**ANALYSIS OF CRACK PROPAGATION FOR DIFFERENT – AL AND MG ALLOYS AT ROOM TEMPERATURE**

**A Project Report submitted in partial fulfilment of the requirements for the award of the degree of,**

**BACHELOR OF TECHNOLOGY IN MECHANICAL ENGINEERING**

Submitted by:

|  |  |
| --- | --- |
| **MUSTAK D** | **321810801012** |
| **VINAY KUMAR REDDY** | **321810801007** |
| **POOJITH KUMAR** | **3210816218** |
|  |  |

**Under the esteemed guidance of**

**RAGHU VAMSI KRISHNA**

**ASSISTANT PROFESSOR**



**Department of Mechanical Engineering,**

**GITAM SCHOOL OF TECHNOLOGY**

**April 2022**



**CERTIFICATE**

This is to certify that the project report entitled **“ANALYSIS OF CRACK PROPAGATION FOR DIFFERENT –AL AND MG ALLOWYS AT ROOM TEMPERATURE** is a bonifide record of work carried out by **MUSTAK D [321810801012], VINAY KUMAR REDDY [321810801007], POOJITH KUMAR [3210816218]** submitted in partial fulfilment of requirement for the award of degree of **Bachelors of Technology Mechanical Engineering**.

**Project Guide. Head of the Department.**

**SIGNATURE OF THE GUIDE SIGNATURE OF THE HOD**

**RAGHU VAMSI KRISHNA Dr.NageshwaraRao T,**

ASSISTANT PROFESSOR. Professor



**DECLARATION**

We, hereby declare that the project report entitled **“ANALYSIS OF CRACK PROPAGATION FOR DIFFERENT –ALLOWYS AT ROOM TEMPERATURE”** is an original work done in the **Department of Mechanical Engineering, GITAM Institute of Technology, GITAM (Deemed to be University)** submitted in partial fulfillment of the requirements for the award of the degree of **B.Tech.** Mechanical Engineering. The work has not been submitted to any other college or University for the **AL** award of any degree.

#### Date:

|  |  |  |
| --- | --- | --- |
| **Registration No(s).** | **Name(s)** | **Signature(s)** |
| 1. **321810801012** 2. **321810801007** 3. **3210816218** | **MUSTAK D**  **VINAY KUMAR REDDY**  **POOJITH KUMAR** |  |

**ACKNOWLEDGEMENT**

The Satisfaction and Euphoria that accompany the successful completion of any Seminar would be incomplete without mentioning the people who made it possible, whose constant guidance and encouragement crowned our efforts with success. We take this opportunity to express the deepest gratitude and appreciation to all those who held us directly or indirectly towards the successful completion of the Seminar.

I would like to thank **Dr. S DINESH**, Ph.D., Director, GITAM School of Technology for all the facilities provided.

I would like to thank **Dr NAGESHWARA RAO T**, Ph.D., Professor-HOD, Department of **Mechanical Engineering** for his support and encouragement that went a long way in the successful completion of this Seminar.

I consider it a privilege to express our heartfelt gratitude and respect to **RAGHU VAMSI KRISHNA,** for being our internal guide for his integral and incessant support offered to us throughout this project and for a constant source of inspiration throughout the Seminar.

I would like to thank our **parents** and our **friends** for their support and encouragement in the completion of the project in time.

Last but not least I would like to thank all the teaching and non-teaching staff members of the **Mechanical Engineering Department**, for their support in completing the project in time.

Student Name’s Registration No.

