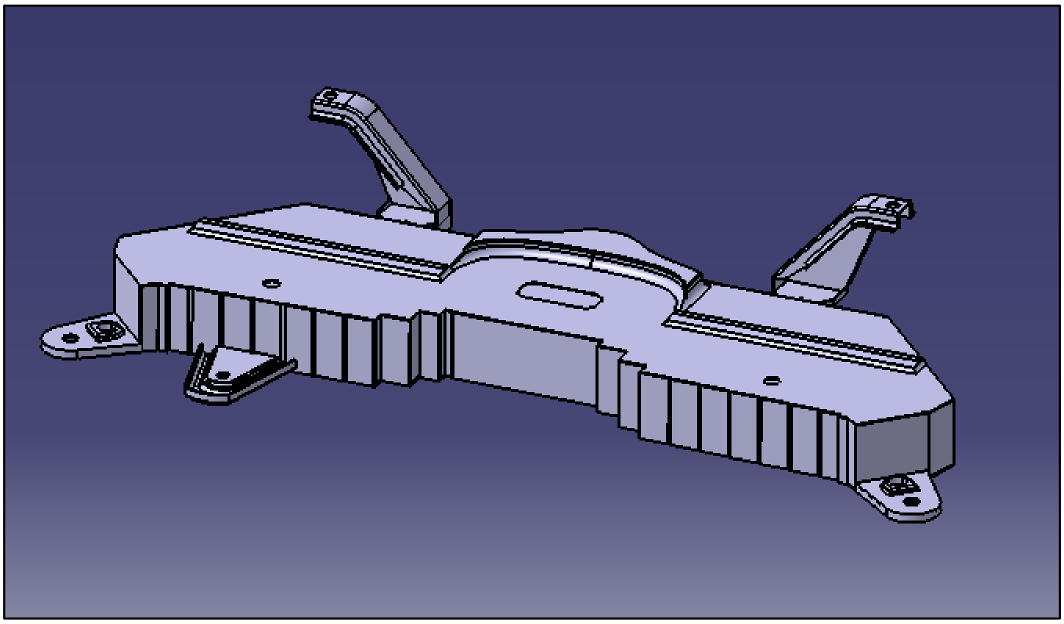
3D wireframe is basically an extension of 2D resolution (rarely used today). Each line should be hand-drawn on the drawing. The final product does not have large associated structures and may not have features added to it directly, such as holes. The user approaches this in much the same way as 2D programs, although many 3D programs allow the use of a wireframe model to make a final view of the engineering drawing.

Solid 3D "solid" objects are created in a way that resembles the illusion of real-world objects (rarely used today). Basic three-dimensional geometric forms (prisms, cylinders, spheres, etc.) have a solid volume added to or removed from them as if they were assembling or cutting objects of real world. Exposed two-dimensional views can easily be made into models. Solid 3D objects often do not include tools that can easily allow parts to move, to limit their movement, or to identify distortions between parts.

There are two types of 3D Solid Modeling

1.Parametric modeling allows the user to use the so-called "design purpose". Created objects and features are customizable. Any future changes can be made by changing the way the first part is constructed. If the feature was intended to be centered, the operator should find it from the cen..."

CAD MODEL AND DRAFTING OF EXISTING SUBFRAME



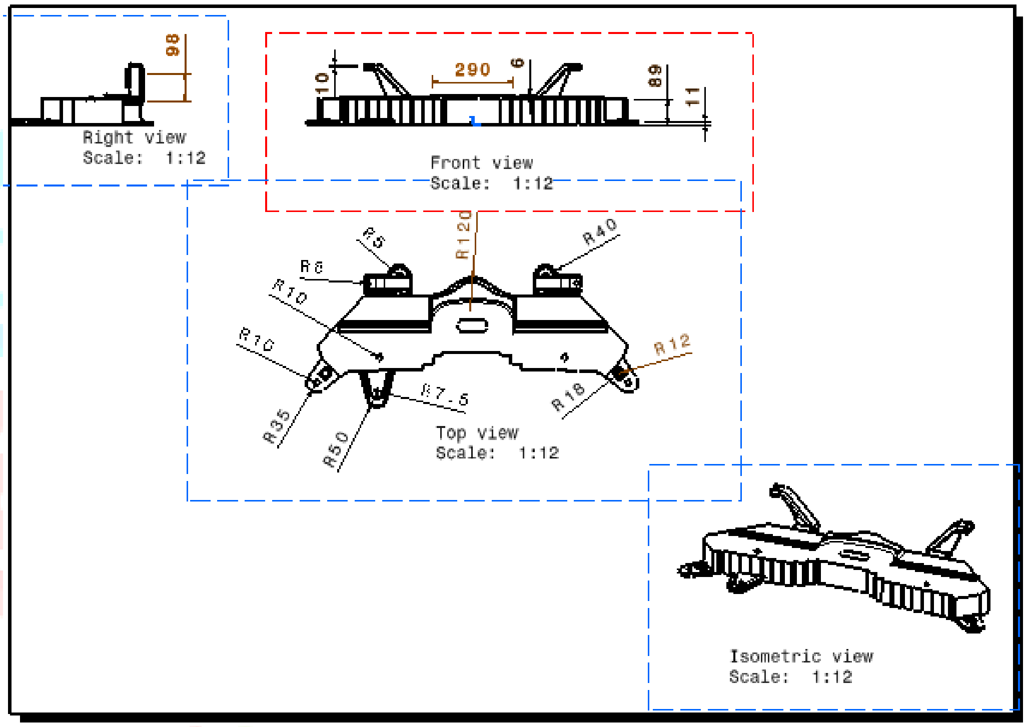
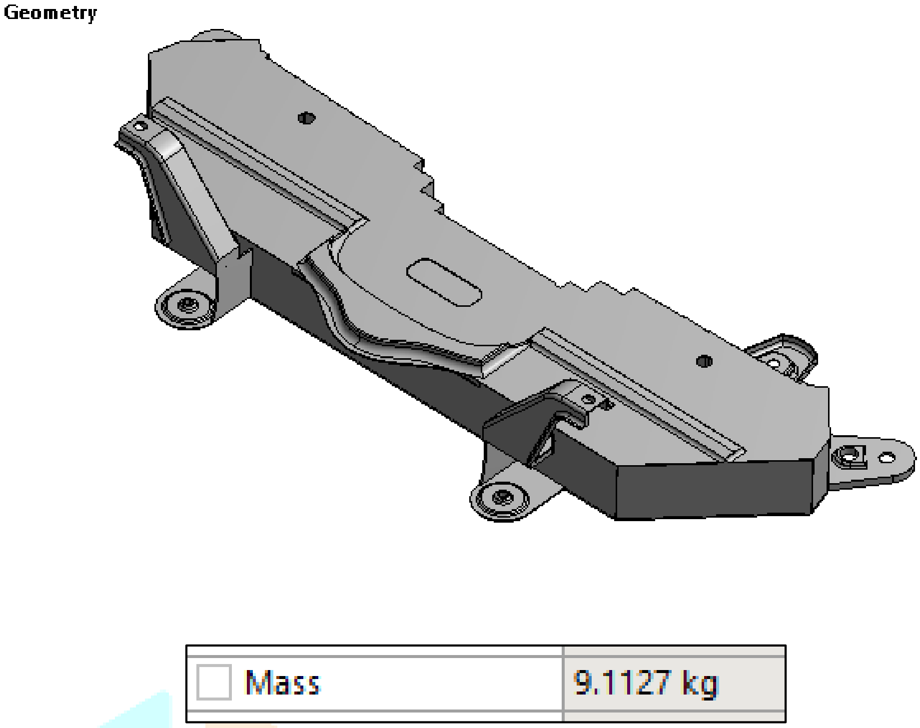


Fig.2: Drafting of existing subframe structure

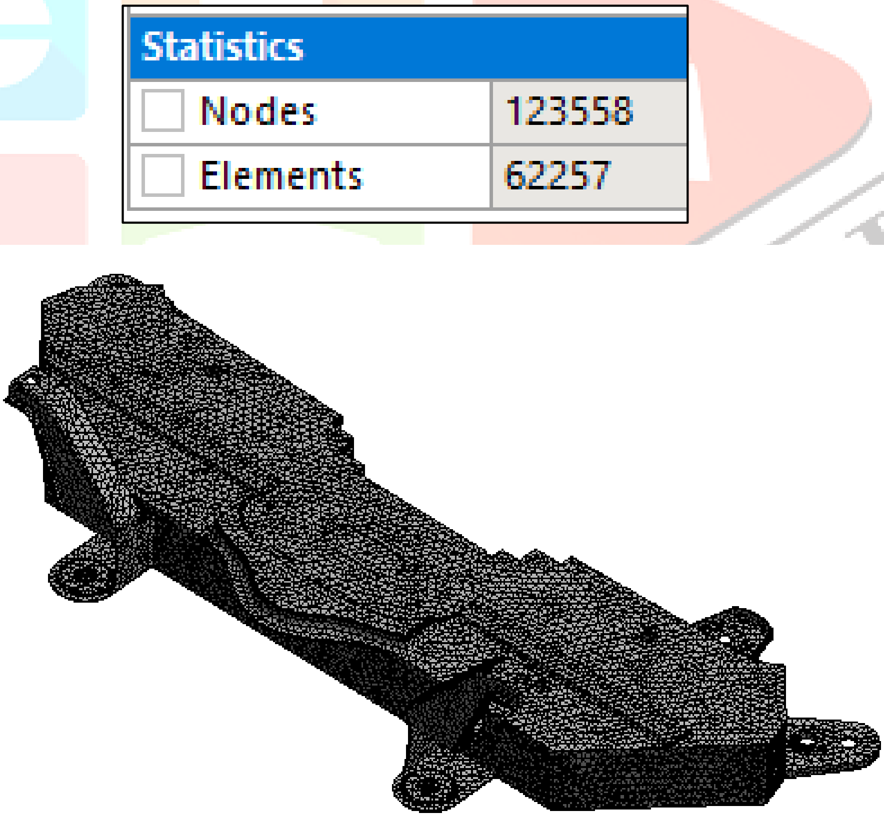
MESHING

ANSYS Meshing is a well-designed, intelligent, automated product that works very well. The producer has the most suitable spacesfor accurate, efficient Multiphysics solutions. A match that is well suited to a particular analysis can be generated with a single mouse click on all parts of the model. Full controls on the options used to produce the mesh are available to the professional user who wants to tune them properly. The same processing power is automatically used to reduce the time you have to wait for match production. Creating the most relevant spaces is the basis of engineering simulation. ANSYS Meshing knows the type of solutions that will be used in a project and has the right conditions to create the most appropriate net. ANSYS Meshing is automatically integrated with each solution within the ANSYS Workbench area. For quick analysis or for a new and unusual user, a usable mesh can be created with a single click of a mouse. ANSYS Meshing selects the most appropriate options based on the type of analysis and geometry of the model. The simplest ability of ANSYS Meshing to automatically use the cores available on a computer is to use the same processing and thus significantly reduce network time. Parallel meshing is available at no additional cost or license requirements



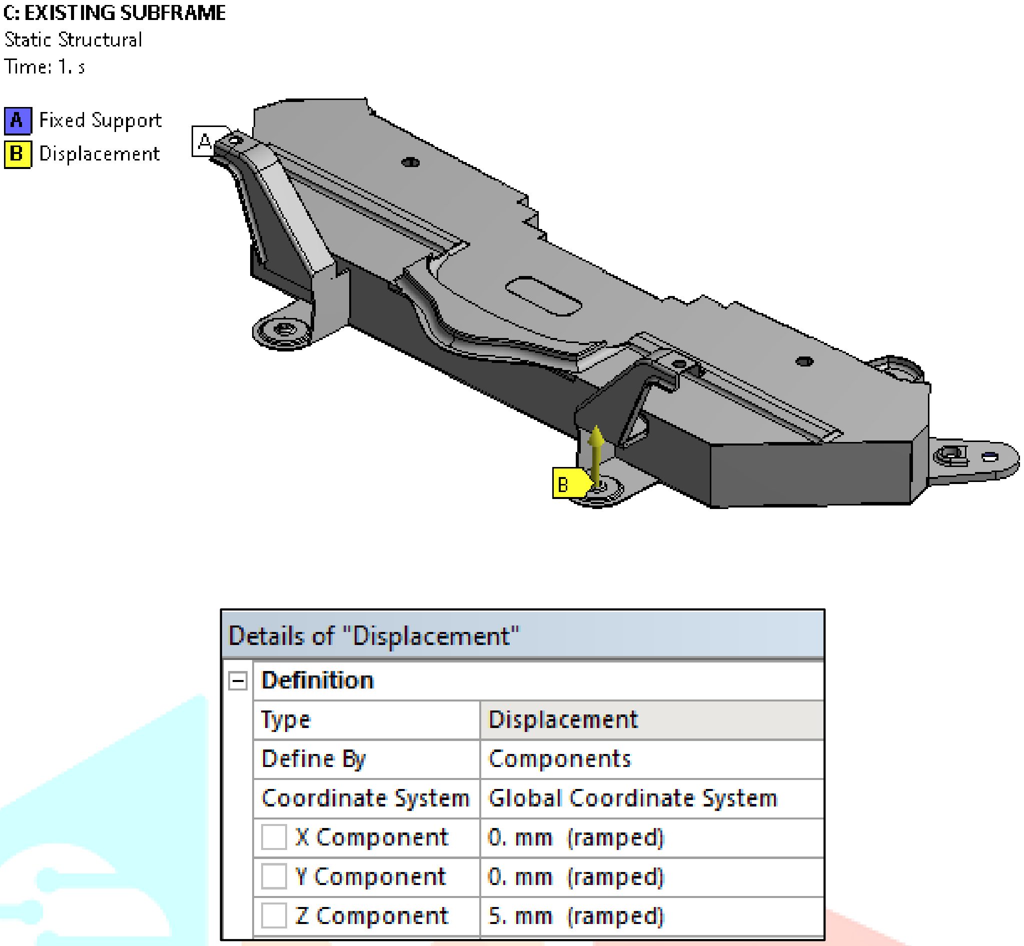
☐ Mass	9.1127 kg

Fig. 3: Existing subframe geometry imported in ANSYS



Statistics	
☐ Nodes	123558
☐ Elements	62257

Fig. 5: Details of meshing and subframe properties



Details of "Displacement"

Definition	
Type	Displacement
Define By	Components
Coordinate System	Global Coordinate System
☐ X Component	0. mm (ramped)
☐ Y Component	0. mm (ramped)
☐ Z Component	5. mm (ramped)

Fig. 6: Boundary conditions for displacement in z axis

Displacement is applied in respective axis to determine reaction force.

