INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X
Impact factor: 4.295
(Volume3, Issue6)
Available online at www.ijariit.com

Analysis of Knee Joint in Various Postures and Finite Element Analysis on Tibia

Badari Bheema Rao
Department of Mechanical Engineering
Indo American Institutions Technical Campus, Anakapalli, Visakhapatnam, Andhra Pradesh
bheema961@gmail.com

G. Siva Karuna
Department of Mechanical Engineering
Visakha Institute of Engineering and Technology, Visakhapatnam, Andhra Pradesh
sivakaruna123@gmail.com

Laveti Santhosh Kumar
Department of Mechanical Engineering
Gayatri Autonomous College, Andhra Pradesh
santhosh.edu92@gmail.com

Abstract: The knee is one of the most frequently injured joint in the human body. A recent study suggests that compressive loads on knee may play a vital role in injury to knee joint parts. This project is focused on the axial compressive force tibia, using that the radial force on the knee cap can also calculate. The compressive force is determined by Tibia in different postures like standing, stepping up, stepping down and in 90^0 bent of the knee using mechanics. Stresses at different points were identified using FEM on Tibia.

Keywords: Bio Mechanics, Knee Cap, Biomechanics.

1.1 NTRODUCTION TO BIOMECHANICS

Biomechanics is the science of movement of a human body in which muscles, bones, tendons, and ligaments work together for the movement of the human body. The mind is to control the movements of a machine. The intrinsic mechanics of this machine gradually became clear through the work of the scientists.

1.2 INTRODUCTION TO HUMAN BODY

Humans possess a unique physical structure that enables them to stand up against the pull of gravity. Humans and animals utilize contact forces to create movement and motion. The biggest part of the human body is the trunk; comprising on the average 43% of the total body weight. Head and neck account for 7% and upper limbs 13% of the human body by weight. The thighs, lower legs, and feet constitute the remaining 37% of the total body weight. The frame of the human body is a tree of bones that are linked together by ligaments in joints called articulations. There are 206 bones in the human body. Bone is a facilitator of movement and protects the soft tissues of the body. Unlike the frames of human-made structures such as that of skyscrapers or bridges, the skeleton would collapse under the action of gravity if it were not pulled on by skeletal muscles. Approximately 700 muscles pull on various parts of the skeleton. These muscles are connected to the bones through cable-like structures called tendons or to other muscles by flat connective tissue sheets called Apo neuroses. About 40% of the body Weight is composed of muscles.

1.3 INTRODUCTION TO KNEE JOINT

The knee joint is the largest joint in the body and is considered the most complicated one, consisting of 4 bones and an extensive network of ligaments and muscles. The knee joins the thigh bone (femur) to the leg bone (tibia). The smaller bone that runs alongside the tibia (fibula) and the kneecap (patella) is the other bones that make the knee joint. It enables rotating movements as the connection between the upper and lower leg. This means that we can not only bend the lower leg backward but also rotate the lower leg and foot towards the upper leg. Particular challenges are presented for the knee joint function. It must be fairly flexible while walking and bending and, at the same time, it is supposed to offer humans great stability while standing up. The knee joint has 6 degrees of freedom, 3 rotations, and 3 translations.

The knee joint is surrounded by a joint capsule. The capsule is lined internally by a mucous membrane which produces synovial fluid, also known as synovia. It must be present in sufficient quantity in the required consistency. Just like a bike chain which must always be well lubricated so that nothing squeaks.

Like most articulating joints, the opposing bone areas are covered by a layer of cartilage so that the desired knee joint function is fulfilled properly. This smooth, firm and elastic layer ensure that the knee moves easily and without friction. The major constituent of the cartilage is water and only a fifth is composed of collagen fires.

Healthy cartilage is like a sponge during compression, metabolic products are squeezed outward and, during relaxation, nutrients can go inward. The cartilage is nourished in this way since it is not supplied by blood vessels.

The knee joint is flexed, and attached to the bone of the thigh. Various forces act on the knee. Excessive pressure on the knee parts is due to over load in various activities, which effects the functioning of the knee. Knee ligament injuries are common particularly in the field of sports and related activities. Rupture of hose ligaments causes an imbalance between knee Movement and stability, which results in abnormal knee kinematics and damage the tissues in and around the joint that lead to severe pain.

2.0 ANATOMY OF KNEE JOINT

The knee is made up of four main bones - the femur or thigh bone, the tibia which is known as the shin bone, the fibula or outer shin bone and patella or kneecap. The main movements of the knee joint occur between the femur, patella, and tibia. Each is covered in articular cartilage which is an extremely hard, smooth substance designed to decrease the frictional forces as movement occurs between the bones.

Figure 1

The patella lies in an indentation at the lower end of the femur known as the inter condylar groove. At the outer surface of the tibia is the fibula, a long thin bone that travels right down to the ankle joint. The function of the tibia is predominantly loading bearing whilst the function of the fibula is predominantly to provide a surface for muscles to attach to.

2.1 FEMUR: The femur, or thigh bone, is the most proximal (closest to the center of the body) bone of the leg in tetrapod vertebrates capable of walking or jumping, such as most land mammals, birds, many reptiles such as lizards, and amphibians such as frogs. In vertebrates with four legs such as dogs and horses, the femur is found only in the rear legs.

The femur is the only bone in the thigh. The femur is the longest, heaviest and by most measures the strongest bone in the human body. Its length is 26% of the person's height, a ratio that is useful in anthropology because it offers a basis for a reasonable estimate of a subject's height from an incomplete skeleton.

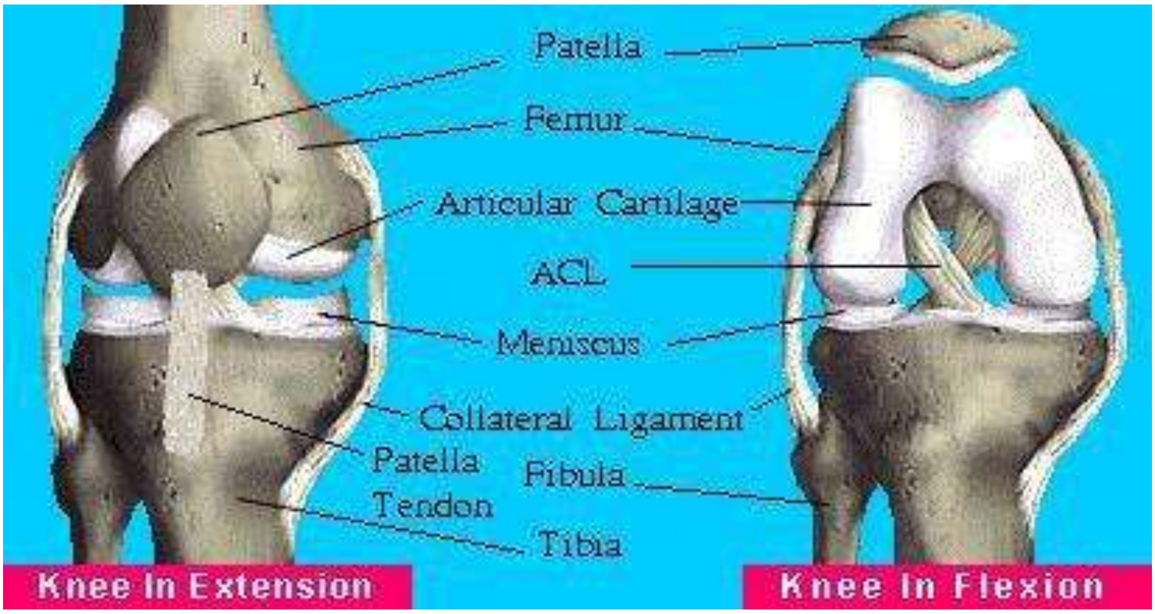


Figure 2

2.2 TIBIA

The tibia also is known as the shinbone or shank bone, is the larger and stronger of the two bones in the leg below the knee in vertebrates (the other being the fibula), and it connects the knee with the ankle bones. The tibia is found next to the fibula on the medial side of the leg, closer to centre-line. The tibia is connected to the fibula by an interosseous membrane, forming a type of joint called a syndesmosis with very little movement.

