VISVESVARAYA TECHNOLOGICAL UNIVERSITY

JNANASANGAMA, BELAGAVI-590018

An Internship Report

"Stress Analysis of Circular Plate"

Submitted in partial fulfillment for the award of degree of
Bachelor of Engineering
In
Mechanical Engineering
Submitted by

PRATHWIN B R

1KG20ME007

Internship Carried Out at

K-TECH CENTRE OF EXCELLENCE IN AEROSPACE AND DEFENCE

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DEPARTMENT OF MECHANICAL ENGINEERING

K S SCHOOL OF ENGINEERING AND MANAGEMENT

 # 15, Mallasandra, off. Kanakapura Road, Bengaluru-560109

2023-24

K S SCHOOL OF ENGINEERING AND MANAGEMENT

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CERTIFICATE

This is to certify that the internship work entitled "**Stress Analysis of Circular Plate**" is a Bonafede work carried out by

PRATHWIN BR **1KG20ME007**

In partial fulfillment for the award of **Bachelor of Engineering** in **Mechanical Engineering** of the **Visvesvaraya Technological University, Belagavi** during the year **2023-24**. It is certified that all corrections/suggestions indicated for Internal Assessment have been incorporated in the Report deposited in the departmental library. The internship report has been approved as it satisfies the academic requirements in respect of internship work prescribed for the said Degree.

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DECLARATION

I, Student of Mechanical Engineering, K. S. School of Engineering and Management, hereby declare that the internship report entitled "**Stress Analysis of Circular Plate**" embodies the record of the internship carried out at **K-Tech** under the guidance of **Dr. Abhishek M R** and **Mr. Madhusudhana Rao** for the fulfilment of the requirement of the award of the Degree of Bachelor of Engineering.

PRATHWIN B R 1KG20ME007

Place: Bengaluru

Date:

ACKNOWLEDGEMENT

The successful completion of any task would be incomplete without the mention of the people, whose constant guidance and encouragement crowned my efforts with success. I consider it as a privilege to express my gratitude and respect to all those who guided me in the successful completion of this internship.

First of all, I am thankful to my college **K S SCHOOL OF ENGINEERING AND MANAGEMENT** for providing support guidance and a platform to work.

I express my gratitude to **K-TECH** for providing opportunity and guidance to carry out internship work.

I take this opportunity to express my deep regards to **Dr. K. Rama Narasimha**, Principal/Director, K S School of Engineering and Management for providing an opportunity to do this Internship Work as a part of our curriculum in the partial fulfilment of the degree course.

I express my gratitude to **Dr. Balaji B**, Professor and Head, Department of Mechanical Engineering, K. S. School of Engineering and Management for providing valuable insights, making the resources available at right time and all the encouragement for the completion of my project.

I owe my profound gratitude to our internship guide **Dr. Abhishek M R** Associate Professor of Mechanical Engineering, KSSEM, Bengaluru & **Mr. Madhusudhana Rao** CEO, K-Tech Nagarbhavi, Bengaluru, who took keen interest in the work and guided all along and for providing all the necessary information.

I extend my profound gratitude to my internship coordinator **Mr. Parashuram A K**, Assistant Professor, Department of Mechanical Engineering, K.S.S.E.M, who took keen interest in the work and guided all along and for providing all the necessary information.

I also wish to thank all the staff of Mechanical Engineering Department for providing all the support whenever needed. I would like to thank my parents for supporting and helping in the completion of the internship work. Last but not the least I would like to thank all my friends without whose support and co-operation the completion of internship would not have been possible.

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ABOUT THE COMPANY

K-tech CoE A&D is focused on providing necessary skill enhancement that is structured based on industry practices. Faculty members have experienced industry professionals carrying a rich background in the aerospace and defense industry Foundation, Advanced, and Industry oriented courses are structured to provide the right level of exposure to students on the industry best practices.

