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Structural analysis of index finger assembly of the robot

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ABSTRACT

An index finger of robot fits in palm whose function is to perform certain task or to touch any object for sensing it. The finger is mostly made up of ABS (Acrylonitrile-Butadiene-Styrene) is a low-cost engineering thermoplastic that is easily machined. The assembly consists of Front piece, Middle piece, Lower piece, Servo motor and Motor handle. The main aim of the paper is to evaluate the structural analysis of Index Finger Assembly. Input will be the Index Finger Assembly SOLIDWORKS model and the outputs will be Total deformation, Stress and Strain plots. The model and analysis are performed using SOLIDWORKS and ANSYS Workbench. Structural analysis is performed on Index Finger Assembly with ABS (Acrylonitrile-Butadiene-Styrene) and Structural Steel material to validate Equivalent stress, Equivalent elastic strain and Total Deformation.

Keywords: *Index finger, Structural analysis, Solid works, ANSYS*

1. INTRODUCTION

Before working or performing analysis knowledge of component is must. The index finger plays a vital role in functioning of whole hand in robots. As every finger has some special feature that other finger cannot do the same operation with same accuracy. Index finger with combination of thumb finger can pick an object or for machines which has touch screen index finger is mostly used for performing operations. Basically for one finger there are 3 pieces which are connected with each other. Front piece is connected to middle and middle one to lower and the lower is connected to a servo motor and motor handle which performs any operation related to hand. The parts are made up of ABS or structural steel due to their properties such as Superior stiffness, Strength and Excellent electrical property.

Fig. 1: Shows a diagram of a typical Index Finger of robot.

2. MATERIAL PROPERTIES

Mostly in this material used for Analysis is ABS. It is thermoplastic material so can be recycled and it has good dimensional stability. Rest common material properties are listed below in table.

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Density	1.01e-006 kg mm^-3
Young's Modulus MPa	2588
Bulk Modulus MPa	20401
Shear Modulus MPa	875
Poisson's Ratio	0.47886
Tensile Yield Strength MPa	18.5
Tensile Ultimate Strength MPa	27.6

3. MODELLING

The Index Finger Assembly was modelled by using SOLIDWORKS software by considering the dimensions of a typical Index Finger Assembly. Structural Analysis was done by using ANSYS software. Analysis is used for finding out the distribution of stress and strain. The deformation will be maximum at the forced surface where as it will be minimum at fixed surface. Firstly, by using SOLIDWORKS software create 5 pieces (Front piece, Middle piece, Lower piece, Servo motor, Motor handle) of Index Finger Assembly Separately and make their assembly and after that save it as IGES format. After this import the file into ANSYS for further assembly analysis.