In human anatomy, the tibia is the second largest bone next to the femur. As in other vertebrates, the tibia is one of two bones in the lower leg, the other being the fibula, and is a component of the knee and ankle joints.

2.3 FIBULA

The fibula or calf bone is leg bone located on the lateral side of the tibia. The fibula does not carry any significant load (weight) of the body. It extends past the lower end of the tibia and forms the outer part of the ankle providing stability to this joint. It has grooves for certain ligaments which gives them leverage and multiplies the muscle force.

2.4 PATELLA

The patella also knew as the kneecap or knee pan, is a thick, circular-triangular bone which articulates with the femur (thigh bone) and covers and protects the anterior articular surface of the knee joint. In humans, the patella is the largest seamed bone in the body.

The patella helps to support the work of the quadriceps muscles during the contraction of the quadriceps that allows for the extension of the knee. The functions of the patella are:

- Protect femur joint surface
- Distribute pressure
- Adjust joint force
- Decreases friction
- Helps to distribute the compressive forces that are placed on the femur

2.5 MUSCLE GROUPS SURROUNDING THE KNEE JOINT

The muscles responsible for the movement of the knee joint belong to either the anterior, medial or posterior compartment of the thigh. The two main muscle groups of the knee joint are the quadriceps and the hamstrings. Both play a vital role, both moving and stabilizing the knee joint. The quadriceps muscle group is made up of four different individual muscles which join together forming the quadriceps tendon. This thick tendon connects the muscle to the patella which in turn connects to the tibia via the patella tendon**.** Contraction of the quadriceps pulls the patella upwards and extends the knee. The quadriceps muscles consist of the biceps femora’s, vast us medial is, vast us intercedes and vast us laterals muscles.

The hamstring muscles at the back of the thigh function in flexing or bending the knee as well as providing stability on either side of the joint line. The hamstring muscles consist of the biceps femora’s, semitendinosus and semimembranosus.

The Quadriceps Mechanism is made up of the patella (kneecap), patellar tendon, and the quadriceps muscles (thigh) on the front of the upper leg. The patella fits into the patella of the amoral groove on the front of the femur and acts as a fulcrum to give the leg its power. The patella slides up and down the groove as the knee bends. When the quadriceps muscles contract they cause the knee to straighten. When they relax, the knee bends.

2.6 LIGAMENTS OF THE KNEE JOINT

The stability of the knee owes greatly to the presence of its ligaments. Each has a particular function in helping to maintain optimal knee stability in a variety of different positions.

- **Medial Collateral Ligament** (tibia collateral ligament)–attaches the medial side of the femur to the medial side of the tibia and limits sideways motion of your knee.

- **Lateral Collateral Ligament** (fibular collateral ligament)–attaches the lateral side of the femur to the lateral side of the fibula and limits sideways motion of your knee.

  Anterior Cruciate Ligament –attaches the tibia and the femur in the center of your knee; it's located deep inside the knee and in front of the posterior cruciate ligament. It limits Rotation and forwards motion of the tibia.

- **Posterior Cruciate Ligament** –is the strongest ligament and attaches the tibia and the femur; it's also deep inside the knee behind the anterior cruciate ligament. It limits the backwards motion of the knee.

- **Patellar ligament** –attaches the kneecap to the tibia.

Figure 3

The medial Collateral Ligament or MCL for sport is a band that runs between the inner surfaces of the femur and the tibia. It resists forces acting from the outer surface of the knee called valgus forces and prevents the knee from collapsing inwards. The medial knee ligament has two parts to it; an inner part which attaches to the cartilage meniscus on the inside of the knee and an outer part with attaches to the tibia bone.

The lateral Collateral Ligament or LCL is on the outside of the knee and joins the outer surface of the femur to the head of the fibula. It resists impacts from the inner surface of the knee known as virus forces. The anterior Crucial Ligament or ACL is one of the most

Important structures in the knee, not least because injury to it may require extensive surgery and rehabilitation. The crucial ligaments are so called because they form a cross in the middle of the knee joint.

2.7 TENDONS

Tendons are bundles or bands of strong fibres that attach muscles to bones. A tendon (or sinew) is a tough band of fibrous connective tissue that usually connects muscle to bone and is capable of withstanding tension. Tendons are similar to ligaments and fasciae; all three are made of collagen. Ligaments join one bone to another bone; fasciae connect muscles to other muscles. Tendons and muscles work together to move bones.

Tendons are elastic tissues that technically part of the muscle and connect muscles to bones. Many of the tendons serve to stabilize the knee. There are two major tendons in the knee – the quadriceps and patellar. The quadriceps tendon connects the quadriceps muscles of the thigh to the kneecap and provides the power for straightening the knee. It also helps hold the patella in the patella femoral groove in the femur. The patellar tendon connects the kneecap to the shinbone (tibia) - which means it's really a ligament

2.8 MENISCUS

The articular disks of the knee-joint are called menisci because they only partly divide the joint space. These two disks, the medial meniscus, and the lateral meniscus, consist of connective tissue with extensive collagen fibres containing cartilage-like cells. Strong

Figure 4

Fibres run along the menisci from one attachment to the other, while weaker radial fibres are interlaced with the former. The menisci are flattened at the centre of the knee joint, fused with the synovial membrane laterally, and can move over the tibia surface.

The menisci serve to protect the ends of the bones from rubbing on each other and to effectively deepen the tibia sockets into which the femur attaches. They also play a role in shock absorption, and may be cracked, or torn, when the knee is forcefully rotated or bent. The Functions are menisci are load bearing capacity, stability, provides joint lubrication and acts as shock absorbers.

2.9 CARTILAGE

Cartilage is a thin, elastic tissue that protects the bone and makes certain that the joint surfaces can slide easily over each other. Cartilage ensures supple knee movement. There are two types of joint cartilage in the knees: fibrous cartilage (the meniscus) and hyaline cartilage. Fibrous cartilage has tensile strength and can resist pressure. Hyaline cartilage covers the surface along which the joints move. Cartilage will wear over the years. Cartilage has a very limited capacity for self-restoration. The newly formed tissue will generally consist of a large part of the fibrous cartilage of lesser quality than the original hyaline cartilage. As a result, new cracks and tears will form in the cartilage over time. It is not as hard and rigid as a bone but is stiffer and less flexible than muscle.

ANALYSIS OF KNEE JOINT

3.0 FORCES ACTING ON KNEE WHILE STANDING

A person is standing stationary. We shall analyse the forces acting on the knee while standing on both legs. The person has a self-weight of W and these acts at Centre of gravity of the whole body and vertically down wards. The normal reaction of the floor on the foot has a magnitude equal to W/2 since the person is standing on both legs.

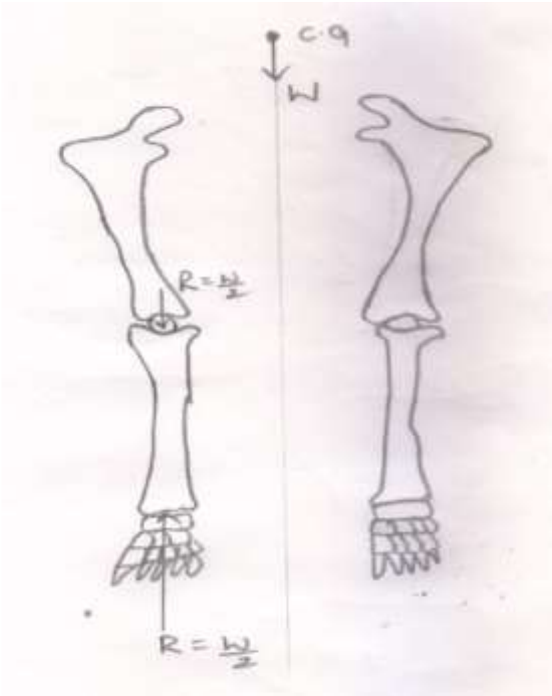


Figure 5

ANALYSIS

Since the person is stationary, the vertical components of the forces are equal to zero.

$$\sum F_y = 0$$

R = W/2

Here W = Body weight

Therefore when the person is standing on both the legs the force acting on the knee is half of the body weight.