This would enable the student's to be 'industry ready' and help them to be productive right from the start in the Industry. Besides, the training program provides 'hands-on' exposure to the digital domain on Dassault Systems 3DEXPERIENCE CATIA, SIMULIA, DELMIA, and Model-Based Systems Engineering (MBSE) Applications that are widely used in the Aerospace and Defence Industry.

K-tech CoE A&D is aimed to provide right a mix of Theory and Hands on Experience in a typical Digital Platform having capabilities in Design, Simulation, Analysis, Manufacturing, Systems Engineering, etc., as part of Air Vehicle Development.

While this capability is focused on Aero domain, there is significant potential to engage with Start-ups for typical Engineering activities, as the processes are similar**.** The Aerospace and Defence industry in India is one of the fastest growing markets in the world. The Defence-manufacturing sector in India is also on the cusp of exponential growth given the focus of Government of India on indigenous manufacturing of Defence equipment.

Introduction

Stress Concentration and Stress Concentration factors:

Stress Concentration factors Grooves, fillets, holes, or other abrupt changes in cross section or any disruption of a smooth surface causes increased stresses around these areas. Notch is a general term meaning any or all of the above. Imagine that the flow of force is like the flow of water. An obstruction in a flow field would cause the water's velocity to increase around the obstruction.

The same is true for force except that the stress increases around the "obstruction".
The stress is said to concentrate around these obstructions, or notches. The amount of stress around a notch is: s max = Kt s nom Kt is called the theoretical stress concentration factor and s nom is called the nominal stress.

In the case of shear stress: t max = Kts t the nominal stress, whether shear or axial, is calculated using the net cross section. In the case of static ductile loading, it is not uncommon to ignore stress risers.

Can you think of why this would be o.k. to do? Stress rises in brittle materials are not ignored, whether loading is dynamic or static, nor are stress rises ignored in ductile materials under dynamic loading.

Once the theoretical stress concentration has been determined, we can account for a reduction in fatigue life due to a notch by introducing a Marin factor for notches.

Some important definitions

Stress: The force of resistance offered by a member per unit area is called stress The external force acting on it is called load. The load is applied on the body and the stress is induced in the material of the body.

Stress = Force(P)/ Area(A) N/mm^2

Strain: Due to the application of load, the length of a member will change. The ratio of change in length to the original length of the member is called Strain.

Strain (e) = change in length (dl)/original length (l)

Tensile Stress: The force of resistance offered by a section of a member, against an increase in length, is called tensile stress. The corresponding strain is called tensile strain.

Compressive Stress: The force of resistance offered by a section of a member due to pushing against a decrease in length allied Compressive stress. The corresponding strain is called Compressive strain.

Temperature Stresses (α): A member will offer stresses if natural change in dimensions is restricted due to rise and fall in temperatures.

Temperature stress = α TE

Where, α = Coefficient Of thermal expansion,

T= temperature rise

E= Elastic Modulus.

Temperature Strain = Expansion or Contraction prevented /Original length.

Young's Modulus: The Young Modulus, E is a material property that describes its stiffness and is therefore one of the most important properties in engineering design Within the limits of elasticity, the ratio of the linear stress to the linear strain is termed the modulus of elasticity or Young's Modulus

Young's Modulus (E) = Stress/Strain

This property determines how much a bar will sag under its own weight or under a loading when used as a beam within its limit of proportionality.

Poisson Ratio: Poisson's ratio deals with the way stretching or compressing an object in one direction causes it to compressor stretch in the other direction. The ratio measures the extent of this effect in a particular substance.

The technical definition of Poisson's ratio is "the ratio of transverse contraction strain to longitudinal expansion strain.”

Density: Density is a physical property of matter, as each element and compound has a unique density associated with it Density defined in a qualitative manner as the measure of the relative "heaviness" of objects with a constant volume.

Density is defined as the mass per unit volume of a substance. It can be expressed as follows:

Density = mass/volume

Shear Modulus: The shear modulus is one of several quantities for measuring the stiffness of +materials. In materials science, shear modulus or modulus of rigidity, denoted by G, is defined as the ratio of shear stress to the shear strain.

