भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

BIOMECHANICS OF CORNEA

A SUMMER INTERNSHIP PROJECT REPORT

Submitted by

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Of

BACHELOR OF TECHNOLOGY

In

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GOVERNMENT COLLEGE OF ENGINEERING, KALAHANDI, ODISHA

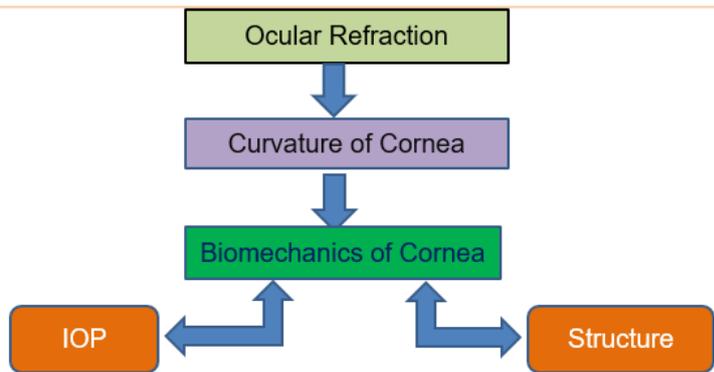Under the supervision of

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INTRODUCTION:

The **cornea** is the transparent front part of the eye that covers the iris, pupil, and anterior chamber. The **cornea**, with the anterior chamber and lens, refracts light, with the **cornea** accounting for approximately two-thirds of the eye's total optical power.

CONTENTS:

OCULAR REFRACTION:

❖ Cornea is the first cellular surface of eye's optical system and it is transparent.

❖ Ocular refraction is the change in the direction of propagation of light rays crossing of transparent media (cornea) and refractive eye.

❖ The object is refracted at lens.

❖ The focus of the object is formed at retina, then we can see the image of that object.
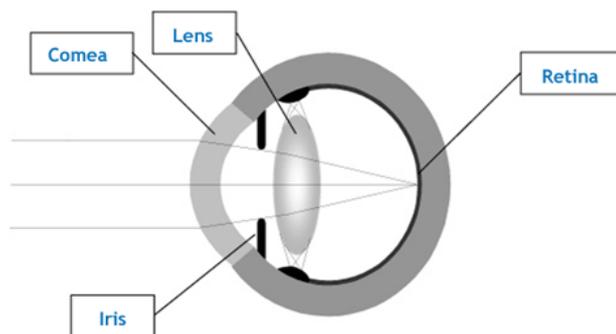
CURVATURE OF CORNEA:

❖ The outer surface of the cornea is called "Anterior cornea".

❖ The inner surface of the cornea is called "Posterior cornea".

❖ The distance from anterior cornea to the lens is called "Anterior chamber depth".

❖ Eye color is defined by "Iris". Iris is a thin,circular structure in eye.
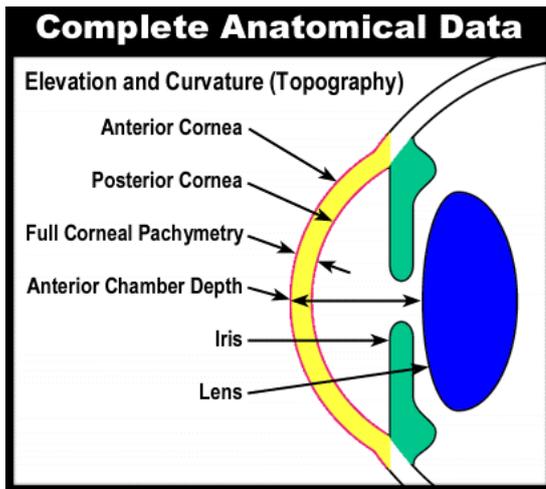
STRUCTURE:

- ❖ Cornea consists of five layers.

- ❖ The epithelium and endothelium layers do not directly contribute to corneal thickness.

- ❖ Bowman's layer gives corneal stability.

- ❖ Stroma represents the largest part of the cornea and mainly defining biomechanical properties of cornea.

