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# STUDY & ANALYSIS OF IMPLANTS USED IN HUMAN BODY

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## Abstract

Aim of this work is to study & analysis various implants used in human body. The study is conducted in three steps. First step is the measurement of the shape and size of the implant using commercial implants available in market. Second step is drafting of the implants using CAD (Computer Aided Design) software. Next step is importing the CAD model of the implants into ANSYS, Finite Element Analysis (FEA) software. After setting up various boundary conditions, the implants are analyzed and the stresses developed in the implants are obtained

**1.0 INTRODUCTION**

In human body there are various joint but following three joint are important in human body

1) Hip joint
2) Knee joint

**1.1 HIP JOINT**

There is one bone which connects the knee with hip is known as Thigh bone which also called as Femur. Femur is a largest and heaviest bone in the skeleton. There are two femurs in human body each of which carries half weight of human body, so weight is not cause of failure of hip joint.

1.1.1 TYPES OF FEMUR BONE FRACTURE

The femur is one of the largest and strongest bones in the body. The femur is the Thigh bone it extends from the hip joint down to the knee joint.A femur fracture occurs, either a large force must be applied or something is wrong with the bone. The most common causes of femur fractures include [1]

- Accidents
- Fall from a height

Many types of fractures about the hip joint are known as 'hip fractures'. The following femur fractures are commonly referred to as hip fractures. The differences between them are important because each factures treated differently.

- Femoral head fractureconsists of fracturing the femoral head. This is a result of high energy shock and a dislocation of the hip joint often accompanies this fracture.
- Femoral neck fracture denotes a fracture between the head and the greater trochanter. These fractures have a tendency to damage the blood supply to the femoral head, due to death of cell tissue associated with vessels.
- Intertrochanteric fracture denotes a break in which the fracture line is between the greater and lesser trochanter on the intertrochanteric line. It is the most common type of 'hip fracture' and it is avoided if the patient is healthy otherwise bony healthy.

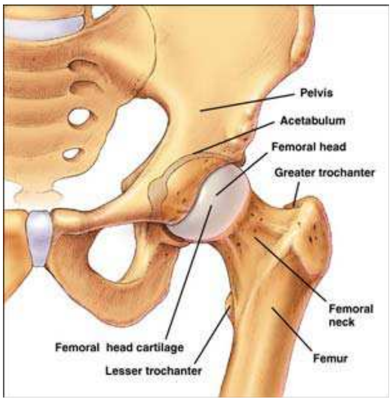



Fig. 1.1Normal working hip

1.1.2PATHOGENESIS/RISK FACTOR

- Subtrochanteric fractureactually involves the shaft of the femur which is immediately below the lesser trochanter.
- Osteoarthritisis the main reason of hip failure, where the cartilage of a person is broken down. Cartilage is the connective tissue that covers the head of the hip bones. When the cartilage is being worn away, the femoral head and the acetabulum will rub one another. This will cause wear on the bone Hip OA is a disorder of the entire joint, involving cartilage, bone, synovium, labrum, and capsule [2].Cartilage is avascular and anueral [3]
- Metastatic cancer deposits in the proximal femur may weaken the bone and cause a Pathological hip fracture.

## 2.0 KNEEJOINT

The knee joint is one of the largest as well as one of the most complex joint in human body. It is able to withstandextensive


Fig. 1.2Degenerated hip

strain and injury; also risks in everyday and occupational life as well asin sports.


Fig. 1.3 Knee Joint

However, people with anatomical Problems such as bowlegs or knock-knees may experience pain. Normal age relatedprocesses and excess weight, as well as physical inactivity, can lead to wear and t ear on the joint. [4]

2.1 ANATOMY AND PHYSIOLOGY

The round femoral knuckles or condyles lieo n theflat tibial plateau, this joint is bent or extended as its rolling or gliding every time. This occurs only if the cartilage layer is intact; the function of cartilage layer is to continuously lubricate a gliding surface by synovial fluid. A thin fibrous cartilage between a surfaces of joint secure firmly outwards and inward on the tibial plateau. Theligament stabilizesthe joint; in order to prevent the femur and tibial plateau from the outward or inward bending under normal condition. The anterior and posterior crcuiate ligments provide additional stailization, so that the tibial plateau is also firmly secure in place to prevent it from slipping too far to the front or back