Coefficient of thermal expansion: All materials change their size when subjected to a temperature change as long as the pressure is held constant. The coefficient of thermal expansion describes how the size of an object changes with a change in temperature.

Shear Force: The sum of vertical forces at a given section of a member is defined as shear Force.

Bending Moment: The algebraic Sum of all the moments at a given section of a member is defined as the Bending moment.

Structural Analysis: Structural analysis is defined as the calculation of the response of structures to actions.

Chapter 2

Project Details

Project Description:

A flat steel circular plate of 1.651mm thick with diameter of 152.4mm is subjected to 0.0413 N/mm2 uniform pressure on the surface. Determine the maximum plate deflection at the center and the radial stresses at the boundary edges of the plate.

a) Derive the simple stress and displacement equations.

b) Use FEM and estimate the results.

c) compare the results and give your comments.

Assume plate material is steel.

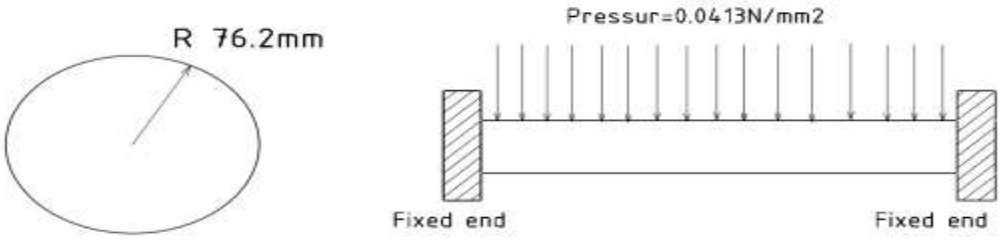

Figure 1: Cross sections

This method of breaking down a structure for FEA is known as the finite element method (FEM).

- **Step 1: Modelling.**

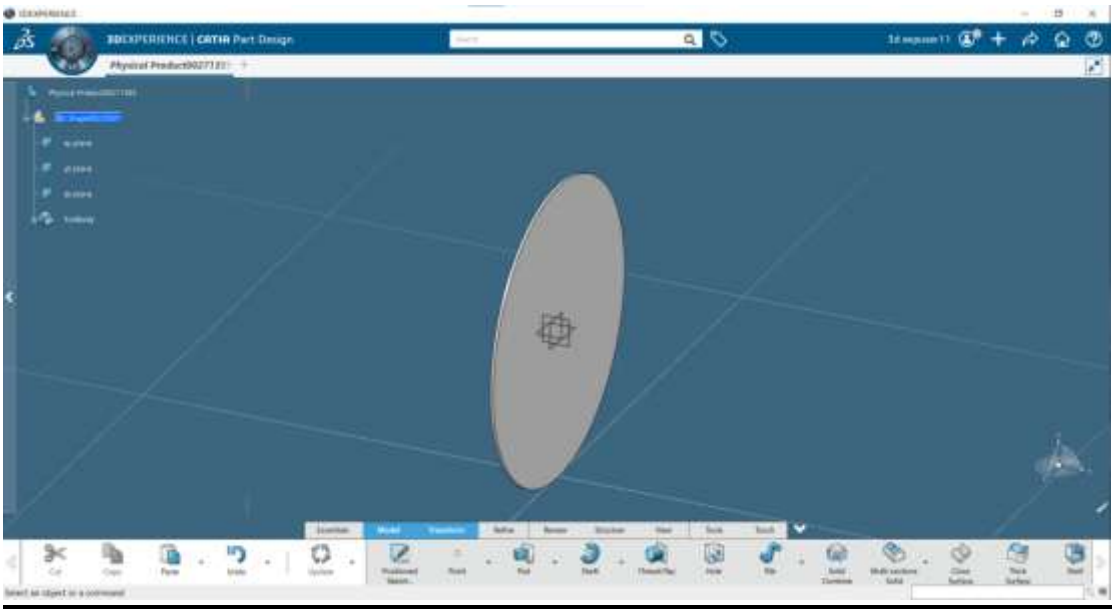

Figure 2: Modelling.