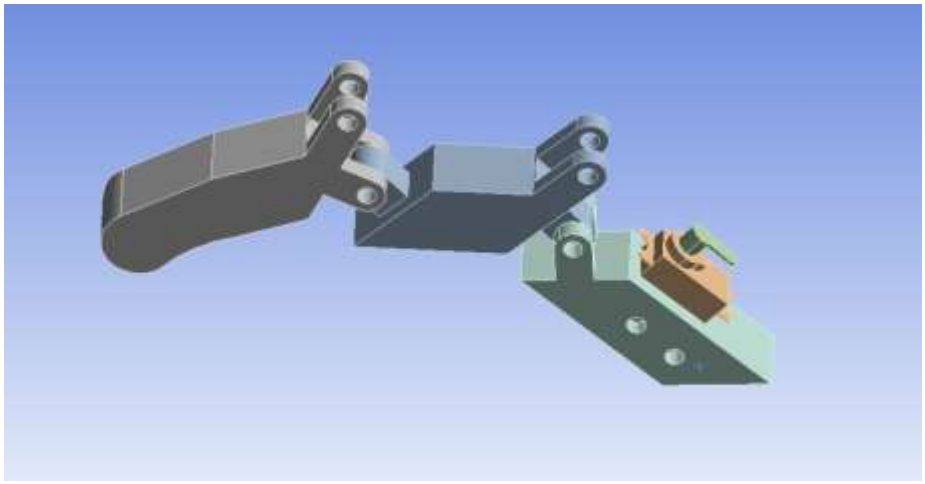

Fig. 2: Solidworks CAD model of Index finger Assembly

4. MESHING

In element analysis, Meshing is the important part. After importing IGES file into Ansys, First of all we have to select the material that is ABS and Structural Steel. After it before starting with meshing, we are supposed to change global setting. we have performed structural analysis of Index Finger Assembly by changing the span angle and curvature angle in meshing. It is used to set the goal for curvature-based refinement. To perform this meshing change the span angle size as per your choice such as coarse, medium, fine. The below Index Finger Assembly is meshed to the span angle size as FINE. You can change the sizing of the mesh by clicking right click on the mesh and in insert go to sizing. To change the normal curvature angle set “advanced size function” and specify the angle at which you want to perform meshing. After changing the values right click on mesh and update it to save the changes. At right click on the mesh and click on generate mesh then the mesh will be generated.

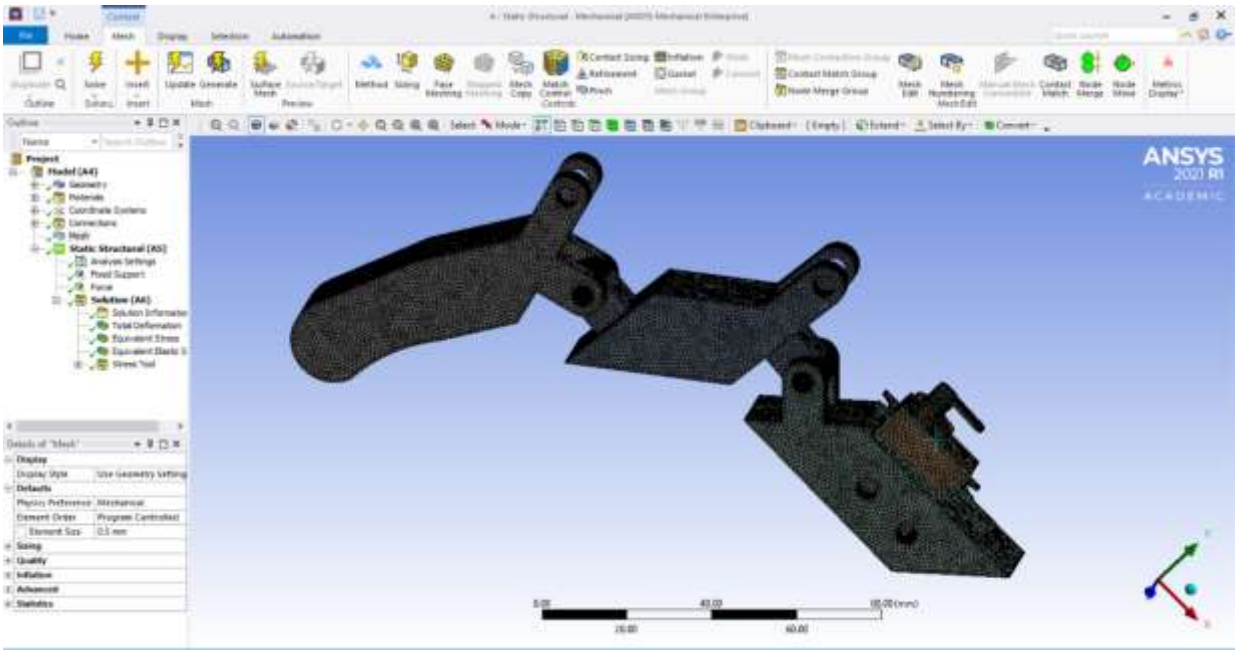

Fig. 3: Meshing

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5. STRUCTURAL ANALYSIS

After meshing the important part is Structural analysis of Index Finger Assembly. Then the boundary conditions are applied such fixed support and force(30N) acting surface. After inserting the boundary conditions the solution of structural analysis is solved. Equivalent stress, Equivalent strain, FOS (Factor Of Safety) and Total deformation is validated in the solution.