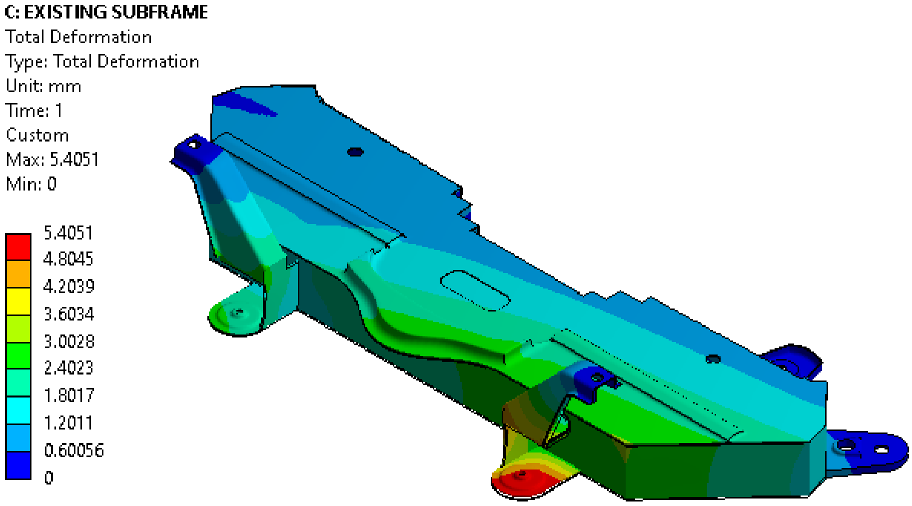
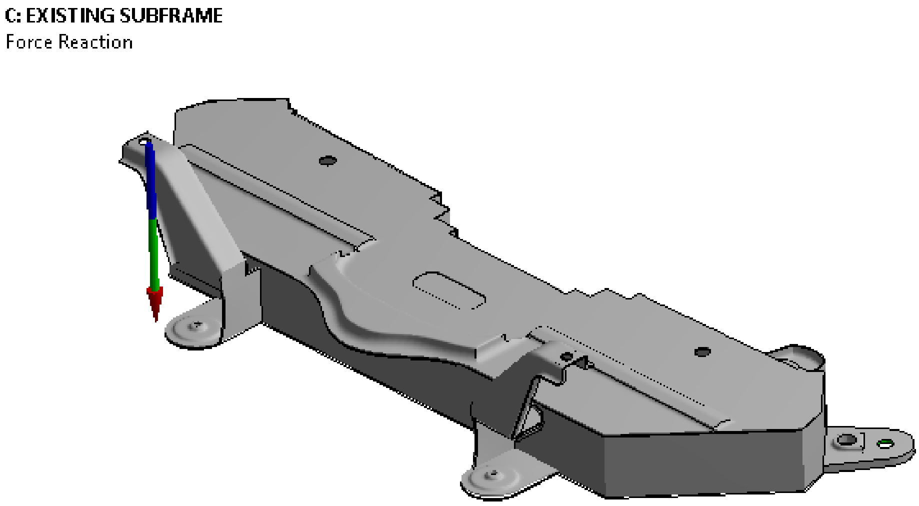
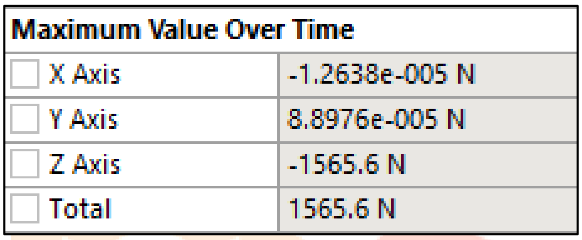


Fig. 7: Total deformation results along z axis

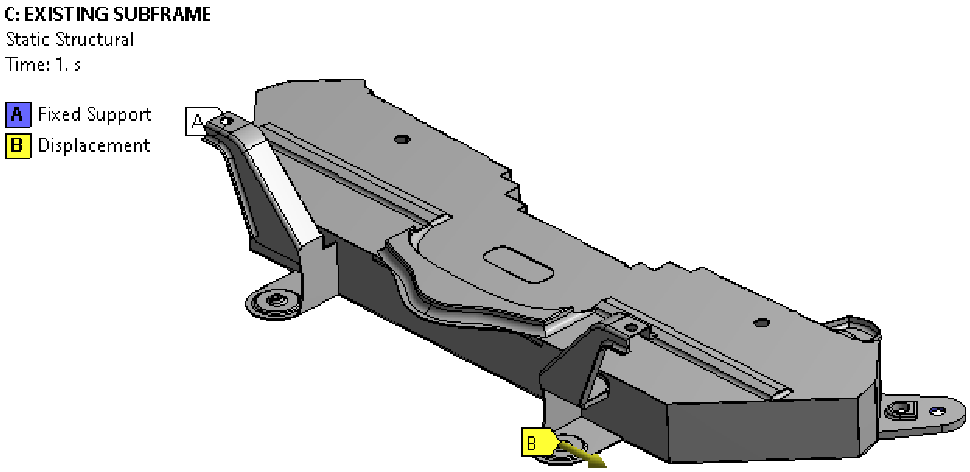


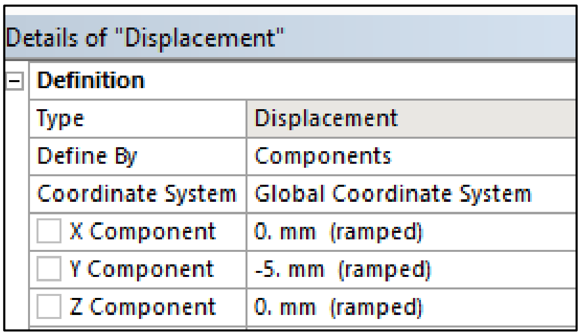


Maximum Value Over Time	
☐ X Axis	-1.2638e-005 N
☐ Y Axis	8.8976e-005 N
☐ Z Axis	-1565.6 N
☐ Total	1565.6 N

Fig. 9: Details of force reaction results along z axis

- Deformation of 5 mm is applied and reaction force is calculated as 1565. 6 N.





Details of "Displacement"	
⊟ **Definition**	
Type	Displacement
Define By	Components
Coordinate System	Global Coordinate System
☐ X Component	0. mm (ramped)
☐ Y Component	-5. mm (ramped)
☐ Z Component	0. mm (ramped)

Fig. 6: Boundary conditions for displacement in y axis

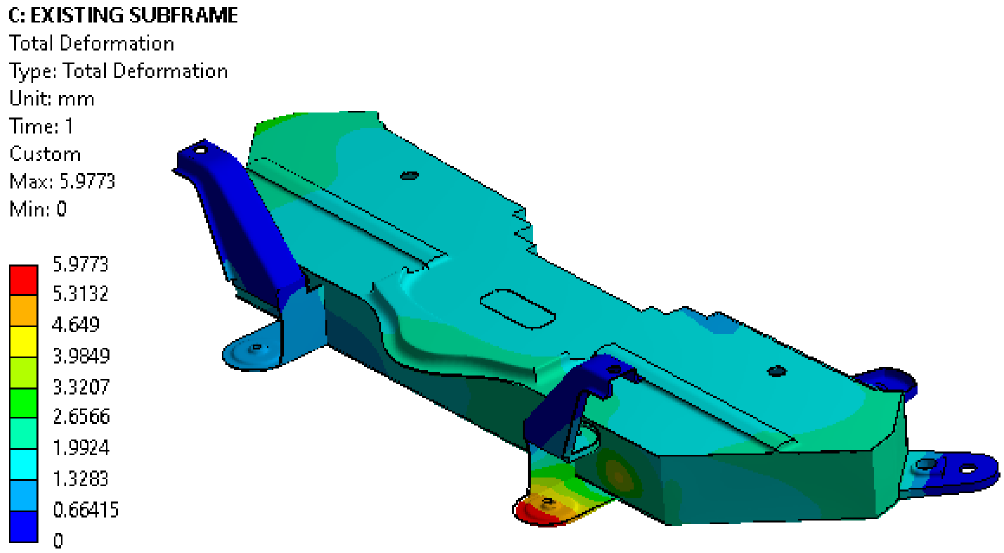
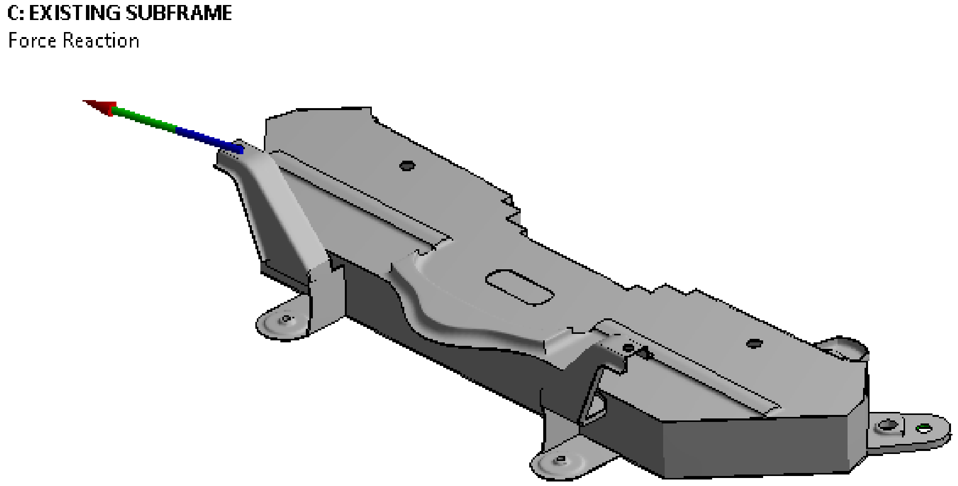
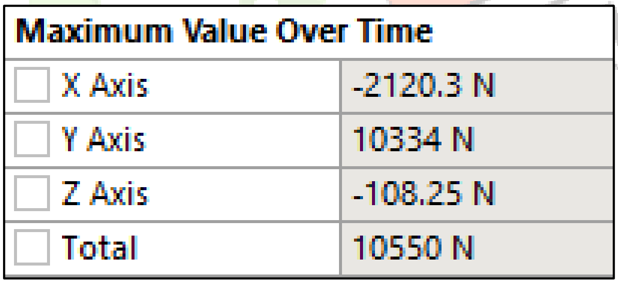


Fig. 7: Total deformation results along y axis

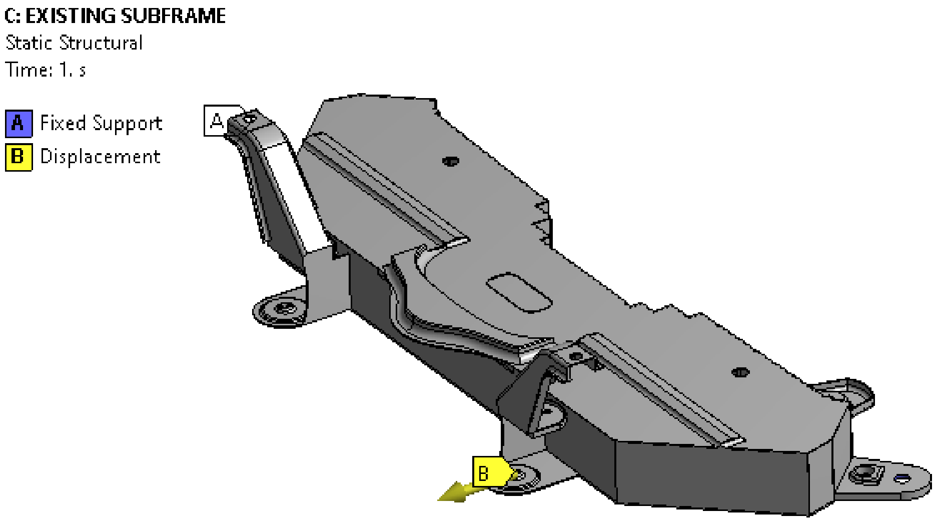


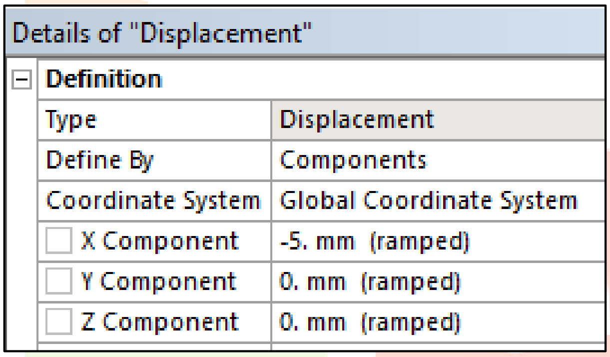


Maximum Value Over Time	
☐ X Axis	-2120.3 N
☐ Y Axis	10334 N
☐ Z Axis	-108.25 N
☐ Total	10550 N

Fig. 9: Details of force reaction results along y axis

- Deformation of 5 mm is applied and reaction force is calculated as 10550 N.





