FRACTURE ANALYSIS

made by -

ADITYA SONI (20UME003)

GANESH AGARWAL (20UME017)

ARTH GUPTA (20UME011)

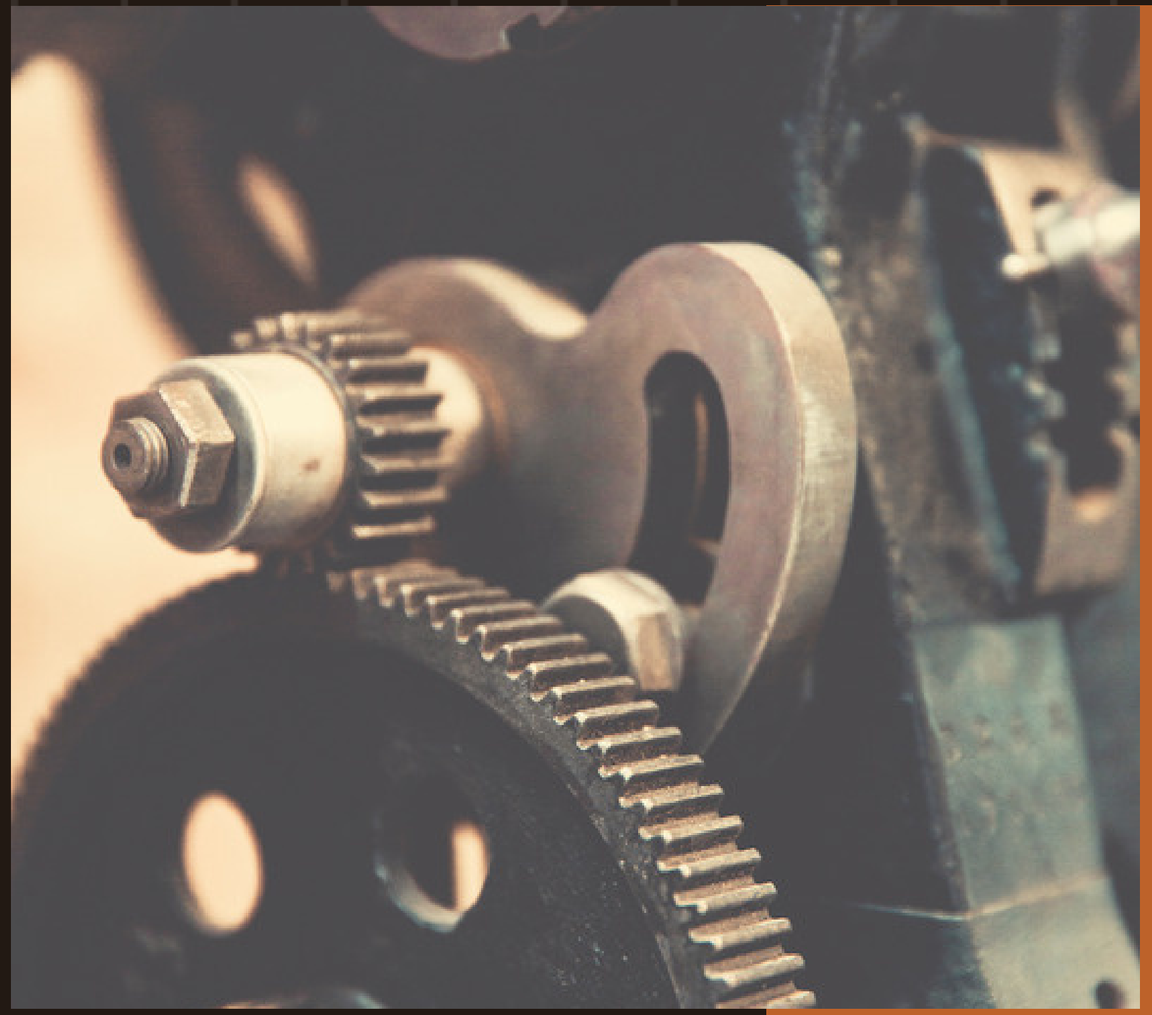
PRANAV SHARMA (20UME040)

Overview

- **Introduction**
- what is fracture
- brittle and ductile fracture
- ansys
- first project overview
- **second project**
- **Thank You**

INTRODUCTION

The study of how fractures spread across materials is the focus of the mechanics discipline known as fracture mechanics. It employs experimental solid mechanics to determine the material's resistance to fracturing and analytical solid mechanics to determine the pushing force on a crack.



what is fracture

Fracture is the division of a solid into two or more pieces when a force or tension is applied. Fractures can be classified as tensile fractures, compressive fractures, shear fractures, fatigue fractures, creep fractures, and cleavage fractures, among others, depending on the kind of pressure applied.

Further there are two types of fracture , that are -

1 .Ductile Fracture

2. Brittle fracture

Brittle and Ductile fracture

Brittle fracture involves crack growth with little or no ductile deformation of the material around the crack tip. This is an undesirable mode of fracture because brittle cracking can lead to complete failure of the material very rapidly when a critical load is reached.

Ductile fracture, in contrast, involves plastic deformation of the material at the crack tip. This often results in a stable and predictable mode of fracture in which crack growth can only occur under an increasing applied load; when the load is reduced the crack stops growing. As a result, ductile fracture is the preferred failure mode for damage-tolerant materials.

ANSYS

ANSYS is a general-purpose, finite-element modeling package for numerically solving a wide variety of mechanical problems. These problems include static/dynamic, structural analysis, heat transfer, and fluid problems, as well as acoustic and electromagnetic problems.

FIRST PROJECT

AIM

IN THIS MODEL WE LEARNED ABOUT k1 , K2 , KE VARIATION WITH WIDTH OF A 3D MODEL .

MATERIAL USED

STAINLESS STEEL IS USED TO BUILD THE MODEL

MESHING

The tetrahedral mesh generation usually tries to generate tetrahedrons as equilateral as possible in order to obtain a high quality mesh. Therefore, the Max. stepwidth setting is a single value consistently applied to all directions.
The tetrahedral mesh generation can be summarized as follow-

1. Build the non-manifold simulation model.
2. Mesh the model’s edges and faces: "surface meshing"
3. Mesh the model’s volumes based on surface mesh: "volume meshing".

A tetra mesh is generated, starting from the inside of the mesh generation region. The advantage of patch independent generation is the ability to ignore points within the model that have no relation to your calculation.

FRACTURES

SEMI -ELLIPTICAL CRACK

Semi-ellipitcal crack gets devloped on the model as we apply the load . The complex loading conditions in rails induce stress and deformations in the material which keep on accumulating and evolve to rolling contact fatigue (RCF) **cracks** as soon as ductility exhaust. The **cracks** can occur at the surface or at the sub-surface level. Generally occurring surface **crack** is of **semi-elliptical** shape.

Smart crack growth

There are two types of smart crack grwoth - Static Crack Grwoth and Fatigue crack grwoth . And here we see static crack growth where we calculated fracture toughness and SIF.

LOADS

The load is applied on the right side of the of the model and the directiion of the load is away from the from the body . The magnitude of the load is - 10 MPa (in the form of pressure) .

FIXED SUPPORT

we applied the ficed support on the smaller side of the rectangular plate , that is opposite to the the side where load is applied .

