Analysis of Solid CAD Model and Cylindrical Extension Spring

Tanisshk Yadav [1], Dr. Atul Kulkarni[2]

[1] Student, Department of Mechanical Engineering, Vishwakarma Institute of Information Technology, Pune-48, Maharashtra, India
[2]Professor, Department of Mechanical Engineering, Vishwakarma Institute of Information Technology, Pune-48, Maharashtra, India

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Abstract - *FEA of cylindrical extension spring and a solid model with the help of Ansys is the main core objective of this paper. .Carrying out the CAD designing in SOLIDWORKS and then analyzing the model by applying tetrahedron and hexahedron mesh on the solid one and thus creating its report .Analysis part is carried out via various other softwares like Abacus, Hypermesh, Nastran, LS Dyna, etc. Only tetrahedron mesh on extension spring was successful as the extension spring has very compact coils arranged, its hexahedron meshing takes errors and further explicit dynamic analysis which is complex is required .Hence, the result acquired is Solid Cad Model is successfully analysed w.r.t extension spring where tetrahedral mesh is preferred over hexahedral mesh and hence accordingly report is attached.*

***Key Words*: Ansys, Meshing, Orthographic CAD Model, Cylindrical Extension Spring**

1. INTRODUCTION

Orthographically projected model is a common CAD model designed nowadays by every CAD designer but its analysis part is still not user friendly due to skill sets required for the same. Ansys helps to resolve such issues and makes the analyzing part better for structural analysis of any CAD model.

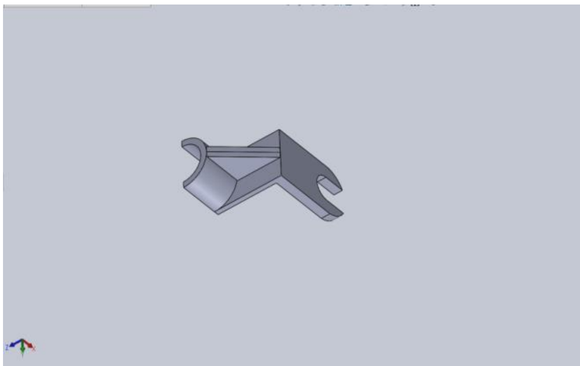
Hypermesh, Nastran, LS Dyna are also some other resources to analyze a part as per desired one but has its own pros and cons at the same time and requires hands on experience and prominent amount of skills to satisfy an output. FEA of these two components helps us to understand their main properties like their coarse, medium and fine granular structure and on with a fixed support on one side and applying load on the other.

Present study on the solid model and extension spring will improve the understanding of Ansys simulation to those who are new to analysis part of extension spring and hence will be newly introduced to FEA.

Though there is a wide range of scope for analysis of cylindrical spring in future and in many aspects like fatigue resistance.

2. METHODOLOGY

2.1 SOLID CAD MODEL



CAD Design Modelling carried out in SOLIDWORKS.

2.2 ANALYSIS OF SOILD MODEL

Further procedure is carried out in Ansys in which models were imported in its workbench. Then opening its mechanical platform where actual analysis is done to obtain the results and then generating the mesh is the process to be done next either choosing the automatic option or selecting the type of mesh option the one which proves more efficient.

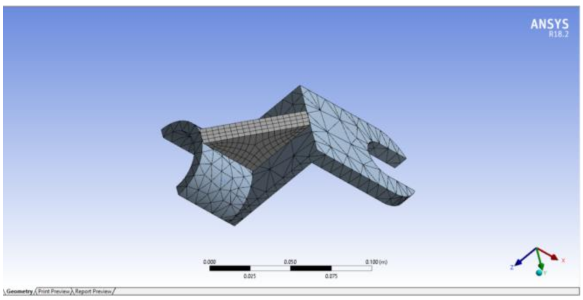
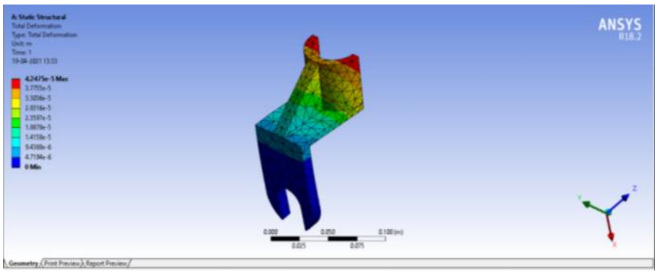