1. MUSTAK D 321810801012

2.VINAY KUMAR REDDY 321810801007

3. POOJITH KUMAR 3210816218

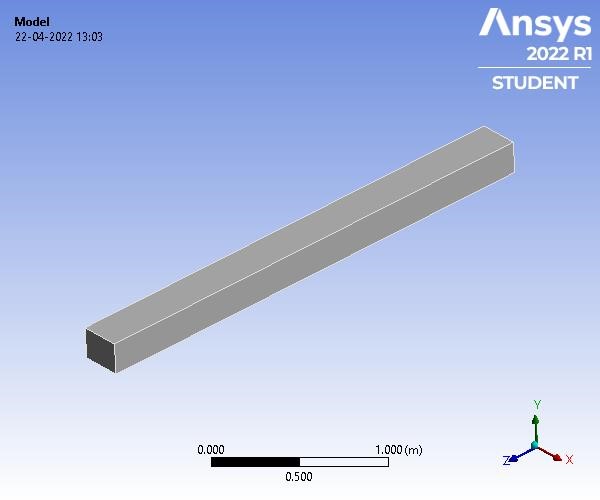
**INTRODUCTION**

All structures are prone to degenerative effects throughout the operation, which may result in the commencement of structural flaws such as cracks, which can lead to catastrophic failure or collapse of the structure over time. The dynamical behaviour of a structural element is influenced by cracks or imperfections, which modify its stiffness and damping qualities. As a result, the structure ’s Natural frequencies and mode shapes convey information about the damage’s position and proportions. Cantilever beams made of mild steel are commonly utilized in ships and offshore platforms. It is also used to build stadiums, bridges, buildings, high-rise towers, and other constructions. As a result, a single crack in a cantilever beam can lead to the collapse of a large structure. It is difficult to perform modal analysis of a cantilever beam using an analytical approach when there are discontinuities. Finite element analysis is the most effective method for handling these problems to date, and in this study, ANSYS is utilized to carry out all the computations. The author gives a free vibration beam model with open edges. It examined how depth and position affect crack frequency. A parametric study and various boundary conditions of cracked beams are studied. The results of previous research studies are compared to ABAQUS finite element analysis . Simply supported beam with triangular cracks’ natural frequency was quantified using FEA and ANSYS. The effects of various crack locations are compared to a simply supported beam without a crack. The beam vibration study shows that the beam without cracks has a lower fundamental frequency than the cracked beams. Gudmonson and Liang et al. [4,5] illustrate that the ratio of two natural frequency shifts is location dependent. As a result, detecting the depth and position of a single crack in a beam is rather straightforward. The most common method for finding cracks in structures is modal analysis. A beam with a single-edged notch was analysed using ANSYS Mechanical APDL 15.0. Modal analysis was used to estimate the beam’s mode shape and natural frequency



**Project**

|  |  |
| --- | --- |
| First Saved | Monday, April 4, 2022 |
| Last Saved | Wednesday, April 6, 2022 |
| Product Version | 2022 R1 |
| Save Project Before Solution | No |
| Save Project After Solution | No |



# Contents

* **Units**
* **Model (A4)** o Geometry Imports
  + Geometry Import (A3) o Geometry
  + Solid o Materials

o Coordinate Systems o Mesh o **Modal (A5)**

* + - Pre-Stress (None)
    - Analysis Settings
    - Fixed Support 2
    - Solution (A6)
    - Solution Information
    - Results
* **Material Data** o magnesium alloy

# Units

## TABLE 1

|  |  |
| --- | --- |
| Unit System | Metric (m, kg, N, s, V, A) Degrees rad/s Celsius |
| Angle | Degrees |
| Rotational Velocity | rad/s |
| Temperature | Celsius |

# Model (A4)

## TABLE 2

**Model (A4) > Geometry Imports**

|  |  |
| --- | --- |
| Object Name | *Geometry Imports* |
| State | Solved |

## TABLE 3

**Model (A4) > Geometry Imports > Geometry Import (A3)**

|  |  |
| --- | --- |
| Object Name | *Geometry Import (A3)* |
| State | Solved |
| **Definition** | |
| Source | C:\Users\HP\AppData\Local\Temp\WB\_HP\_9064\_2\wbnew\_files\dp0\SYS\DM\SYS.agdb |
| Type | DesignModeler |
| **Basic Geometry Options** | |
| Solid Bodies | Yes |
| Surface  Bodies | Yes |
| Line Bodies | Yes |
| Parameters | Independent |

|  |  |
| --- | --- |
| Parameter  Key |  |
| Attributes | Yes |
| Attribute Key |  |
| Named  Selections | Yes |
| Named  Selection Key |  |
| Material  Properties | Yes |
| **Advanced Geometry Options** | |
| Use  Associativity | Yes |
| Coordinate Systems | Yes |
| Coordinate System Key |  |
| Reader  Mode  Saves  Updated  File | No |
| Use Instances | Yes |
| Smart CAD Update | Yes |
| Compare  Parts On Update | No |
| Compare  Parts Tolerance | Tight |
| Analysis Type | 3-D |
| Mixed  Import Resolution | None |
| Import  Facet Quality | Source |
| Clean  Bodies On Import | No |
| Stitch  Surfaces On Import | None |
| Stitch Tolerance | 0.0000001 |
| Decompose  Disjoint Geometry | Yes |
| Enclosure and  Symmetry Processing | Yes |

## *Geometry*

**TABLE 4**

**Model (A4) > Geometry**

|  |  |
| --- | --- |
| Object Name | *Geometry* |
| State | Fully Defined |
| **Definition** | |
| Source | C:\Users\HP\AppData\Local\Temp\WB\_HP\_9064\_2\wbnew\_files\dp0\SYS\DM\SYS.agdb |
| Type | DesignModeler |
| Length Unit | Meters |
| Element Control | Program Controlled |
| Display Style | Body Color |
| **Bounding Box** | |
| Length X | 0.25 m |
| Length Y | 0.2 m |
| Length Z | 3. m |
| **Properties** | |
| Volume | 0.15 m³ |
| Mass | 270. kg |
| Scale  Factor Value | 1. |
| **Statistics** | |
| Bodies | 1 |
| Active Bodies | 1 |
| Nodes | 30422 |
| Elements | 6300 |
| Mesh Metric | None |
| **Update Options** | |
| Assign  Default Material | No |
| **Basic Geometry Options** | |
| Parameters | Independent |
| Parameter  Key |  |
| Attributes | Yes |
| Attribute Key |  |
| Named  Selections | Yes |
| Named  Selection Key |  |
| Material  Properties | Yes |
| **Advanced Geometry Options** | |
| Use  Associativity | Yes |
| Coordinate Systems | Yes |
| Coordinate System Key |  |
| Reader  Mode  Saves  Updated  File | No |
| Use Instances | Yes |
| Smart CAD Update | Yes |
| Compare  Parts On Update | No |
| Analysis Type | 3-D |
| Import  Facet Quality | Source |
| Clean  Bodies On Import | No |
| Stitch  Surfaces On Import | None |
| Decompose  Disjoint Geometry | Yes |
| Enclosure and  Symmetry Processing | Yes |