Details of "Displacement"	
Definition	
Type	Displacement
Define By	Components
Coordinate System	Global Coordinate System
☐ X Component	-5. mm (ramped)
☐ Y Component	0. mm (ramped)
☐ Z Component	0. mm (ramped)

Fig. 6: Boundary conditions for displacement in x axis

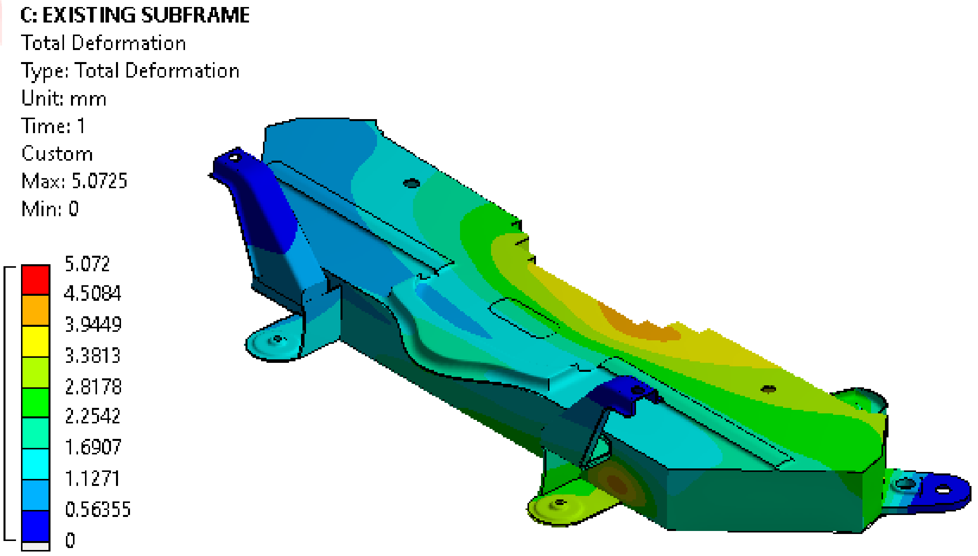
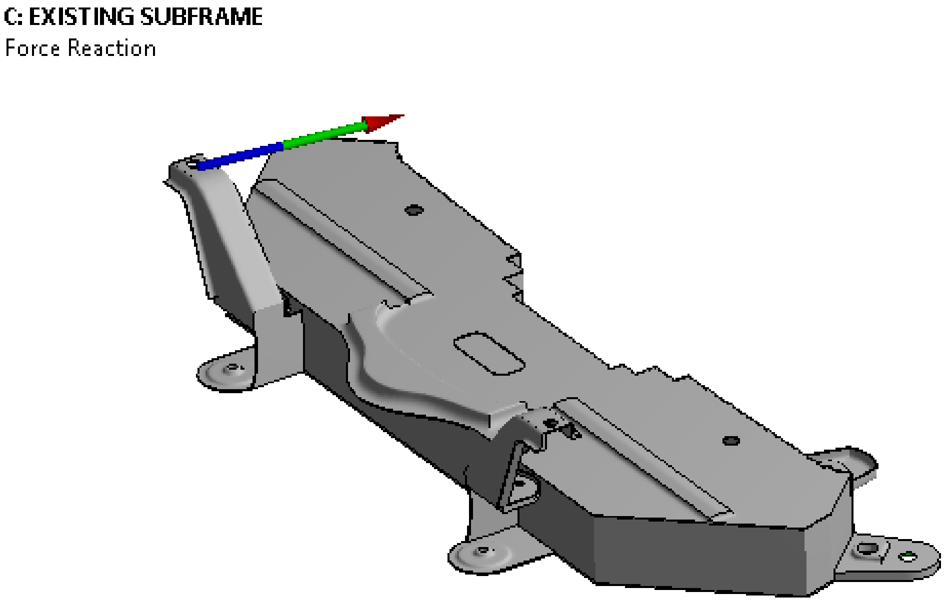
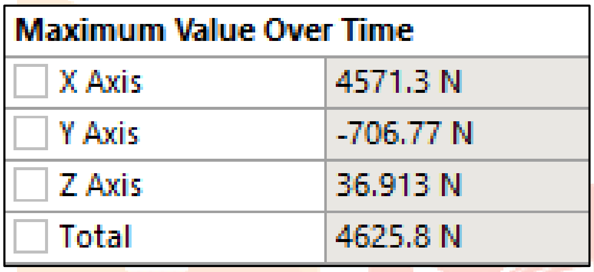


Fig. 7: Total deformation results along y axis





Maximum Value Over Time	
☐ X Axis	4571.3 N
☐ Y Axis	-706.77 N
☐ Z Axis	36.913 N
☐ Total	4625.8 N

Fig. 9: Details of force reaction results along x axis

3.1 • A deformation of 5 mm is used and the reaction power is calculated as 4625.8 N

MODERN ANALYSIS

Everything has an internal frequency (or resonant frequency) at which the object can vibrate naturally. It is also the cashew here an object will allow for the transfer of energy from one form to another with minimal loss. As the frequency increases toward "resonant frequency," the amplitude of the reaction increases sympathetically. In other words, the results of modal analysis are these frequencies where the amplitude increases indefinitely .The whole system can be defined in terms of the dynamic matrix that connects migration and power. These frequencies are known as natural frequency frequencies and are provided by the eigenvectors of the dynamic matrix. These frequencies are also known as resonant......

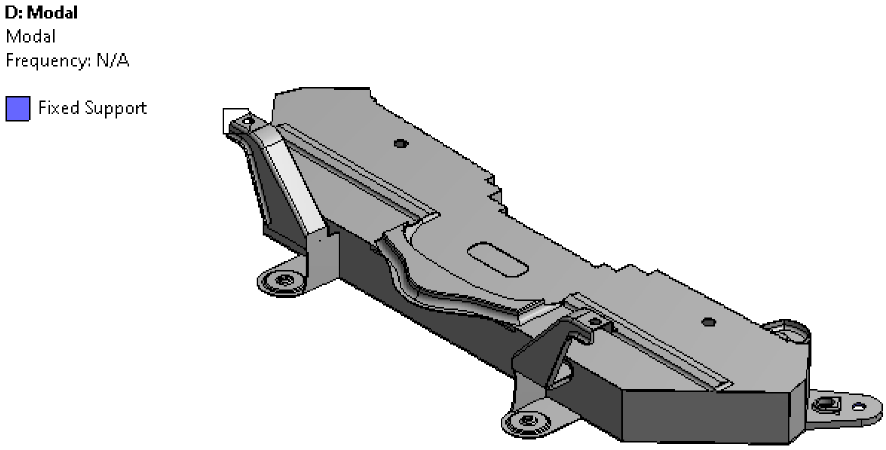
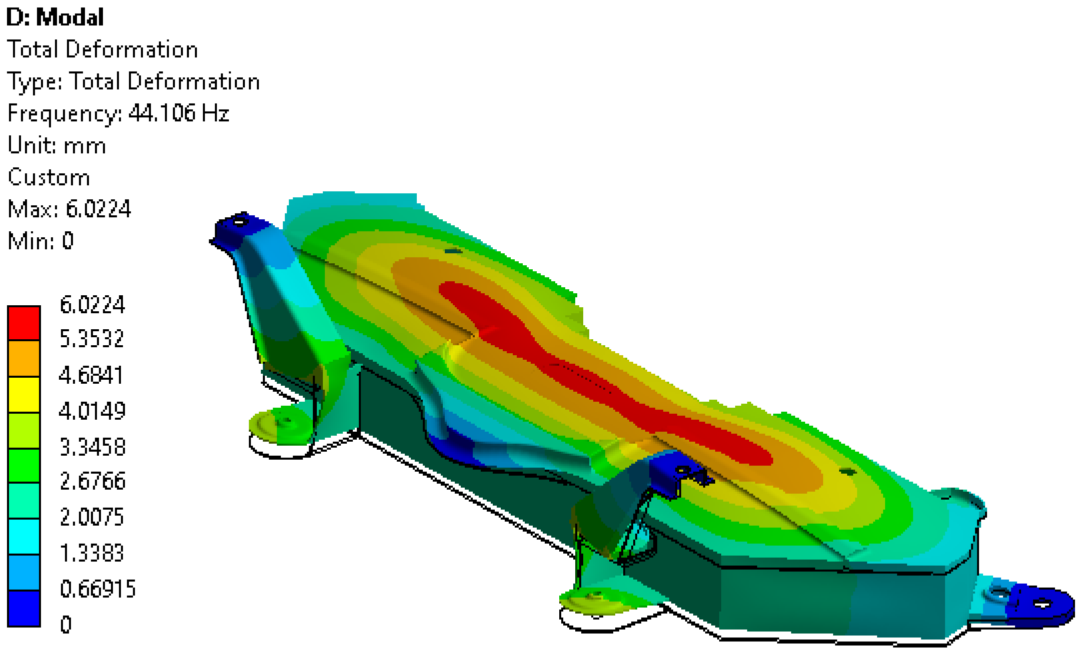
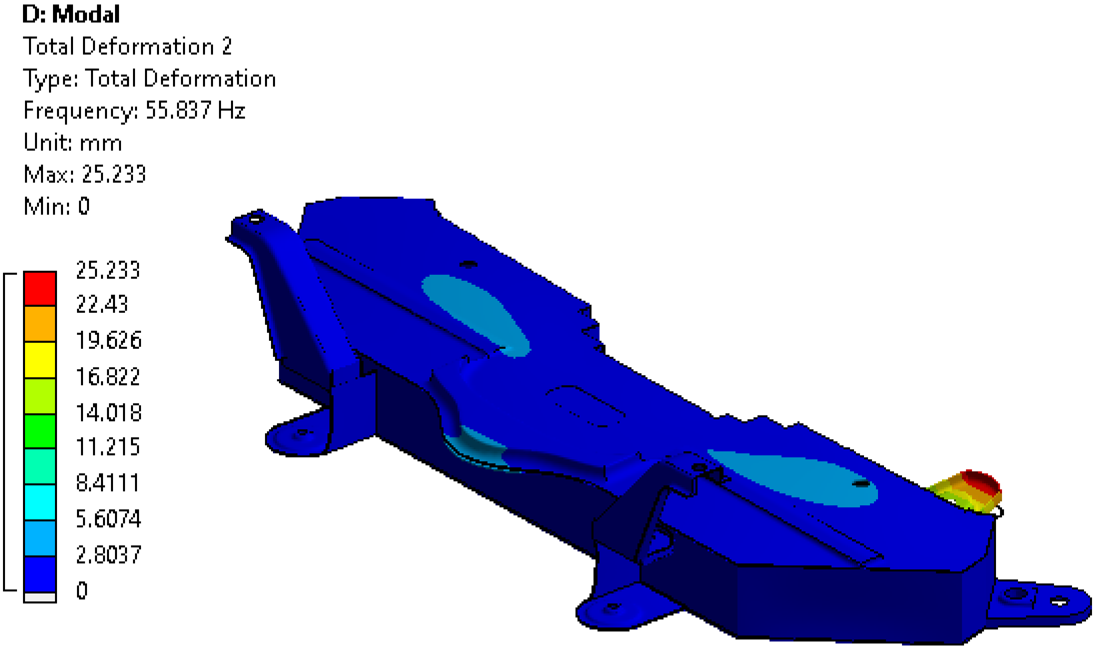