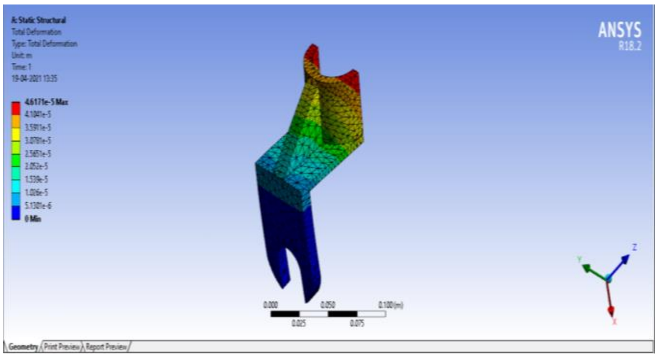
Figure 2. Generated Mesh

Then tetrahedral mesh is done on fine, coarse and medium meshes. The structure element and nodes of mesh results in the variation of analytic properties. Fine refinement gives a good result of strain and deformation compared to the medium and coarse and hence gives a different amount of nodes and elements.

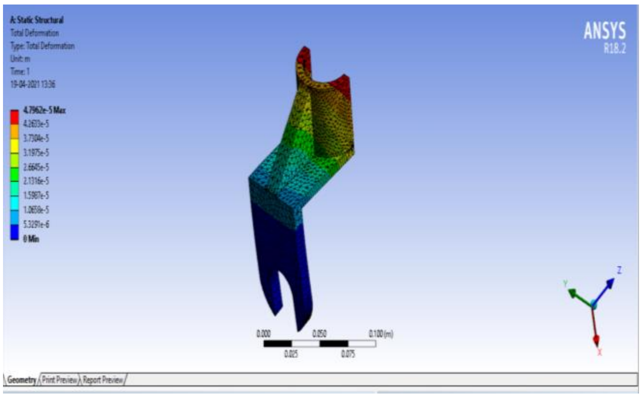
Its analysis depending on the type of refinement is as follows:



A. Tetrahedral Coarse Mesh

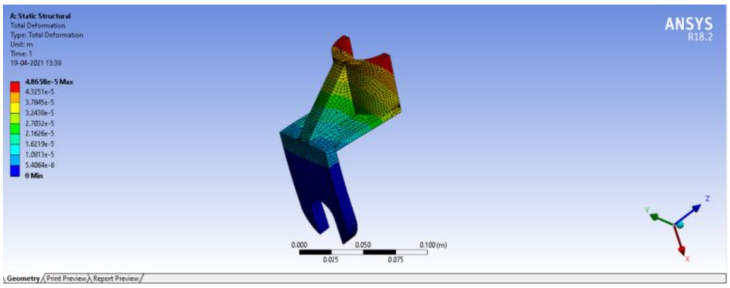


B. Tetrahedral Medium Mesh

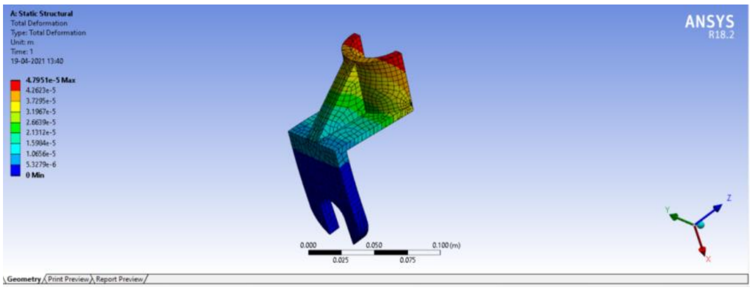


C. Tetrahedral Fine Mesh

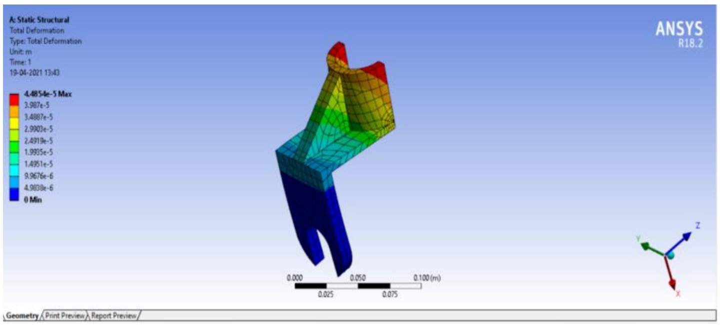
After the tetrahedral mesh is successfully applied then Hexa dominant mesh is applied as per the followed procedure.