**TABLE 5 Model (A4) > Geometry > Parts**

|  |  |
| --- | --- |
| Object Name | *Solid* |
| State | Meshed |
| **Graphics Properties** | |
| Visible | Yes |
| Transparency | 1 |
| **Definition** | |
| Suppressed | No |
| Stiffness Behavior | Flexible |
| Coordinate System | Default Coordinate System |
| Reference Temperature | By Environment |
| Treatment | None |
| **Material** | |
| Assignment | magnesium alloy |
| Nonlinear Effects | Yes |
| Thermal Strain Effects | Yes |
| **Bounding Box** | |
| Length X | 0.25 m |
| Length Y | 0.2 m |
| Length Z | 3. m |
| **Properties** | |
| Volume | 0.15 m³ |
| Mass | 270. kg |
| Centroid X | 0.125 m |
| Centroid Y | 0.1 m |
| Centroid Z | 1.5 m |
| Moment of Inertia Ip1 | 203.4 kg·m² |
| Moment of Inertia Ip2 | 203.91 kg·m² |
| Moment of Inertia Ip3 | 2.3063 kg·m² |
| **Statistics** | |
| Nodes | 30422 |
| Elements | 6300 |
| Mesh Metric | None |

### TABLE 6 Model (A4) > Materials

|  |  |
| --- | --- |
| Object Name | *Materials* |
| State | Fully Defined |
| **Statistics** | |
| Materials | 2 |
| Material Assignments | 0 |

## *Coordinate Systems*

### TABLE 7

**Model (A4) > Coordinate Systems > Coordinate System**

|  |  |
| --- | --- |
| Object Name | *Global Coordinate System* |
| State | Fully Defined |
| **Definition** | |
| Type | Cartesian |
| Coordinate System ID | 0. |
| **Origin** | |
| Origin X | 0. m |
| Origin Y | 0. m |
| Origin Z | 0. m |
| **Directional Vectors** | |
| X Axis Data | [ 1. 0. 0. ] |
| Y Axis Data | [ 0. 1. 0. ] |
| Z Axis Data | [ 0. 0. 1. ] |

## *Mesh*

### TABLE 8 Model (A4) > Mesh

|  |  |
| --- | --- |
| Object Name | *Mesh* |
| State | Solved |
| **Display** | |
| Display Style | Use Geometry Setting |
| **Defaults** | |
| Physics Preference | Mechanical |
| Element Order | Program Controlled |
| Element Size | 3.e-002 m |
| **Sizing** | |
| Use Adaptive Sizing | Yes |
| Resolution | Default (2) |
| Mesh Defeaturing | Yes |
| Defeature Size | Default |
| Transition | Fast |
| Span Angle Center | Coarse |
| Initial Size Seed | Assembly |
| Bounding Box Diagonal | 3.017 m |
| Average Surface Area | 0.46667 m² |
| Minimum Edge Length | 0.2 m |
| **Quality** | |
| Check Mesh Quality | Yes, Errors |
| Error Limits | Aggressive Mechanical |
| Target Element Quality | Default (5.e-002) |
| Smoothing | Medium |
| Mesh Metric | None |
| **Inflation** | |
| Use Automatic Inflation | None |
| Inflation Option | Smooth Transition |
| Transition Ratio | 0.272 |
| Maximum Layers | 5 |
| Growth Rate | 1.2 |
| Inflation Algorithm | Pre |
| View Advanced Options | No |
| **Advanced** | |
| Number of CPUs for Parallel Part Meshing | Program Controlled |
| Straight Sided Elements | No |
| Rigid Body Behavior | Dimensionally Reduced |
| Triangle Surface Mesher | Program Controlled |
| Topology Checking | Yes |
| Pinch Tolerance | Please Define |
| Generate Pinch on Refresh | No |
| **Statistics** | |
| Nodes | 30422 |
| Elements | 6300 |

# Modal (A5)

**TABLE 9**

**Model (A4) > Analysis**

|  |  |
| --- | --- |
| Object Name | *Modal (A5)* |
| State | Solved |
| **Definition** | |
| Physics Type | Structural |
| Analysis Type | Modal |
| Solver Target | Mechanical APDL |
| **Options** | |
| Environment Temperature | 22. °C |
| Generate Input Only | No |

## TABLE 10

**Model (A4) > Modal (A5) > Initial Condition**

|  |  |
| --- | --- |
| Object Name | *Pre-Stress (None)* |
| State | Fully Defined |
| **Definition** | |
| Pre-Stress Environment | None Available |