Fig. 14: Boundary condition

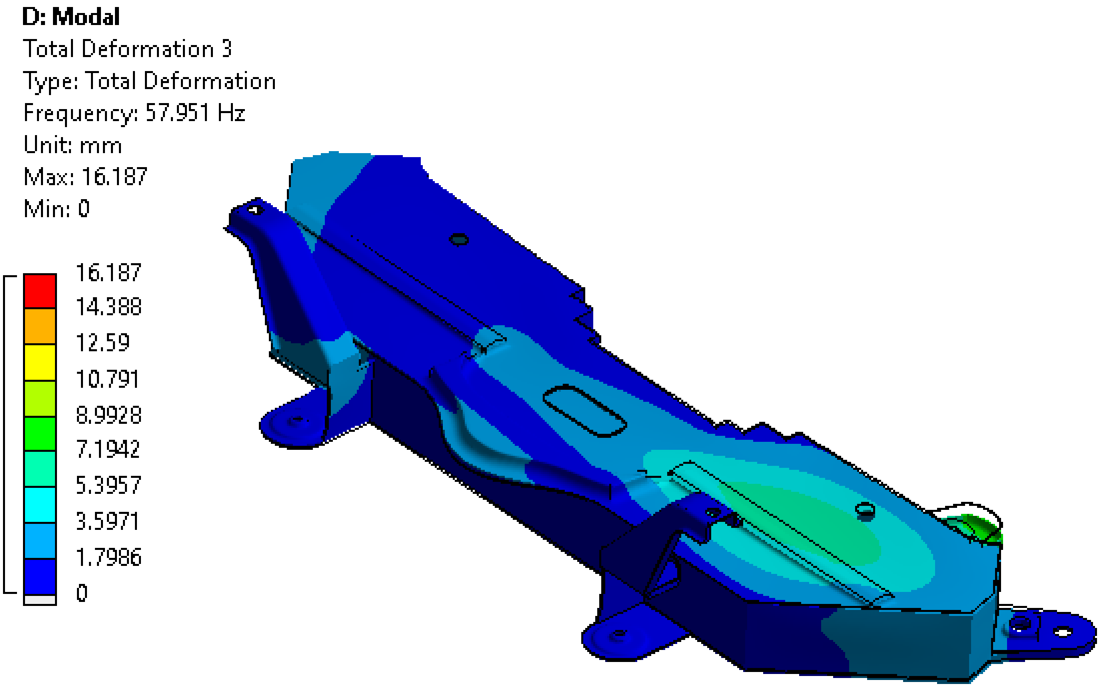
- For modal analysis fixed support is applied across edges and mode shape along with natural frequencies are calculated.



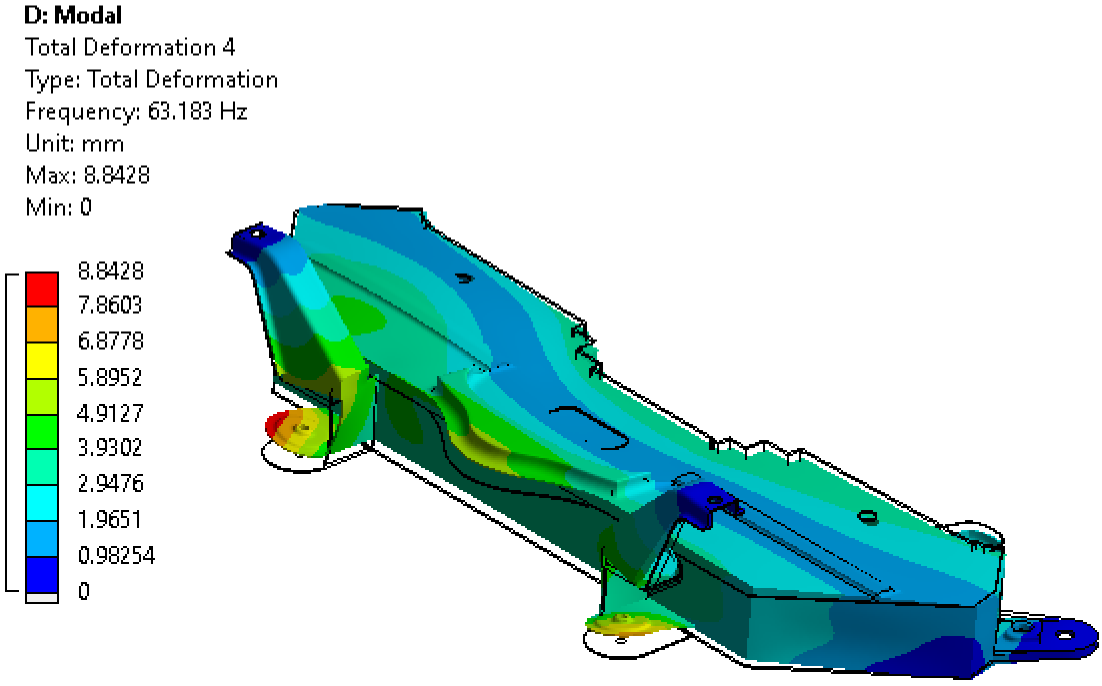
MODE SHAPE 1



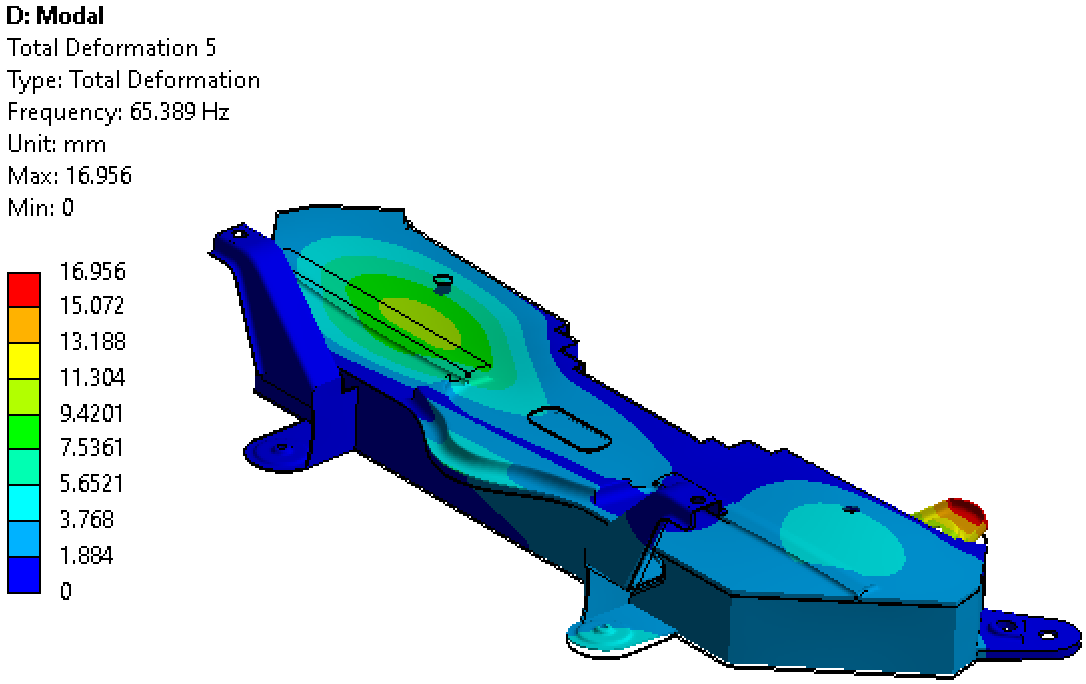
MODE SHAPE 2



MODE SHAPE 3

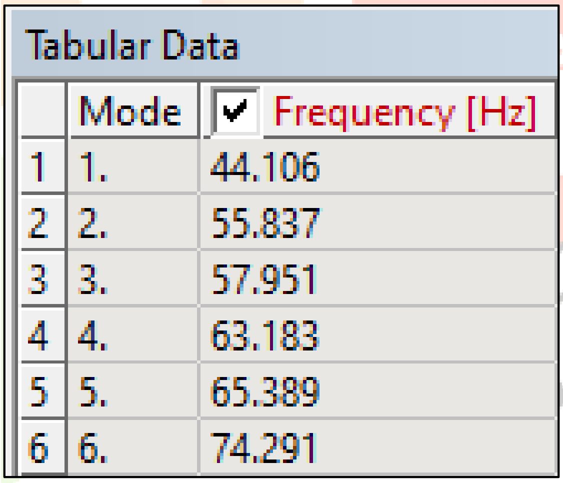


MODE SHAPE 4



MODE SHAPE 5

Table. Tabular data of natural frequency with respective mode shapes


Tabular Data

	Mode	☑ Frequency [Hz]
1	1.	44.106
2	2.	55.837
3	3.	57.951
4	4.	63.183
5	5.	65.389
6	6.	74.291

CAD MODEL AND DRAFTING OF SQUARE SUBFRAME STRUCTURE

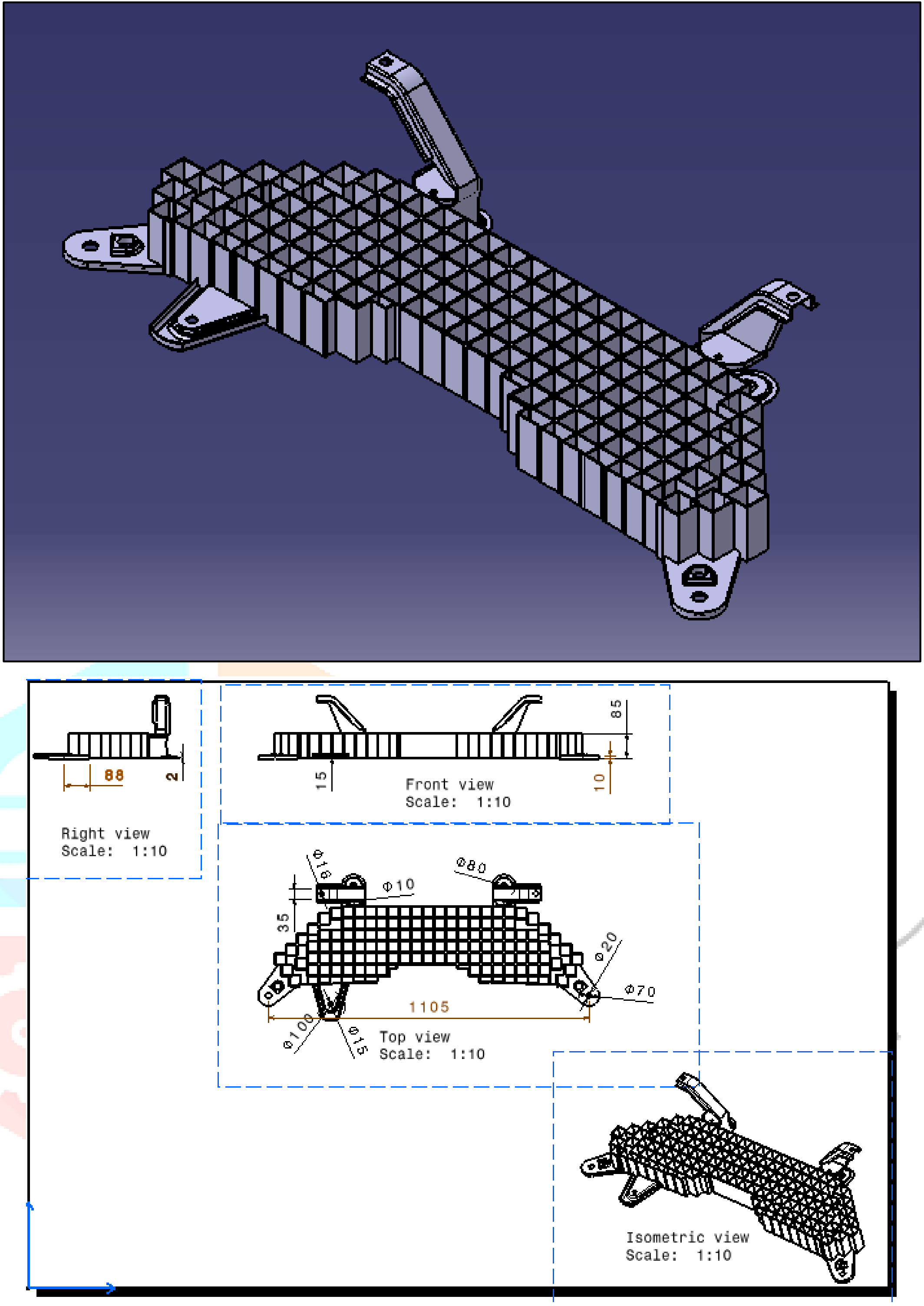
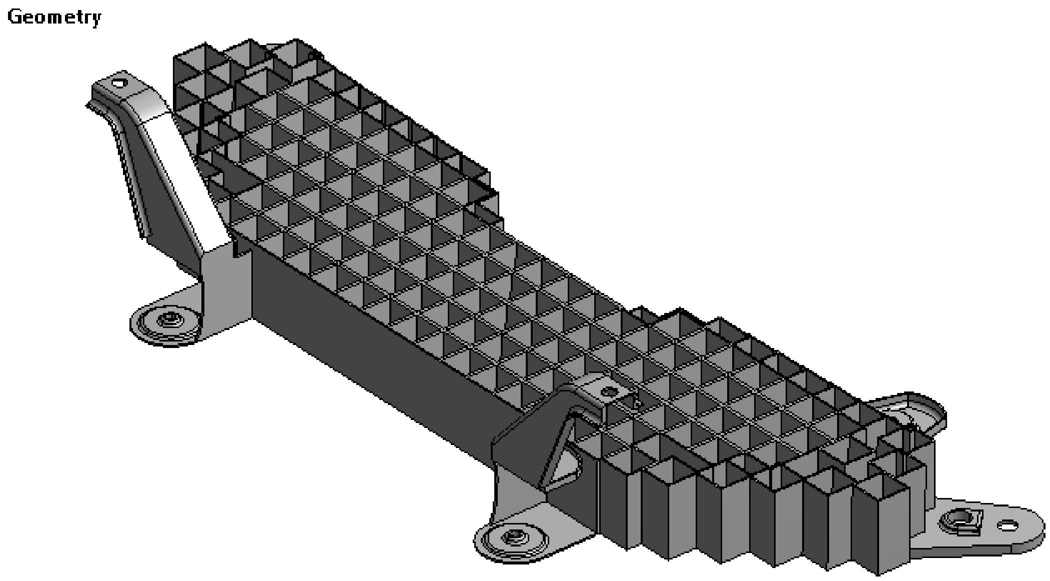
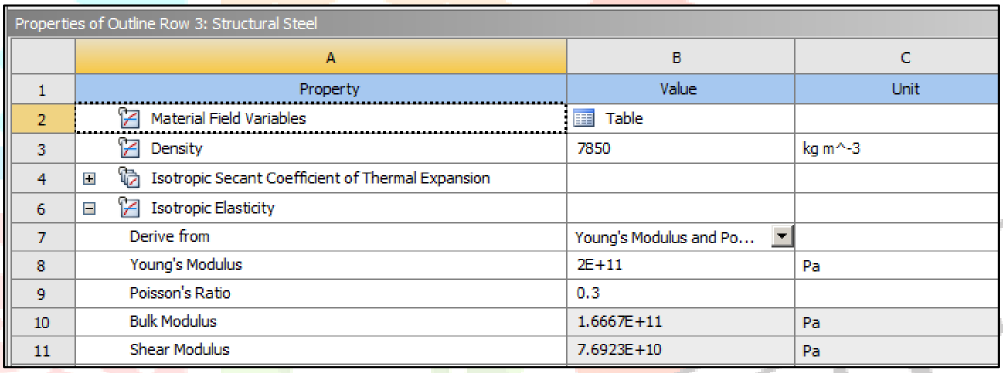