RESULTS

TOTAL DEFORAMTAION

Deforamtion **refers to the change in size or shape of an object .**

SIF (stress intesnsity factor)

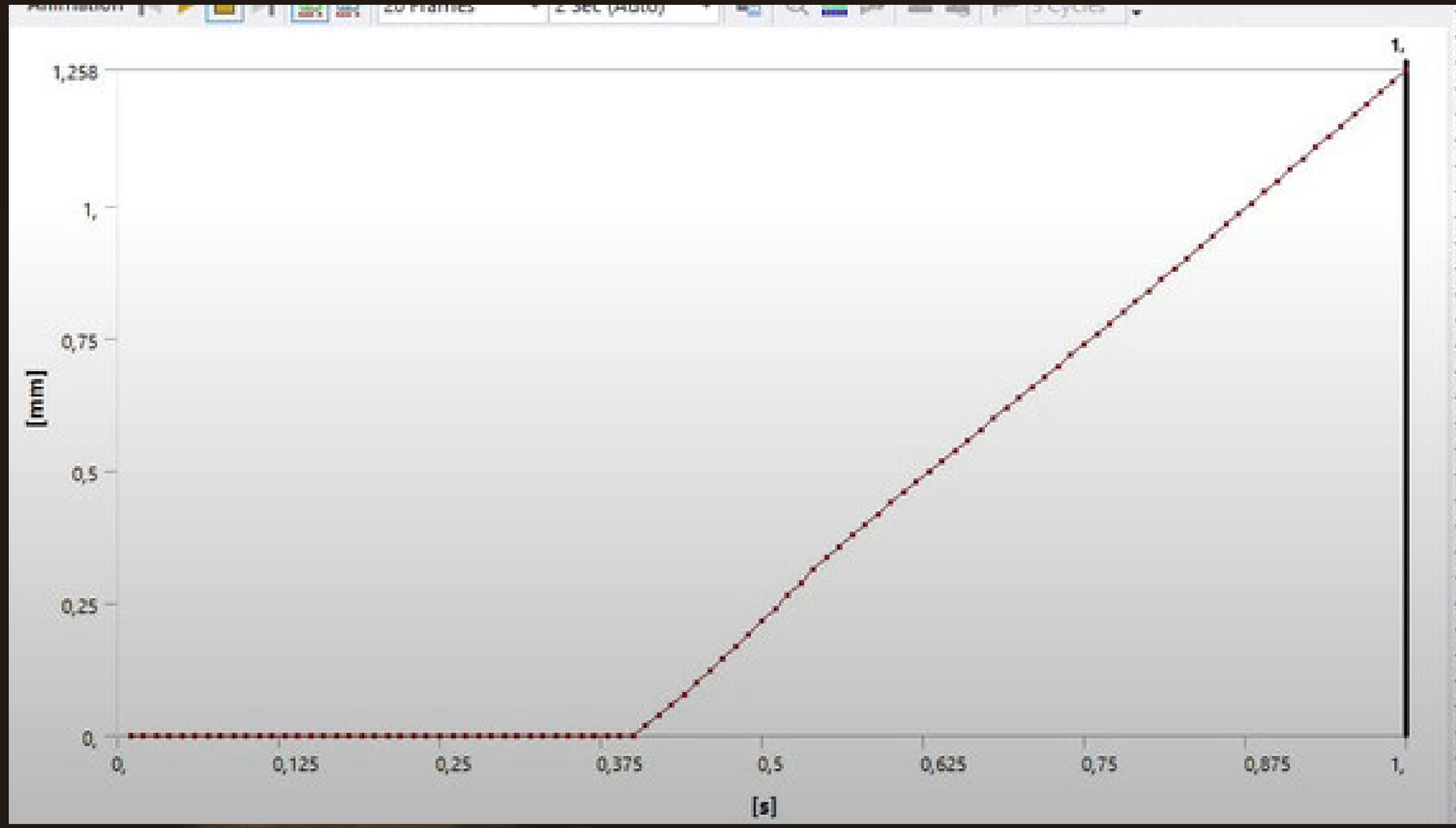
It is one of the most fundamental and useful parameters in all of fracture mechanics. The stress intensity factor describes the stress state at a crack tip, is related to the rate of crack growth, and is used to establish failure criteria due to fracture.

STEPS

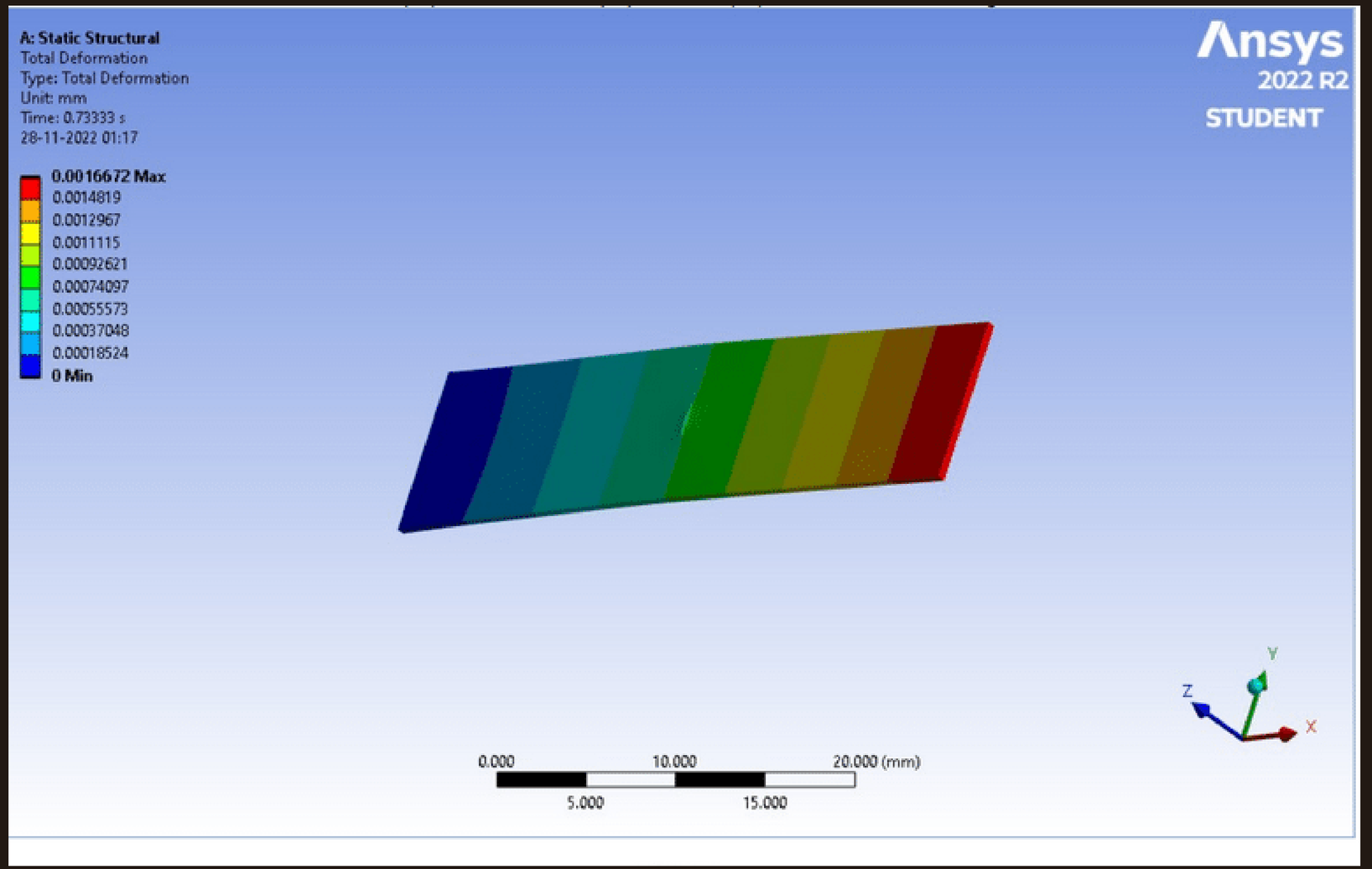
1. We perform our analysis in static structural.
2. Structural steel is selected for the analysis.
3. For geometry a rectangle is created of dimensions 40.00*10.00 *0.5 (in mm) .