3.2 FORCES ACTING ON KNEE DURING ASCENDING STAIRCASE

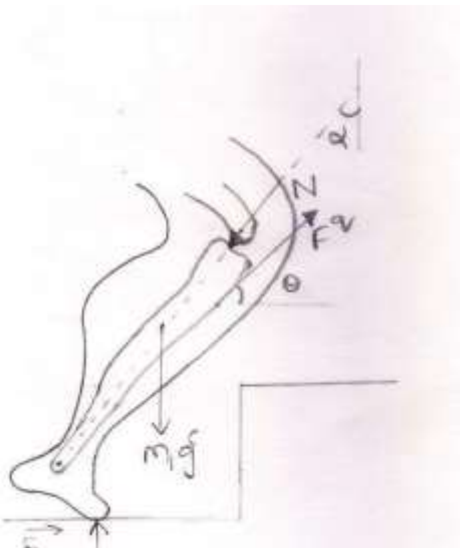


Figure 6

Let us consider a person of mass 60kg who is ascending a stair case

m_1g = Weight of leg which is approximately 1/10th of the body weight
R = Normal reaction from ground
N = Axial compressive force on leg bone (tibia)
F^q = Quadriceps muscle force
α = Angle made by N with vertical
θ = Angle made by F^q with horizontal From the configuration,

$$\sum F_x = 0$$

$$F^q cos\theta = N sin\alpha$$

$$\sum F_y = 0$$

$$F^q sin\theta + R = m_1 g + N cos\alpha$$

We conducted experiment on a male human body of mass 60 kg, so m_1= (1/10)*60kg; R=60 ×9.81 and we found that α=15^0 and the corresponding θ=50^0 by substituting these values in the above equations

$$F^q cos15 = N sin50$$
$$F^q sin15 + 60 \times 9.81 = 6 \times 9.81 + N cos50$$

The solution to all of these equations is,

$$N = 1208.56\ newtons$$

Therefore it is clear that 1208.56 newtons is greater than twice the weight of a man, that acts on knee axially.

3.2 FORCES ACTING ON KNEE DURING DESCENDING STAIRCASE

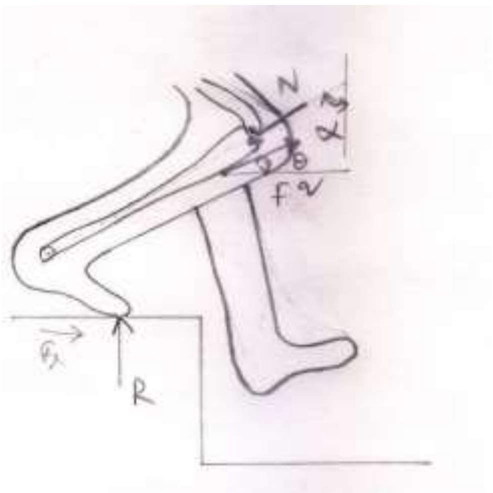


Figure 7

Let

m1g = weight of leg which is approximately 1/10th of the body weight

R = Normal reaction from ground

N = Axial compressive force on leg bone (tibia)

F^q = Quadriceps muscle force

α = Angle made by N with vertical

θ = Angle made by F^q with horizontal From the configuration,

$$\sum F_x = 0$$

$$F^q cos\theta = N sin\alpha$$

$$\sum F_y = 0$$

$$F^q sin\theta + R = m_1 g + N cos\alpha$$

We conducted the experiment on 60kg mass of the body so m1=10kg R=60 ×9.81 and we also found that α= 60^0 and the corresponding θ= 20^0 by substituting these values in the above equations

$$F^q cos20 = N sin60$$

$$F^q sin20 + 60 \times 9.81 = 6 \times 9.81 + N cos60$$

The solution to all of these equations is $N = 2858\, newtons$

Therefore the value 2858 newton's is greater than thrice of body weight that acts on knee axially compressing.

3.4 TENSOIN ACTING ON ACL

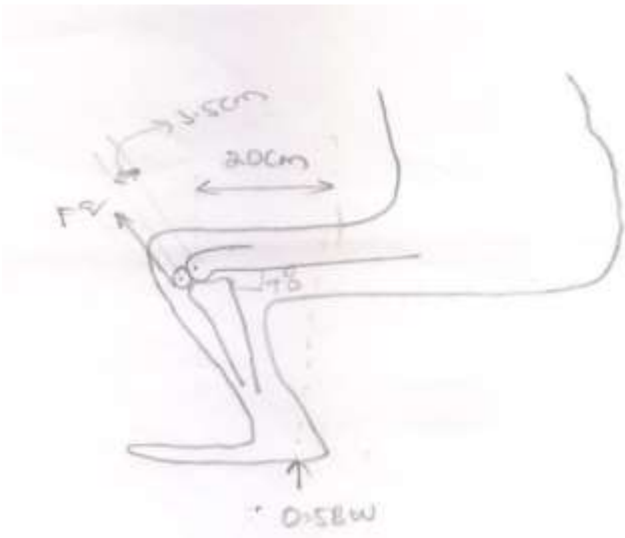


Figure 8

Let

F^q = Quadriceps muscle force

BW = Body Weight

From the Configuration,

$$\sum M_o = 0$$

$$F^q \times 3.5 = 0.5 \times BW \times 20$$

Here, we conducted the experiment on the person whose mass is 60kg Therefore, BW =60 $\times 9.81$

By substituting this value in the above equation we get, F^q = 1681.71 newton's

The femur slides and then rotates about point (O) on the tibia.

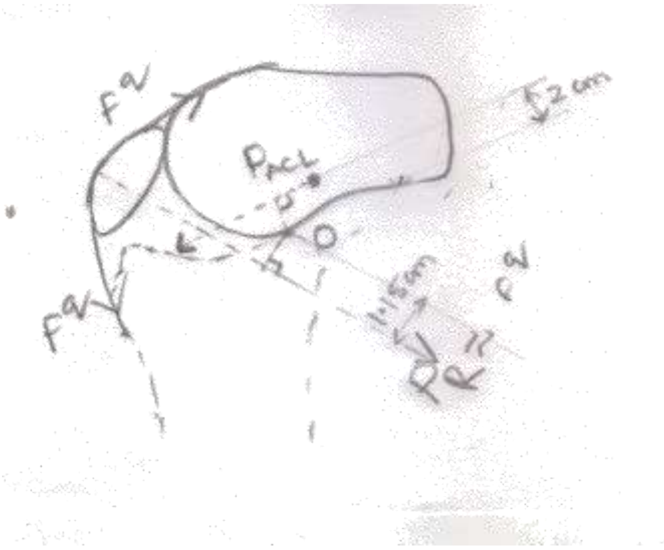
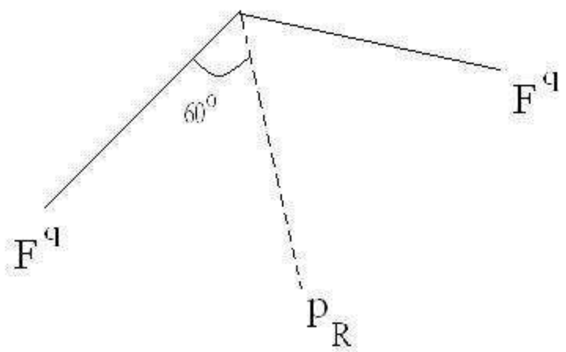