- ❖ Descemet's layer contributes significantly to corneal stiffness.
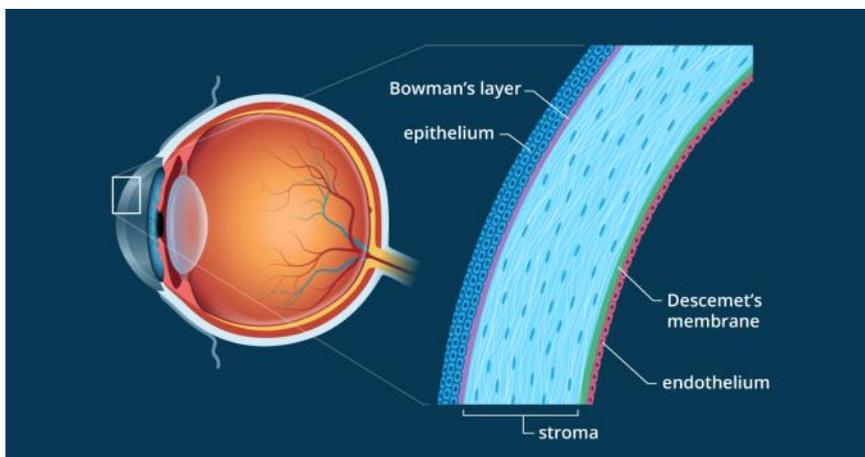
IOP:

- ❖ Generally in case of Glaucoma (eye disease) , the optic nerve of the eye (connected to the brain) damage.
- ❖ The reason of glaucoma is diabetes.

❖ In glaucoma, the fluid in eye gradually build up , the drainage of fluid does not occur properly and increase the pressure in eye, this pressure is called "intraocular pressure(IOP) ".


Development of Glaucoma
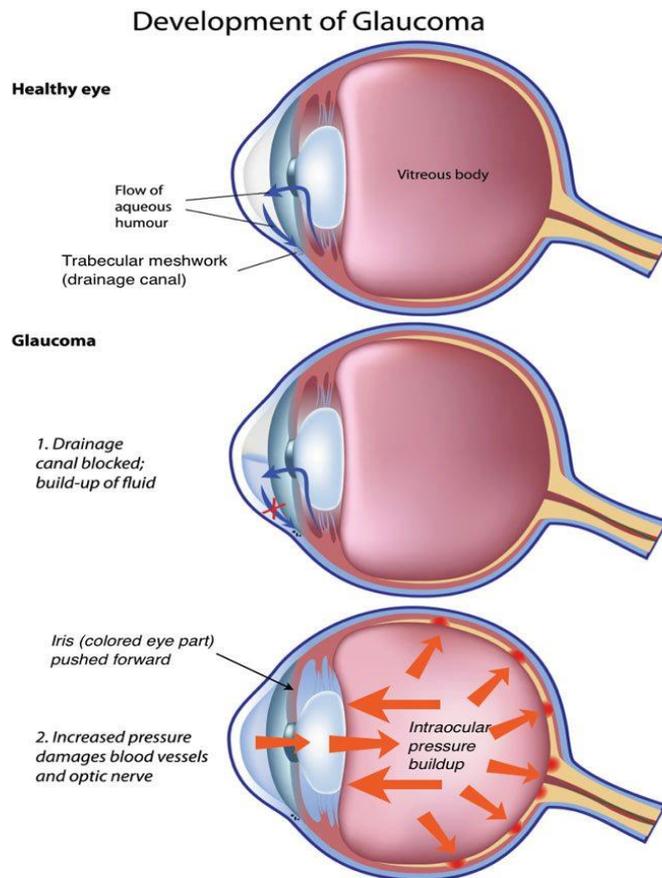
ABAQUS SOFTWARE:

ABAQUS is a software suite for finite element analysis and computer-aided engineering. The name and logo of this software are based on the abacus calculation tool. The Abaqus product suite consists of five core software products:

1. *Abaqus/CAE*, or "Complete Abaqus Environment". It is a software application used for both the modelling and analysis of mechanical components and assemblies and visualizing the finite element analysis result. A subset of Abaqus/CAE including only the post-processing module can be launched independently in the *Abaqus/Viewer* product.
2. *Abaqus/Standard*, a general-purpose Finite-Element analyser that employs implicit integration scheme.
3. *Abaqus/Explicit*, a special-purpose Finite-Element analyser that employs explicit integration scheme to solve highly nonlinear systems with many complex contacts under transient loads.
4. *Abaqus/CFD*, a Computational Fluid Dynamics software application which provides advanced computational fluid dynamics capabilities with extensive support for pre-processing and postprocessing provided in Abaqus/CAE
5. *Abaqus/Electromagnetic*, a Computational electromagnetics software application which solves advanced computational electromagnetic problems.

MODELING OF CORNEA:

- ➢ The structural model of cornea can be approached by creating a 3D shell model.

