DEVELOPMENT OF MODIFIED SETUP FOR ALIGNMENT OF ROD/ ARTIFICIAL FRACTURE FEMUR BONE

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Abstract – *The project is mainly based on the automation of the fracture alignment process of femur bone after the fracture. It includes simple mechanical motion such as linear motion and rotational motion or twisting motion. After fractu,re the femur bone get dislocated and gets twisted too. To align the femur bone, we have to use external fixation devices. It requires constant monitoring on the patient's movements and tedious surgeries. As per the project we are developing we are developing a mechanism which can align the femur bone on its own and the fractural gap is closed automatically. In this project we are going realign the femur bone position. After fracture the femur bone gets twisted and the twisting angle ranges from 3-33 degrees and the linear offset of the bone is 0.4-1. 5cm.The motors which are being used are stepper motors, so we can easily control the angular twist of the femur bone. And also, for the linear motion of the femur bone we are preferring stepper motor for the required linear motion with reference of time.*

Key Words: **Femur Bone, CATIA, Static Analysis, Principal Stress, etc.**

1. INTRODUCTION

Bone regeneration represents a complicated process, of which primary biologic standards were evolutionarily conserved over a large variety of various species. Bone represents one in all few tissues which could heal with out forming a fibrous scar and, as such, resembles a completely unique shape of tissue regeneration. Despite a splendid development in surgical strategies withinside the beyond decades, impaired bone regeneration inclusive of non-unions nevertheless have an effect on a massive quantity of sufferers with fractures. As impaired bone regeneration is related to excessive socio-financial implications, it's miles an critical scientific want to benefit a complete know-how of the pathophysiology and pick out novel remedy approaches.

1.2 FEMUR BONE

Femur bone is also known as thigh bone. The femur bone is the longest, heaviest and strongest bone in the human body. The length of this bone is almost 26% of the height of person. Femur bone is divided into three parts: upper extremity, body and lower extremity. The upper part consists of head, neck and the tow trochanters. Body is the long and almost cylindrical in shape. It is slightly arched. Lower extremity is bigger than upper extremity. It is slightly cuboid in form but its diagonal diameter is bigger than its anteroposterior.

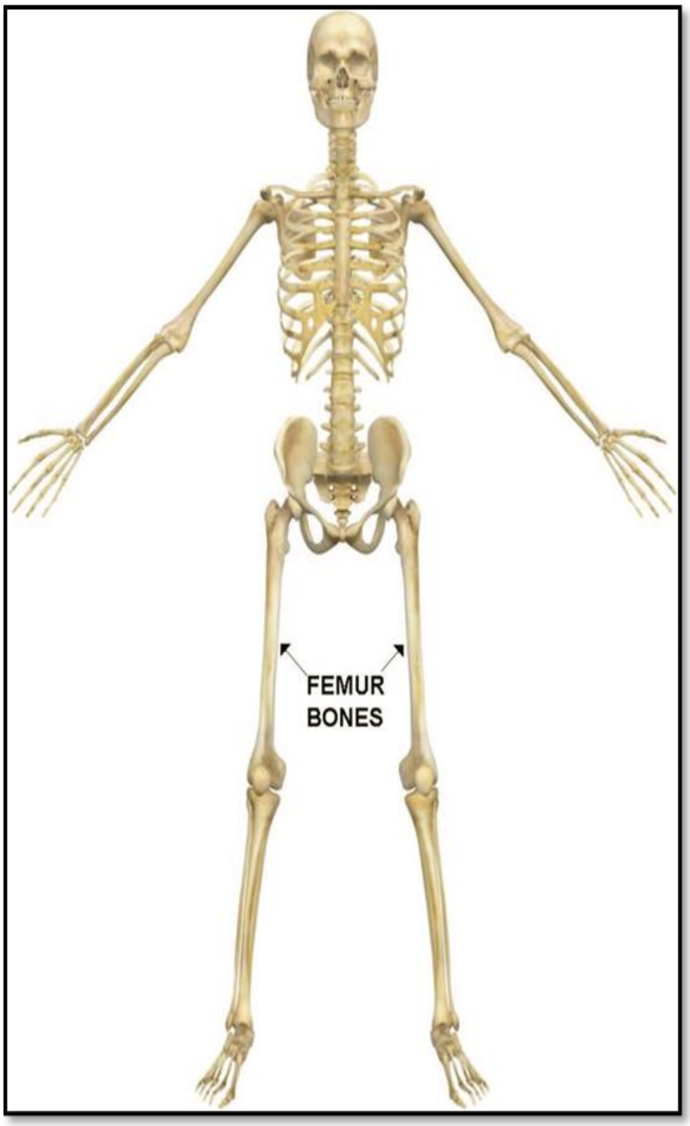


Fig-1

2. METHODOLOGY

Step 1: - We started the work of this project with a literature survey. We gathered many research papers which are relevant to this topic. After going through these papers, we learnt about bone rupture treatment.

Step2: - After that the components which are required for my project are decided.

Step 3: - After deciding the components, the 3 D Model and drafting will be done with the help of CATIA software.

Step 4: - The components will be manufactured and then assembled together.