Fig. CATIA and drafting of square structure subframe



☐ Mass 7.1942 kg

Fig. : Existing subframe geometry imported in ANSYS



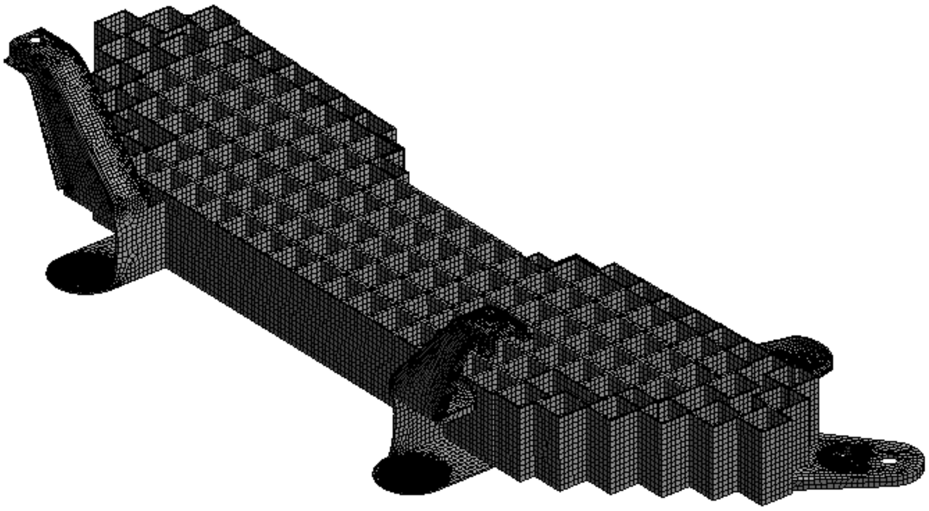
Properties of Outline Row 3: Structural Steel

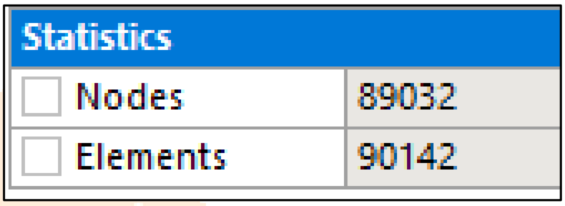
	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7850	kg m^-3
4	⊞ Isotropic Secant Coefficient of Thermal Expansion		
6	⊟ Isotropic Elasticity		
7	Derive from	Young's Modulus and Po...	
8	Young's Modulus	2E+11	Pa
9	Poisson's Ratio	0.3	
10	Bulk Modulus	1.6667E+11	Pa
11	Shear Modulus	7.6923E+10	Pa

- Yield strength of structural steel is about 36,000 psi (250 MPa) and ultimate tensile

MESHING

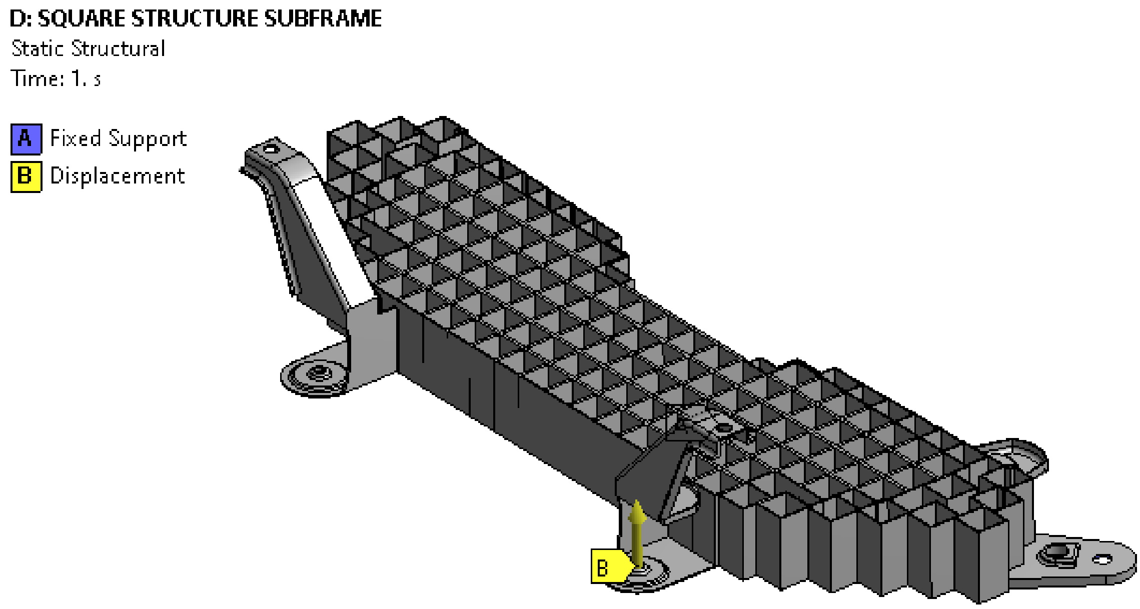
ANSYS Meshing is a well-designed, intelligent, automated product that works very well. It produces power of 58,000–80,000 psi (400–550 MPa) with the most suitable space for accurate and effective Multiphysics solutions. A match that is well suited to a particular analysis can be generated with a single mouse click on all parts of the model. Full controls on the options used to produce the mesh are available to the professional user who wants to tune them properly. The same processing power is automatically used to reduce the time you have to wait for match production. Creating the most relevant spaces is the basis of engineering simulation. ANSYS Meshing knows the type of solutions that will be used in a project and has the right conditions to create the most appropriate net. ANSYS Meshing is automatically integrated with each solution within the ANSYS Workbench area. For quick analysis or for a new and unusual user, a usable mesh can be created with a single click of a mouse. ANSYS Meshing selects the most appropriate options based on the type of analysis and geometry of the model. The simplest ability of ANSYS Meshing to automatically use the cores available on a computer is to use the same processing and thus significantly reduce network time. Parallel meshing is available at no additional cost or license requirements.

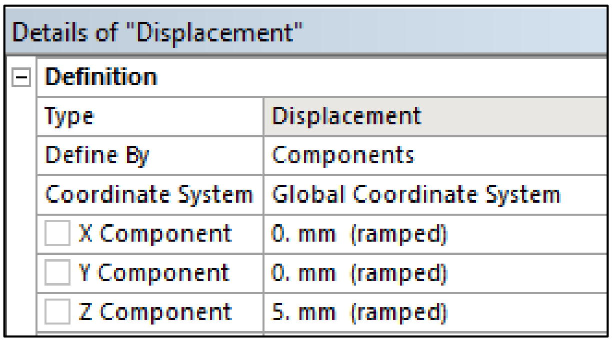




Statistics	
☐ Nodes	89032
☐ Elements	90142

Fig. 5: Details of meshing and subframe properties





Details of "Displacement"	
⊟ Definition	
Type	Displacement
Define By	Components
Coordinate System	Global Coordinate System
☐ X Component	0. mm (ramped)
☐ Y Component	0. mm (ramped)
☐ Z Component	5. mm (ramped)

Fig. 6: Boundary conditions for displacement in z axis

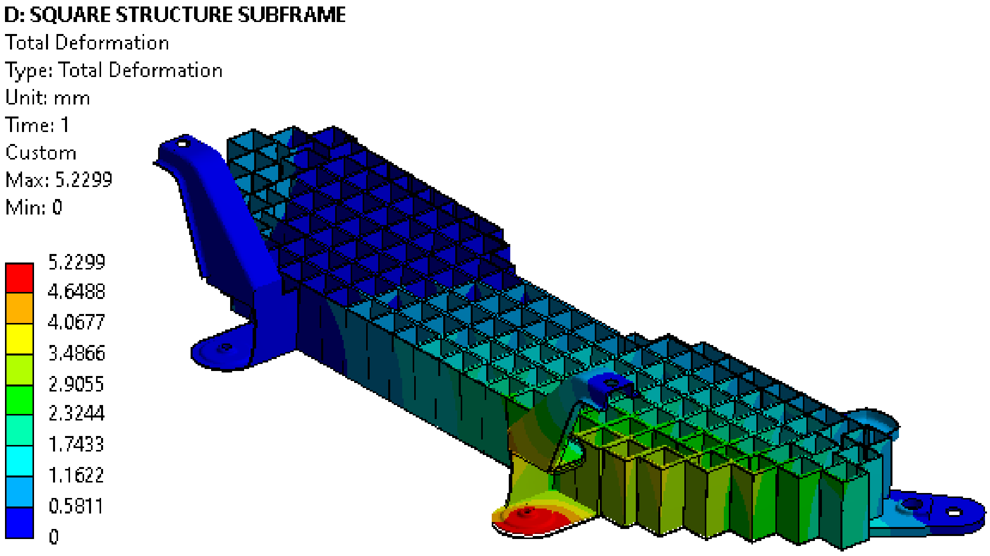
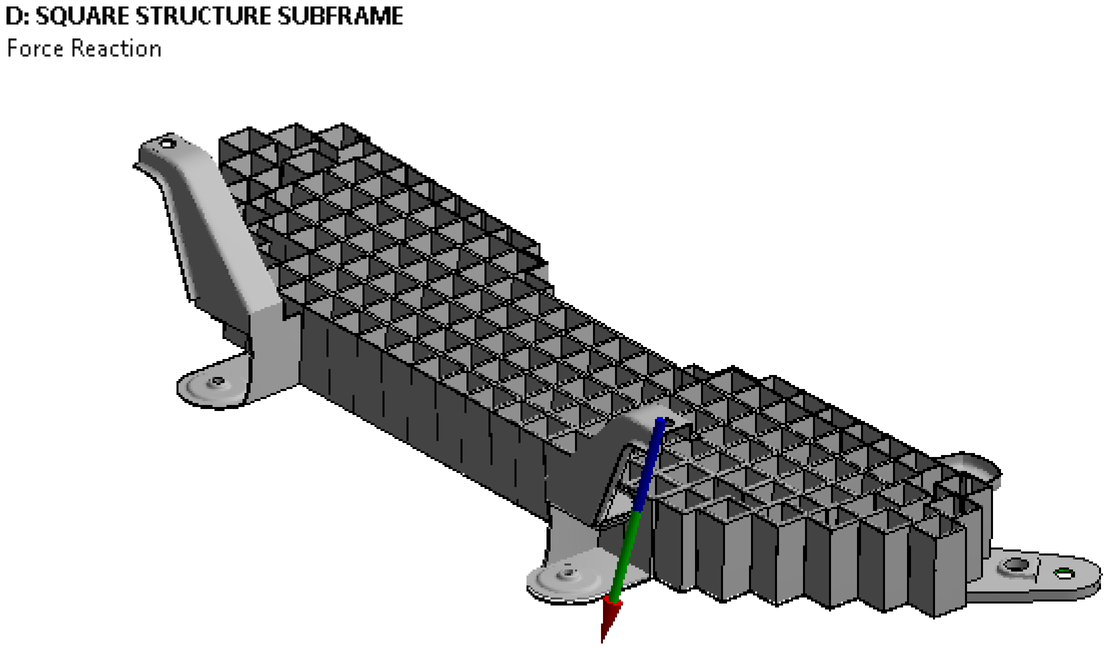
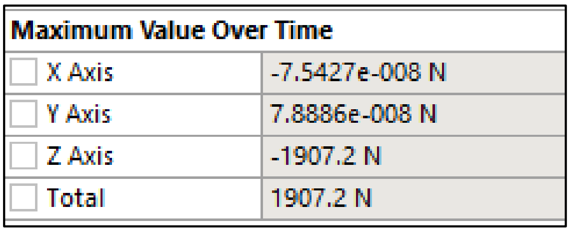