STEPS

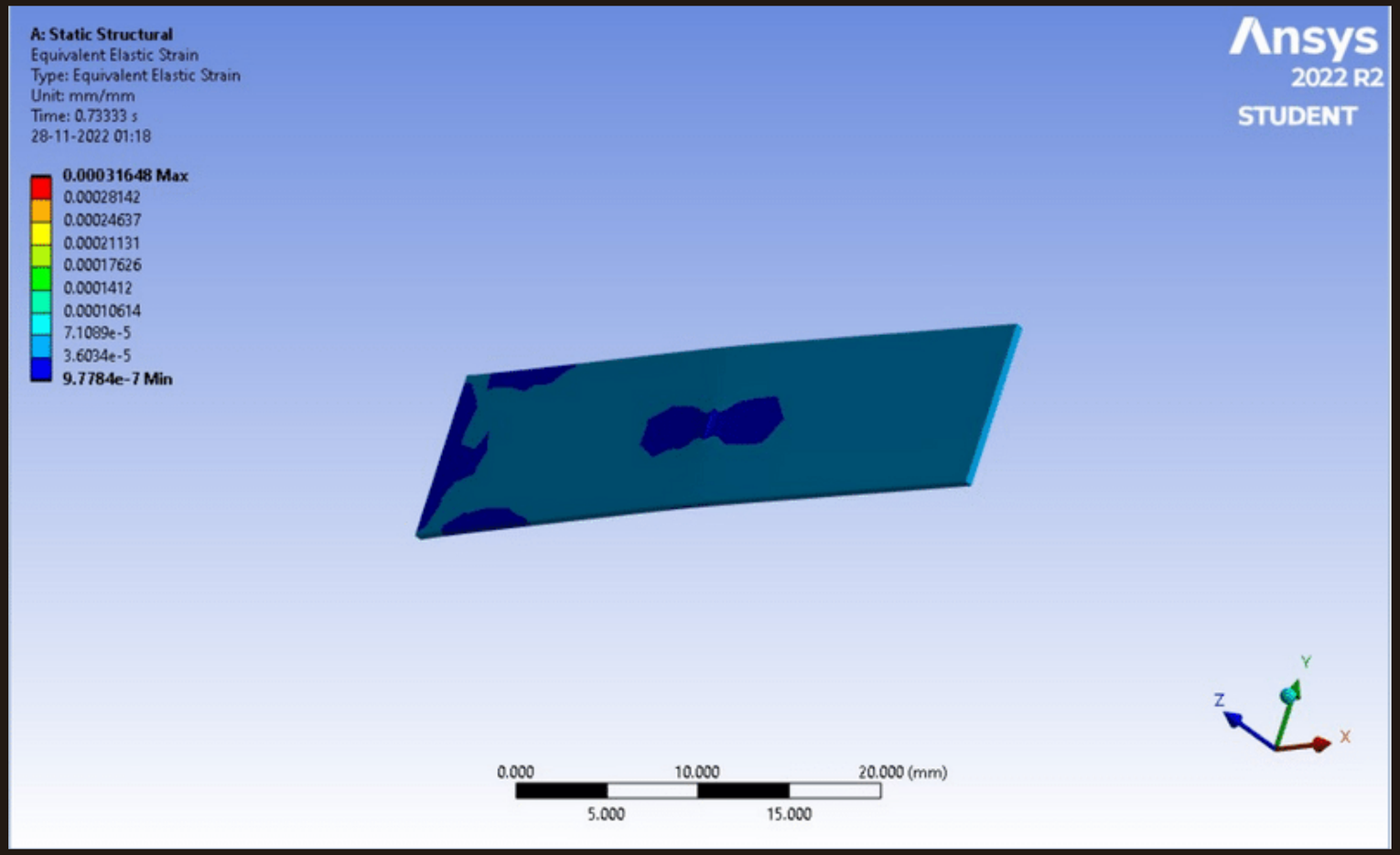
4. In modal analysis we first change the geometric coordinate system from global to user defined. Then tetrahedral meshing is performed. Then we add fracture tool and in fracture tool semi elliptical crack is created at the centre of plate whose minor radius is 1.00 mm and major radius is 0.2 mm. Also we add smart crack growth from fracture tool to analyse crack growth in z direction. For solution purpose we add k1,k2,k3 and plot the values of k1,k2,k3 with crack growth in z direction.



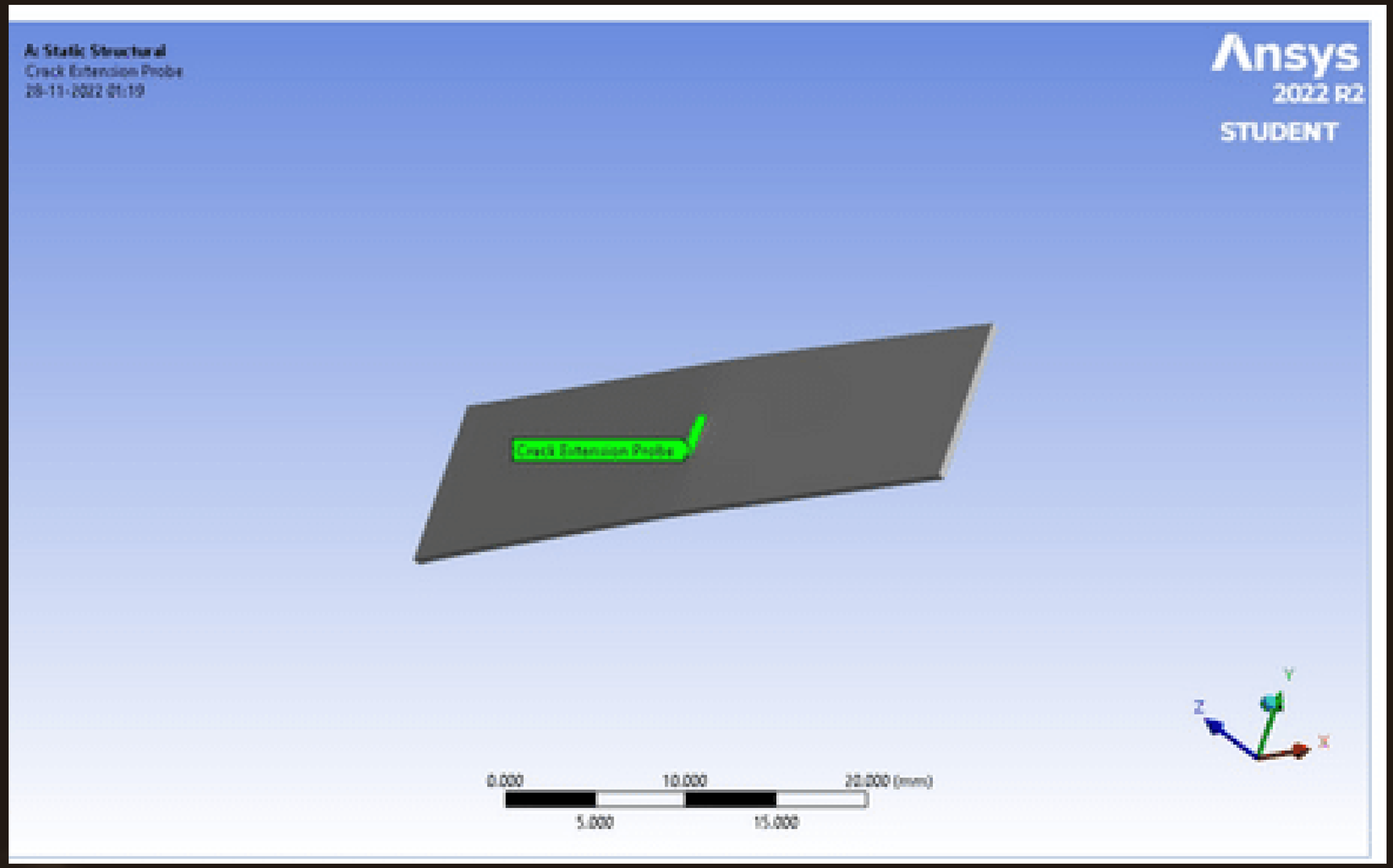
28	0,28	0,	
29	0,29	0,	
30	0,3	0,	
31	0,31	0,	
32	0,32	0,	
33	0,33	0,	
34	0,34	0,	
35	0,35	0,	
36	0,36	0,	
37	0,37	0,	
38	0,38	0,	
39	0,39	0,	
40	0,4	0,	
41	0,41	1,8635e-002	
42	0,42	3,8236e-002	Yes
43	0,43	5,8509e-002	Yes
44	0,44	7,9387e-002	Yes
45	0,45	0,10097	Yes
46	0,46	0,12308	Yes
47	0,47	0,14572	Yes
48	0,48	0,16876	Yes
49	0,49	0,19234	Yes
50	0,5	0,21611	Yes
51	0,51	0,24036	Yes
52	0,52	0,26483	Yes
53	0,53	0,28959	Yes
54	0,54	0,31415	Yes
55	0,55	0,33615	Yes
56	0,56	0,35737	Yes
57	0,57	0,37811	Yes
58	0,58	0,39863	Yes