While modeling the object, you should omit the sophisticated geometrical features and see the basic structure of the object. Pay attention to what features are present for structural reasons versus aesthetic appeal. Understand why you're removing one geometrical aspect while maintaining another.

➢ Step 2: Material definition.

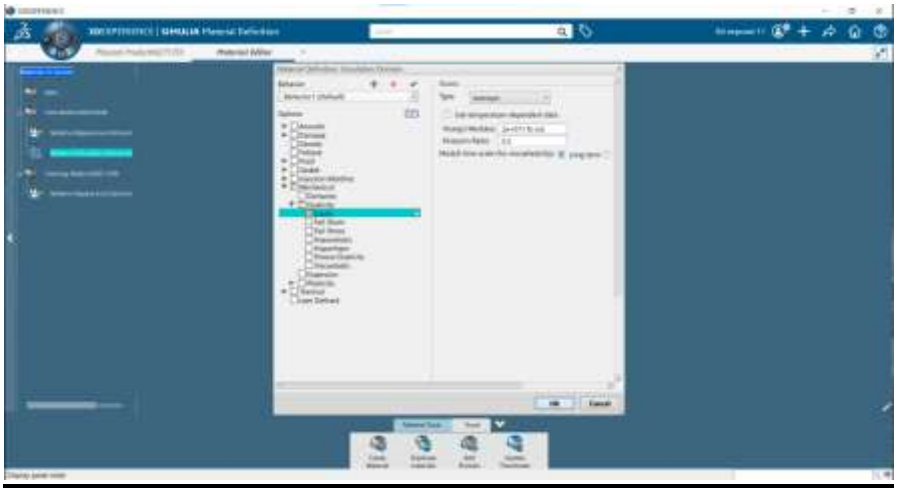

Figure 3: Material definition.

As the name of the step suggests, material properties should be defined here. These depend on the type of analysis that is being carried out. Play around with different materials to check which one fits the needs required.

➢ Step 3: Defining loads.

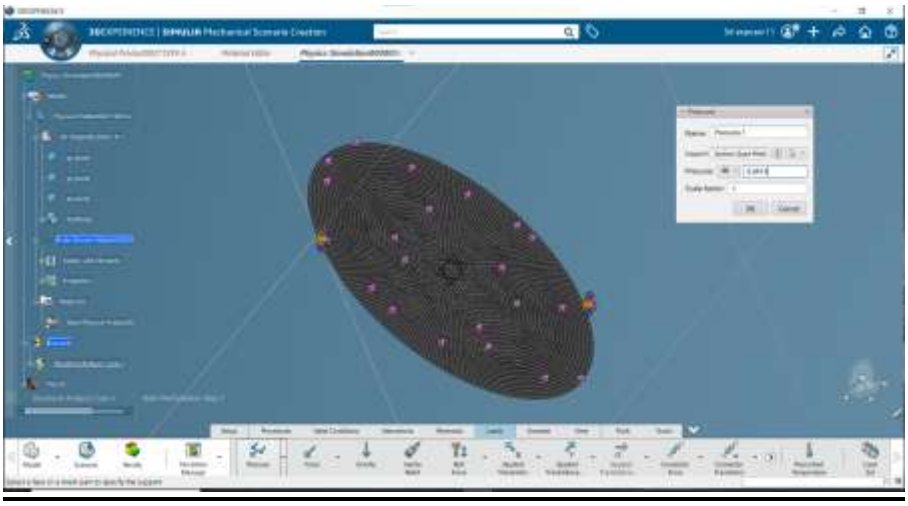

Figure 4:Defining loads.