Figure 9

Here

PR = resultant of quadriceps forces (F^q) on patella
PACL = the tensile force on ACL



From parallelogram law of forces

$$PR = \sqrt{F_q^2 + F_q^2 + 2 \times F_q \times F_q \times cos120^0}$$

But, we found that PR = 1681.71N

By substituting this value in the above equation we get

PR = 1681.71N

∑MO = 0

PACL × 2 = PR× 1.15

$$PACL \times 2 = 1681.71 \times 1.15$$

$$PACL = 966.98 \text{ newton's}$$

3.4.1 MAXIMUM DEFLECTION OF ACL

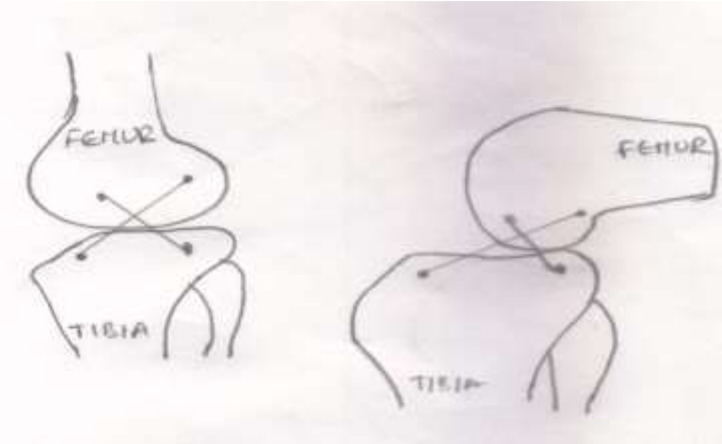


Figure 10

Stiffness of ACL, k = 242 N/mm

Tension in ACL, $F = k \times x$

$x = F / k$

$x = 966.98 / 242$

Therefore maximum deflection of ACL, x = 3.99 mm

STRESS ANALYSIS

In the chapter-3, we found that forces acting on the knee while standing, ascending staircase and descending staircase. Now we analyse stresses acting on tibia surface. The tibia surface area is A = 65mm × 43mm

4.1 STRESS ACTING ON KNEE WHILE STANDING

Stress acting anti biasurface while standing, $\sigma C = \dfrac{\text{Force acting on knee while standing}}{\text{Tibial surface area}}$

$$\sigma C = \frac{0.5 \times 60 \times 9.81}{65 \times 43}$$

$$\sigma_C = 105.29\ KPa$$

Therefore stress on the tibia surface while standing is 105.29 KPa

4.2 STRESS ACTING ON KNEE DURING ASCENDING STAIRCASE

Stress acting on tibia surface while ascending staircase,

$$\sigma_c = \frac{\text{Force acting on knee while ascending staircase}}{\text{Tibial surface area}}$$

$$\sigma_c = \frac{1203}{65 \times 43}$$

$$\sigma_c = 432.2\ KPa$$

Therefore stress on the tibia surface while ascending staircase is $432.2 KPa$

$$\sqrt[3]{\frac{F}{\Delta^2}\left[\frac{1}{R_1}-\frac{1}{R_2}\right]^2}$$

4.3 STRESS ACTING ON KNEE DURING DESCENDING

STAIRCASE

Stress acting on tibia surface while descending staircase,

$$\sigma_c = \frac{Force\ acting\ on\ knee\ while\ descending\ staircase}{Tibial\ surface\ area}$$

$$\sigma_c = \frac{2858}{65\times43}$$

$$\sigma_c = 1022.5\ KPa$$

Therefore stress on the tibia surface while descending staircase = σ_c =1022 5KPa

4.4 CONTACT STRESSES ON KNEE JOINT

Let us simplify the analysis by considering two bones as configuration shown in fig. below

The lower end of the femur have a convex surface of R1 Radius and the tibia upper part has surfaced with R2 Radius.

And R1< R2

Here R1 = Radius of femur = 50mm

R2 = Radius of Tibia = 100mm

While knee bends as shown in figure,

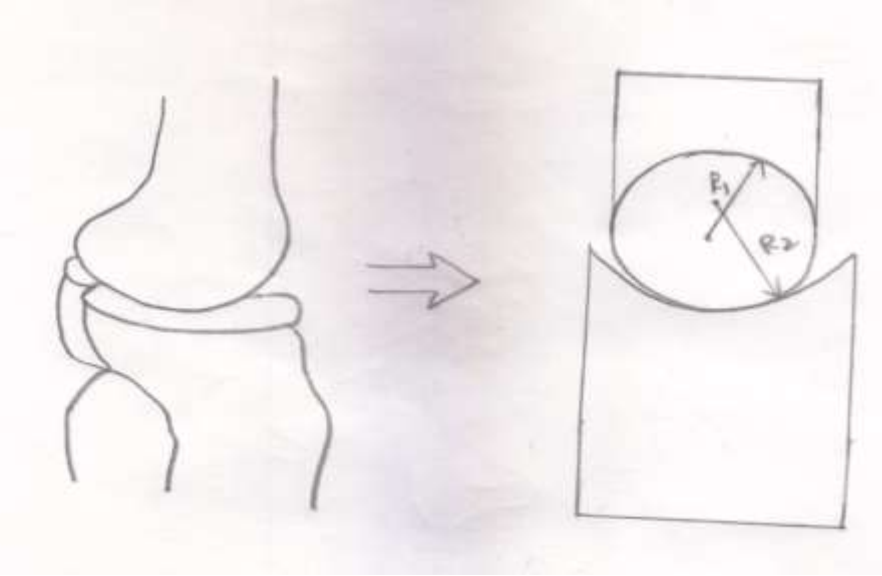


Figure 11

4.4.1 HERTZ CONTACT STRESS ON KNEE JOINT

Let us analyse contact stresses on knee using Hertz contact stresses theory, According to Hertz contact stresses theory

Maximum contact pressure, p=0.578

Where $\Delta =$ Material Property

F = resultant of quadriceps forces on patella

= 1681.71N

Material Property $\Delta = \frac{1-\upsilon_1^2}{E_1} + \frac{1-\upsilon_2^2}{E_2}$

Here υ_1 = Poisson's ratio of Cartilage of Femur

υ_2 = Poisson's ratio of Menisci on tibia

E1 = Modulus of elasticity of Femoral Cartilage

E2 = Modulus of elasticity of Tibia Menisci

For Femur and Tibia Poisson's ratio, $\upsilon_1 = 0.46\ and\ \upsilon_2 = 0.49$ For Femur and Tibia Modulus of Elasticity's, E1 = 5 Mpa, E2 = 59 Mpa by substituting these values in the above equation,

We get,

Therefore Maximum contact pressure p=0.578 $\sqrt[3]{\frac{F}{\Delta^2}\left[\frac{1}{R_1} - \frac{1}{R_2}\right]^2}$

P=1.038MPa

5. SOLID MODELING AND STATIC FINITE ELEMENT ANALYSIS OF THE HUMAN TIBIA

Computer Tomography (CT) scans or Magnetic Resonance Imaging (MRI) constitute the input data required for modelling the human parts such as bones. Using those data we can make FEM model incorporating the material properties and the loading conditions which yield required results. Since bone is an anisotropic material the properties in three directions must be used. In this project, we got the dimensions through various papers and the MRI scans. We used the anisotropic properties of the tibia bone.