- ➢ The material is isotropic.

- ➢ Value of Intra Ocular Pressure = 15 mm of Hg

  =0.00196 MPa

- ➢ Young's modulus of elasticity, E = 0.3 MPa

- ➢ Poisson's ratio = 0.49
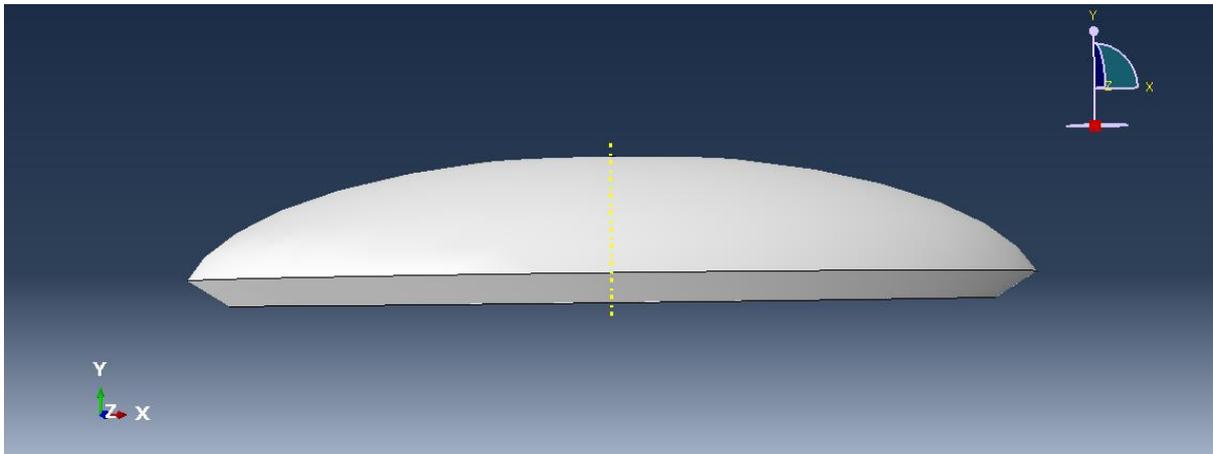
GEOMETRY:

- ➢ The structure of human cornea has a nonuniform curvature with variable thickness throughout.

- ➢ This is thinner at the center and thickens towards the edges.