Your structure cannot exist in a vacuum. This step helps you identify which external forces are acting on the structure. How does it affect one component versus another.

- **Step 4: Boundary conditions.**

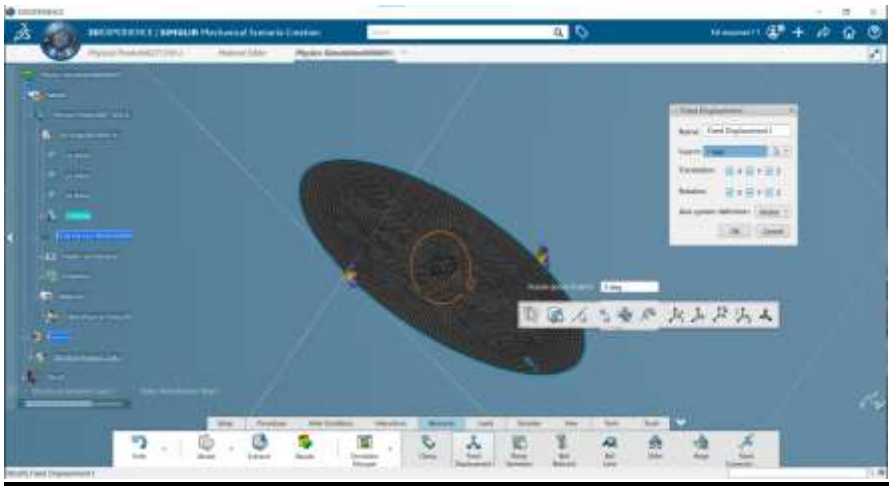

Figure 5: Boundary conditions.

As we've done in mathematical problems before, setting conditions for which the structure will exist is mainly done to reduce the complexity of the problem. If we know the conditions beforehand, it helps us save a lot of time when calculating.

- **Step 5: Meshing.**

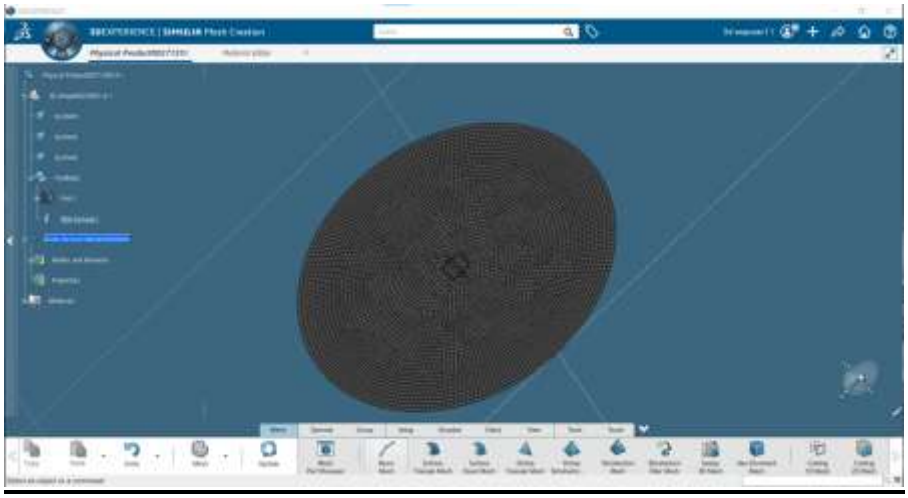

Figure 6: Meshing.

The geometry of your structure is divided into smaller shapes called as, doldrums , finite elements. Meshing simply means connecting the computations from these finite elements to create a mesh structure.