A. Hex Dominant Fine

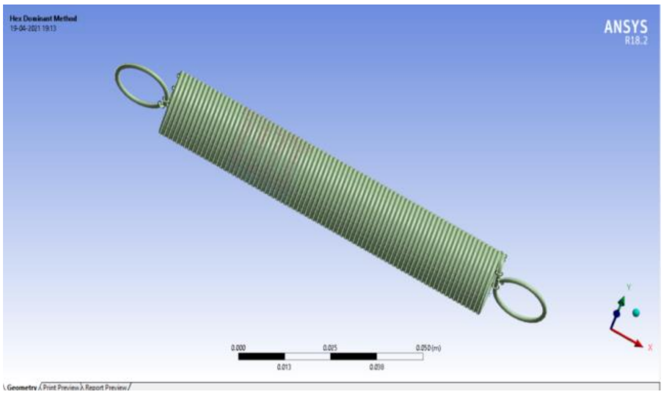


B. Hex Dominant Medium



C. Hex Dominant Coarse

3.1 CYLINDRICAL EXTENSION SPRING



CAD MODEL

3.2 ANALYSIS OF CYLINDRICAL EXTENSION SPRING

Analysis of this extension spring is quite critical which cause there is error while doing its Hexahedral mesh as its coils are very compact and nodes are getting occupied very close to each other hence obtaining refinement difficult. Moreover we can carry out its structural analysis by only applying parabolic and tetrahedral meshing of which we've applied the second one.

Dimensions of the Extension Spring are as follows:

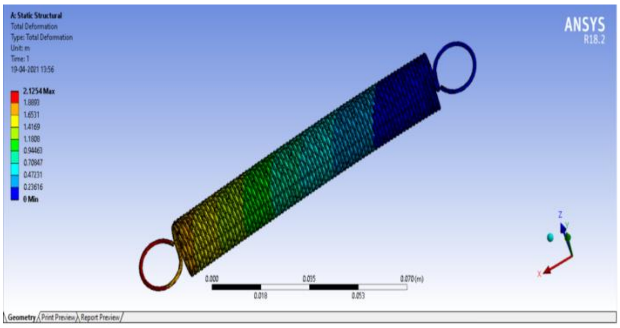
Wire Diameter- 1.19mm

Outer Diameter- 15.88mm

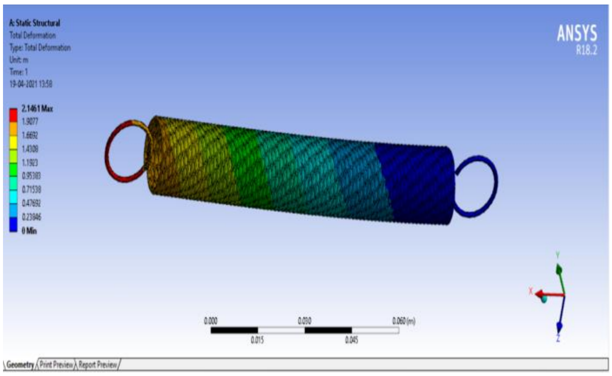
Length- 127.0mm

Rate- 0.074 N/mm

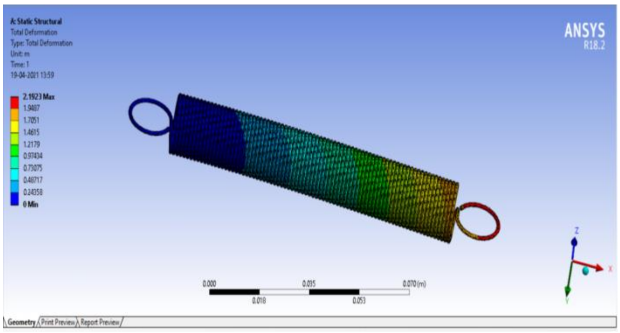
Load is applied from one end of 100 N and other end is fixed.



A. Tetrahedral Coarse



B. Tetrahedral Medium



C. Tetrahedral Fine

4. RESULT AND DISCUSSION

In both models a 100 N force was applied of which the displayed images are obtained which shows the distortion and subject of matter to change showing varying results.

We can comment from the analysis that in both models there is a little bit difference in coarse and medium structural analysis whereas high in fine refinement in tetrahedral mesh. In hexahedral mesh of solid model we can verify its significance from the readings by itself.