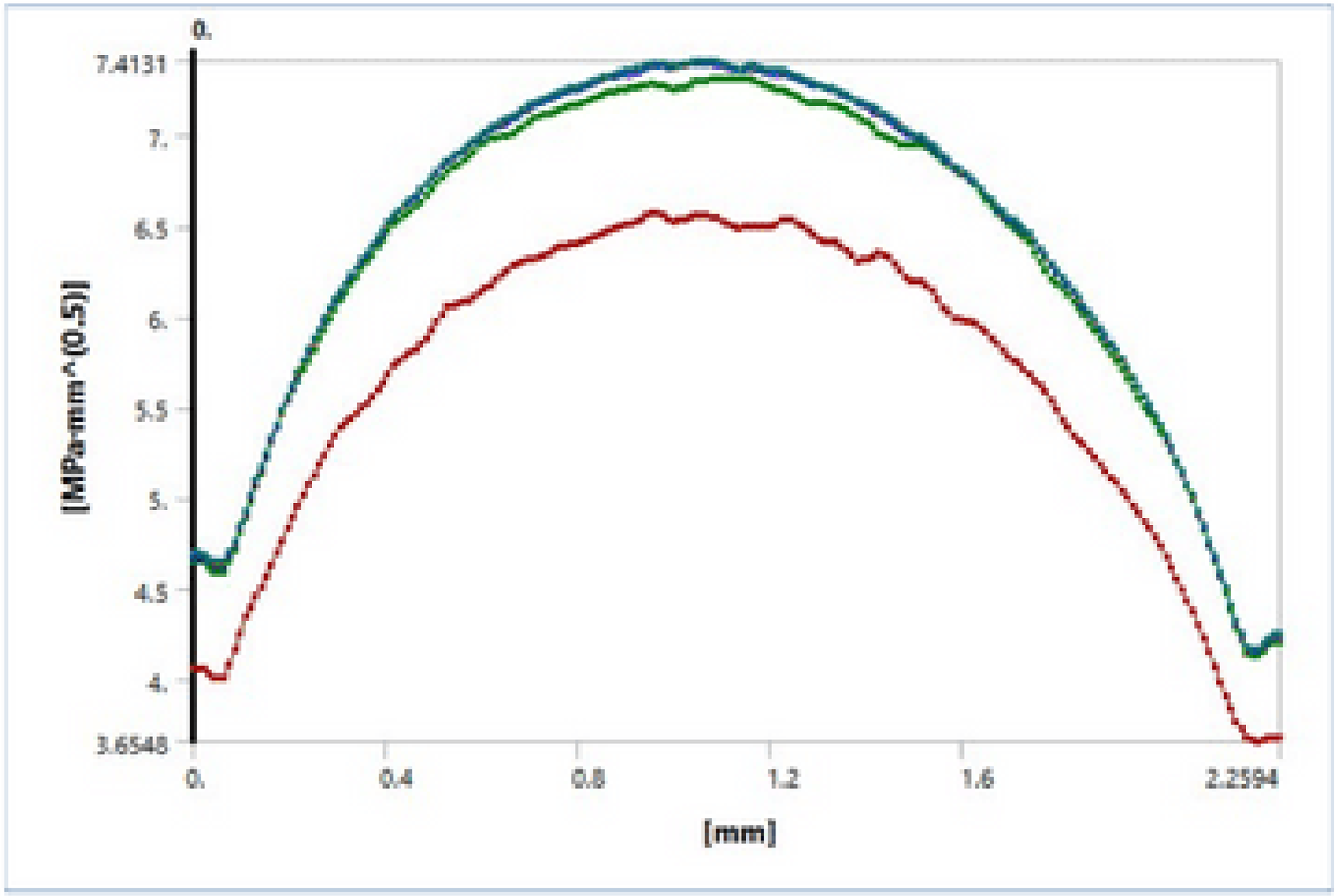
TOTAL DEFORMATION



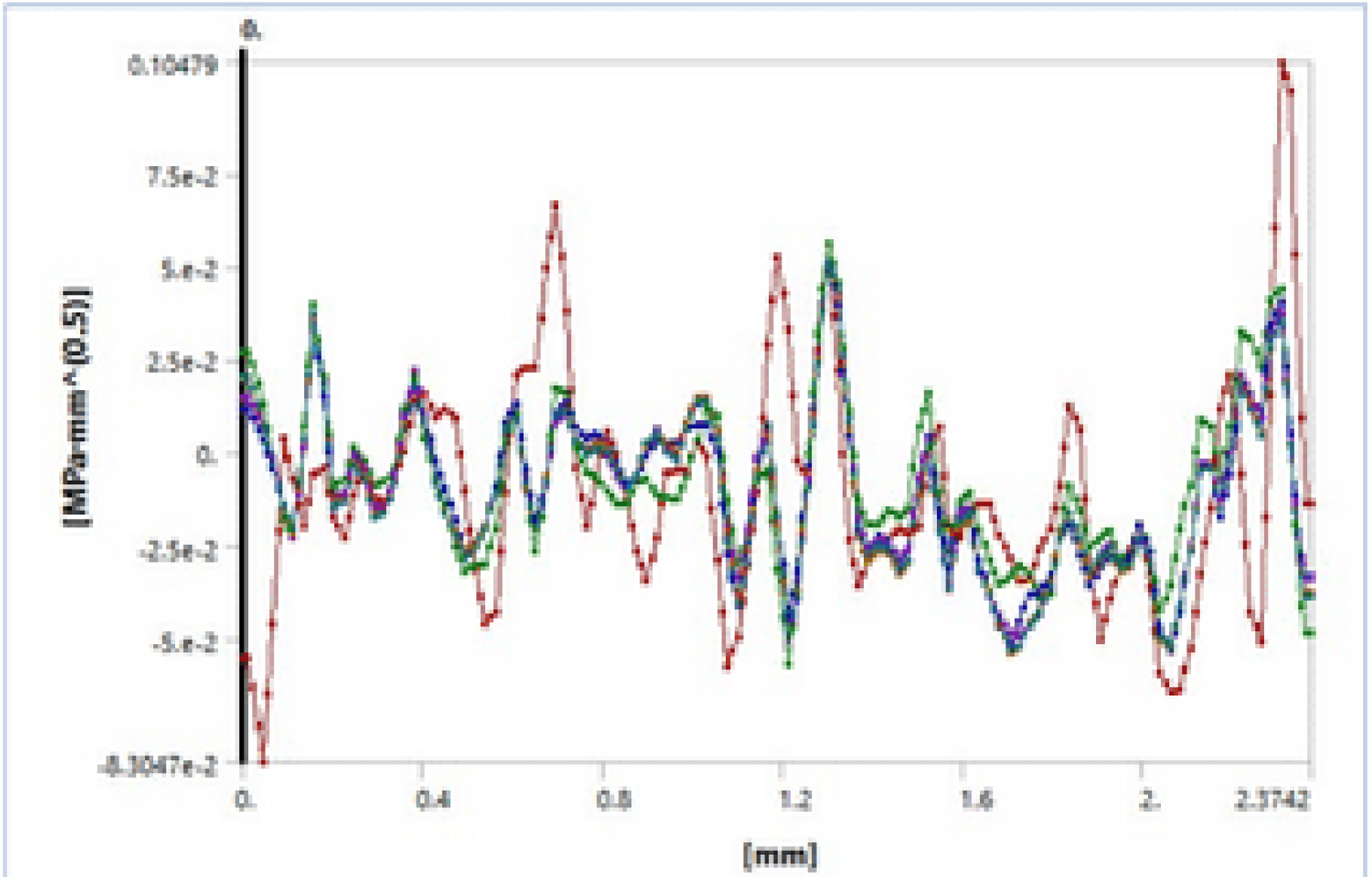
EQUIVALENT ELASTIC STRAIN



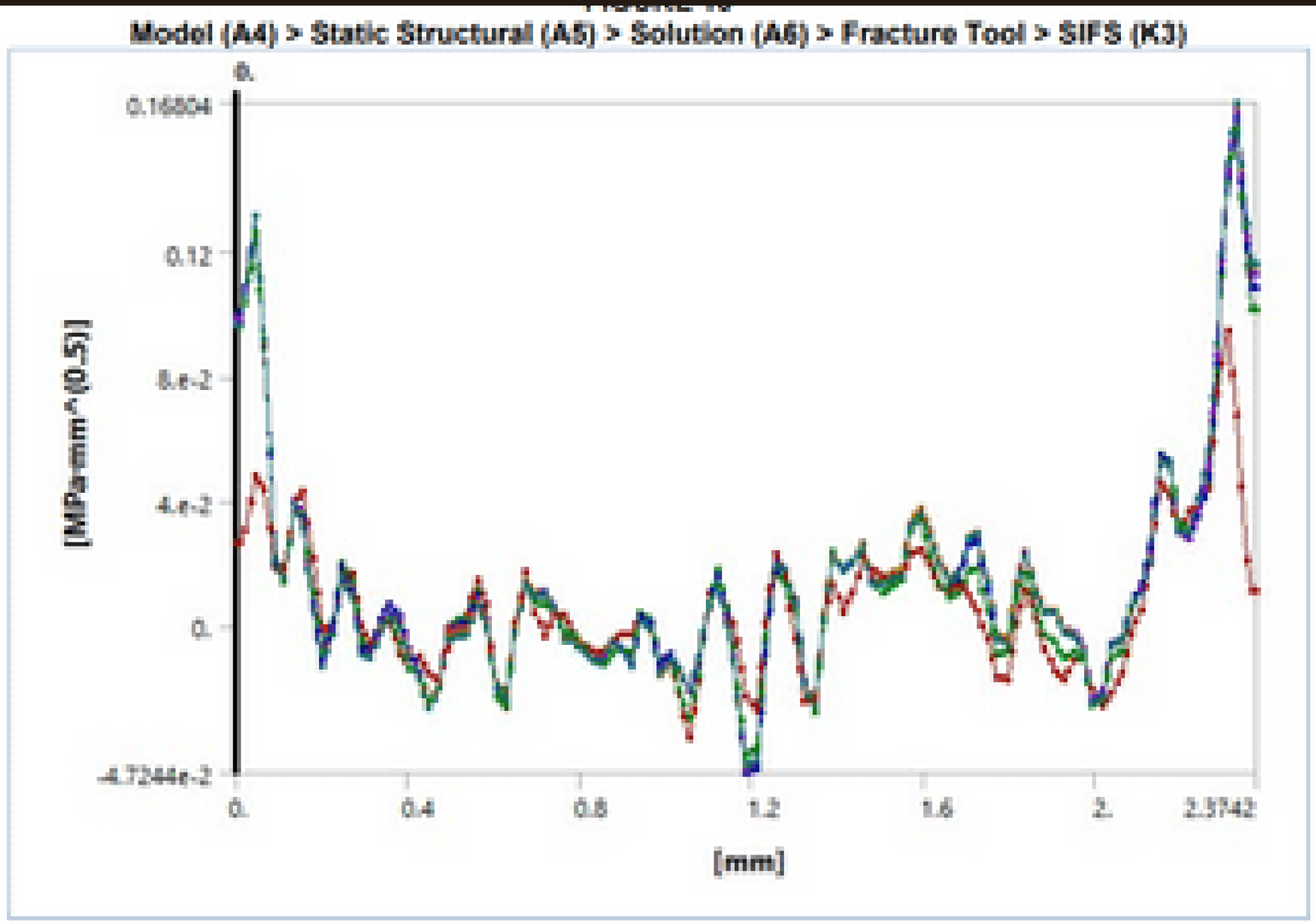