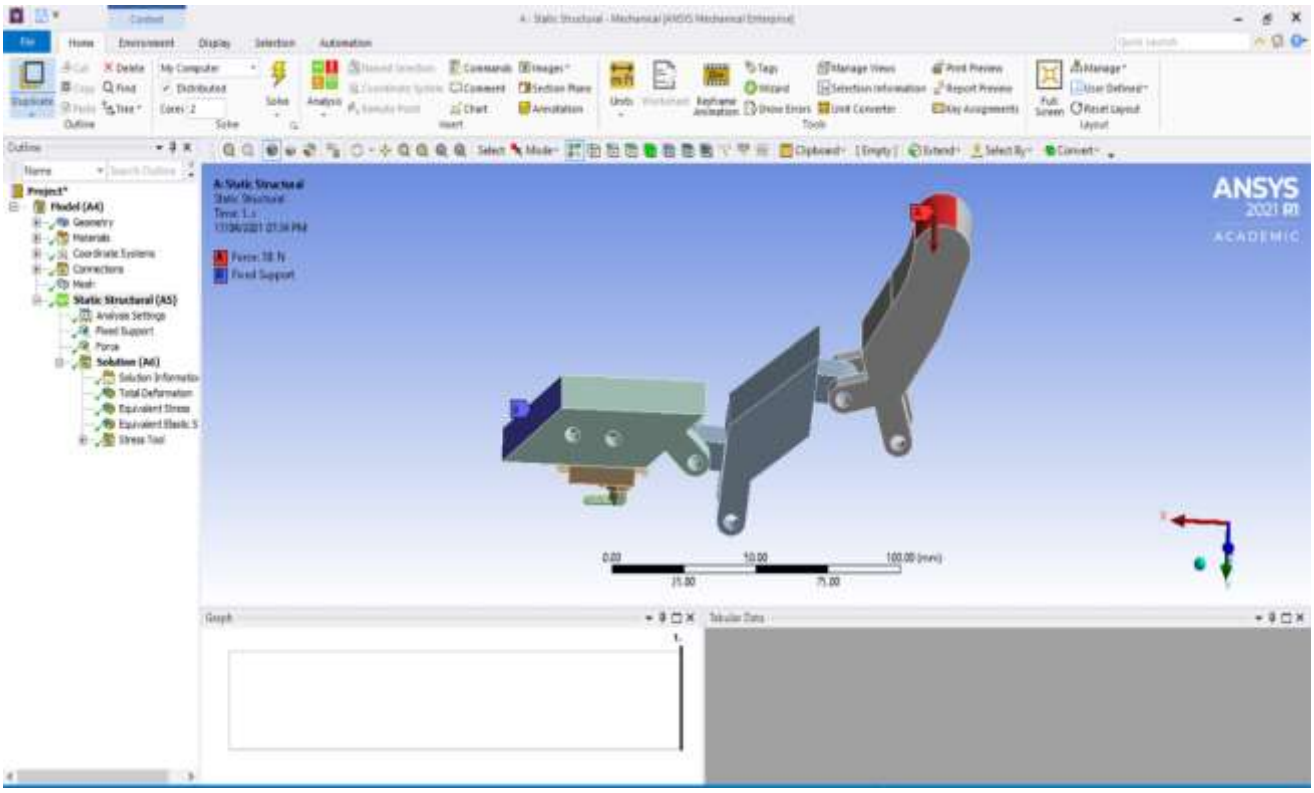

Fig. 4: Boundary conditions (Force acting surface and Fixed support)