For Solid Model:

Tetrahedron Max Value=4.7962e-5m (FINE MESH)

Tetrahedron Min Value=0m

Hexahedral Max Value=4.8658e-5m (FINE MESH)

Hexahedral Min Value=0m

Tetrahedron	Coarse	Medium	Fine
Min (m)	0	0	0
Max (m)	4.2475e-5	4.6171e-5	4.7962e-5

Hexa Dominant	Coarse	Medium	Fine
Min(m)	0	0	0
Max(m)	4.4854e-5	4.7951e-5	4.8658e-5

Tetrahedral	Coarse	Medium	Fine
Nodes	2404	8352	24762
Elements	1078	4372	13692

Hexa Dominant	Coarse	Medium	Fine
Nodes	4541	12215	33780
Elements	1434	3602	9666

For Cylindrical Extension Spring

Tetrahedron Max Value=2.1923m (FINE MESH)

Tetrahedron Min Value=0m

Tetrahedron	Coarse	Medium	Fine
Min (m)	0	0	0
Max (m)	2.1254	2.1461	2.1923

Tetrahedral	Coarse	Medium	Fine
Nodes	35804	35457	48491
Elements	12598	12576	16910

5. ANSYS REPORT

1. **Table -1:** SOLID MODEL

Bounding Box	
Length X	0.13656 m
Length Y	5.5502e-002 m
Length Z	7.8e-002 m
Properties	
Volume	9.5542e-005 m^3
Mass	0.75 kg
Scale Factor Value	1.
Statistics	
Bodies	2
Active Bodies	2
Nodes	3533
Elements	1123
Assignment	Structural Steel
Properties	
Volume	9.5542e-005 m^3
Mass	0.75 kg
Centroid X	-2.5595e-002 m
Centroid Y	3.8269e-007 m
Centroid Z	3.101e-002 m
Moment of Inertia Ip1	3.4092e-004 kg·m^2
Moment of Inertia Ip2	1.1844e-003 kg·m^2
Moment of Inertia Ip3	1.2104e-003 kg·m^2
Tolerance Value	4.1693e-004 m
Bounding Box Diagonal	0.166770 m
Minimum Edge Length	1.7285e-004 m
Transition Ratio	0.272
Maximum Layers	5
Growth Rate	1.2

2. **Table -2:** CYLINDRICAL EXTENSION SPRING

Bounding Box		
Length X	0.12939 m	
Length Y	1.5875e-002 m	
Length Z	1.5875e-002 m	
Properties		
Volume	4.2511e-006 m^3	
Mass	3.3371e-002 kg	
Scale Factor Value	1.	
Statistics		
Bodies	1	
Active Bodies	1	
Nodes	35804	
Elements	12598	
Bounding Box		
Length X	0.12939 m	
Length Y	1.5875e-002 m	
Length Z	1.5875e-002 m	
Properties		
Volume	4.2511e-006 m^3	
Mass	3.3371e-002 kg	
Centroid X	9.3705e-007 m	
Centroid Y	2.4084e-005 m	
Centroid Z	9.9116e-009 m	
Moment of Inertia Ip1	1.7527e-006 kg·m^2	
Moment of Inertia Ip2	2.8675e-005 kg·m^2	
Moment of Inertia Ip3	2.8656e-005 kg·m^2	
Statistics		
Nodes	35804	
Elements	12598	
Mesh Metric	None	
Bounding Box Diagonal	0.131320 m	
Minimum Edge Length	9.4641e-004 m	
Transition Ratio	0.272	
Maximum Layers	5	
Growth Rate	1.2	
Geometry	38 Faces	42 Faces

5. CONCLUSIONS

From the results and report we can understand the analysis of the solid model and the cylindrical extension spring as well as shown in the tabular format the one can identify significance of nodes and elements, max and mi n value of tetrahedron as well as hehxahedral mesh.

The analysis of the solid orthographic model is more effective and primitive and took less amount of time while meshing thus generating its report accurate indicating the tolerance value, minimum edge length, transition ratio, etc. Whereas, the analysis of cylindrical extension spring proved effective only during its tetrahedron meshing and didn't succeed in hexahedral meshing from making a point that due to its nodes which are very compactly arranged and as the coils of springs are continuous attached it becomes difficult to software to refine its hex dominant meshing and thus taking definitive amount of time with uncertainty to proceed further.

The Cylindrical extension spring still has a scope for its nonlinear analysis and explicit dynamic analysis which can be further useful for research but should be carried out in Hypermesh or Abacus software due to limitations imposed by Ansys.

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