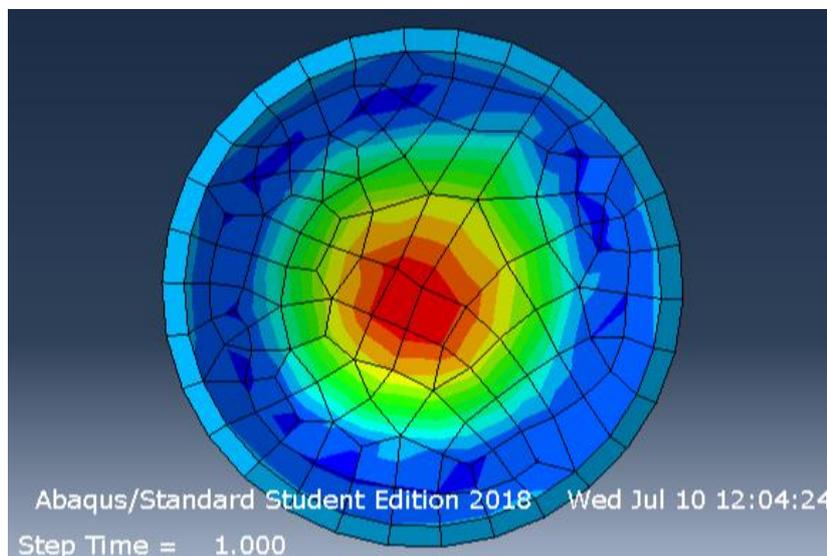- ➢ 3D corneal models meshed into hexahedral or tetrahedral elements.
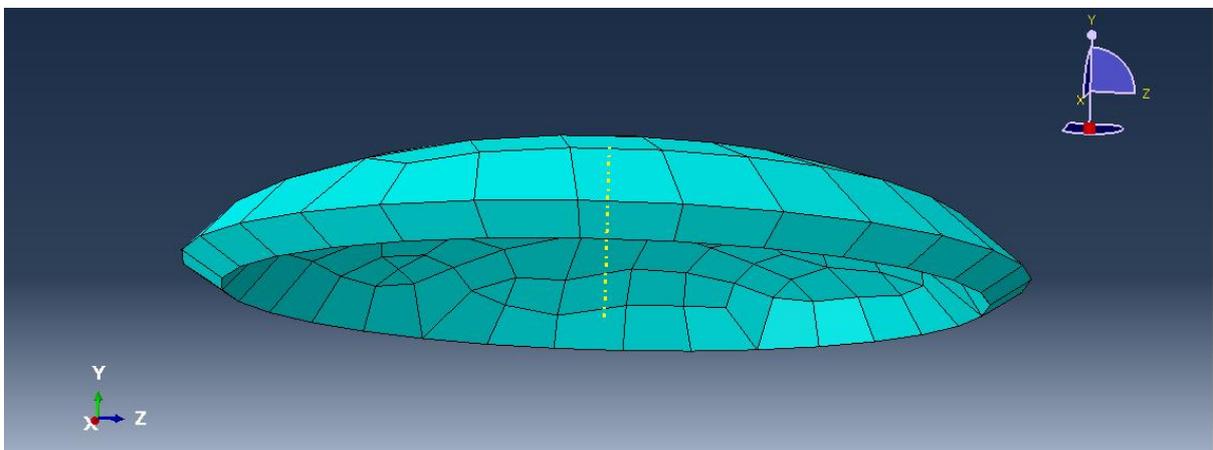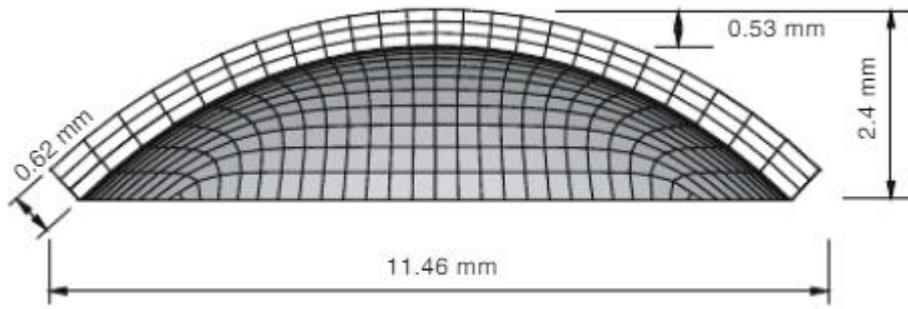
BOUNDARY CONDITIONS:

> ➢ For boundary condition, roller support is provided at the edges inclined at 40^0 with respect to the horizontal axis to represent cornea-limbus behavior.
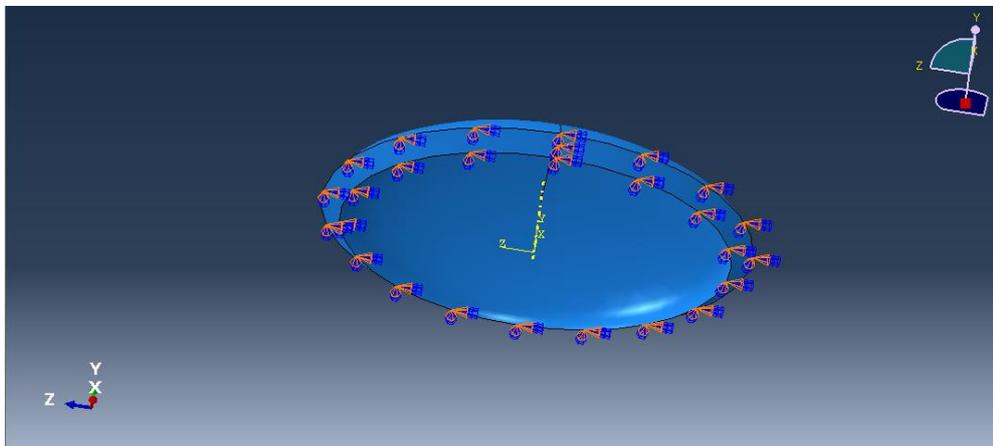
MATERIAL MODELS:

> ❖ Finite element model of cornea is linear elastic model, homogeneous and isotropic material.

CONCLUSION:

❖ From Abaqus software we observe that the contour levels of the maximum Cauchy stress are about 0.20MPa for a cornea at 15mm Hg Intra Ocular Pressure.

❖ One main benefit of using Abaqus is the ability to operate between the implicit solver, generally used for stress, strain simulation.

** THANK YOU **