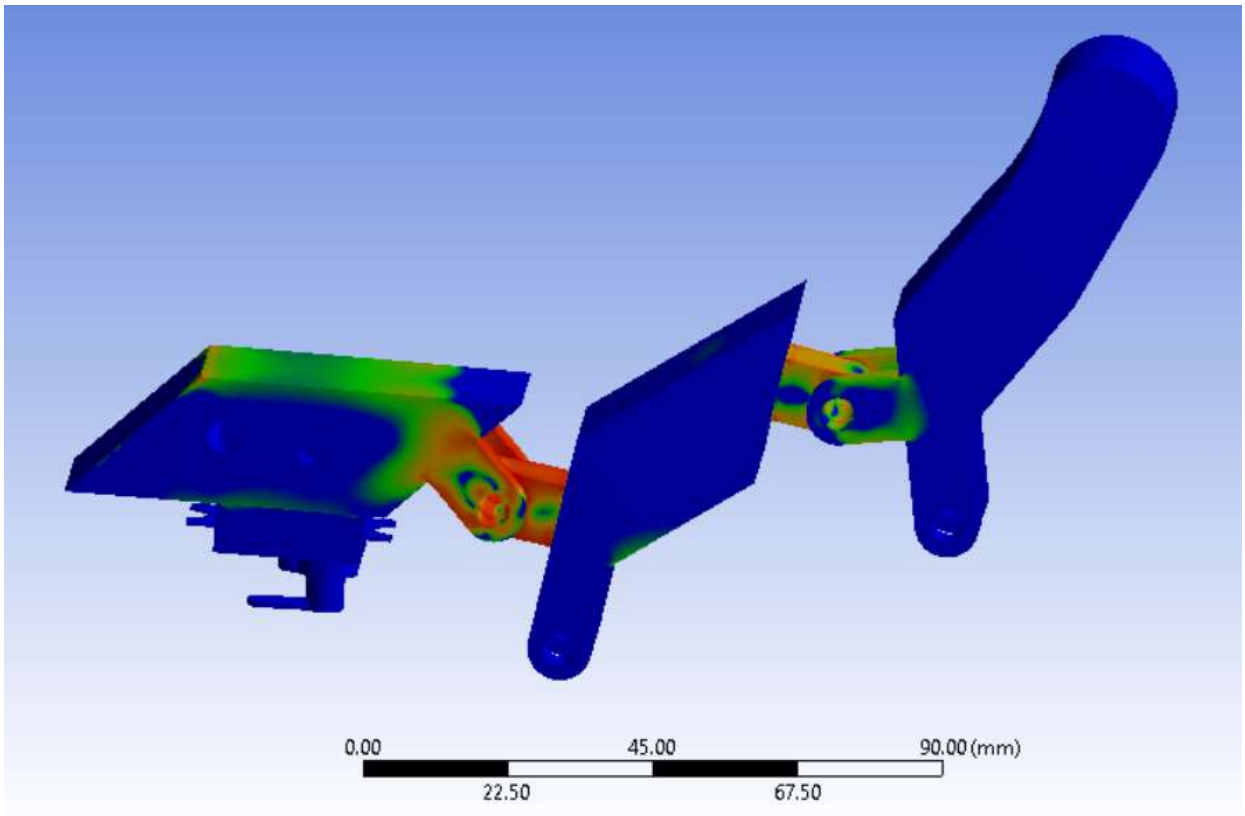

Fig. 5: FOS (Factor Of Safety)