Fig. 7: Total deformation results along z axis

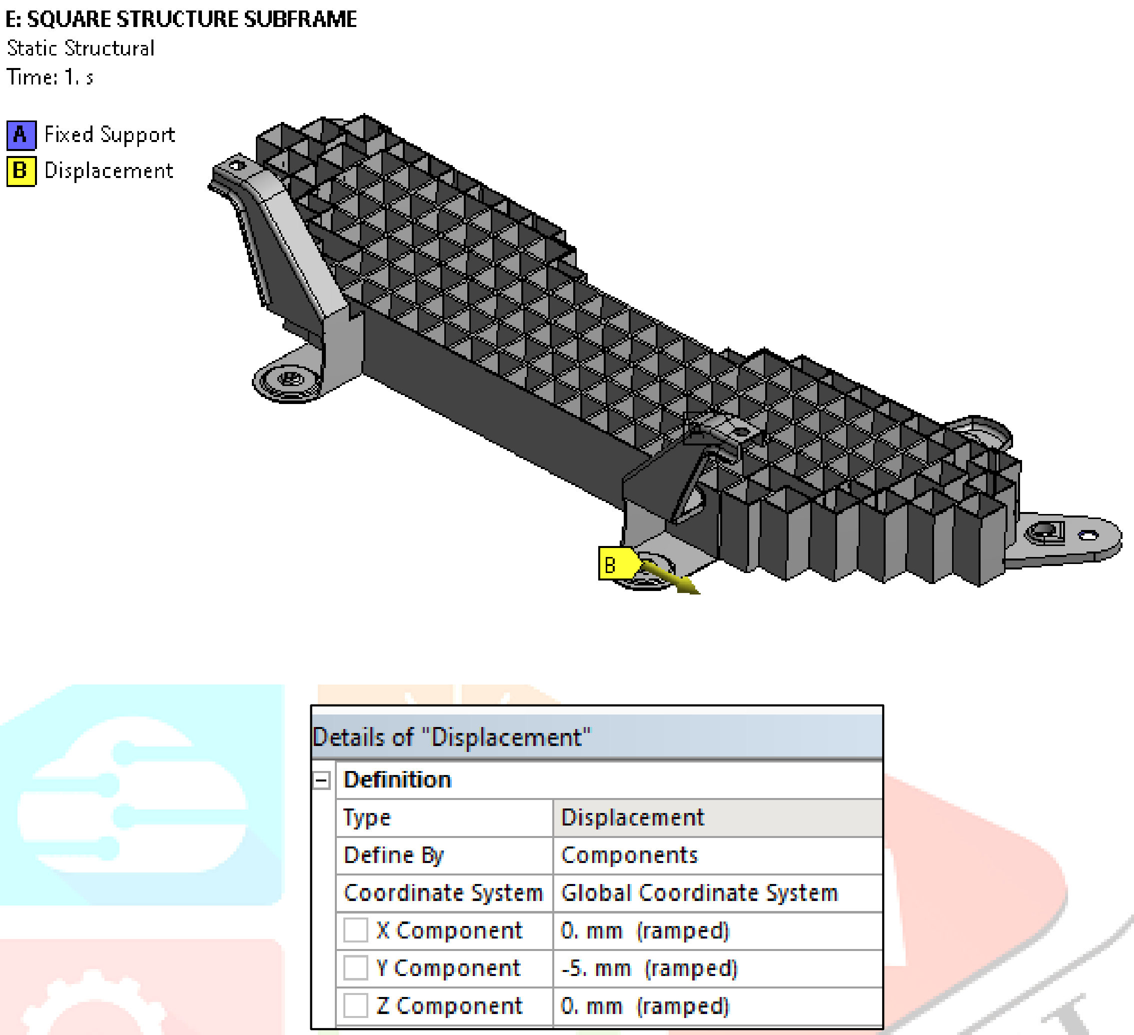




Maximum Value Over Time	
☐ X Axis	-7.5427e-008 N
☐ Y Axis	7.8886e-008 N
☐ Z Axis	-1907.2 N
☐ Total	1907.2 N

Fig. 9: Details of force reaction results along z axis

- Deformation of 5 mm is applied and reaction force is calculated as 1907.2 N.



Details of "Displacement"

⊟ **Definition**

Type	Displacement
Define By	Components
Coordinate System	Global Coordinate System
☐ X Component	0. mm (ramped)
☐ Y Component	-5. mm (ramped)
☐ Z Component	0. mm (ramped)

Fig. 6: Boundary conditions for displacement in y axis

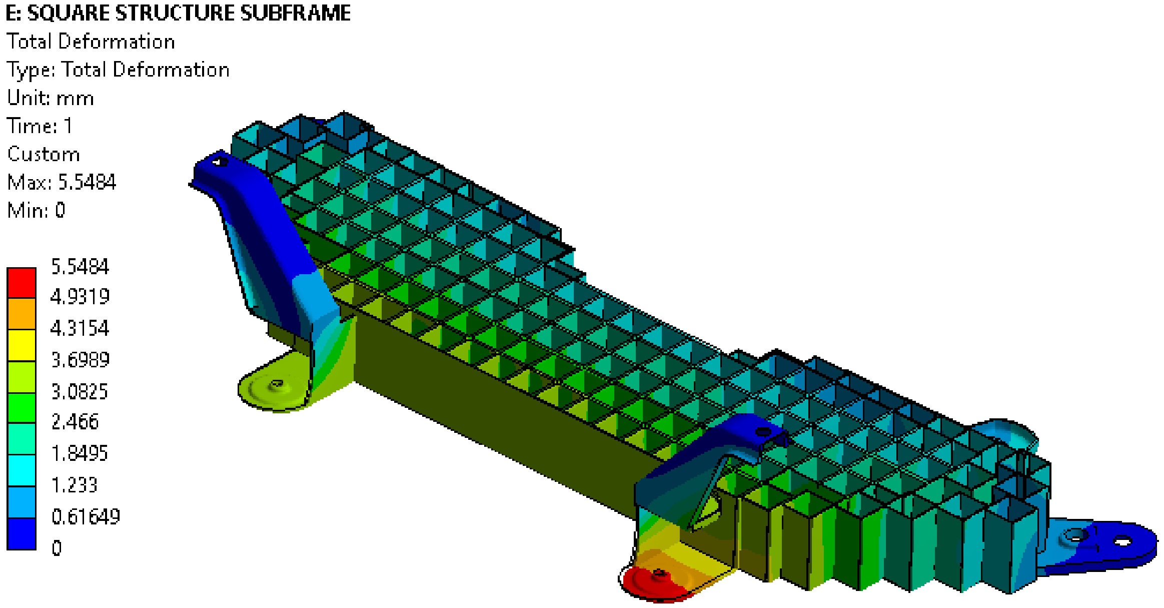
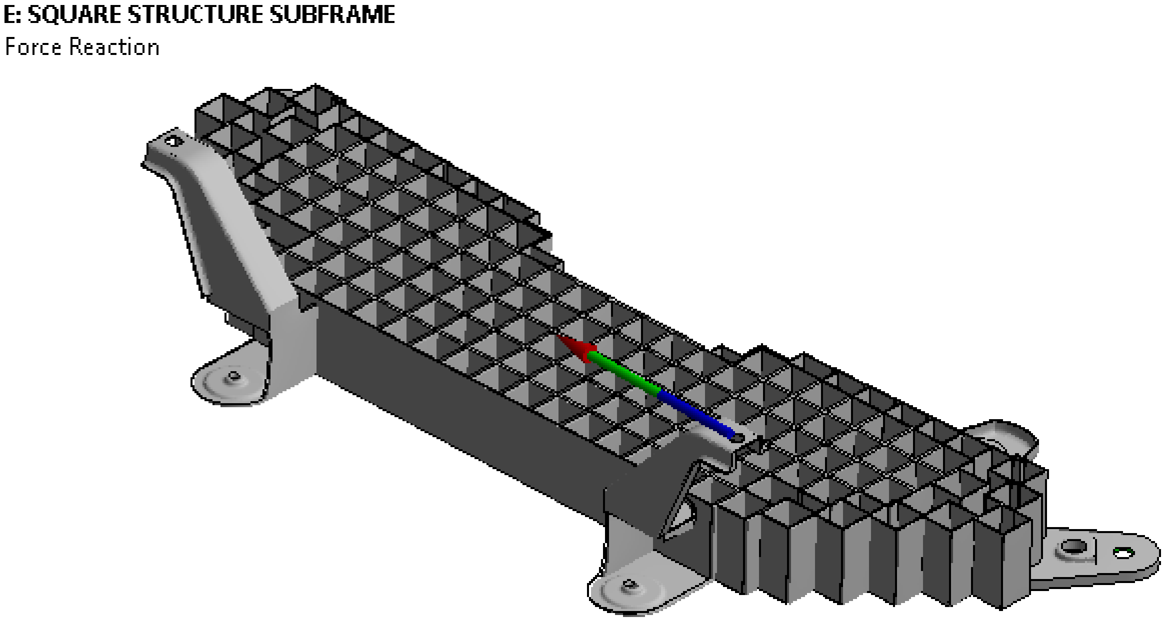
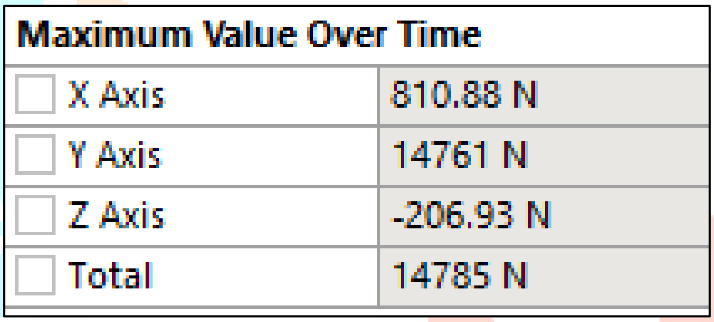


Fig. 7: Total deformation results along y axis

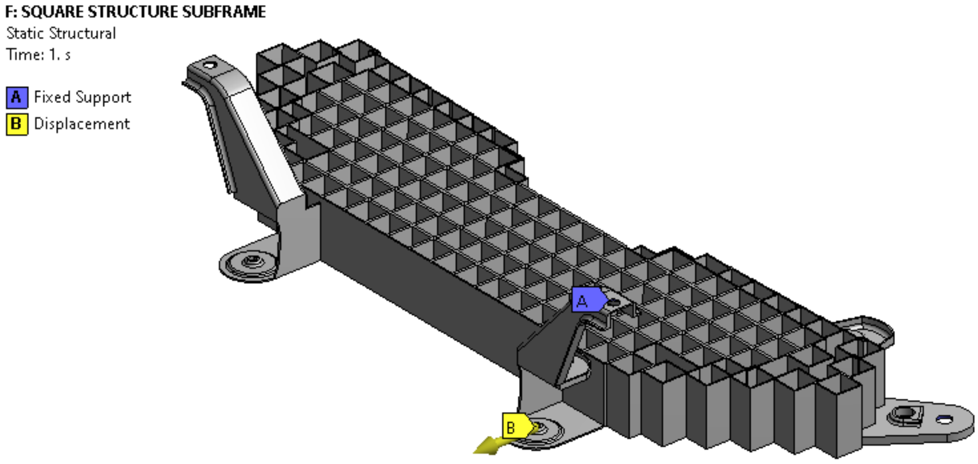


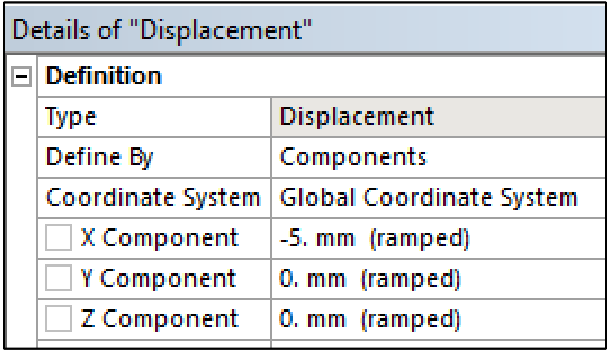


Maximum Value Over Time	
☐ X Axis	810.88 N
☐ Y Axis	14761 N
☐ Z Axis	-206.93 N
☐ Total	14785 N

Fig. 9: Details of force reaction results along y axis

- Deformation of 5 mm is applied and reaction force is calculated as 14785 N.