Step 5: - The static analysis on ANSYS will be carried out and then the result and conclusion will be drawn.

3. DATA COLLECTION

3.1Method to find Angular and Linear Offset for broken Bone:-

I. Mark points on the fractured Bone X-ray P1 toP10.

II. Draw parallel lines coinciding with these points.

III. Draw the centerline of both parts of the Bone.

IV. The intersection point where both centerlines meet, mark that point.

V. Measure the angle now and thus we get the Angular Offset.

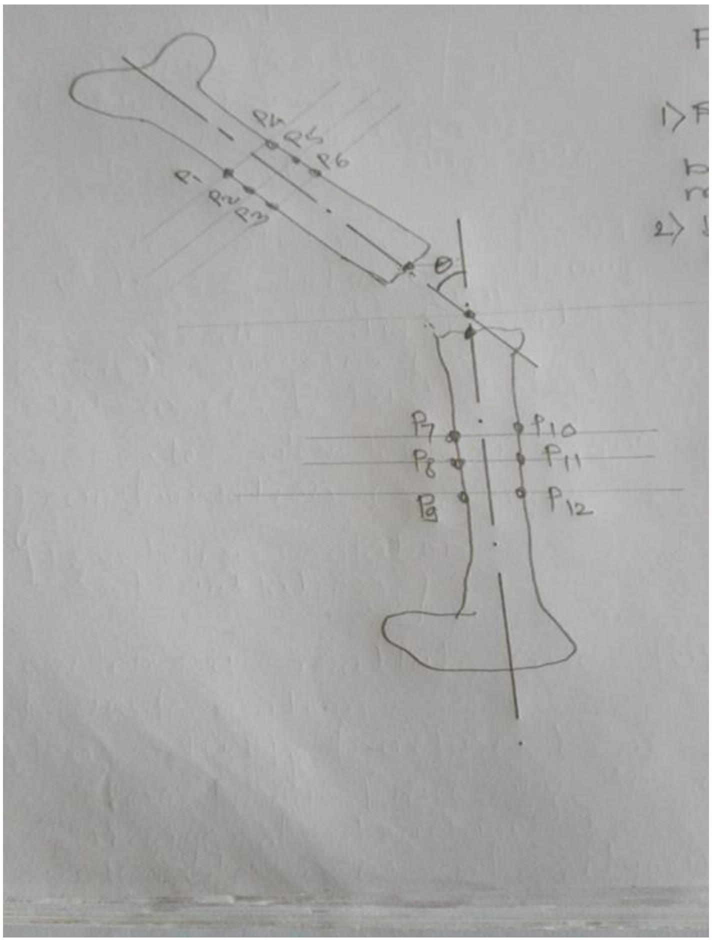


Fig-2

3.2 Femur Bone samples: -

Fig-1

Angular Offset is- 3^0

Fig-2

Angular Offset is-

1)lateral-12.5^0

2)A.P-3^0

3.3Table for Bone Offsets-

X-RAY NO.	Bone Type	Angular Offset	Linear Offset	View
1.	Femur	14°	-	Lateral
2.	Femur	9°	-	Antero Posterior
3.	Femur	18°	-	Oblique
4.	Femur	10°	-	Antero Posterior
5.	Femur	9°	-	Antero Posterior
6.	Femur	4°	-	Lateral
7.	Femur	12.5°	-	Lateral
8.	Femur	12.5°	-	Lateral
9.	Femur	3°	-	Antero Posterior
10.	Femur	21°	-	Lateral
11.	Femur	7°	-	Antero Posterior
12.	Femur	17°	-	Antero Posterior
13.	Femur	15°	-	Lateral
14.	Femur	6°	-	Antero Posterior
15.	Femur	33°	-	Antero Posterior

4. Design consideration and calculations

4.1CATIA

CATIA is a leading product design platform created by a company with headquarters in France. It is a great tool for companies to come up with designs, perform comprehensive analysis, and produce new products that can be helpful in product development. CATIA can benefit OEMs and manufacturers in various industries as they can use the tool to ensure faster analysis, design and creation of new products. This revolutionary software integrates different approaches to product design and development, allowing different industries to use their current tools at different stages of product development. , making CATIA convenient for architects, engineers and industrial designers. CATIA provides an efficient 3D design environment that allows stakeholders and designers to work together on product prototyping and to share their product designs.

4.2Orthographic and Isometric view of the model:

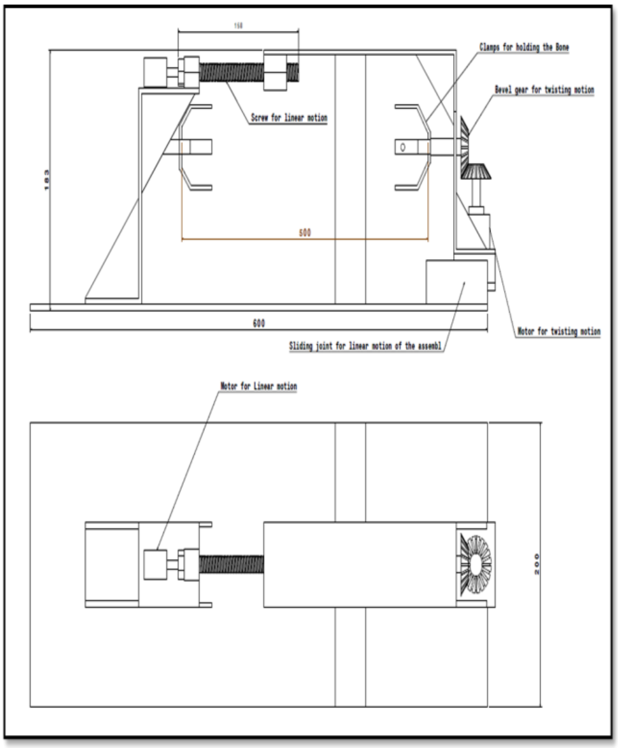


Fig-3

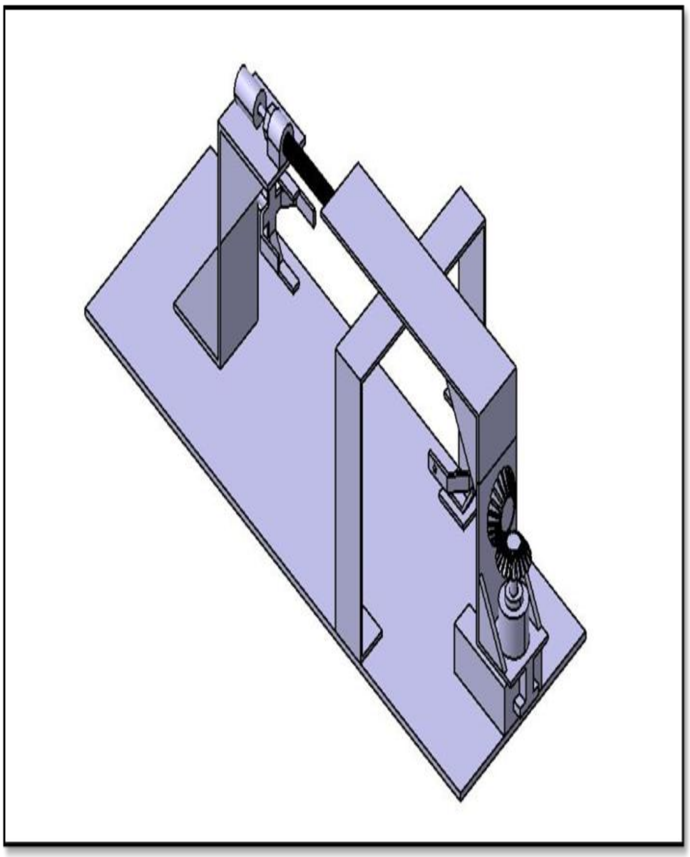


Fig-4

4.3. Components :

1) Bevel gears:

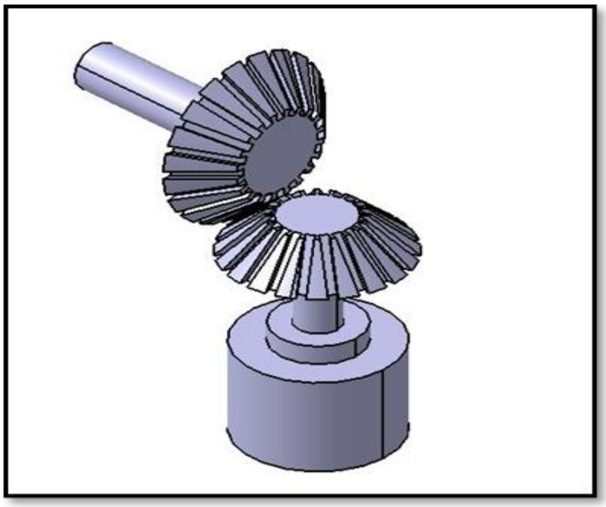


Fig-5

2) Bolt for linear motion:

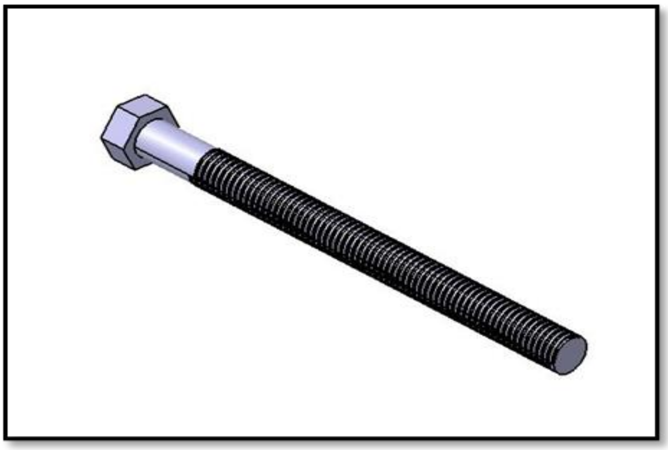


Fig-6

3)Clamp for holding bone:

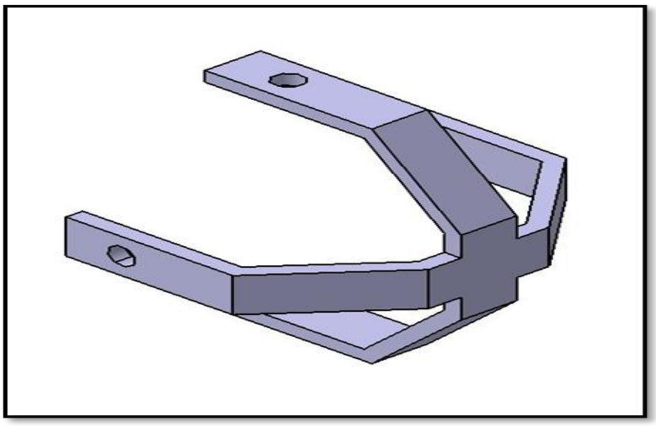


Fig-7

4) Setup for Linear motion:

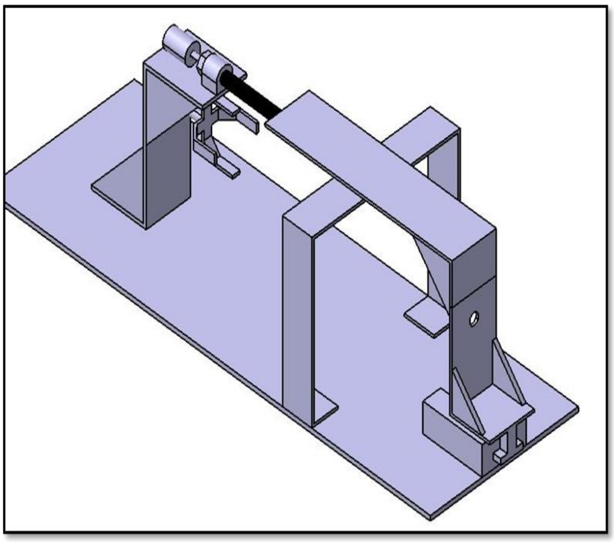


Fig-8

5)Setup for twisting motion:

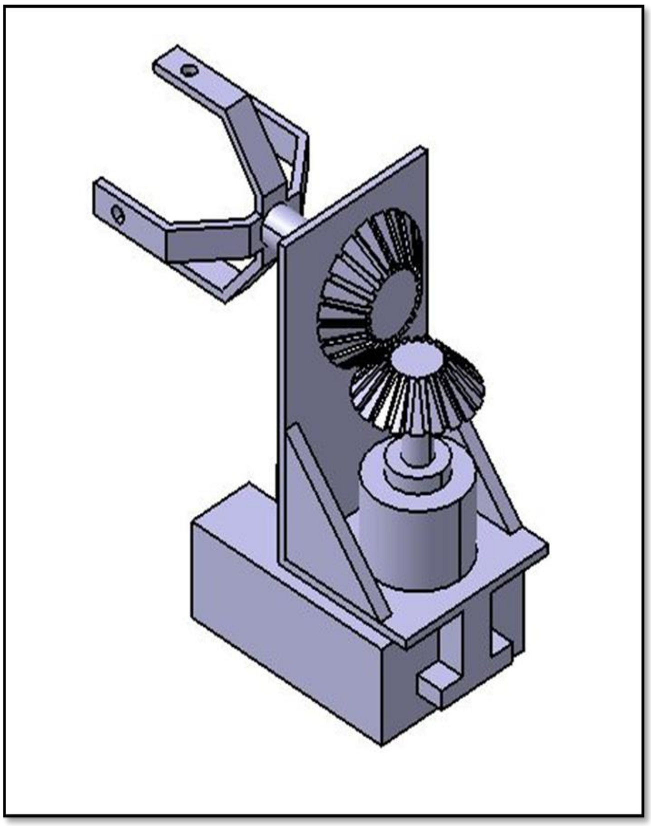


Fig-9

6) Artificial 3D bone:

Fig-10

4.4 Basic calculations:

ASSUMPTIONS

We have assumed that the bolt we are using for linear motion of the bone would be M12 and the gears which we have used in the mechanism are selected as per availability in the market.

The twisting moment and the linear motion of the bone are controlled by the motors, which are being programmed as per requirement.

The motor that we are using for the motion is being calculated as follows:

Base motor design

Let, P=24 watt, 12 volt, & 2A

Power (P) =2πNT/60

T =24*60/2π10

T =22.91Nm this is the available torque

Consider the weight of the male femur bone = 290 grams (approximately)

So the force applied is equal to = 0.290x9.81 newton.

F= 2.845 N

As the weight of the bone is applied on the bevel gear and the bevel gear is attached to the motor. So, we can calculate the torque required for motor to rotate the boneHence, the torque required = 2.845x 20 mm

= 56.9 N-mm = **0.0569 N-m**

So we have to select a motor having considerably similar torque as calculated.

5. SERVO MOTOR:

A **servomotor** is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

Servomotors are not a specific class of motor although the term *servomotor* is often used to refer to a motor suitable for use in a closed-loop control system.

Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.