Crack extension probe



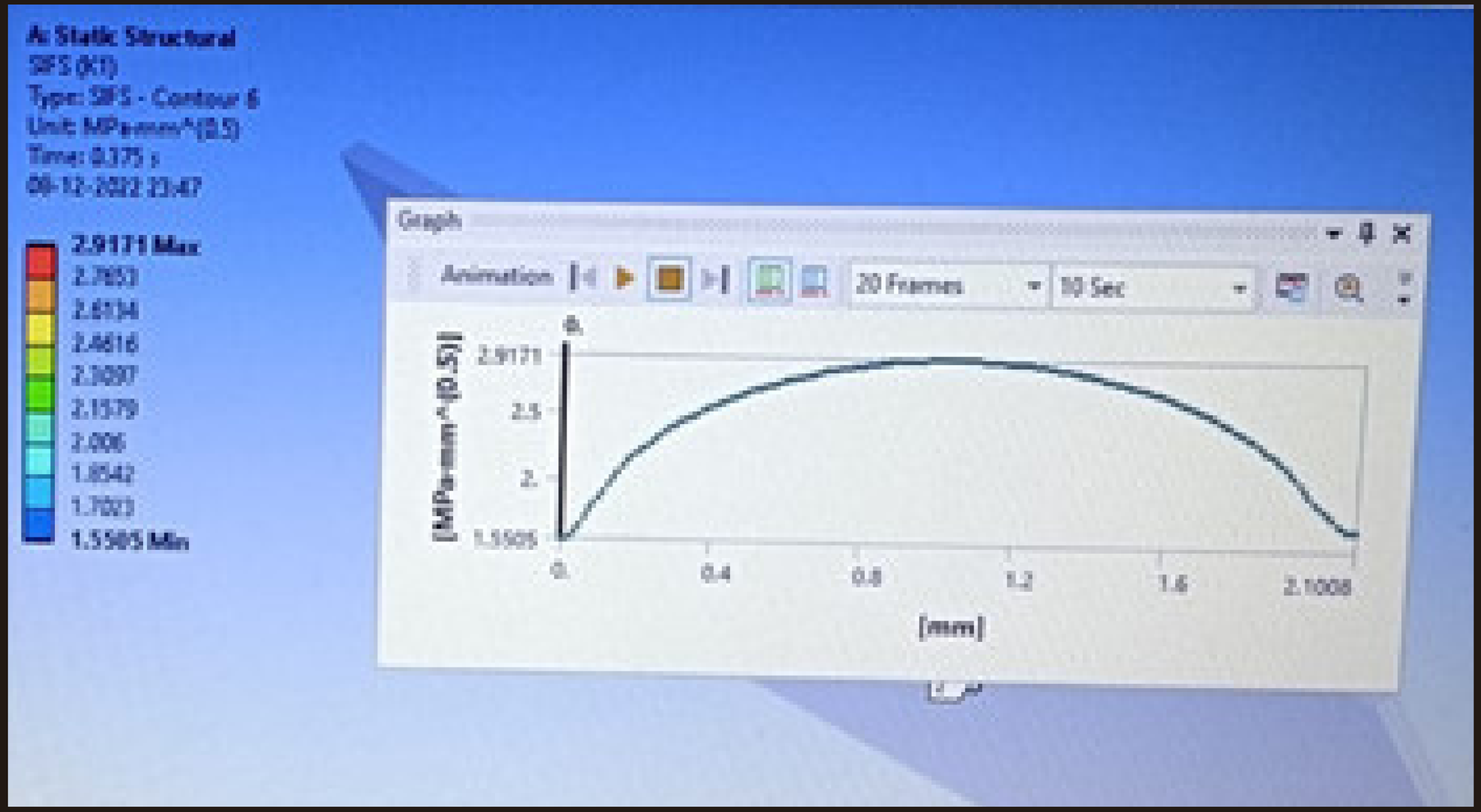
SIF graph


0.
0.10479
7.5e-2
5.e-2
2.5e-2
0.
-2.5e-2
-5.e-2
-8.3047e-2
[MPa-mm^(0.5)]
0.
0.4
0.8
1.2
1.6
2.
2.3742
[mm]