Details of "Displacement"

⊟ **Definition**

Type	Displacement
Define By	Components
Coordinate System	Global Coordinate System
☐ X Component	-5. mm (ramped)
☐ Y Component	0. mm (ramped)
☐ Z Component	0. mm (ramped)

Fig. 6: Boundary conditions for displacement in x axis

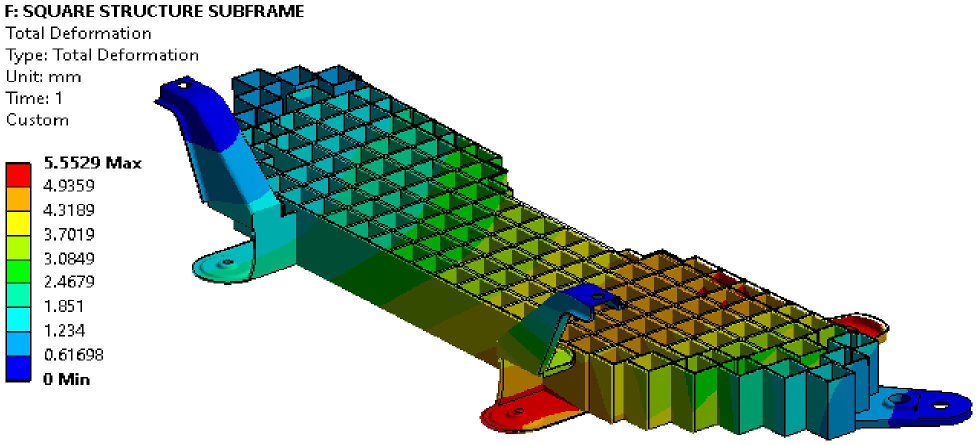
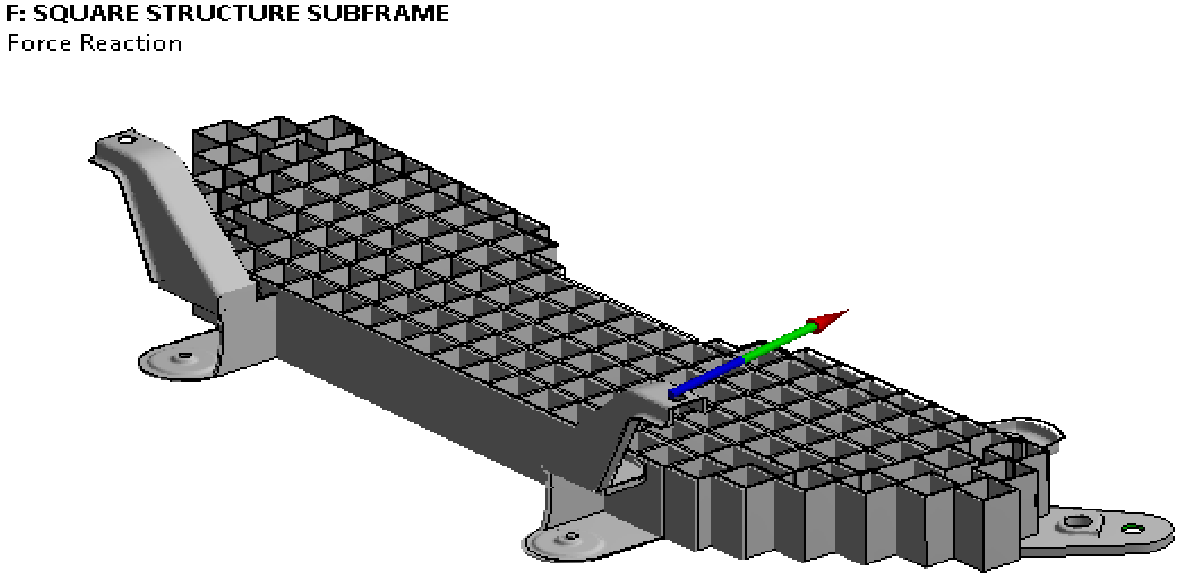
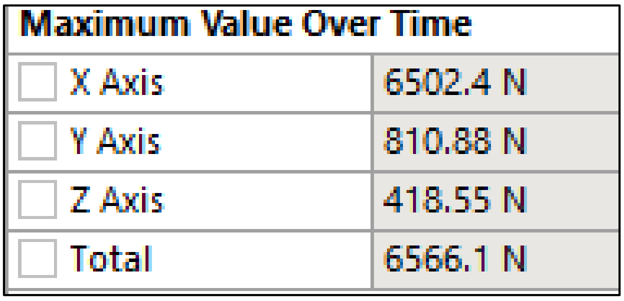


Fig. 7: Total deformation results along y axis





Maximum Value Over Time

☐ X Axis	6502.4 N
☐ Y Axis	810.88 N
☐ Z Axis	418.55 N
☐ Total	6566.1 N

Fig. 9: Details of force reaction results along x axis

- Deformation of 5 mm is applied and reaction force is calculated as 6566.1 N.

MODERN ANALYSIS

Everything has an internal frequency (or resonant frequency) at which the object can vibrate naturally. It is also the case where an object will allow for the transfer of energy from one form to another with minimal loss. As the frequency increases toward "resonant frequency," the amplitude of the reaction increases sympathetically. In other words, the results of modal analysis are these frequencies where the amplitude increases indefinitely.

The whole system can be defined in terms of the dynamic matrix that connects migration and power. These frequencies are known as natural frequency frequencies and are provided by the eigenvectors of the dynamic matrix. These frequencies are also known as resonant frequencies

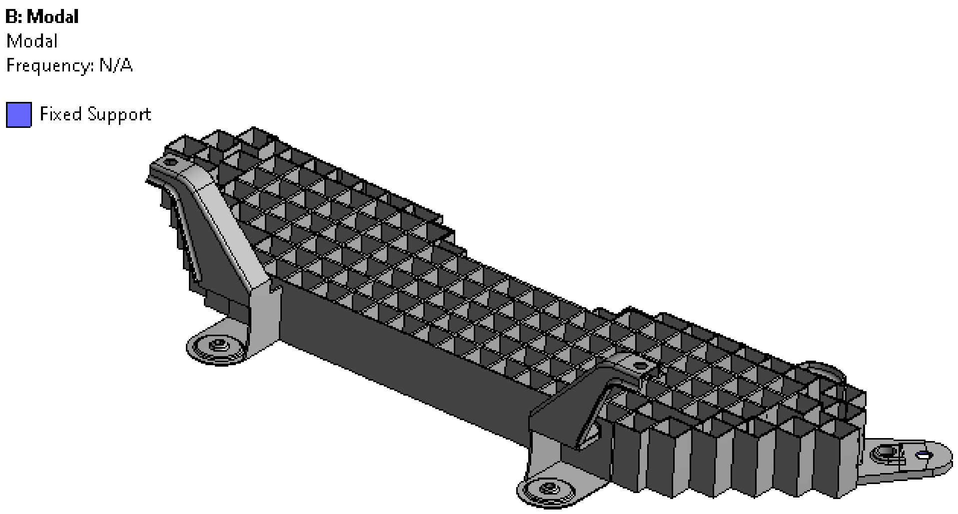
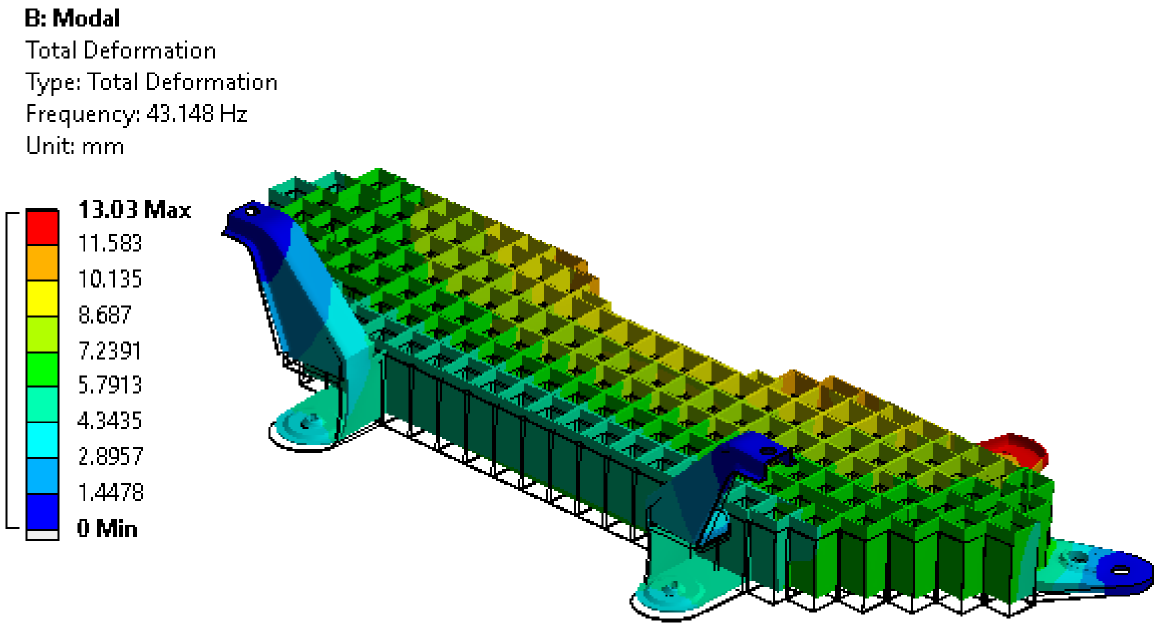
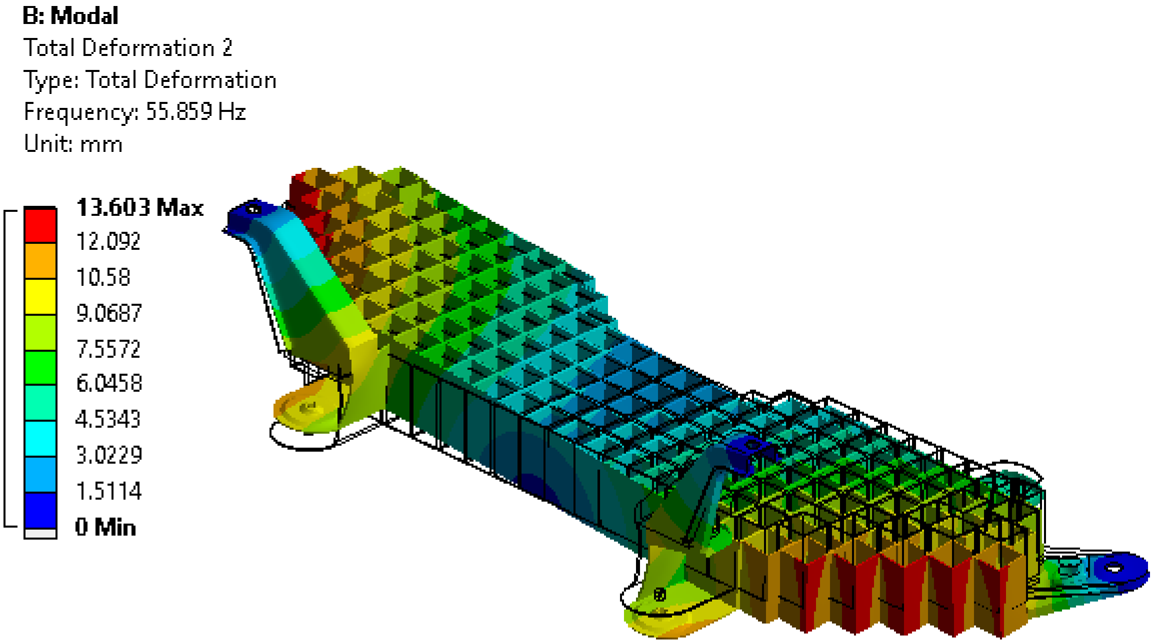


Fig. 14: Boundary condition

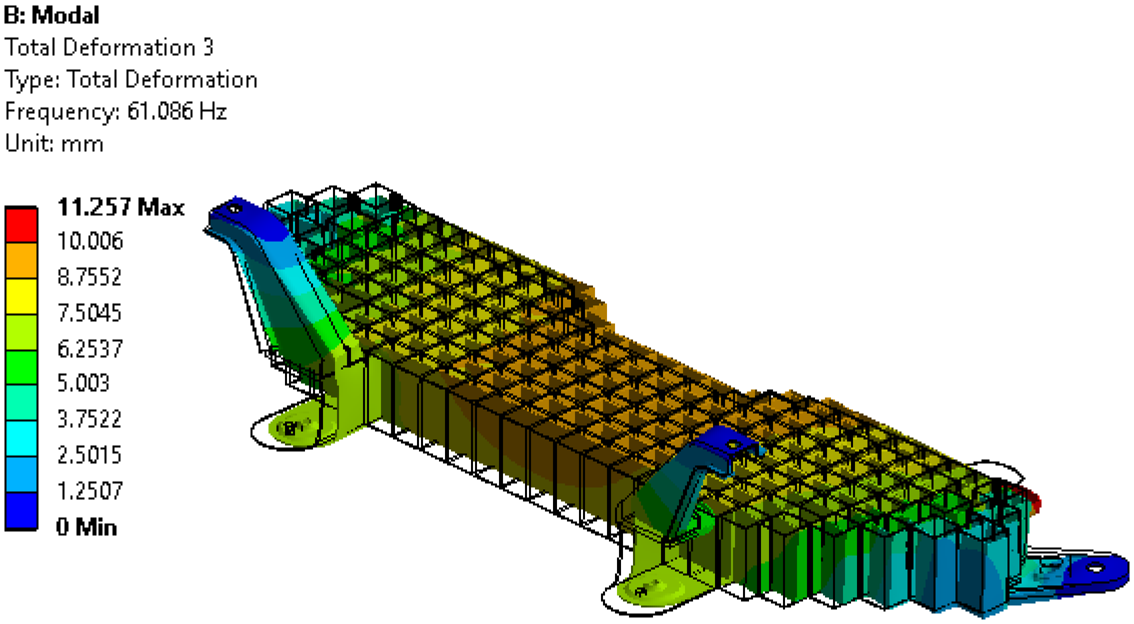
- For modal analysis fixed support is applied across edges and mode shape along with natural frequencies are calculated.