## TABLE 11

**Model (A4) > Modal (A5) > Analysis Settings**

|  |  |
| --- | --- |
| Object Name | *Analysis Settings* |
| State | Fully Defined |
| **Options** | |
| Max Modes to Find | 6 |
| Limit Search to Range | No |
| On Demand Expansion | No |
| **Solver Controls** | |
| Damped | No |
| Solver Type | Program Controlled |
| **Rotordynamics Controls** | |
| Coriolis Effect | Off |
| Campbell Diagram | Off |
| **Advanced** | |
| Contact Split (DMP) | Off |
| **Output Controls** | |
| Stress | No |
| Surface Stress | No |
| Back Stress | No |
| Strain | No |
| Contact Data | No |
| Nodal Forces | No |
| Volume and Energy | No |
| Euler Angles | No |
| Calculate Reactions | No |
| General Miscellaneous | No |
| Result File Compression | Program Controlled |
| **Analysis Data Management** | |
| Solver Files Directory | C:\Users\HP\OneDrive\Desktop\mus\_files\dp0\SYS\MECH\ |
| Future Analysis | None |
| Scratch Solver Files Directory |  |
| Save MAPDL db | No |
| Contact Summary | Program Controlled |
| Delete Unneeded Files | Yes |
| Solver Units | Active System |
| Solver Unit System | mks |

## TABLE 12 Model (A4) > Modal (A5) > Loads

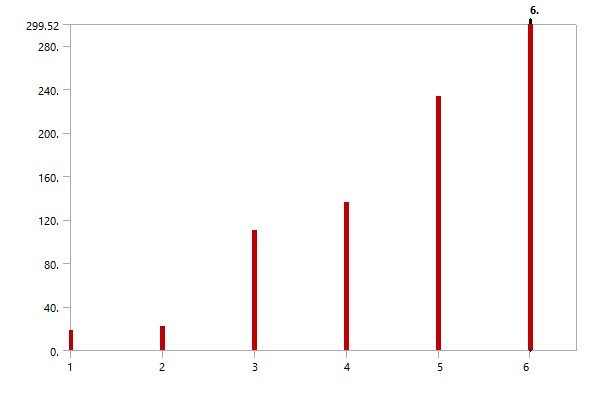
|  |  |
| --- | --- |
| Object Name | *Fixed Support 2* |
| State | Fully Defined |
| **Scope** | |
| Scoping Method | Geometry Selection |
| Geometry | 1 Face |
| **Definition** | |
| Type | Fixed Support |
| Suppressed | No |

## *Solution (A6)*

### TABLE 13 Model (A4) > Modal (A5) > Solution

|  |  |
| --- | --- |
| Object Name | *Solution (A6)* |
| State | Solved |
| **Adaptive Mesh Refinement** | |
| Max Refinement Loops | 1. |
| Refinement Depth | 2. |
| **Information** | |
| Status | Done |
| MAPDL Elapsed Time | 12. s |
| MAPDL Memory Used | 1.6406 GB |
| MAPDL Result File Size | 8.0625 MB |
| **Post Processing** | |
| Beam Section Results | No |

The following bar chart indicates the frequency at each calculated mode.



### FIGURE 1 Model (A4) > Modal (A5) > Solution (A6)

### TABLE 14 Model (A4) > Modal (A5) > Solution (A6)

|  |  |
| --- | --- |
| Mode | Frequency [Hz] |
| 1. | 17.95 |
| 2. | 22.384 |
| 3. | 110.25 |
| 4. | 136.01 |
| 5. | 233.19 |
| 6. | 299.52 |

### TABLE 15

**Model (A4) > Modal (A5) > Solution (A6) > Solution Information**

|  |  |
| --- | --- |
| Object Name | *Solution Information* |
| State | Solved |
| **Solution Information** | |
| Solution Output | Solver Output |
| Newton-Raphson Residuals | 0 |
| Identify Element Violations | 0 |
| Update Interval | 2.5 s |
| Display Points | All |
| **FE Connection Visibility** | |
| Activate Visibility | Yes |
| Display | All FE Connectors |
| Draw Connections Attached To | All Nodes |
| Line Color | Connection Type |
| Visible on Results | No |
| Line Thickness | Single |
| Display Type | Lines |

### TABLE 16 Model (A4) > Modal (A5) > Solution (A6) > Results

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Object Name | *Total Deformation* | *Total*  *Deformation 2* | *Total*  *Deformation 3* | *Total*  *Deformation 4* | *Total*  *Deformation 5* | *Total*  *Deformation 6* |
| State |  | | Solved | |  | |
|  | | | **Scope** | |  | |
| Scoping Method |  | | Geometry Selection | |  | |
| Geometry |  | | All Bodies | |  | |
|  | | | **Definition** | |  | |
| Type |  | | Total Deformation | |  | |
| Mode | 1. | 2. | 3. | 4. | 5. | 6. |
| Identifier |  | |  | |  | |
| Suppressed |  | | No | |  | |
|  | | | **Results** | |  | |
| Minimum |  | | 0. m | |  | |
| Maximum | 0.1217 m | 0.12161 m | 0.12141 m | 0.12118 m | 0.14929 m | 0.12125 m |
| Average | 4.7816e-002 m | 4.787e-002 m | 5.2944e-002 m | 5.318e-002 m | 5.5697e-002 m | 5.4475e-002 m |
| Minimum Occurs On |  | | Solid | |  | |
| Maximum Occurs On |  | | Solid | |  | |
|  | | | **Information** | |  | |
| Frequency | 17.95 Hz | 22.384 Hz | 110.25 Hz | 136.01 Hz | 233.19 Hz | 299.52 Hz |