- **Step 6: Solution.**

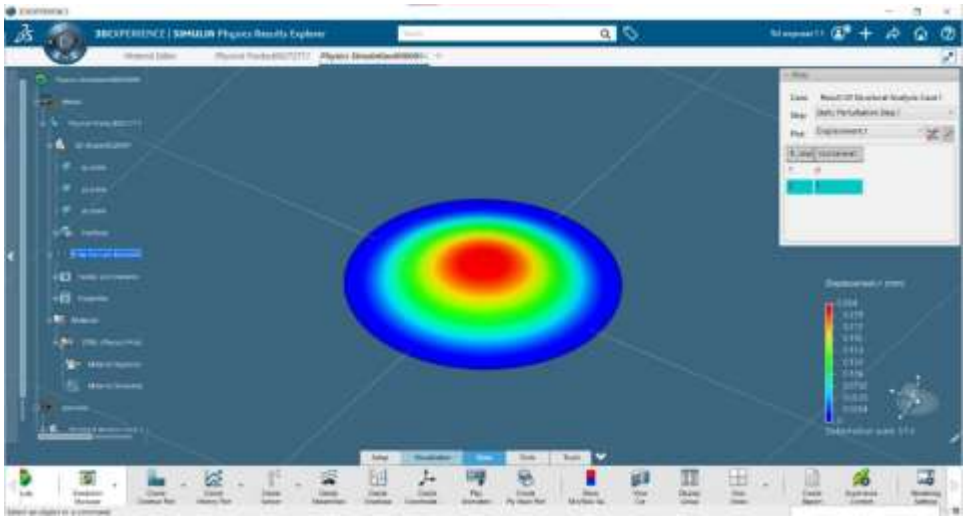

Figure 7: Solution.

Simply put, partial differential equations are converted into algebraic equations. This will help represent equations as matrices. The singular matrices are then assembled into one global matrices, which is then solved for unknown variables.

At this point, your FEM computing software will have created a representation for your object. Keep checking across different designs to see which one suits your requirements.

Chapter 3

RESULTS AND DISCUSSION

The analysis of the given structure was broke down into 3 cases for interpretation of the results. The three cases chosen where are as below:

1. Quad 2mm Mesh 1st Order element.
2. Quad 2mm Mesh 2nd Order element.
3. Hexa Mesh 2mm 2nd Order element.

One can find the results of the above three cases in the figures and table below.

➢ Case-1: Quad 2mm Mesh 1st Order element

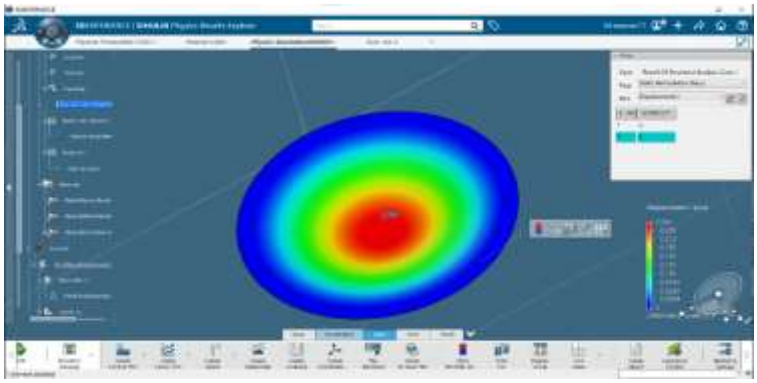

Figure 8: Displacement Solution of Quad 2mm Mesh 1st Order element.