Fig-11 Servometer

6. Analysis :

The finite element method (FEM) is a numerical method for solving problems in engineering and mathematical physics. Typical problem areas of interest include structural analysis, heat transfer, fluid flow, mass transport, and electromagnetic potential. Analytical solutions of these problems often require the solutions of limit value problems for partial differential equations. The construction of the problem according to the finite element method leads to a system of algebraic equations. This method provides approximate values of the unknowns in a discrete number of points in the field. To solve the problem, he divided a large problem into smaller, simpler parts called finite elements. The simple equations that model these finite elements are then assembled into a larger system of equations that model the whole problem. FEM then uses variable computation methods to approximate a solution by minimizing an associated error function. Studying or analyzing a phenomenon with FEM is often referred to as Finite Element Analysis (FEA).

6.1 Geometry:

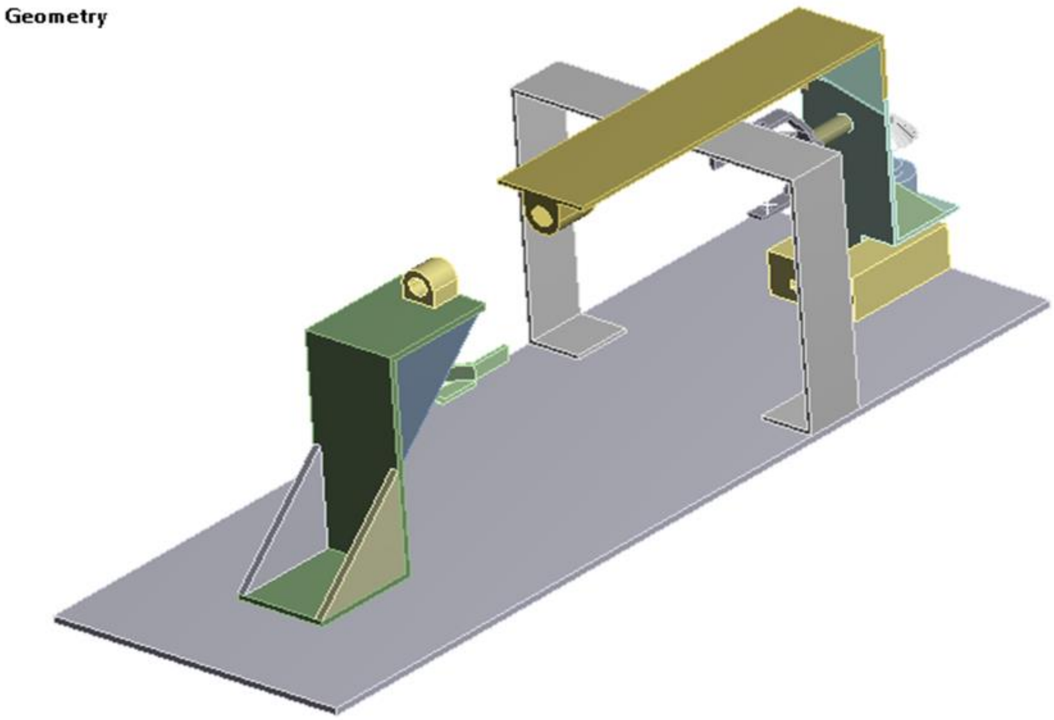
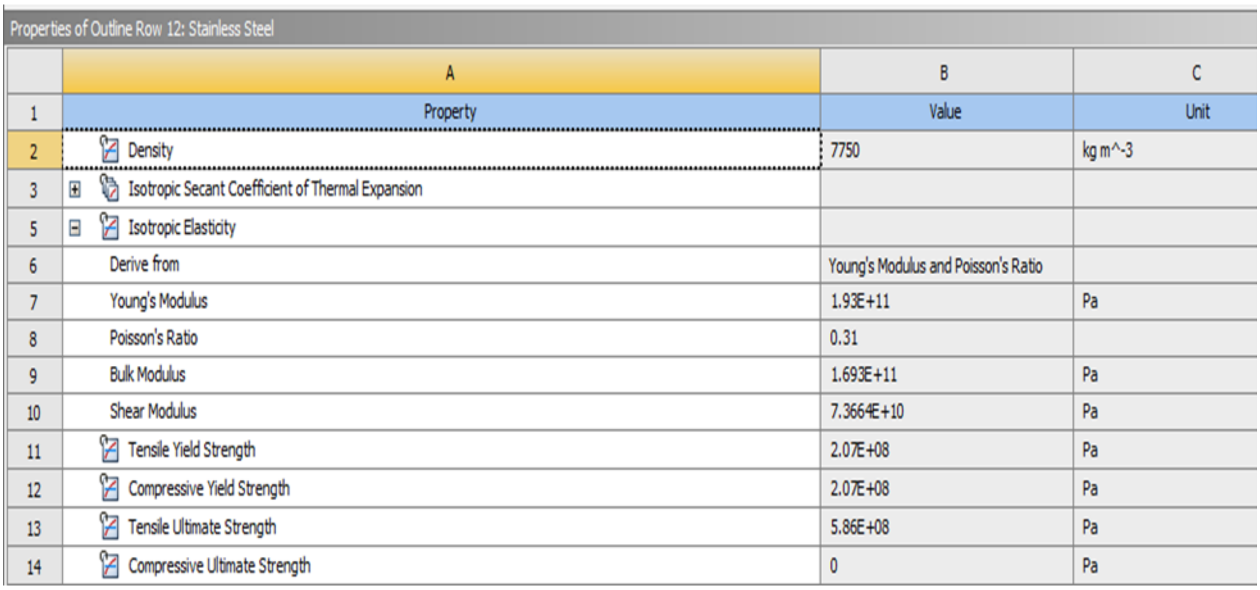