5.1 PROCESS OF CREATING FEM MODEL OF TIBIA

1. We analysed the tibia of 21 year old male of weight 60 kg and tibia length 30 cm and the area of the top of the tibia as 6.5*4.3 cm^2.
2. We used the multi section solid command to get different cross sections.
3. We neglected the fibula since it carries no load.
4. Later we cut him top of the tibia with a surface having profile same as that of tibia surface.
5. Later it is saved in igs. file

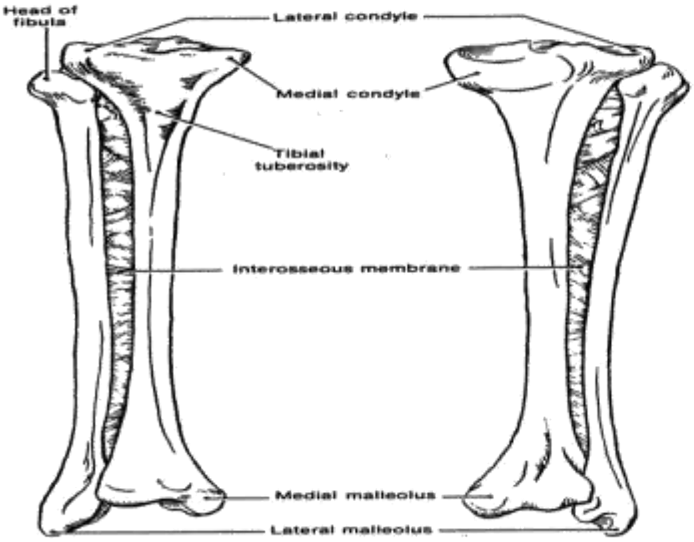


Figure 12

5.2 DIFFERENT VIEWS OF MODEL IN CATIA

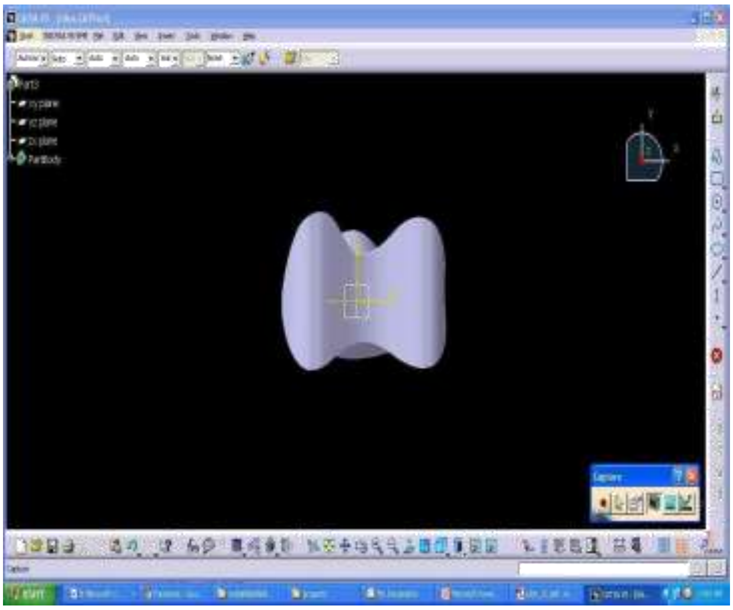


Fig 13

Figure 14

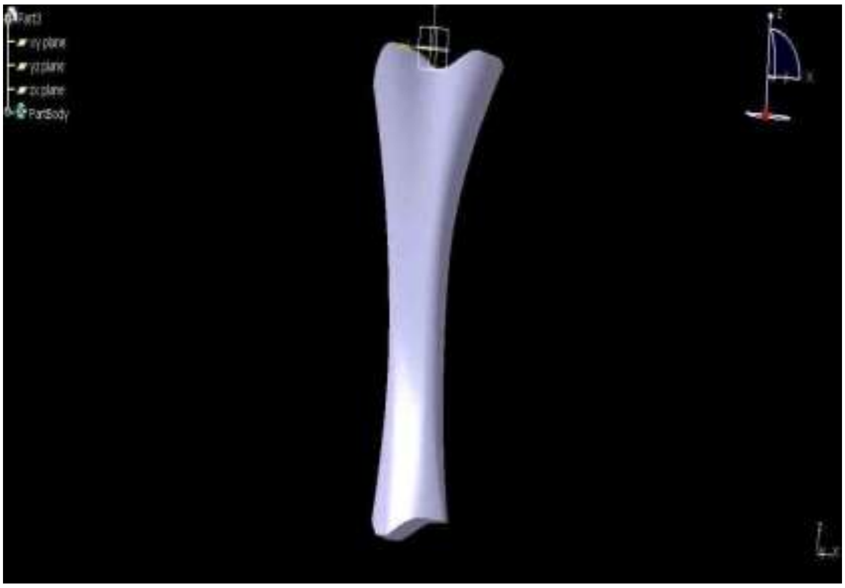


Figure 15

5.3 FEM MODEL FOR ANALYSIS OF TIBIA

1. The CATIA file saved in .igs file is imported in ANSYS MECHANICAL APDL SOFT WARE.
2. Later the material properties were given such as the Young's Modulus and Poisson ratio in all three directions.

MATERIAL PROPERTY	VALUE	
E1	4.48	Gpa
E2	4.48	Gpa
E3	9.64	Gpa
G12	1.41	Gpa
G13	1.28	Gpa
G23	1.28	Gpa
12 (Poisson ratio)	0.35	
13	0.12	
23	0.12	
DENSITY	1.835 g/ cm^3	

3. We used 10 nodded solid tetrahedron as the mesh element.
4. The meshing was done in fine mesh mode.
5. Boundary conditions:
    a) Lower end of Tibia was fixed in all three DOF applied a uniform pressure of 210 kpa i.e the maximum pressure while standing was applied on the top of tibia
    b) In the similar boundary condition, a uniform pressure of 421 kpa was applied simulating the condition ascending stair case.
    c) A 631 kpa uniform pressure simulates the condition of descending stair case
    d) With lower end fixed a point load of 2000N was applied on edge parallel to the top surface.