### TABLE 17

**Model (A4) > Modal (A5) > Solution (A6) > Total Deformation**

|  |  |
| --- | --- |
| Mode | Frequency [Hz] |
| 1. | 17.95 |
| 2. | 22.384 |
| 3. | 110.25 |
| 4. | 136.01 |
| 5. | 233.19 |
| 6. | 299.52 |

### TABLE 18

**Model (A4) > Modal (A5) > Solution (A6) > Total Deformation 2**

|  |  |
| --- | --- |
| Mode | Frequency [Hz] |
| 1. | 17.95 |
| 2. | 22.384 |
| 3. | 110.25 |
| 4. | 136.01 |
| 5. | 233.19 |
| 6. | 299.52 |

### TABLE 19

**Model (A4) > Modal (A5) > Solution (A6) > Total Deformation 3**

|  |  |
| --- | --- |
| Mode | Frequency [Hz] |
| 1. | 17.95 |
| 2. | 22.384 |
| 3. | 110.25 |
| 4. | 136.01 |
| 5. | 233.19 |
| 6. | 299.52 |

### TABLE 20

**Model (A4) > Modal (A5) > Solution (A6) > Total Deformation 4**

|  |  |
| --- | --- |
| Mode | Frequency [Hz] |
| 1. | 17.95 |
| 2. | 22.384 |
| 3. | 110.25 |
| 4. | 136.01 |
| 5. | 233.19 |
| 6. | 299.52 |

### TABLE 21

**Model (A4) > Modal (A5) > Solution (A6) > Total Deformation 5**

|  |  |
| --- | --- |
| Mode | Frequency [Hz] |
| 1. | 17.95 |
| 2. | 22.384 |
| 3. | 110.25 |
| 4. | 136.01 |
| 5. | 233.19 |
| 6. | 299.52 |

### TABLE 22

**Model (A4) > Modal (A5) > Solution (A6) > Total Deformation 6**

|  |  |
| --- | --- |
| Mode | Frequency [Hz] |
| 1. | 17.95 |
| 2. | 22.384 |
| 3. | 110.25 |
| 4. | 136.01 |
| 5. | 233.19 |
| 6. | 299.52 |

## Material Data *magnesium alloy*

### TABLE 23 magnesium alloy > Constants

|  |  |
| --- | --- |
| Density | 1800 kg m^-3 |

### TABLE 24 magnesium alloy > Color

|  |  |  |
| --- | --- | --- |
| Red | Green | Blue |
| 103 | 192 | 205 |

### TABLE 25

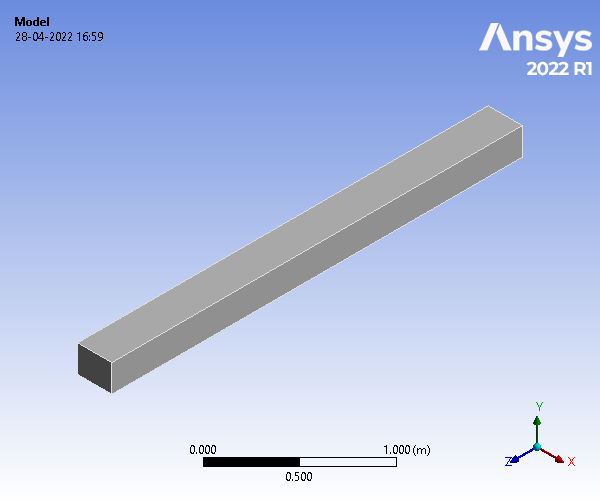
**magnesium alloy > Isotropic Elasticity**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Young's Modulus Pa | Poisson's Ratio | Bulk Modulus Pa | Shear Modulus Pa | Temperature C |
| 4.5e+010 | 0.29 | 3.5714e+010 | 1.7442e+010 |  |



# Project

|  |  |
| --- | --- |
| First Saved | Thursday, April 28, 2022 |
| Last Saved | Thursday, April 28, 2022 |
| Product Version | 2022 R1 |
| Save Project Before Solution | No |
| Save Project After Solution | No |



## Contents

* [**Units**](#UNITS)
* [**Model (A4)**](#12)
  + [Geometry Imports](#13)
    - [Geometry Import (A3)](#14)
  + [Geometry](#15)
    - [Solid](#21)
  + [Materials](#18)
  + [Coordinate Systems](#23)
  + [Mesh](#16)
  + [**Modal (A5)**](#25)
    - [Pre-Stress (None)](#28)
    - [Analysis Settings](#29)
    - [Fixed Support](#32)
    - [Solution (A6)](#26)
      * [Solution Information](#27)
      * [Results](#35)
* [**Material Data**](#Materials)
  + [al7079](#EngineeringData1)

## Report Not Finalized

**Not all objects described below are in a finalized state.** As a result, data may be incomplete, obsolete or in error. [View first state problem](#25). To finalize this report, edit objects as needed and solve the analyses.

