STRESS AND STRAIN ANALYSIS OF THE 10 MeV CYCLOTRON MAGNET

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Abstract

In cyclotrons the heaviest part of the machine, is magnet system. In the 10 MeV cyclotron which is under construction At AmirKabir University of technology AISI 1010 is used for material because of its magnetic properties. AISI 1010 has got medium mechanical strength among steels. In detail engineering design for magnet system of 10 MeV cyclotron in amirkabir University of technology, because of drilling locations for joints and bolts and weight of magnet system, which is concentrated of specific parts, stress and strain analyze of some parts played an important role in insurance of mechanical stability of system. In this paper an attempt has been done for stress and strain simulation on detailed design of Magnet system for 10 MeV cyclotron using Ansys and Solidworks.

INTRODUCTION

The 10 MeV cyclotron which is under construction at AmirKabir university of technology for medical propose, is a compact AVF cyclotron. In this machine all parts specially magnet, are embedded in specific way in order to be compact [1]. In Table 1 parameters of magnet can be seen.

Table 1: Magnet Parameters

Parameter	Value
Material	AISI 1010
Weigh of one yoke System	5624 kg
Total number of pins	11
Total number of bolts	48
Type of bolts	M 10
Tensile strength: Yield (proof)	200 MPa

For insuring the stability of joints and bolts, stress and strain an analysis has been done on magnet structure. In Figure 1 magnet structure be shown. For simulation of stress and strain all parts modeled by solid works and Ansys workbench static structure has been used for simulation.

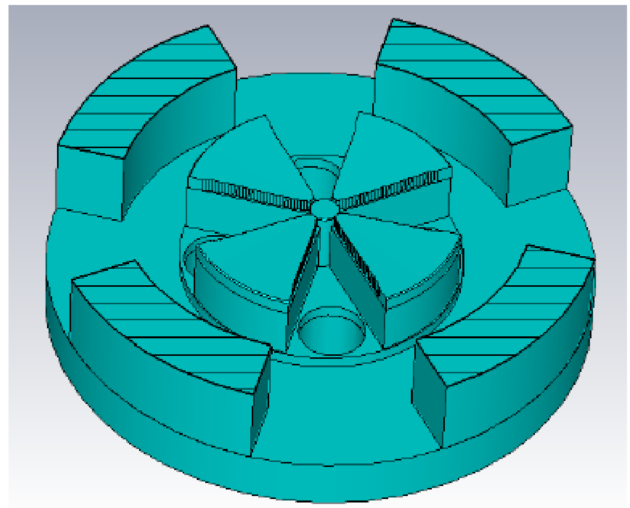

Figure 1: Magnet structure for the 10 MeV cyclotron.

In the structure of this magnet, there is a crucial part which joint poles to yokes, it is called extra part. In fact extra part is critical in way of stress and strain because it endures weight of all part except yokes and it is proportionally thin. In Figure 2 extra part can be seen.

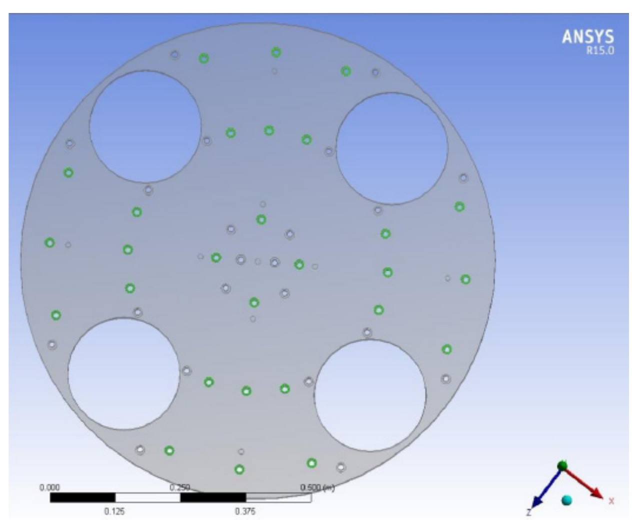

Figure 2: Extra part with drilling points.

As can be seen in Figure 2, there are some drilling points in extra part which can make it more [2].

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SIMULATION

For simulation this structure all parts modeled in solid works and equivalent forces which caused by weight of RF Cavity and other parts applied of each structure. By considering priority of forces and weight all parts analyzed. Ansys static structure has been used for this simulation and because of applying details and considering all points, accuracy of simulation is significant. First step after providing geometry in Ansys is meshing [3]. Also suitable meshing can contribute proper simulation. For these simulations, an attain has been done in order to reach high quality of meshing as much as possible. In Figure 3 and Table 2, mesh characteristic for extra part can be seen.