Time [s]	Minimum	Maximum	Average
1.	0.33966	15.	12.673

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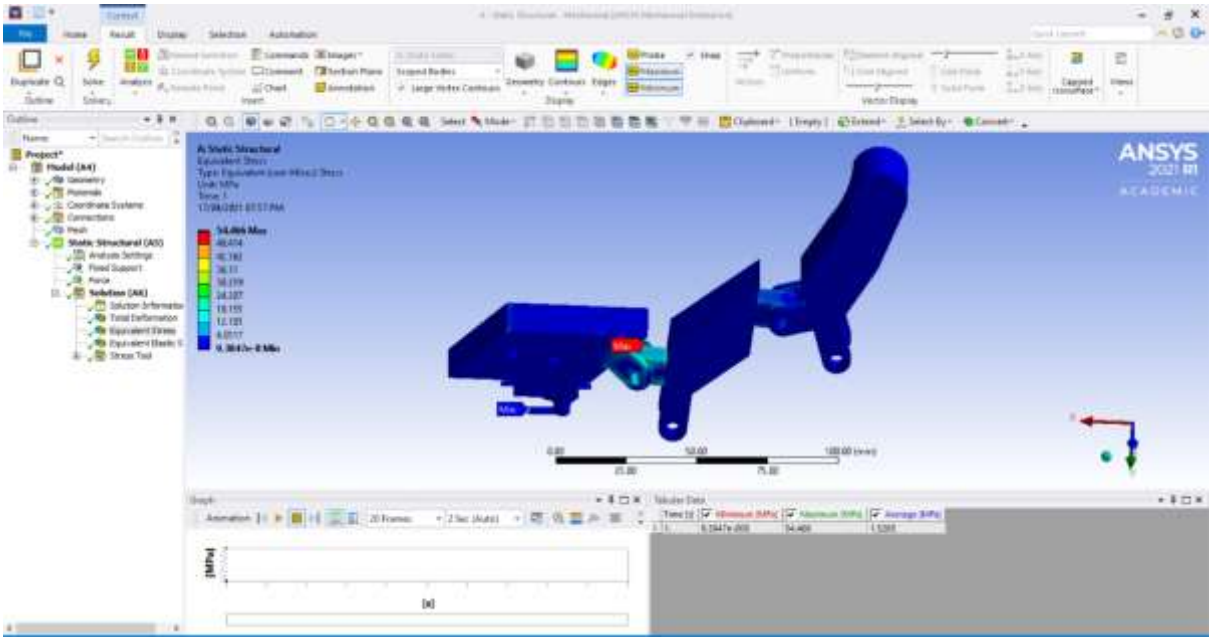