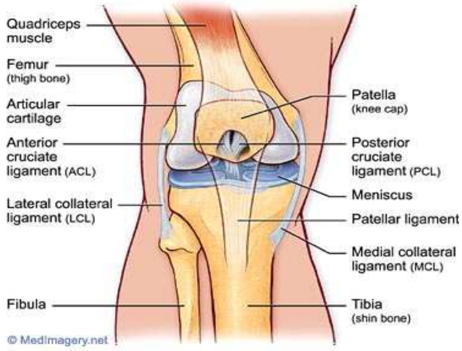



Fig.1.4Normal working Knee

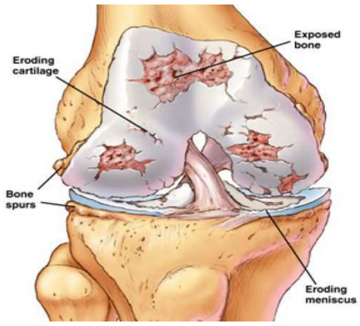



Fig.1.5 Degenrated Knee

**3.0 IMPLANTS**

An object made from non-living material that is deliberately inserted by a surgeon into the humanbody where it is intended to remain for a significantperiod of time in order to perform a specific function. [5]

3.1 METALLIC BIOMATERIALS

The materials that are used as biomaterials include polymers, metals, ceramics and composites. The metals used as biomaterials include titanium and its alloys, cobalt-chromium alloys, stainless steels, gold, silver and platinum. Out of those metals, the SS 316L is one of the most commonly used biomaterial.

3.2 STAINLESS STEEL

The reason that SS 316L serves as a good biomaterial is that firstly, it is a very strong material. This helps the implant to withstand high load. Secondly, carbon content improves the corrosion resistance and minimizes sensitization. The chromium gives the scratch-resistance and corrosion resistance. The nickel provides a smooth and polished finish. The molybdenum gives greater hardness, and helps maintaining a cutting edge.[6]

| Element | Composition (%) |
|---|---|
| Carbon | 0.03 max |
| Manganese | 2.00 max |
| Sulphur | 0.03 max |
| Silicon | 0.75 max |
| Chromium | 17.00-20.00 |
| Nickel | 12.00-14.00 |
| Molybdenum | 2.00-4.00 |

Table 1.1 Chemical Compositions of 316L Stainless Steel (ASTM, 1980)

3.3 TITANIUM ALLOY

The advantage of Titanium alloy is it is light in weight and having a good physical properties, but titanium has poor shear strength. This characteristic makes it less desirable for bone screws and plates. It also tends to affect suddenly when in sliding contact with itself or other metals.

Following table 1.2 shows the comparative study of Metallic Biomaterials which are used for manufactured an implant.[7]

**4.0 SOLIDMODEL**

The one of the objective of this paper was to design a model of prosthetic joint from the available literature and studythe distribution of contact stresses in the same. A solid model is a three-dimensional mathematicalrepresentation of an object. When solid modeling isused to represent parts (three-dimensional constructions)that are already in existence, rather than to design parts, itis referred to as reverse engineering. In recent years, solid modeling has been used extensivelyin medical applications. Creating solid models of hipprosthetics, Knee prosthetics etc.The PRO/E software offers several different approaches to develop a solid model of prosthetics like part design, surface design etc. [8] Modelling of implant requires following steps:

**4.1 FOR HIP IMPLANT**

1. Getting a 2-D (Two Dimensional) sketch of an implant.

2. Operations carried out in Pro/E WILDFIRE 4.0:-

a) Sketching

b) Dimensioning

c) Revolve

d) Protrusion id 98

d) Extrusion

e) Mirroring

f) Draft

g) Round

3. Save drawing as Pro/E part file and IGES file format, for analysis purpose.

**Fig. 1.6 Metallic Hip Implant**

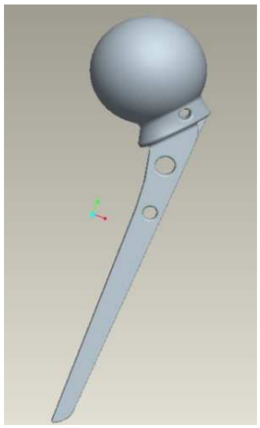


**Fig. 1.7 CAD Model of Hip Implant**

**4.2 FOR KNEE IMPLANT**

1. Getting a 2-D (Two Dimensional) sketch of an implant.

2. Operations carried out in PRO/E WILDFIRE 4.0:-

a) Sketching

b) Dimensioning

c) Extrusion

d) Revolve

e) Mirroring

f) Shell

g) Round

3. Save drawing as PRO/E part file and IGS file format, for analysis purpose.

**5.0 FEA**

Finite element analysis is a technique which is widely used to analyze stress-strain states in various biomedical devices and in prosthetic bone joints.