## Units

TABLE 1

|  |  |
| --- | --- |
| Unit System | Metric (m, kg, N, s, V, A) Degrees rad/s Celsius |
| Angle | Degrees |
| Rotational Velocity | rad/s |
| Temperature | Celsius |

## Model (A4)

TABLE 2  
Model (A4) > Geometry Imports

|  |  |
| --- | --- |
| Object Name | *Geometry Imports* |
| State | Solved |

TABLE 3  
Model (A4) > Geometry Imports > Geometry Import (A3)

|  |  |
| --- | --- |
| Object Name | *Geometry Import (A3)* |
| State | Solved |
| **Definition** | |
| Source | C:\Users\HP\AppData\Local\Temp\WB\_HP\_19796\_2\wbnew\_files\dp0\SYS-4\DM\SYS-4.agdb |
| Type | DesignModeler |
| **Basic Geometry Options** | |
| Solid Bodies | Yes |
| Surface Bodies | Yes |
| Line Bodies | Yes |
| Parameters | Independent |
| Parameter Key |  |
| Attributes | Yes |
| Attribute Key |  |
| Named Selections | Yes |
| Named Selection Key |  |
| Material Properties | Yes |
| **Advanced Geometry Options** | |
| Use Associativity | Yes |
| Coordinate Systems | Yes |
| Coordinate System Key |  |
| Reader Mode Saves Updated File | No |
| Use Instances | Yes |
| Smart CAD Update | Yes |
| Compare Parts On Update | No |
| Compare Parts Tolerance | Tight |
| Analysis Type | 3-D |
| Mixed Import Resolution | None |
| Import Facet Quality | Source |
| Clean Bodies On Import | No |
| Stitch Surfaces On Import | None |
| Stitch Tolerance | 0.0000001 |
| Decompose Disjoint Geometry | Yes |
| Enclosure and Symmetry Processing | Yes |

### Geometry

TABLE 4  
Model (A4) > Geometry

|  |  |
| --- | --- |
| Object Name | *Geometry* |
| State | Fully Defined |
| **Definition** | |
| Source | C:\Users\HP\AppData\Local\Temp\WB\_HP\_19796\_2\wbnew\_files\dp0\SYS-4\DM\SYS-4.agdb |
| Type | DesignModeler |
| Length Unit | Meters |
| Element Control | Program Controlled |
| Display Style | Body Color |
| **Bounding Box** | |
| Length X | 0.25 m |
| Length Y | 0.2 m |
| Length Z | 3. m |
| **Properties** | |
| Volume | 0.15 m³ |
| Mass | 420. kg |
| Scale Factor Value | 1. |
| **Statistics** | |
| Bodies | 1 |
| Active Bodies | 1 |
| Nodes | 30422 |
| Elements | 6300 |
| Mesh Metric | None |
| **Update Options** | |
| Assign Default Material | No |
| **Basic Geometry Options** | |
| Parameters | Independent |
| Parameter Key |  |
| Attributes | Yes |
| Attribute Key |  |
| Named Selections | Yes |
| Named Selection Key |  |
| Material Properties | Yes |
| **Advanced Geometry Options** | |
| Use Associativity | Yes |
| Coordinate Systems | Yes |
| Coordinate System Key |  |
| Reader Mode Saves Updated File | No |
| Use Instances | Yes |
| Smart CAD Update | Yes |
| Compare Parts On Update | No |
| Analysis Type | 3-D |
| Import Facet Quality | Source |
| Clean Bodies On Import | No |
| Stitch Surfaces On Import | None |
| Decompose Disjoint Geometry | Yes |
| Enclosure and Symmetry Processing | Yes |

TABLE 5  
Model (A4) > Geometry > Parts

|  |  |
| --- | --- |
| Object Name | *Solid* |
| State | Meshed |
| **Graphics Properties** | |
| Visible | Yes |
| Transparency | 1 |
| **Definition** | |
| Suppressed | No |
| Stiffness Behavior | Flexible |
| Coordinate System | Default Coordinate System |
| Reference Temperature | By Environment |
| Treatment | None |
| **Material** | |
| Assignment | al7079 |
| Nonlinear Effects | Yes |
| Thermal Strain Effects | Yes |
| **Bounding Box** | |
| Length X | 0.25 m |
| Length Y | 0.2 m |
| Length Z | 3. m |
| **Properties** | |
| Volume | 0.15 m³ |
| Mass | 420. kg |
| Centroid X | 0.125 m |
| Centroid Y | 0.1 m |
| Centroid Z | 1.5 m |
| Moment of Inertia Ip1 | 316.4 kg·m² |
| Moment of Inertia Ip2 | 317.19 kg·m² |
| Moment of Inertia Ip3 | 3.5875 kg·m² |
| **Statistics** | |
| Nodes | 30422 |
| Elements | 6300 |
| Mesh Metric | None |

TABLE 6  
Model (A4) > Materials

|  |  |
| --- | --- |
| Object Name | *Materials* |
| State | Fully Defined |
| **Statistics** | |
| Materials | 2 |
| Material Assignments | 0 |