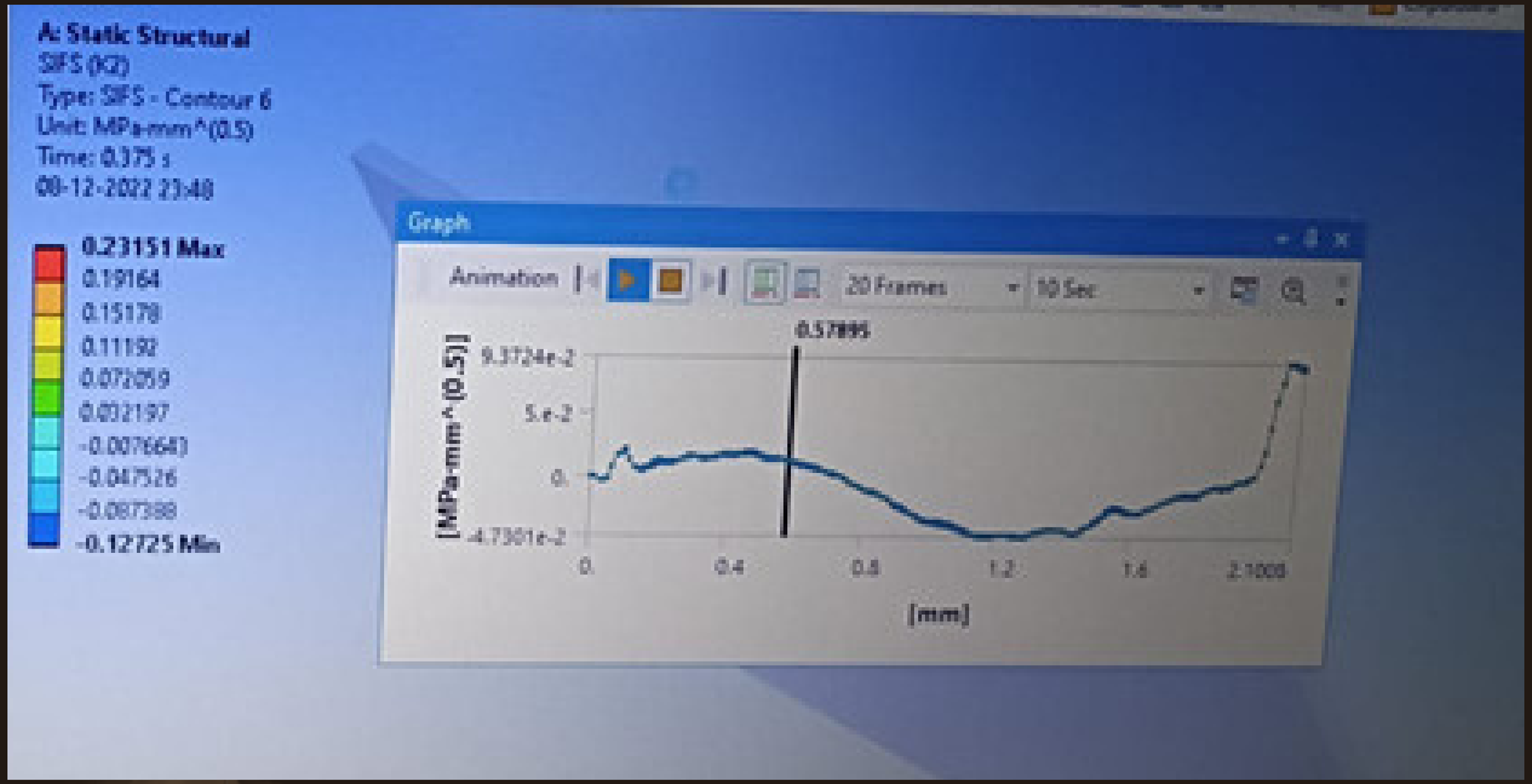
SIF graph k2

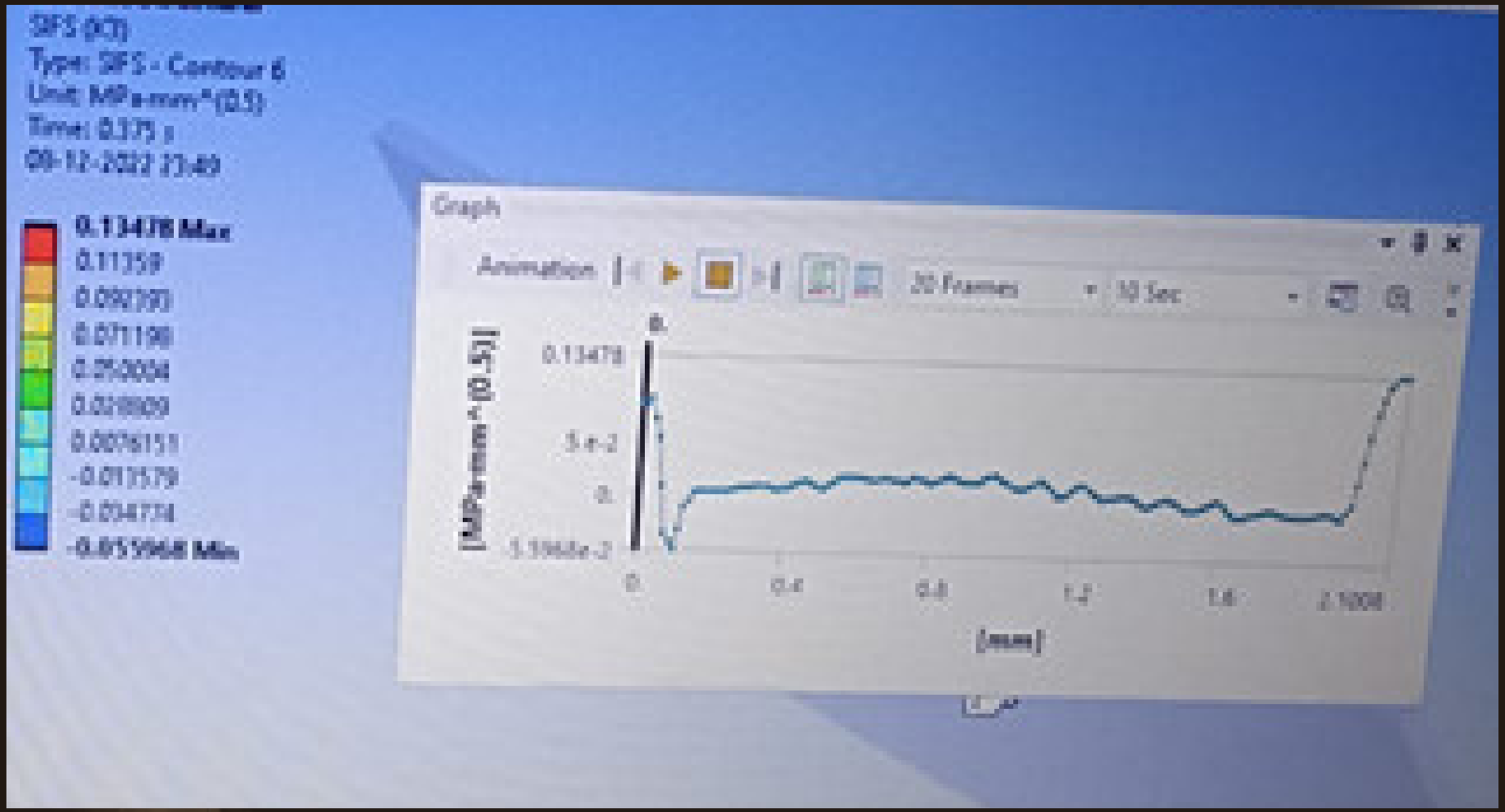

Model (A4) > Static Structural (A5) > Solution (A6) > Fracture Tool > SIFS (K3)
0.
0.16804
0.12
8.e-2
4.e-2
0.
-4.7244e-2
[MPa*mm^(0.5)]
0.
0.4
0.8
1.2
1.6
2.
2.3742
[mm]