ANALYSIS ON ANSYS CONSIST OF FOLLOWING STEPS

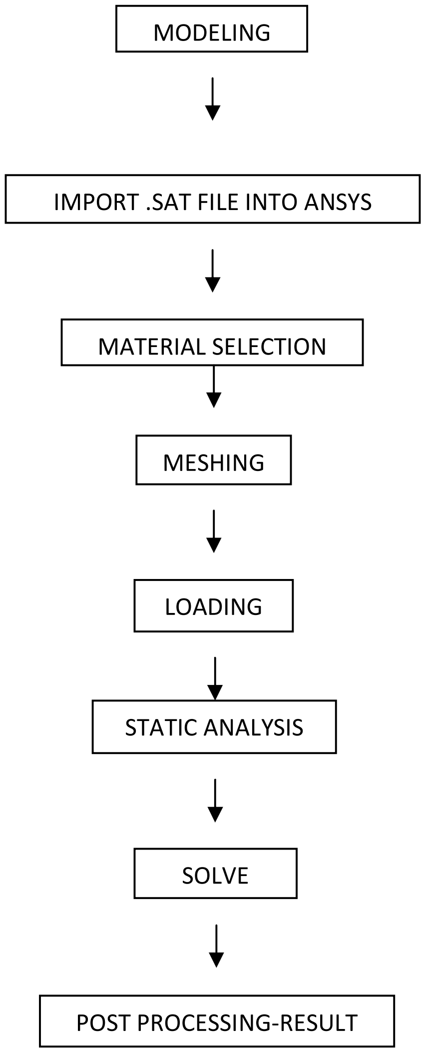



Fig. 1.10 Flow chart of analysis process

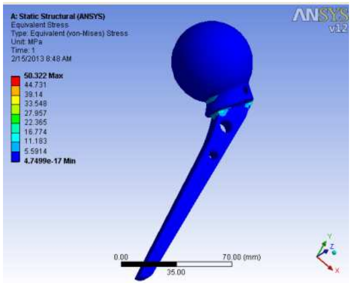
Following table 1.4 shows behaviour of hip prosthesis after applying a various boundary condition and load on the hip prosthesis.

**Tale 1.4 Tabulated Results for Hip Implants**

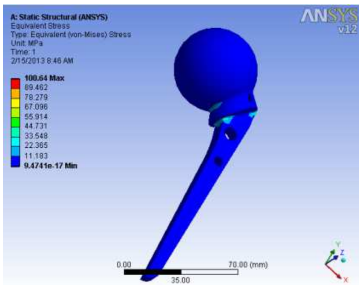
| Patient weight (N) | 50 | 100 | 150 |
|---|---|---|---|
| Load (N) | 500 | 1000 | 1500 |
| Deformation (max) mm | 0.0024083 | 0.0048167 | 0.007225 |
| Shear Stress (max) mpa | 16.852 | 33.705 | 50.557 |
| Vonmises Stress (max) mpa | 50.322 | 100.64 | 150.97 |

**For Hip**

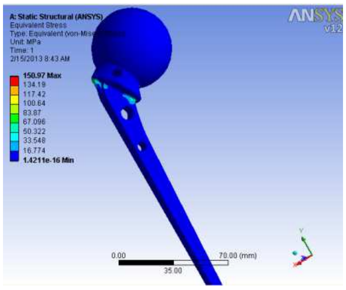
**Load 500 N** **Load 1000 N** **Load 1500 N**



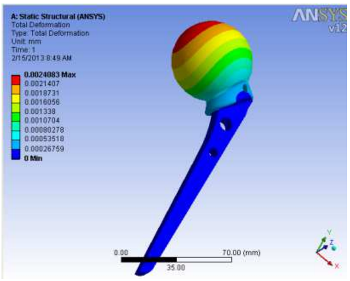

**Von-Mises Stress**



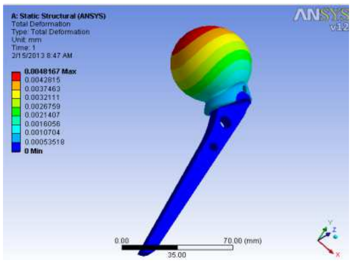

**Von-Mises Stress**




**Von-Mises Stress**




**Deformation**

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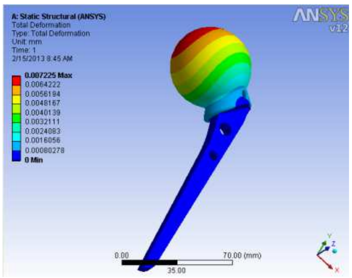