### Coordinate Systems

TABLE 7  
Model (A4) > Coordinate Systems > Coordinate System

|  |  |
| --- | --- |
| Object Name | *Global Coordinate System* |
| State | Fully Defined |
| **Definition** | |
| Type | Cartesian |
| Coordinate System ID | 0. |
| **Origin** | |
| Origin X | 0. m |
| Origin Y | 0. m |
| Origin Z | 0. m |
| **Directional Vectors** | |
| X Axis Data | [ 1. 0. 0. ] |
| Y Axis Data | [ 0. 1. 0. ] |
| Z Axis Data | [ 0. 0. 1. ] |

### Mesh

TABLE 8  
Model (A4) > Mesh

|  |  |
| --- | --- |
| Object Name | *Mesh* |
| State | Solved |
| **Display** | |
| Display Style | Use Geometry Setting |
| **Defaults** | |
| Physics Preference | Mechanical |
| Element Order | Program Controlled |
| Element Size | 3.e-002 m |
| **Sizing** | |
| Use Adaptive Sizing | Yes |
| Resolution | Default (2) |
| Mesh Defeaturing | Yes |
| Defeature Size | Default |
| Transition | Fast |
| Span Angle Center | Coarse |
| Initial Size Seed | Assembly |
| Bounding Box Diagonal | 3.017 m |
| Average Surface Area | 0.46667 m² |
| Minimum Edge Length | 0.2 m |
| **Quality** | |
| Check Mesh Quality | Yes, Errors |
| Error Limits | Aggressive Mechanical |
| Target Element Quality | Default (5.e-002) |
| Smoothing | Medium |
| Mesh Metric | None |
| **Inflation** | |
| Use Automatic Inflation | None |
| Inflation Option | Smooth Transition |
| Transition Ratio | 0.272 |
| Maximum Layers | 5 |
| Growth Rate | 1.2 |
| Inflation Algorithm | Pre |
| View Advanced Options | No |
| **Advanced** | |
| Number of CPUs for Parallel Part Meshing | Program Controlled |
| Straight Sided Elements | No |
| Rigid Body Behavior | Dimensionally Reduced |
| Triangle Surface Mesher | Program Controlled |
| Topology Checking | Yes |
| Pinch Tolerance | Please Define |
| Generate Pinch on Refresh | No |
| **Statistics** | |
| Nodes | 30422 |
| Elements | 6300 |

## Modal (A5)

TABLE 9  
Model (A4) > Analysis

|  |  |
| --- | --- |
| Object Name | *Modal (A5)* |
| State | License Conflict |
| **Definition** | |
| Physics Type | Structural |
| Analysis Type | Modal |
| Solver Target | Mechanical APDL |
| **Options** | |
| Environment Temperature | 22. °C |
| Generate Input Only | No |

TABLE 10  
Model (A4) > Modal (A5) > Initial Condition

|  |  |
| --- | --- |
| Object Name | *Pre-Stress (None)* |
| State | Fully Defined |
| **Definition** | |
| Pre-Stress Environment | None Available |

TABLE 11  
Model (A4) > Modal (A5) > Analysis Settings

|  |  |
| --- | --- |
| Object Name | *Analysis Settings* |
| State | Fully Defined |
| **Options** | |
| Max Modes to Find | 6 |
| Limit Search to Range | No |
| On Demand Expansion | No |
| **Solver Controls** | |
| Solver Type | Program Controlled |
| **Advanced** | |
| Contact Split (DMP) | Off |
| **Output Controls** | |
| Stress | No |
| Surface Stress | No |
| Back Stress | No |
| Strain | No |
| Contact Data | No |
| Nodal Forces | No |
| Volume and Energy | No |
| Euler Angles | No |
| Calculate Reactions | No |
| General Miscellaneous | No |
| Result File Compression | Program Controlled |
| **Analysis Data Management** | |
| Solver Files Directory | C:\Users\HP\AppData\Local\Temp\WB\_HP\_19796\_2\wbnew\_files\dp0\SYS-5\MECH\ |
| Future Analysis | None |
| Scratch Solver Files Directory |  |
| Save MAPDL db | No |
| Contact Summary | Program Controlled |
| Delete Unneeded Files | Yes |
| Solver Units | Active System |
| Solver Unit System | mks |

TABLE 12  
Model (A4) > Modal (A5) > Loads

|  |  |
| --- | --- |
| Object Name | *Fixed Support* |
| State | Fully Defined |
| **Scope** | |
| Scoping Method | Geometry Selection |
| Geometry | 1 Face |
| **Definition** | |
| Type | Fixed Support |
| Suppressed | No |

### Solution (A6)

TABLE 13  
Model (A4) > Modal (A5) > Solution

|  |  |
| --- | --- |
| Object Name | *Solution (A6)* |
| State | Not Solved |
| **Adaptive Mesh Refinement** | |
| Max Refinement Loops | 1. |
| Refinement Depth | 2. |
| **Information** | |
| Status | Solve Required |
| MAPDL Elapsed Time |  |
| MAPDL Memory Used |  |
| MAPDL Result File Size |  |
| **Post Processing** | |
| Beam Section Results | No |