5.4 IMPORTED .IGS FILE

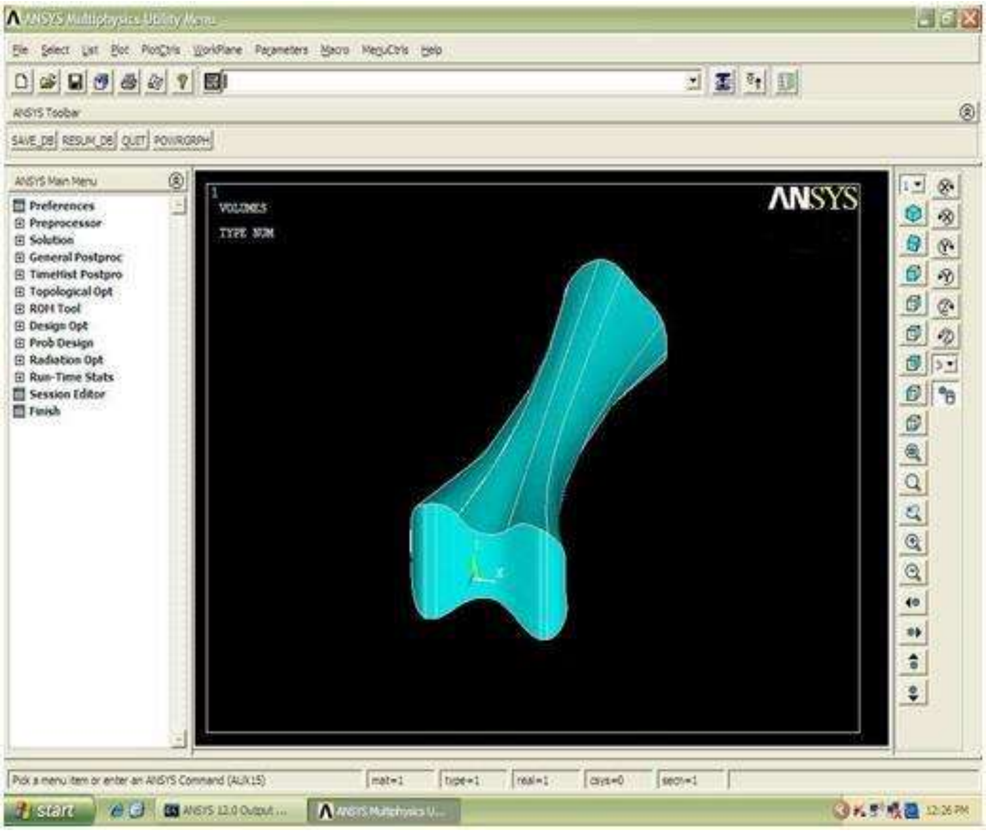


Figure 16

5.5 MESHED TIBIA

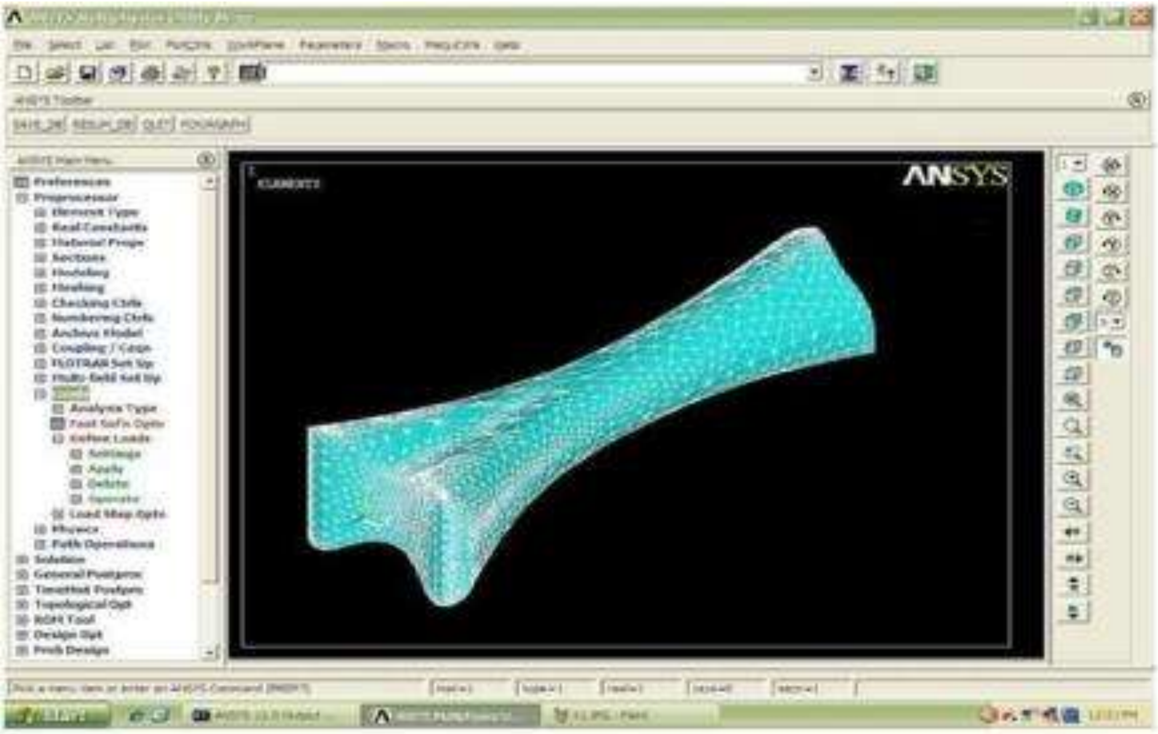


Figure 17
The element used is 10 nodded solid tetrahedron with 4723 elements.

5.6 TIBIA WITH BOUNDARY CONDITIONS

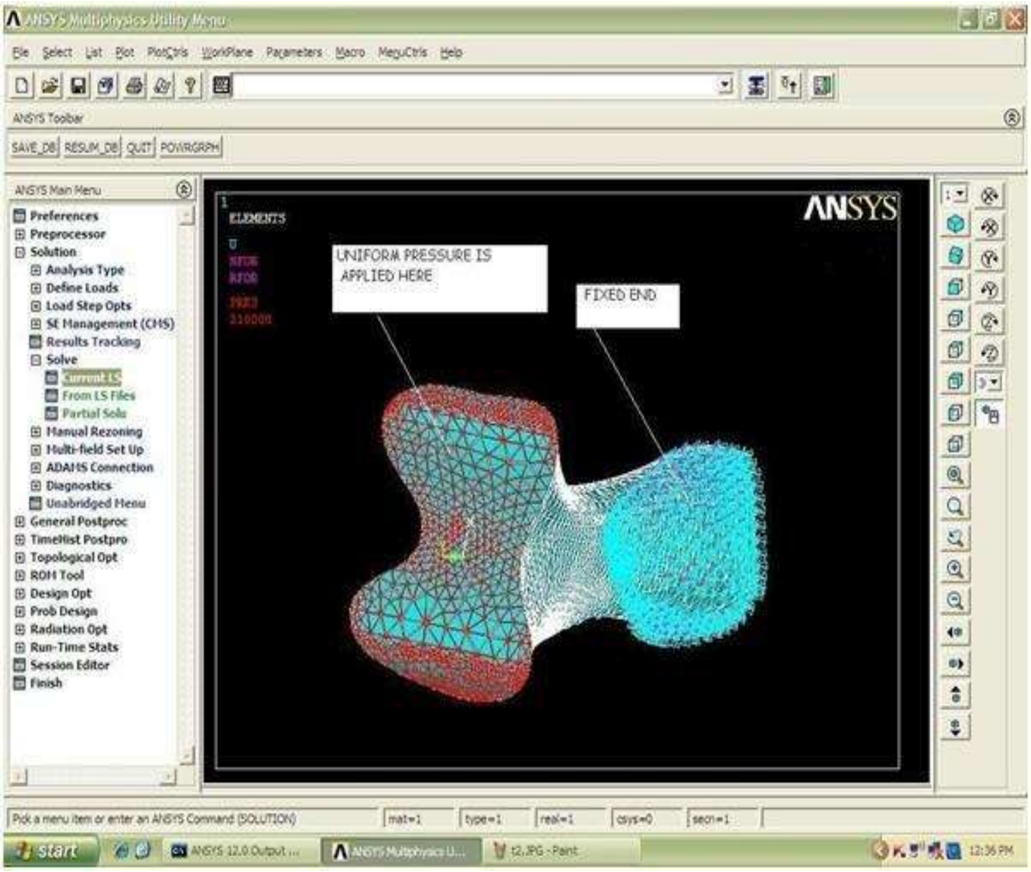


Figure 18
The lower end of the tibia was constrained in all three directions and a uniform Pressure of 210 kpa was applied on top surface.