Table 2: Mesh Characteristic for Extra Part

Parameter	Value
Method	Hex dominant
Total number of elements	383265
Total number of nodes	1523653
Maximum Aspect ratio	56
Average aspect ratio	1.325
Maximum skewness	0.86
Average skewness	0.3

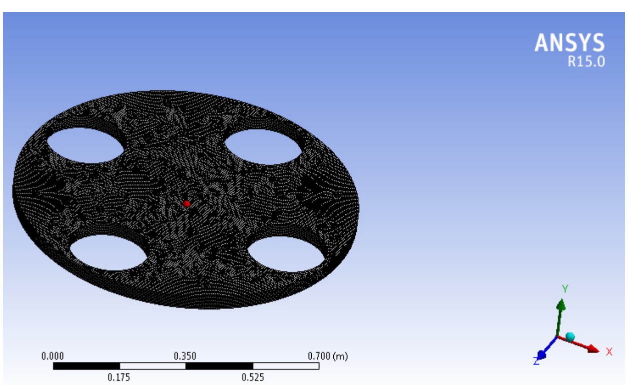

Figure 3: High quality meshing for extra part.

In Figure 4, Figure 5 and Figure 6 stress and strain distribution in magnet of the 10 MeV cyclotron is shown.

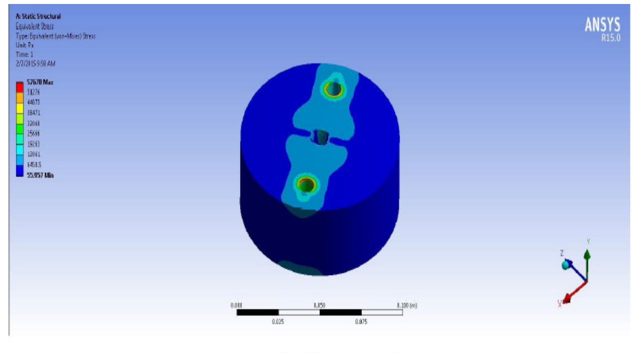

Figure 4: Stress distribution in central plug.

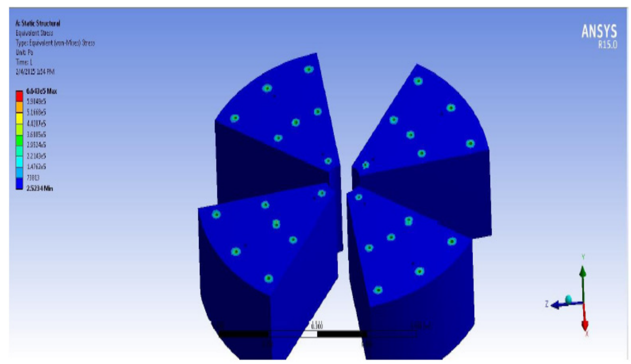

Figure 5 : Stress distribution in poles.

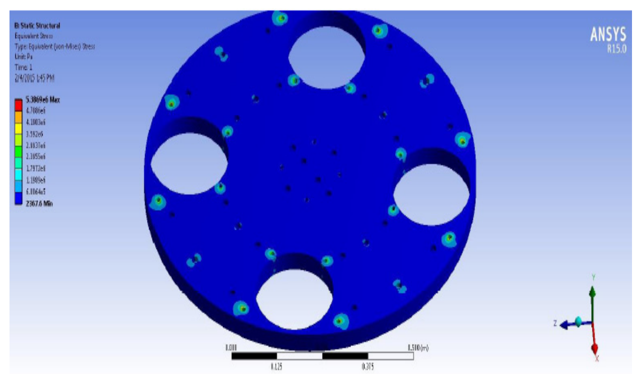

Figure 6: Stress distribution in extra part.

Because of the importance of extra part in structure stability of magnet system and accuracy of assembling, evaluating of total deformation in extra part is also essential. In Figure 7, deformation distribution in extra part is shown.

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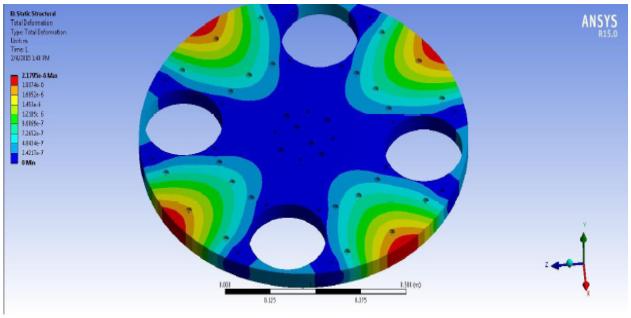

Figure 7: Deformation distribution in extra part.

CONCLUSION

In magnet structure, pins considered just for guiding and accuracy of assembly so they do not endure or apply any forces or pressure. As can be seen in Figure 6, maximum amount of stress (Von- mises) occurred in extra part bolts locations and its value is 5.369 MPa which is much less than Tensile strength. Also by considering deformation (Von -mises) in Figure 7, which has got maximum value of 2.170 µm, insurance safety and structure stability of magnet in time of working can be inferred. Also it indicates that the layout of drilling and joints is suitable for the 10 MeV compact cyclotron. This layout can help other parts of cyclotron in order to be compact and it is economical for manufacturing.

REFERENCES

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