Fig-12

Material used:



Properties of Outline Row 12: Stainless Steel

	A	B	C
1	Property	Value	Unit
2	Density	7750	kg m^-3
3	⊞ Isotropic Secant Coefficient of Thermal Expansion		
5	⊟ Isotropic Elasticity		
6	Derive from	Young's Modulus and Poisson's Ratio	
7	Young's Modulus	1.93E+11	Pa
8	Poisson's Ratio	0.31	
9	Bulk Modulus	1.693E+11	Pa
10	Shear Modulus	7.3664E+10	Pa
11	Tensile Yield Strength	2.07E+08	Pa
12	Compressive Yield Strength	2.07E+08	Pa
13	Tensile Ultimate Strength	5.86E+08	Pa
14	Compressive Ultimate Strength	0	Pa

Fig-13

6.2 Meshing:

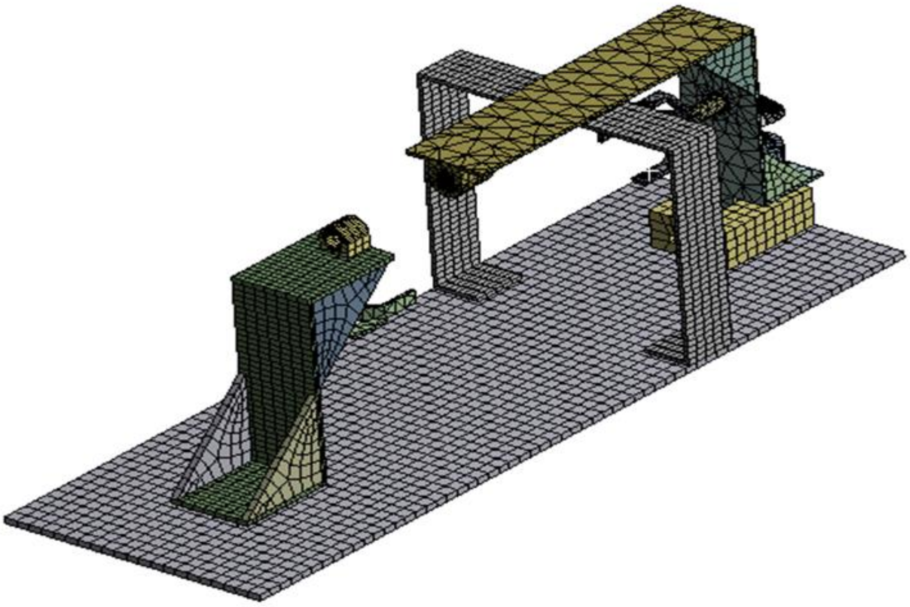
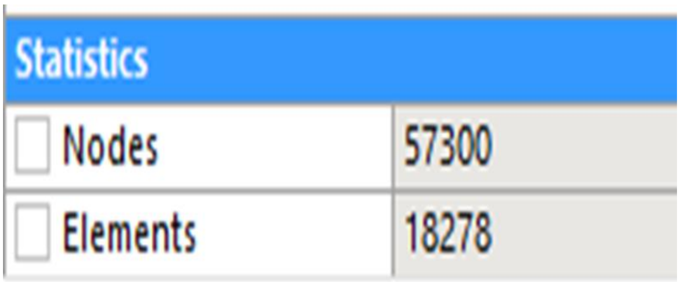


Fig-14

NODES AND ELEMENTS:



Statistics	
☐ Nodes	57300
☐ Elements	18278

Fig-15

6.3 STATIC ANALYSIS OF FRAME BOUNDARY CONDITION:

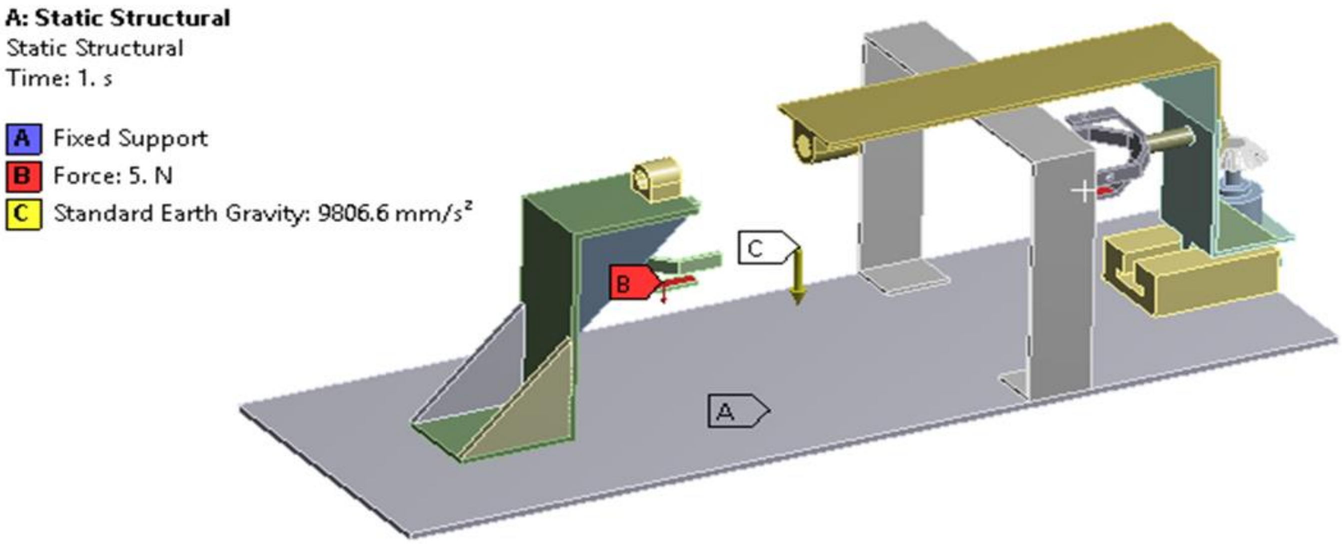


Fig-16

As the bone is being clamped on the clamps which has weight of 500 gram than 5 N of force is applied on the clamp and also the standard gravitational force will also act on the frame.