5.7 DESCRIPTION OF RESULT OF ANALYSIS ON CREATED FEM MODEL:

5.7.1 STRESS IN STANDING

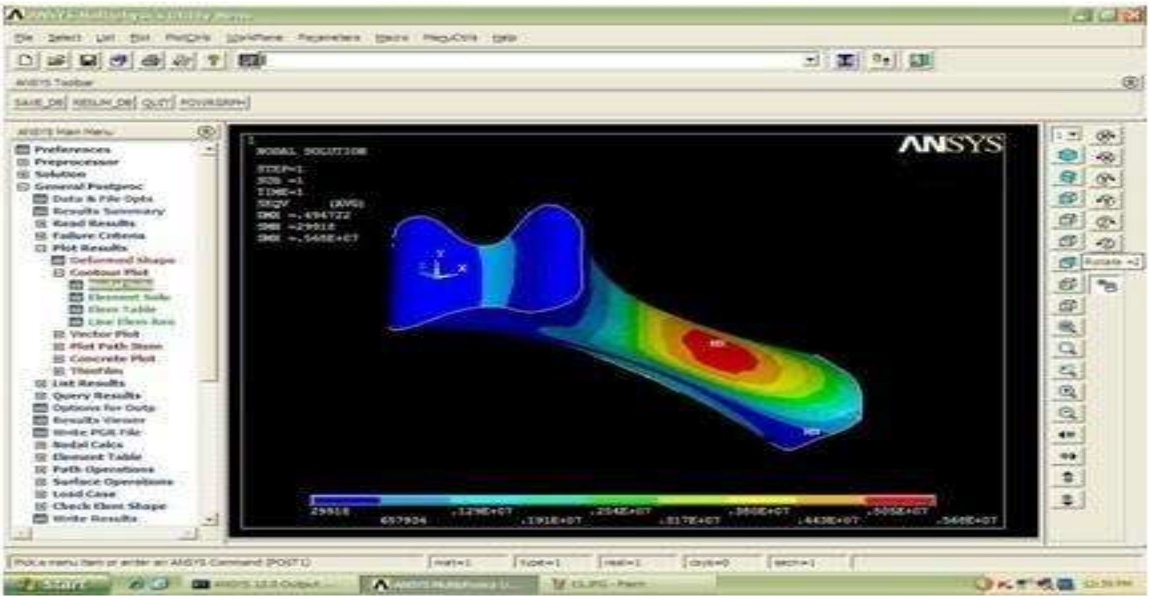


Figure 19
The maximum stressed zone is at 1/3 to 1/4 from the bottom.
For a given pressure of 210 kpa during standing, the maximum stress obtained is 5.6 pa

5.7.2 DEFORMED SHAPE IN STANDING

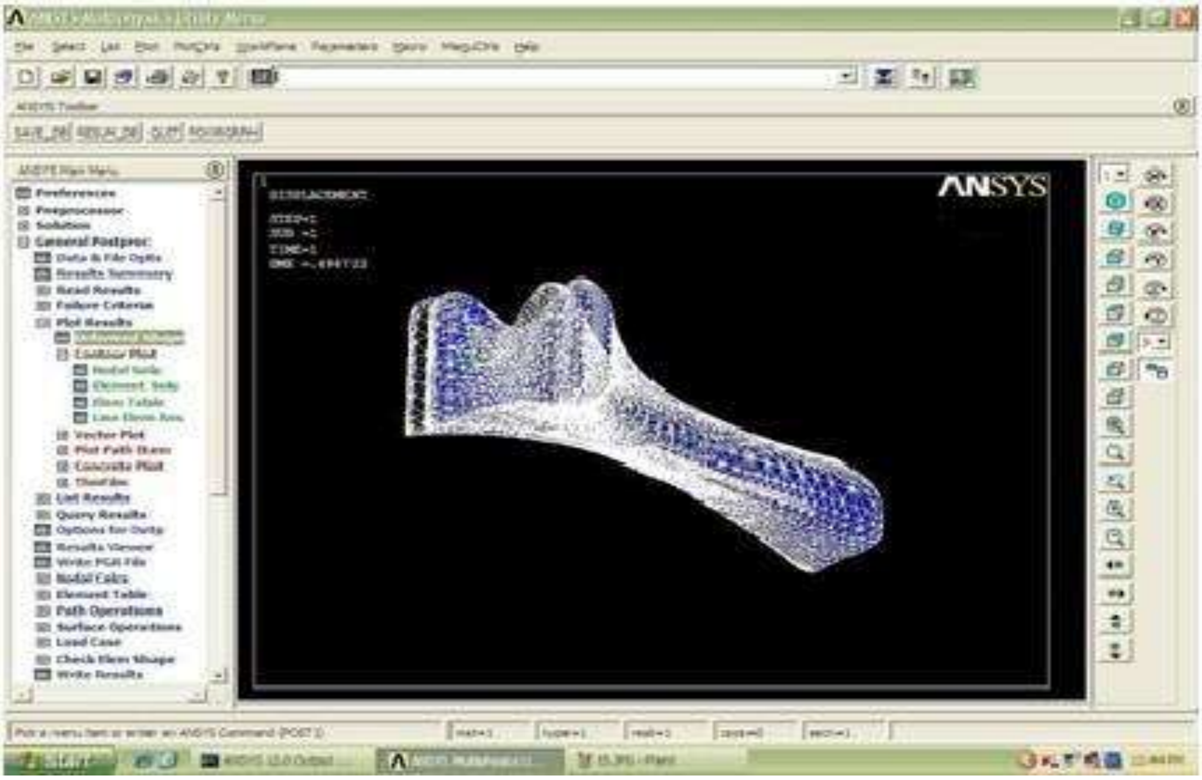


Figure 20

The maximum deformation occurred is 0.49 mm
A maximum stress of 11 MPa will act on the knee during ascending a stair case.