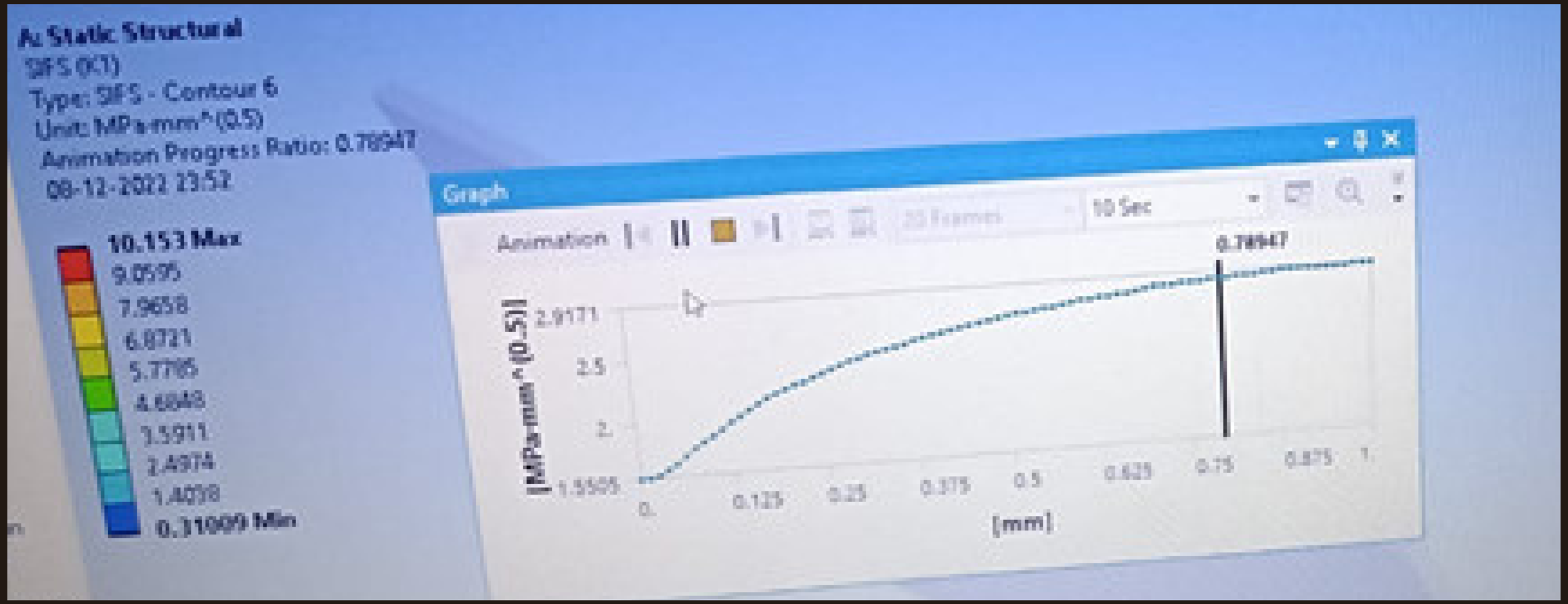
SIF graph - k3


A: Static Structural
SFS (K1)
Type: SFS - Contour 6
Unit: MPa*mm^(0.5)
Time: 0.375 s
09-12-2022 23:47
2.9171 Max
2.7653
2.6134
2.4616
2.3097
2.1579
2.006
1.8542
1.7023
1.5505 Min
Graph
Animation
20 Frames
10 Sec
[MPa*mm^(0.5)]
2.9171
2.5
2.
1.5505
0.
0.4
0.8
1.2
1.6
2.1008
[mm]

SIF graph - k3


A: Static Structural
SIFS (K2)
Type: SIFS - Contour 6
Unit: MPa-mm^(0.5)
Time: 0.375 s
08-12-2022 23:48
0.23151 Max
0.19164
0.15178
0.11192
0.072059
0.032197
-0.0076643
-0.047526
-0.087388
-0.12725 Min
Graph
Animation
20 Frames
10 Sec
0.57895
9.3724e-2
5.e-2
0.
-4.7301e-2
[MPa-mm^(0.5)]
0
0.4
0.8
1.2
1.6
2.1008
[mm]


SIFS (KJ)
Type: SIFS - Contour 6
Unit: MPa·mm^(0.5)
Time: 0.375 s
09-12-2022 13:49
0.13478 Max
0.11359
0.092393
0.071198
0.050004
0.028809
0.0076151
-0.013579
-0.034774
-0.055968 Min
Graph
Animation
30 Frames
10 Sec
0.13478
5.e-2
0.
-5.59682e-2
0.
0.4
0.8
1.2
1.6
2.1008
[mm]


A: Static Structural
SFS (K1)
Type: SFS - Contour 6
Unit: MPa·mm^(0.5)
Animation Progress Ratio: 0.78947
08-12-2022 23:52
10.153 Max
9.0595
7.9658
6.8721
5.7785
4.6848
3.5911
2.4974
1.4038
0.31009 Min
Graph
Animation
10 Sec
0.78947
[MPa·mm^(0.5)]
2.9171
2.5
2.
1.9505
0.
0.125
0.25
0.375
0.5
0.625
0.75
0.875
1.
[mm]

SECOND PROJECT

PREFACE

In this model we analysed crack growth in 2d .

MATERIAL USED

STAINLESS STEEL IS USED TO BUILD THE MODEL

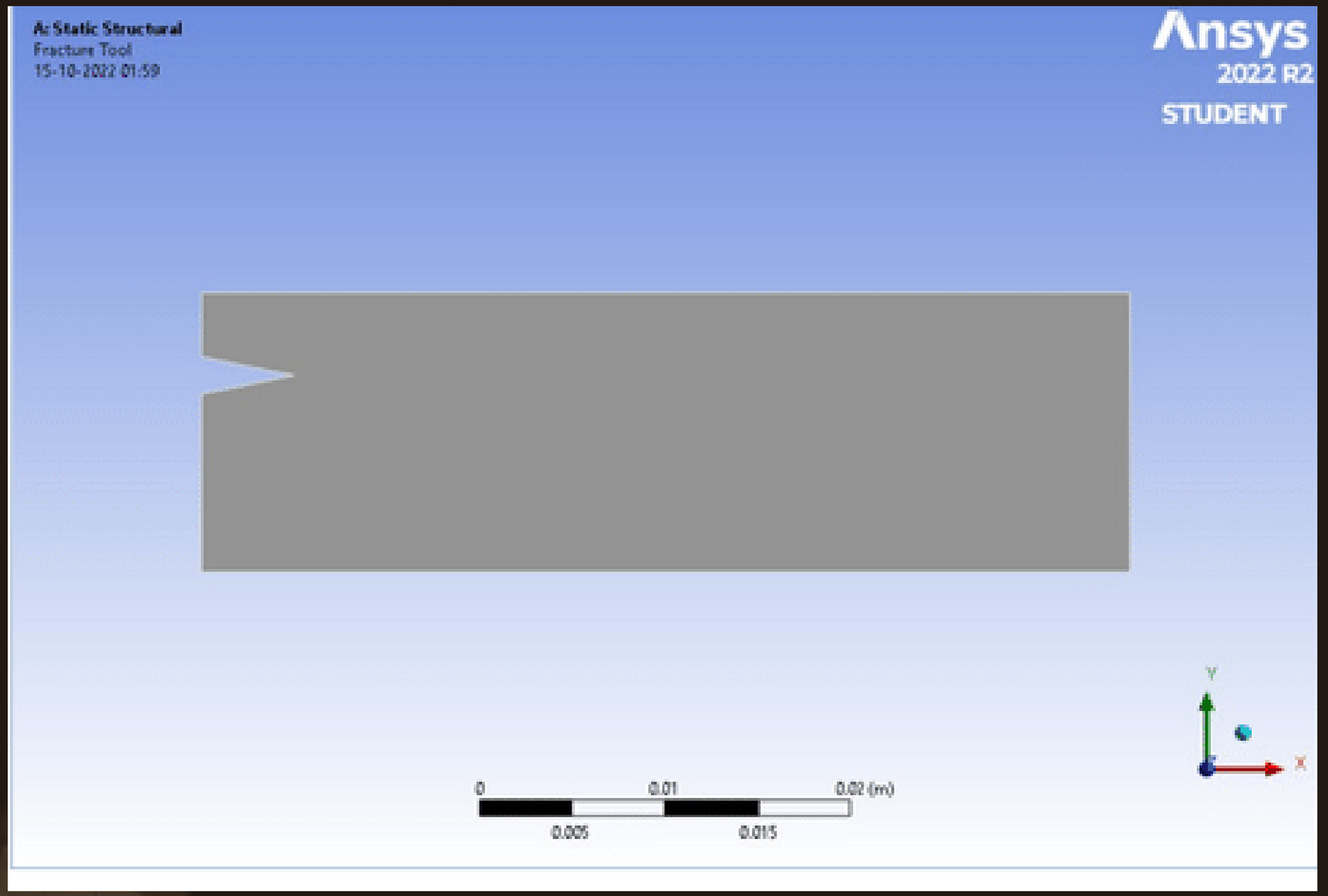
RESULTS

TOTAL DEFORAMTAION

Deforamtion **refers to the change in size or shape of an object .**
Here the total deformation value is -
min. - 0 (at blue regin) ; max - 0.0005855 m