6.4 RESULTS AND PLOT OF THE ANALYSIS:

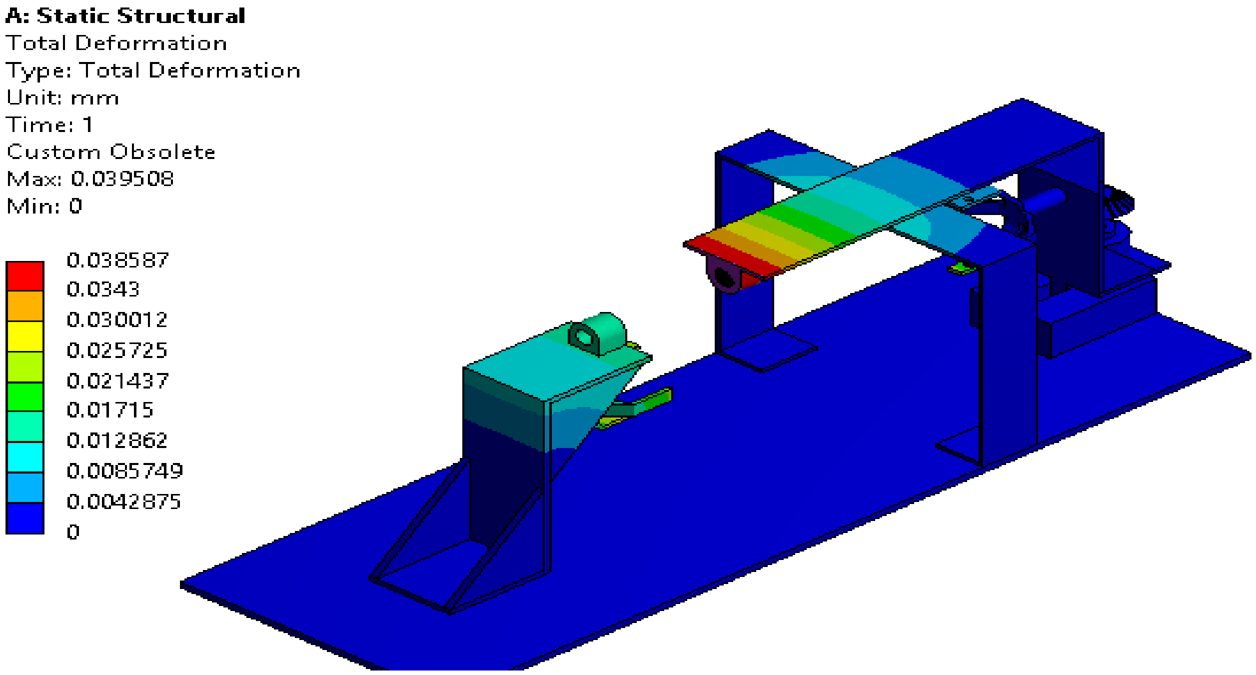


Fig-17

TOTAL DEFORMATION IS 0.0386MM

6.5 EQUIVALENT STRESS PLOT OF FRAME:

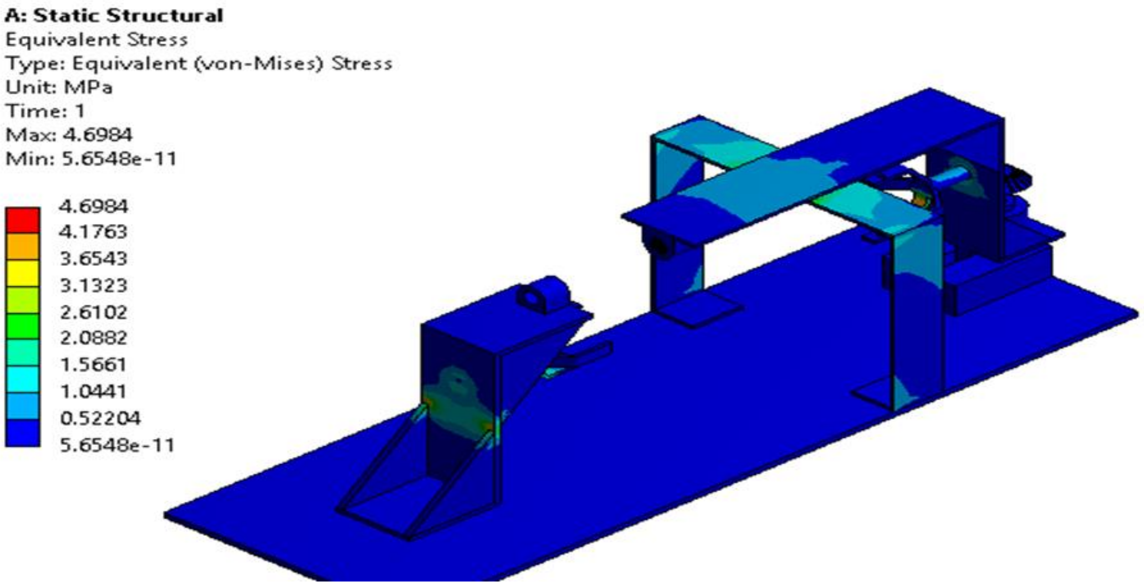


Fig-18

EQUIVALENT STRESS IS OBSERVED TO BE 4.6984 MPa

6.6 MAXIMUM PRINCIPLE STRESS PLOT:

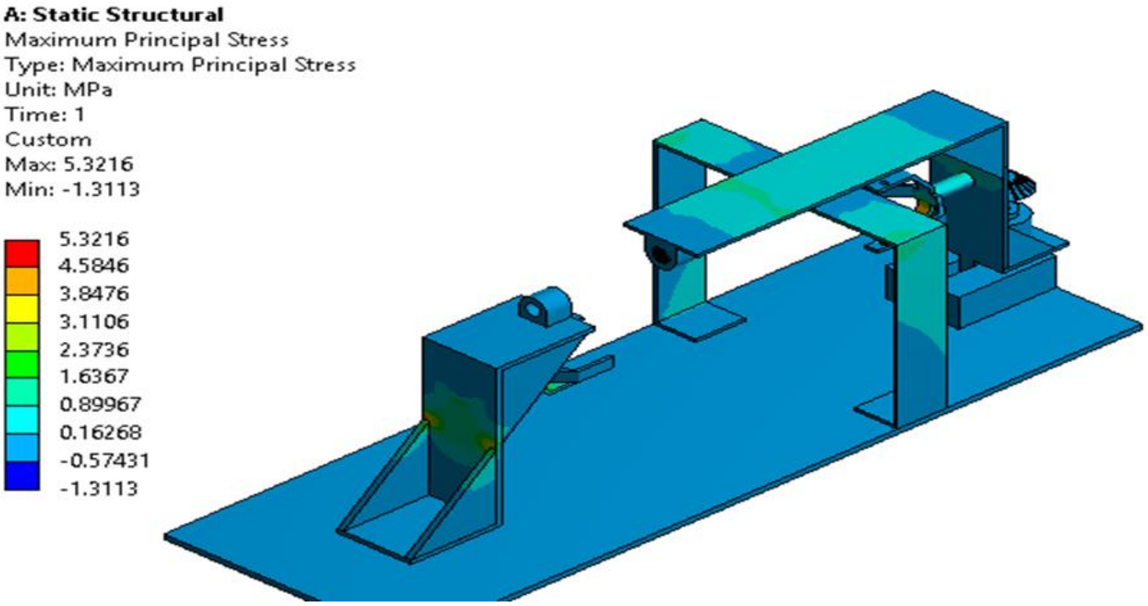


Fig-19

MAXIMUM PRINCIPLE STRESS IS 5.32 MPa

As we have done static structural analysis of the frame, we have plotted the results of total deformation or defection of the chassis. The stresses that are being developed inside the chassis and also the maximum principle stress induced inside chassis. As the yield strength of the material is greater than the stresses developed inside chassis. So the design is safe.

7. CONCLUSIONS:

1. The significant targets and related work plan can be extensively compressed as:

i. To study the working principle, components and details of the equipment.

ii. To create a solid model of the basic structure which aligns the bones.

2.It reduces (halves or more) treatment time required for complete healing and alignment of bone.

3. Significantly reduces pain through which the patient is suffering during treatment period.

4. Treatment will be done in very minimal cost.

8. ACKNOWLEDGEMENT

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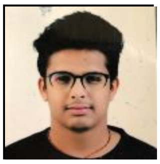
BIOGRAPHIES



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