5.7.3 STRESS IN ASCENDING STAIRCASE

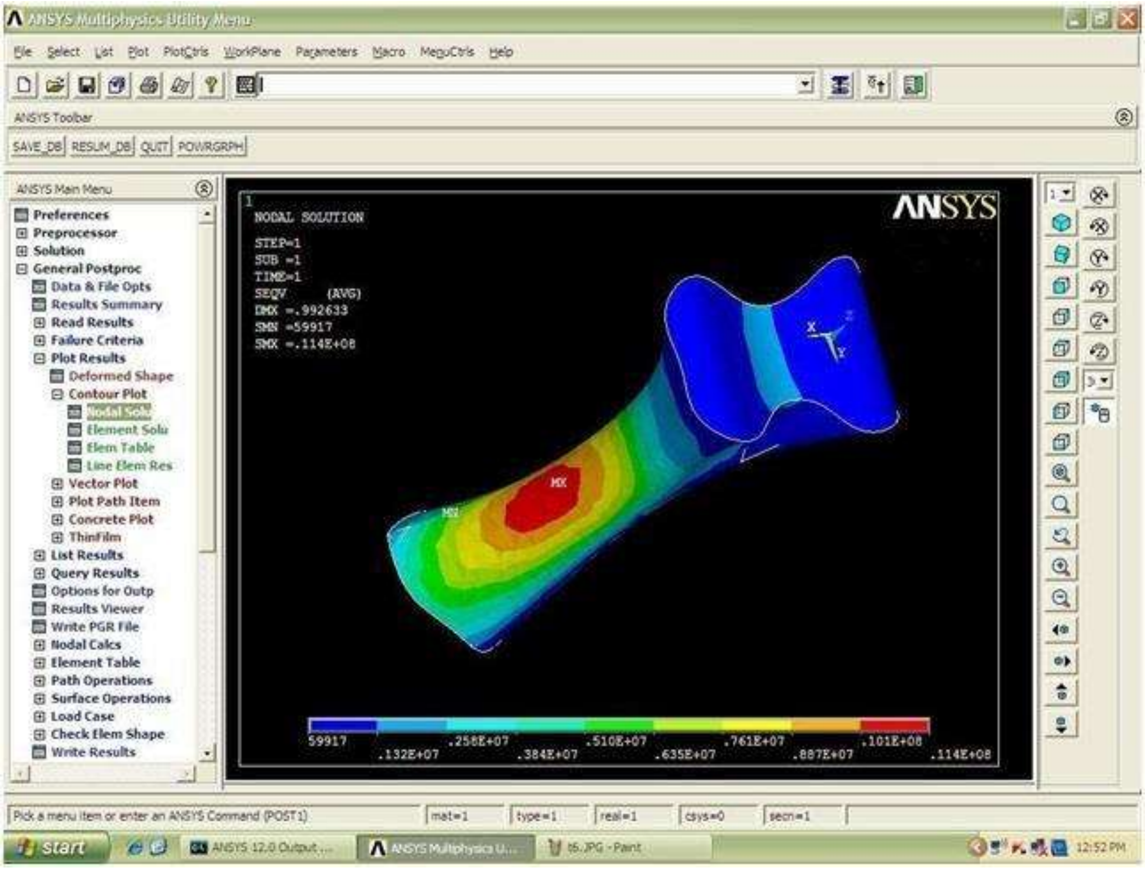


Figure 21

A maximum deformation of 1.489 mm occurs during stepping up

5.7.4 STRESS DURING DESCENDING STAIRCASE

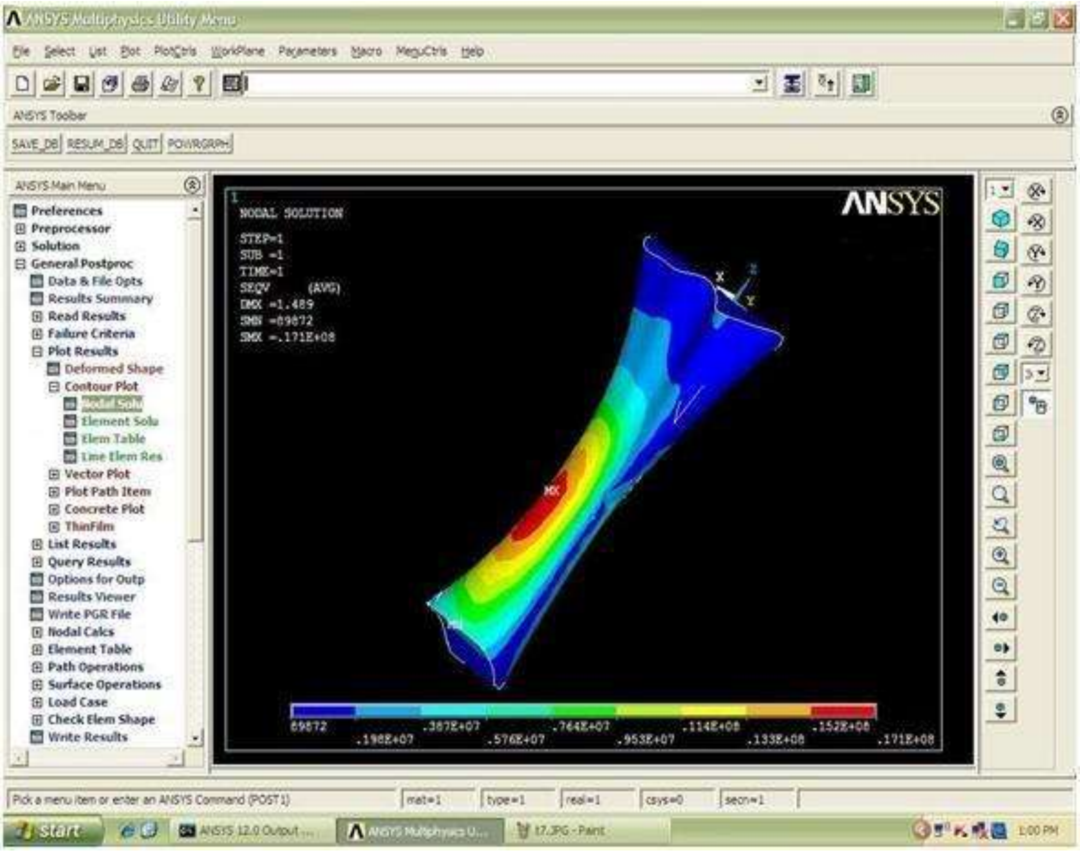


Figure 22

Maximum stress of 17 MPa will act on knee during descending of stair case

5.7.5 STRESS IN POINT LOAD APPLICATION

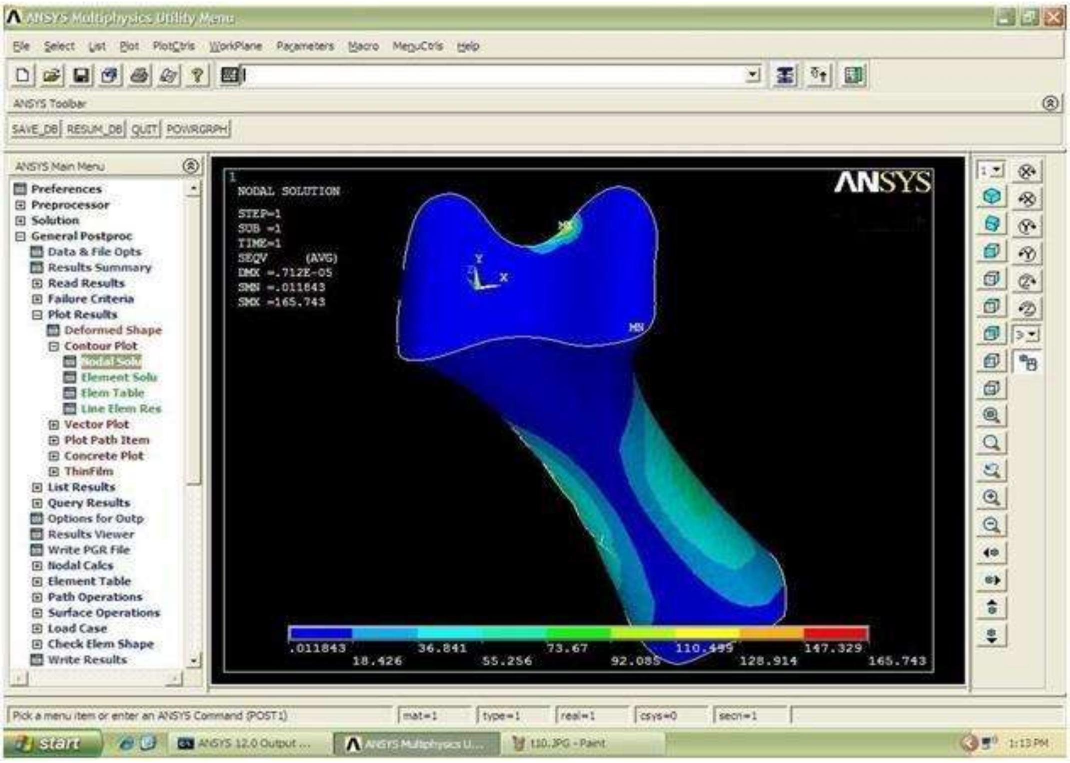


Figure 23

A maximum stress of 165 pa will act on an application of 2000 N force at edge parallel to surface

RESULTS

FROM MANNUAL CALCULATIONS CONSIDERING A MALE HUMAN OF 60 Kg BODY WEIGHT (BW)

1. Maximum axial compressive force act on knee during standing on both legs = BW/2
2. Maximum axial compressive force act on knee during ascending stair case = 2BW
3. Maximum axial compressive force act on knee during descending stair case = 3BW
4. Maximum deformation of ACL is 4mm
5. Stress acting on tibia surface during standing = 105 Kpa
6. Stress acting on tibia surface during ascending stair case = 432 Kpa
7. Stress acting on tibia surface during descending stair case = 1022 Kpa
8. Maximum Hertz contact pressure that acts on knee = 1.038 Mpa

FROM FINITE ELEMENT ANALYSIS

1. Maximum Compressive stress on tibia during standing posture = 5.6 Mpa
2. Maximum Compressive stress on tibia during ascending stair case = 11 Mpa
3. Maximum Compressive stress on tibia during descending stair case = 17 Mpa
4. Maximum stress act on edge parallel to tibia surface when a force of 2000N acts on tibia

CONCLUSIONS

Presently, many people above 50 years are being suffered from arthritis, due to excessive weight and also facing problems with meniscus wear, especially the sports people will face the damage of ligaments in which no perfect substitute is found so far and the number of people undergoing knee replacement was increasing and lot of research should be done in this area. The forces and stresses are being calculated, from these results, it is clear that more forces are exerted on the knee during staircase descent than accent and also the maximum stress will act 1/4 to 1/3 length of the tibia from the base. FEA analysis is done on the tibia with this stress distribution is identified.