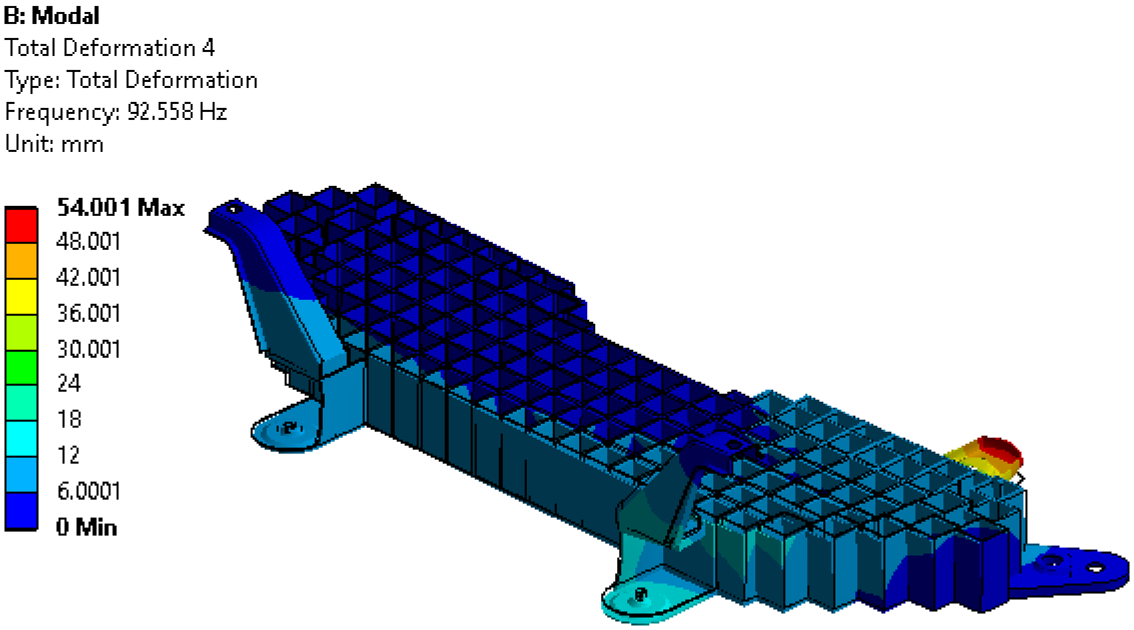
MODE SHAPE 1



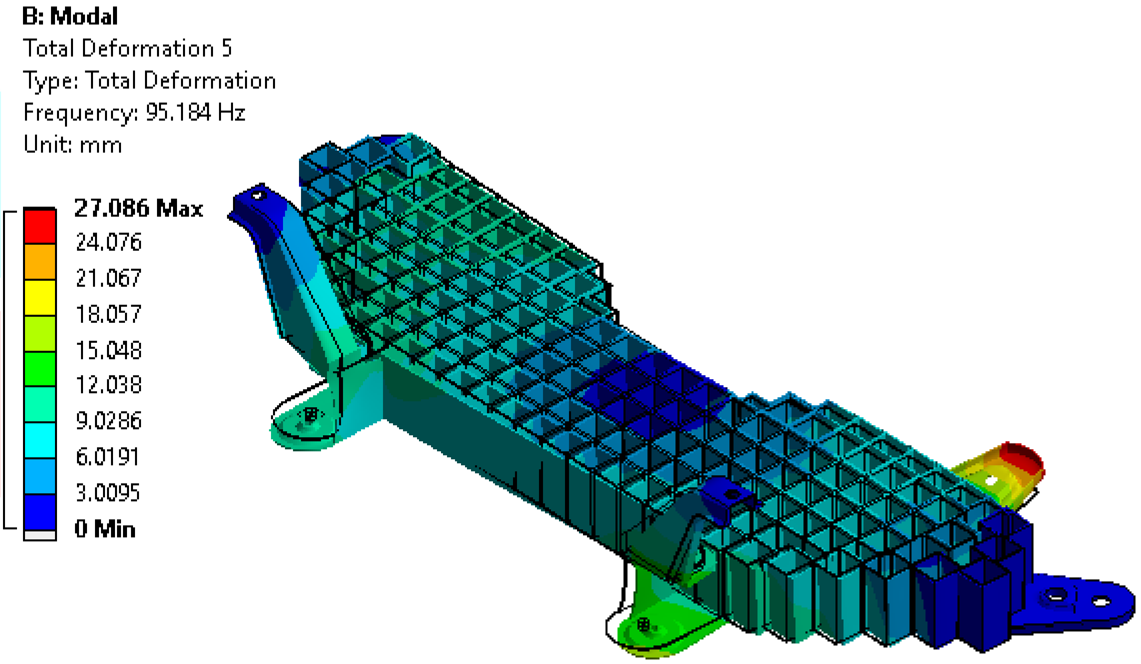
MODE SHAPE 2



MODE SHAPE 3

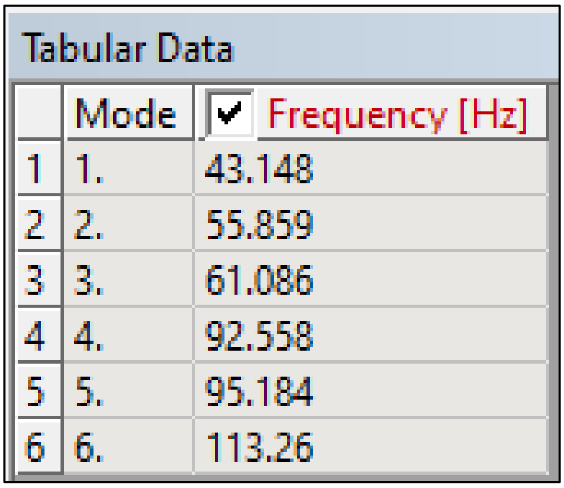


MODE SHAPE 4



MODE SHAPE 5

Table. Tabular data of natural frequency with respective mode shapes


Tabular Data

	Mode	☑ Frequency [Hz]
1	1.	43.148
2	2.	55.859
3	3.	61.086
4	4.	92.558
5	5.	95.184
6	6.	113.26

EXPERIMENTAL TEST

The Universal Testing Machine (UTM) is used to test the strength of solid and compact materials. Universal Inspection Systems are so named because they can perform many types of tests in a wide variety of materials, materials, and structures.Universal Inspection Equipment can contain many types of building materials, from solid samples, such as metal and concrete, to flexible samples, such as rubber and fabrics. This versatility makes the Global Testing Machine work equally well in almost any manufacturing industry. UTM is a fragmentary and flexible testing tool that can test the properties of materials such as strength, elasticity, compression, yield strength, plastic transformation and elasticity, bending pressure, and durability. Different models of Universal Test Equipment have different loading capacity, some as low as 5kN and some up to 2,000kN.

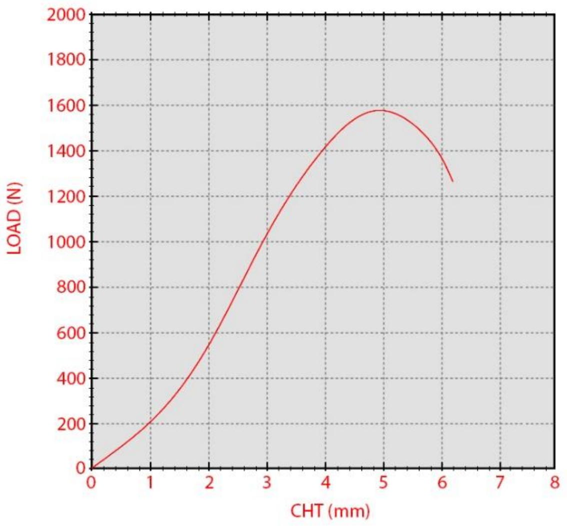
SPECIFICATION OF UTM

1	Max Capacity	400KN
2	Measuring range	0-400KN
3	Least Count	0.04KN
4	Clearance for Tensile Test	50-700 mm
5	Clearance for Compression Test	0- 700 mm
6	Clearance Between column	500 mm
7	Ram stroke	200 mm
8	Power supply	3 Phase, 440Volts, 50 cycle. A.C
9	Overall dimension of machine (L*W*H)	2100*800*2060
10	Weight	2300Kg

TEMPTATION PROCESS

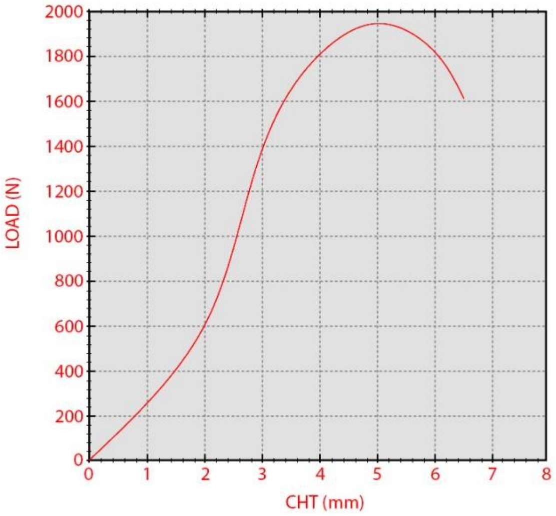
The smallest square frame size is measured in three different places in length / height to determine the center of the cross section. The ends of the small square frames should be flattened and made into a Z-axis to determine the strength of the specified removal probe.A small square subframe is placed in the center between the two compression plates, so that the center of the moving head is vertical above the small frame.The load is applied to a small square frame by moving the moving head.The load and corresponding load are measured at different intervals. Load is applied until the final result is obtained with a load graph compared to CHT.

Fig. Experimental testing under UTM



Graph. Variation of load vs displacement in existing subframe

Testing force for 5 mm is observed around 1590 N for displacement of 5 mm in existing subframe.



Graph. Variation of load vs displacement in square subframe

Testing force for 5 mm is observed around 1985 N for displacement of 5 mm in square subframe.

CONCLUSION

In the present study a comparative analysis was performed on the structure of the existing and modified framework.

In the present study 5 mm subtraction is given to the x, y and z axis to determine the intensity or strength of each reaction. It is noteworthy that in the strength of the subfloor there are approximately 464, 10550 and 1565 N respectively.

In a fixed floor structure with a square structure the same displacement of 5 mm is given to the x, y and z axis to determine the strength or strength of each reaction. It is noteworthy that the force of the square subframe force is seen around 6566, 14785 and 1907 N respectively.

It is noted in the FEA analysis that the response capacity of a square frame is greater than the existing design. Therefore, it is advantageous to replace the existing frame with a square frame.

The current weight of the small frame is approximately 9.11 kg and the sub-frame is approximately 7.19 kg. Weight correction of approximately 21% is observed.

From the UTM experiment it appears that the experimental force required on the Z-axis side of the existing and small square frame is approximately 1590 and 1985 N corresponding to the range of numerical results 1565 and 1907 N respectively.

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[5] Turan, A., "The Multi-Purpose Development of the Chassis Framework," SAE Technical Paper 2016-01-1398, 2016, doi: 10.4271 / 2016-01-1398.

[6] Chuaymung, C., Benyajati, C., and Olarnrithinun, S., "Structural Strength Simulations of Ladder Frame Chassis for Light Agriculture Truck," SAE Technical Paper 201