TABLE 14  
Model (A4) > Modal (A5) > Solution (A6)

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| TABLE 15 Model (A4) > Modal (A5) > Solution (A6) > Solution Information   |  |  | | --- | --- | | Object Name | *Solution Information* | | State | Not Solved | | **Solution Information** | | | Solution Output | Solver Output | | Newton-Raphson Residuals | 0 | | Identify Element Violations | 0 | | Update Interval | 2.5 s | | Display Points | All | | **FE Connection Visibility** | | | Activate Visibility | Yes | | Display | All FE Connectors | | Draw Connections Attached To | All Nodes | | Line Color | Connection Type | | Visible on Results | No | | Line Thickness | Single | | Display Type | Lines |   TABLE 16 Model (A4) > Modal (A5) > Solution (A6) > Results   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | Object Name | *Total Deformation* | *Total Deformation 2* | *Total Deformation 3* | *Total Deformation 4* | *Total Deformation 5* | *Total Deformation 6* | *Total Deformation 7* | | State | Not Solved | | | | | | | | **Scope** | | | | | | | | | Scoping Method | Geometry Selection | | | | | | | | Geometry | All Bodies | | | | | | | | **Definition** | | | | | | | | | Type | Total Deformation | | | | | | | | Mode | 1. | 2. | 3. | 4. | 5. | 6. | 1. | | Identifier |  | | | | | | | | Suppressed | No | | | | | | | | **Results** | | | | | | | | | Minimum |  | | | | | | | | Maximum |  | | | | | | | | Average |  | | | | | | | | Minimum Occurs On |  | | | | | | | | Maximum Occurs On |  | | | | | | | | **Information** | | | | | | | | | Frequency |  | | | | | | |  Material Dataal7079 TABLE 17 al7079 > Constants   |  |  | | --- | --- | | Density | 2800 kg m^-3 |   TABLE 18 al7079 > Color   |  |  |  | | --- | --- | --- | | Red | Green | Blue | | 161 | 209 | 255 |   TABLE 19 al7079 > Isotropic Elasticity   |  |  |  |  |  | | --- | --- | --- | --- | --- | | Young's Modulus Pa | Poisson's Ratio | Bulk Modulus Pa | Shear Modulus Pa | Temperature C | | 72 | 0.3 | 60 | 27.692 |  | |

CONCLUSION

The following conclusions have been reached from the modal analysis of uncracked and cracked cantilever beam investigations: Analytical identification of natural frequency values is highly accurate in terms of obtaining theoretical values. The presence of cracks reduces the natural frequency, and the amount of reduction varies depending on the position of the cracks (top, middle, or bottom). The natural frequency of cracked cantilever beams reduces when the crack is provided on the top and bottom edges of the beam, but the crack in the middle of the beam remains stable. The natural frequency changes slightly as the crack shifts from the fixed to the free end of the cantilever beam. The mode shapes of a cracked cantilever beam depend on the depth and position of the crack. The effect of a crack varied based on the mode of vibration. The above information can be utilized to predict beam failure and take preventative measures.

1] P.M. Jagdale, M.A. Chakrabarti, Free vibration analysis of cracked beam, Int. J. Eng. Res. Appl. 3 (2013) 1172–1176. [2] P. Yamuna, P. Sambasivarao, Vibration analysis of beam with varying crack location, Int. J. Eng. Res. General Sci. 2 (2014) 1008–10017. [3] P. Gudmundson, Eigen frequency changes of structures due to cracks, notches, or other geometrical changes, J. Mech. Phys. Solids 30 (5) (1982) 339–353. [4] R.Y. Liang, J. Hu, F. Choy, Theoretical study of crack-induced eigenfrequency changes on beam structures, J. Eng. Mech., 118 (1992), 384-396. [5] R. Y. Liang, F. Choy, J. Hu, Detection of cracks in beam structures using measurements of natural frequencies, J. Franklin Institute, 328 (1991), 505- 518. [6] C. Ramachandran, R. Ponnudurai, Modal analysis of beam with varying crack depth, Int. Re. J. Eng. Techno. 4 (2017) 452–458. [7] P.Y. Ghodke, D.H. Tupe, G.R. Gandhe, Modal analysis of cracked continuous beam using ANSYS, Int. Res. J. Eng. Technol. 4 (2017) 86–93. [8] S.B. Bagal, C.P. Pise, Y.P. Pawar, S.S. Kadam, Vibration analysis of fixed-fixed beam with varying crack depth, Int. J. Eng. Trends. Technol. 47 (2017) 394–398. [9] Md. Shumon Miaa, Md. Shahidul Islamb, Udayan Ghoshc, Modal analysis of cracked cantilever beam by finite element simulation, Procedia Eng. 194 (2017) 509–516. [10] V. Khalkar, S. Ramachandran, Analysis of the effect of V-shape and rectangular shape cracks on the natural frequencies of a spring steel cantilever beam, Mater. Today. Proc. 5 (2018) 855–862. [11] W.D. Pilkey, Formulas for stress, strain, and structural matrices, second ed., John Wiley & Sons Inc, Hoboken, New Jersey, 2005. [12] ANSYS Release 12.1, ANSYS Inc.