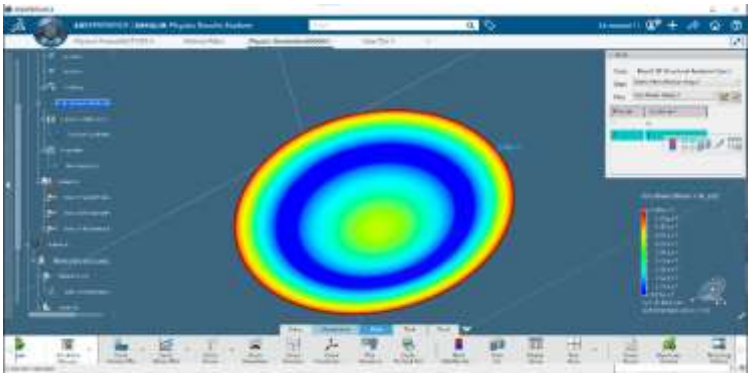

Figure 9: Stress Solution of Quad 2mm Mesh 1st Order element

➢ Case-2: Quad 2mm Mesh 2nd Order element

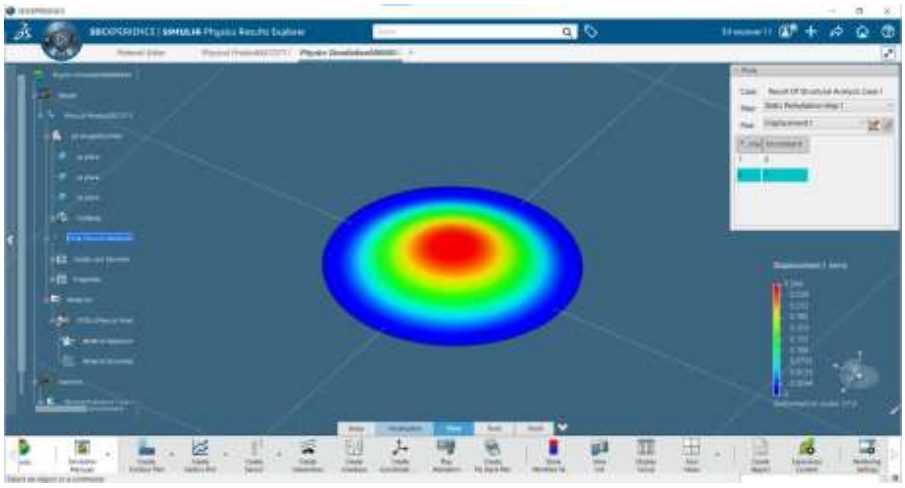

Figure 10: Displacement Solution of Quad 2mm Mesh 2nd Order element.