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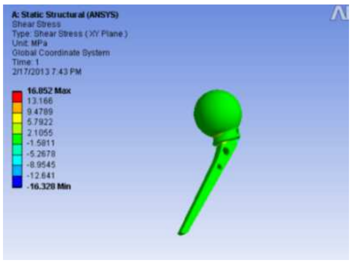
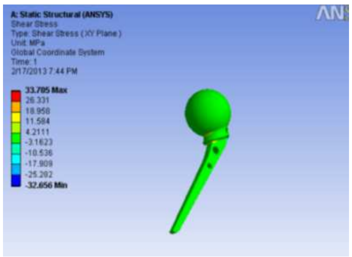
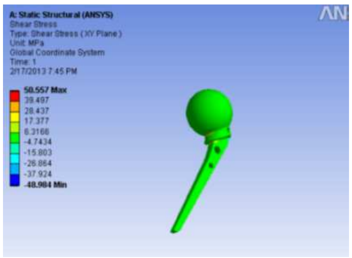



**Shear Stress**

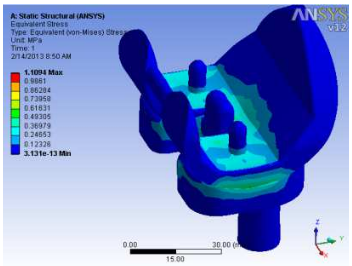


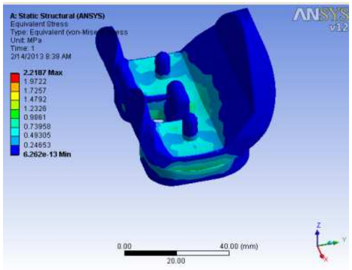

**Shear Stress**

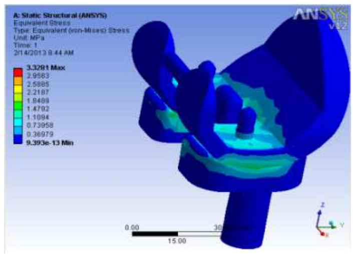



**Shear Stress**

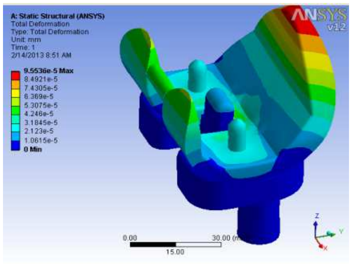
**For knee**




**Load 500 N** **Load 1000 N** **Load 1500 N**

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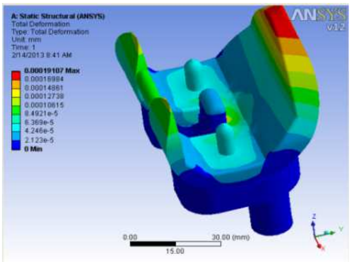


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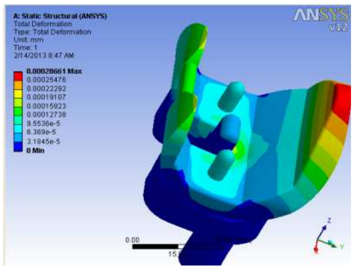


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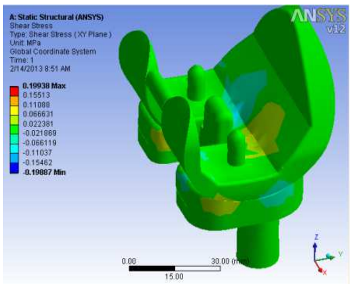
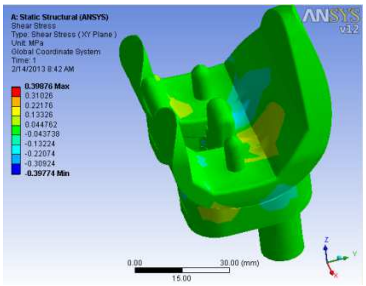
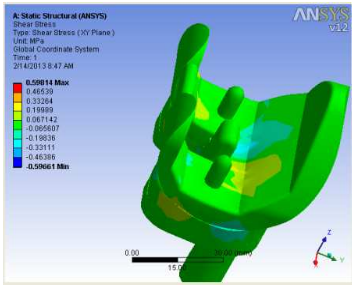



**Shear Stress**




**Shear Stress**




**Shear Stress**

**Tale 1.5 Tabulated Results for Knee Implants**

| Patient weight (N) | 50 | 100 | 150 |
|---|---|---|---|
| Load (N) | 500 | 1000 | 1500 |
| Deformation (max) mm | 0.000095536 | 0.00019107 | 0.00028661 |
| Shear Stress (max) mpa | 0.19938 | 0.39876 | 0.59814 |
| Vonmises Stress (max) mpa | 1.1094 | 2.2187 | 3.3281 |

**CONCLUSION**

The aim of this study is successfully achieved

- SS 316-L has excellent bio-compatible properties along with physical properties which makes it an ideal implant material for surgeries.

- Improvement in primary stability.
- Provides favourable conditions for bone remodelling.
- Excellent pre-operative planning.

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