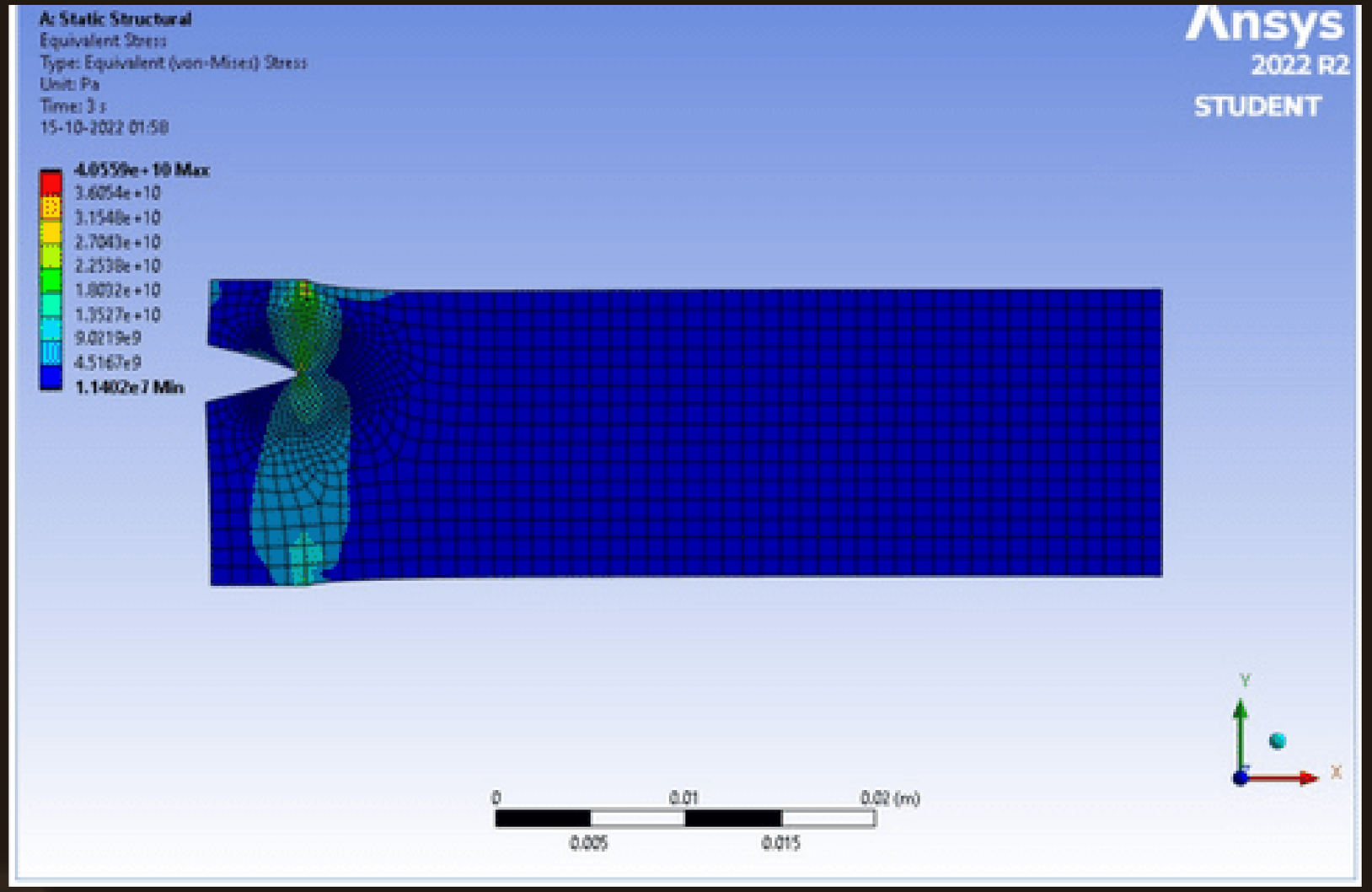
SIF (stress intesnsity factor)

It is one of the most fundamental and useful parameters in all of fracture mechanics. The stress intensity factor describes the stress state at a crack tip, is related to the rate of crack growth, and is used to establish failure criteria due to fracture.
SIF - min : 1.4721 e7 ; max : 1.4721 e7 unit -- pa.m^0.5



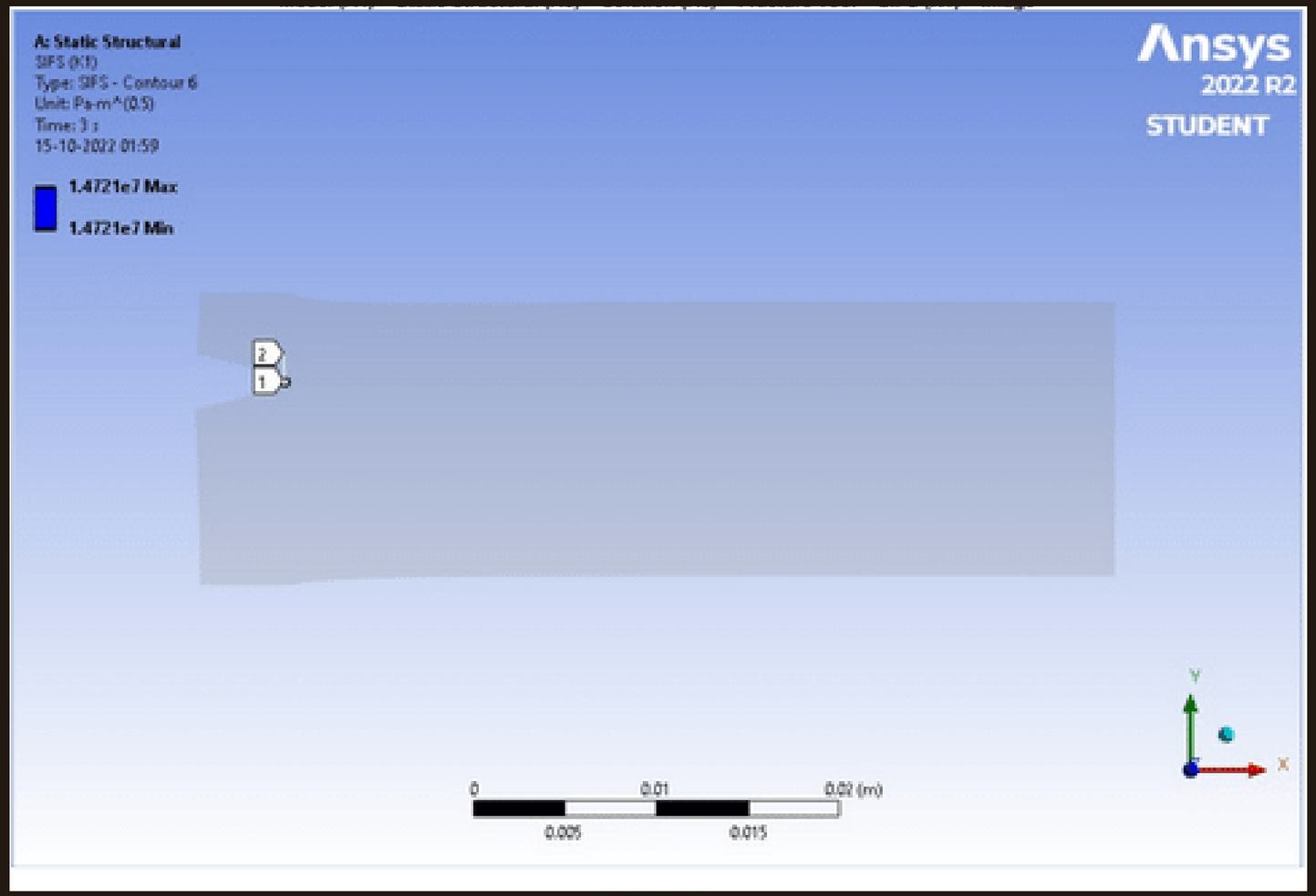
Fracture tool

Presentation by **Juliana Silva**



Equivalent stress

Presentation by **Juliana Silva**



SIFS

THANK YOU