Fig. 6: Equivalent Stress

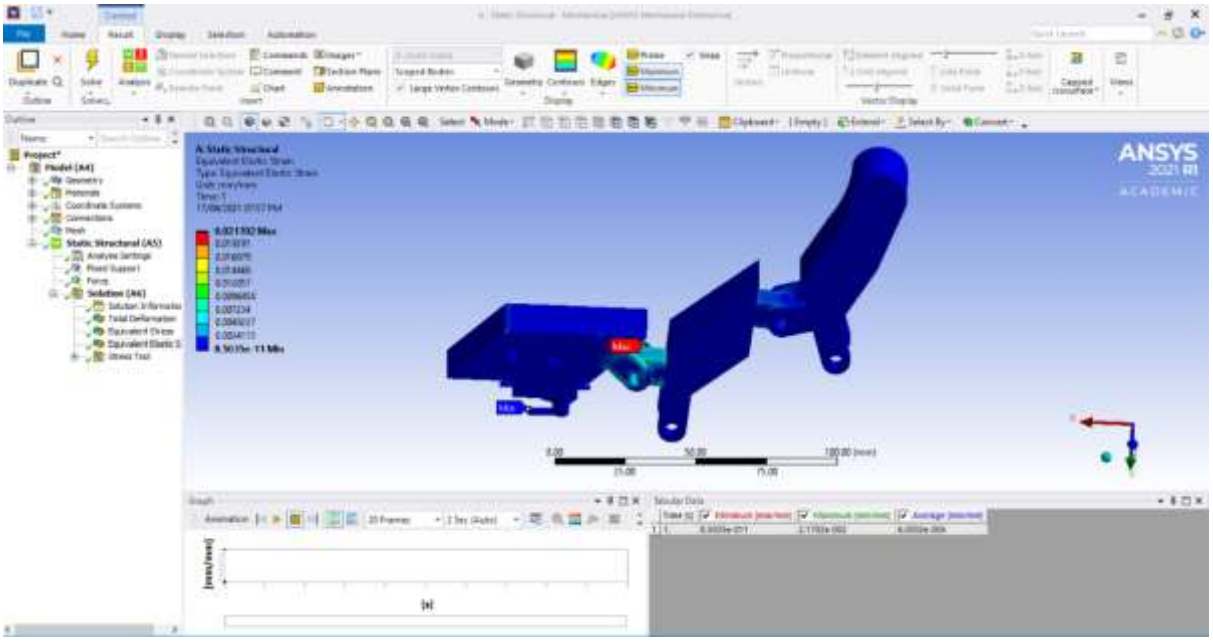

Fig. 7: Equivalent Strain

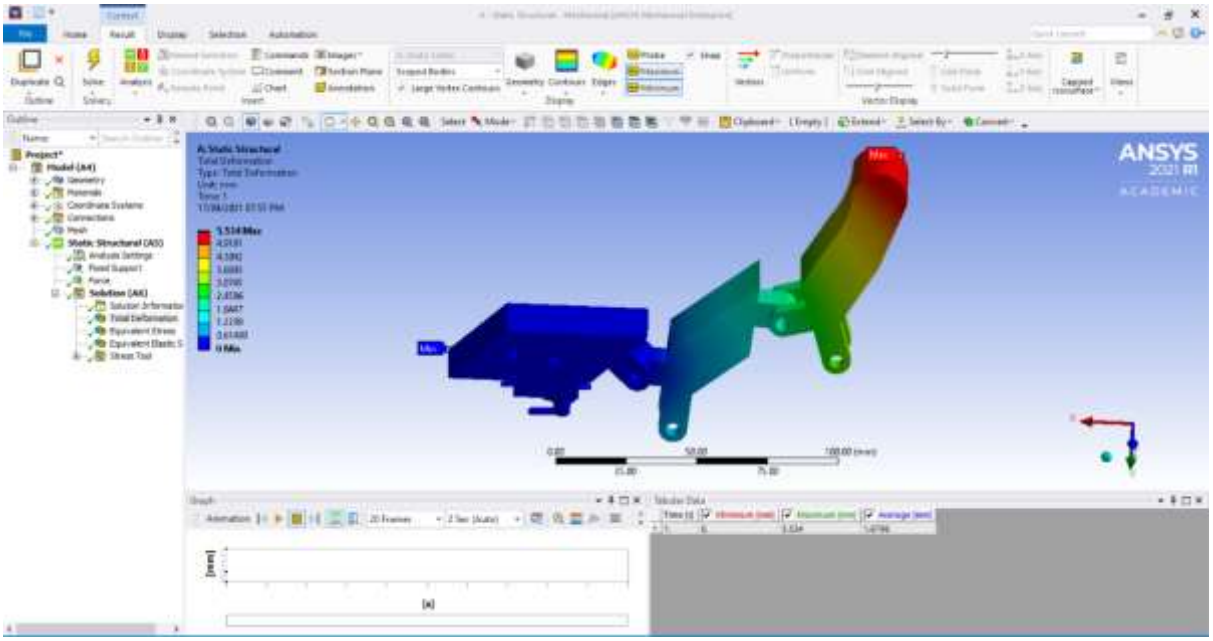

Fig. 8: Total Deformation

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6. RESULTS

The structural analysis of Index Finger Assembly calculates the Equivalent Stress, Equivalent Strain and Total deformation. Given below table gives the comparison between Total deformation, Equivalent stress and strain respectively.

Object Name	Total Deformation	Equivalent Stress	Equivalent Elastic Strain
Minimum	0. mm	9.3847e-008 MPa	8.5035e-011 mm/mm
Maximum	5.534 mm	54.466 MPa	2.1702e-002 mm/mm
Average	1.6796 mm	1.5265 MPa	6.0502e-004 mm/mm
Minimum Occurs On	lower piece	S Motor handle	
Maximum Occurs On	front piece	lower piece	

7. CONCLUSION

The Structural analysis of Index Finger Assembly has been done successfully. The Index Finger Assembly was modelled in SOLIDWORKS software and the Structural analysis were performed in ANSYS software. The application of Index finger is clear it is used in robots hand assembling and now a days there are lots of work which are performed using robots to reduce human efforts and as robots are more accurate and efficient than human they are used in factory and machine operating task in Industrial sector. This study of Structural analysis of Index Finger Assembly has output data as Equivalent stress, Equivalent strain and Total deformation.

8. REFERENCES

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