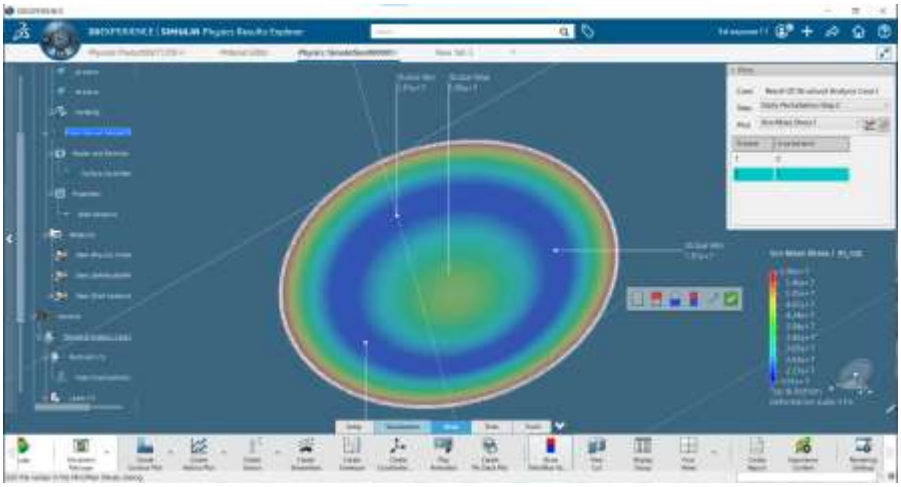

Figure 11: Stress Solution of Quad 2mm Mesh 2nd Order element

➢ Case-3: Hexa Mesh 2mm 2nd Order element

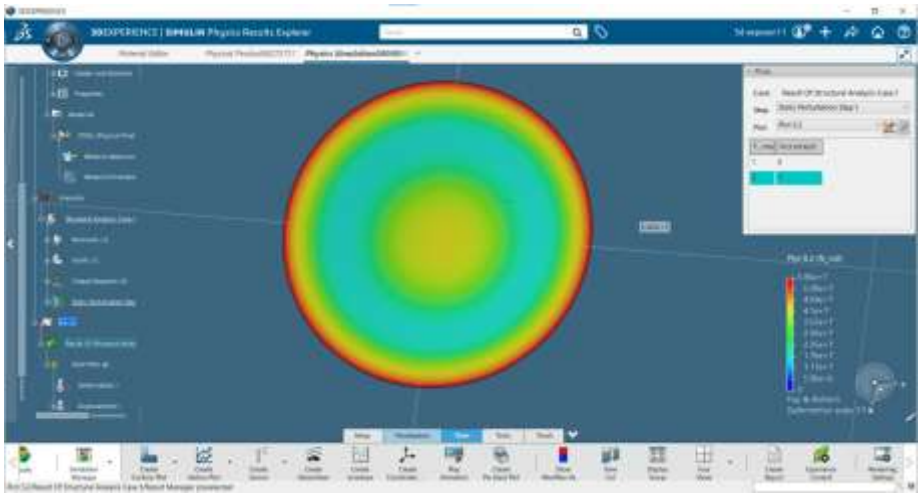

Figure 12: Displacement Solution of Hexa 2mm Mesh 2nd Order element.

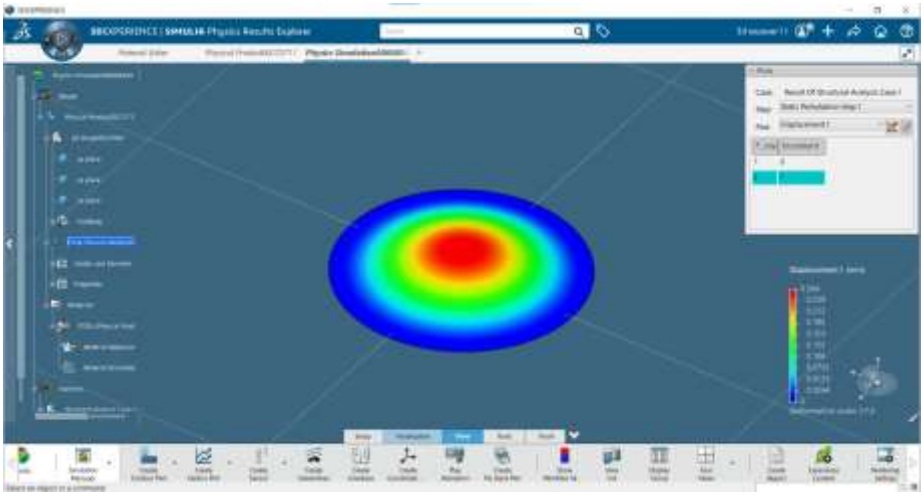

Figure 13: Stress Solution of Hexa 2mm Mesh 2nd Order element.

General observation

Sl.NO.	Type Of Analysis	Element Size Type	Displacement in (mm)	Von-Mises Stress in N/mm2
1	Static	Quad 2mm Mesh 1st Order	Maximum Displacement = 0.264mm	Maximum Stress = 58.6MPa
2	Static	Quad 2mm Mesh2nd Order	Maximum Displacement = 0.264mm	Maximum Stress = 58.6MPa
3	Static	Hexa Mesh 2mm 2nd Order	Maximum Displacement =0.264mm	Maximum Stress = 55.8MPa
4	Analytic	- -	Maximum Displacement =0.264mm	Maximum Stress = 65.9MPa

Table no: 1

1. As we changed the mesh size there was significant changes in the results.
2. Lesser the mesh size would bring up the result accuracy.
3. Changing the element type that is the order of the element would bring changes in the results.
4. The type of the meshing type that is either surface quad meshing or Hexa quad meshing would have relevant changes in the results.
5. Quad 2mm Mesh 1st Order element gave an result which was approximately closer to the analytical solutions.

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