Finite element analysis of turbine blade based on UG

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Abstract

Based on the simplified turbine blades model and using finite element analysis module of UG, we can obtain the stress and strain nephogram of turbine blade.This method provides a theoretical basis for the actual turbine blade design and optimization.It's also laid the foundation for the subsequent learning and mastering complex parts, the static structure analysis of assembly parts and other finite element analysis.

Keywords

Turbine blade, UG, finite element analysis.

1. Introduction

The essence of the finite element analysis is to disperse a continuous discrete geometry into an aggregate composed by a finite number of units through the mesh generation, each unit connects into a whole by nodes. The operation process can be divided into preprocessing, background calculation and final treatment[1].UG NX is a CAD/CAE/CAM integrated software module toward enterprises. The finite element analysis module of UG (also known as advanced simulation) has multiple functions such as linear statics, buckling response, nonlinear, dynamics, thermal analysis, fatigue analysis and optimization analysis. The turbine blade is an important component of aero-engine. The establishment of accurate finite element model and accurate finite element analysis are the necessary steps for the prediction of fatigue lifespan[2].

2. The Main Structure of Turbine Blade

As shown in Fig. 1,take the simplify model of turbine blade as an example, use drawing, surface modeling and other functions of UG to draw a three-dimensional turbine blade model. Its features is 5 blades of a conical column body, the material is quality 40Cr (used in UG base material AISI_STEEL_4340), the work speed is 10000r/min,the pressure of the leave's back surface is 15MPa.

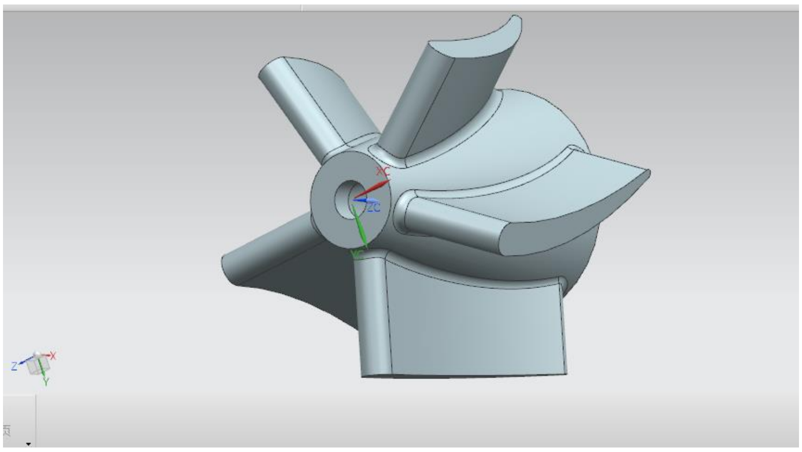

Fig. 1 3D model of turbine blade

3. Finite Element Analysis of Turbine Blade

3.1 The Operation Steps of Finite Element Analysis

(1)Definition of Material

The material of turbine blade is 40Cr, the following parameters were determined according to the related materials: the density of the material is 7.85e-006kg/mm^3, the Young's modulus is 1.93e+008mN/mm^2 (kPa), the Poisson's ratio is 0.284, the yield strength is 1.178e+006mN/mm^2 (KPa), the ultimate tensile strength is 1.24e+006mN/mm^2 (KPa). The material property of the body structure model then can be given by the definition of good’s material[3].

The physical property name of the model is set to PSOLID1, the type is set to PSOLID, and the material is set to the already defined material 40Cr (applied to the UG library material for AISI_STEEL_4340).

The grid collector sets the unit family to 3D, the collector type is an entity, the physical property type is PSOLID and the entity type is POSLID1.

(2)Mesh Generation

When generate the grid ,we should use 3D ten node tetrahedral mesh, the grid size of the main structural parts is set to 20, because of the complicated shape, if still need to improve the calculation accuracy, reduce the size of the unit once again is suggested, especially need to decrease the unit size of the blade[4]. The mesh generation results is shown in fig.2.

Fig. 2 The effect diagram mesh generation

(3) Restraint and Load Setting

According to the type of restraint and load of UG software and the structure type of turbine blade, the set of the binding force and load force are respectively: the two end surfaces of turbine blade using fixed constraint; the concave surface of the back of 5 blade is applied pressure of 15MPa; set the angular velocity of the centrifugal force of the turbine blade for 10000rev/min.

3.2 the Analysis of Finite Element Calculation Results

When analysis the structure strength of elastoplastic metal material, we often using Von Mises yield criterion to determine whether the structure is in a state of yield failure.Von Mises Stress is a kind of equivalent stress, using stress contours to show the stress division within the model can clearly describe the variation and distribution of a result in the whole model,so that the analyst personnel can quickly determine the most dangerous area in the model[5].

Fig.3 provides a stress nephogram of the turbine blade, it can be seen from the figure that the maximum stress value is 858.13MPa, far less than the material yield strength of 1178MPa, so it can be judged that the model is in elastic deformation stage under the conditions; the maximum stress concentration in the junction of the leaves and the body (the back of the blade near the blade root part), stress concentration is found in local area.

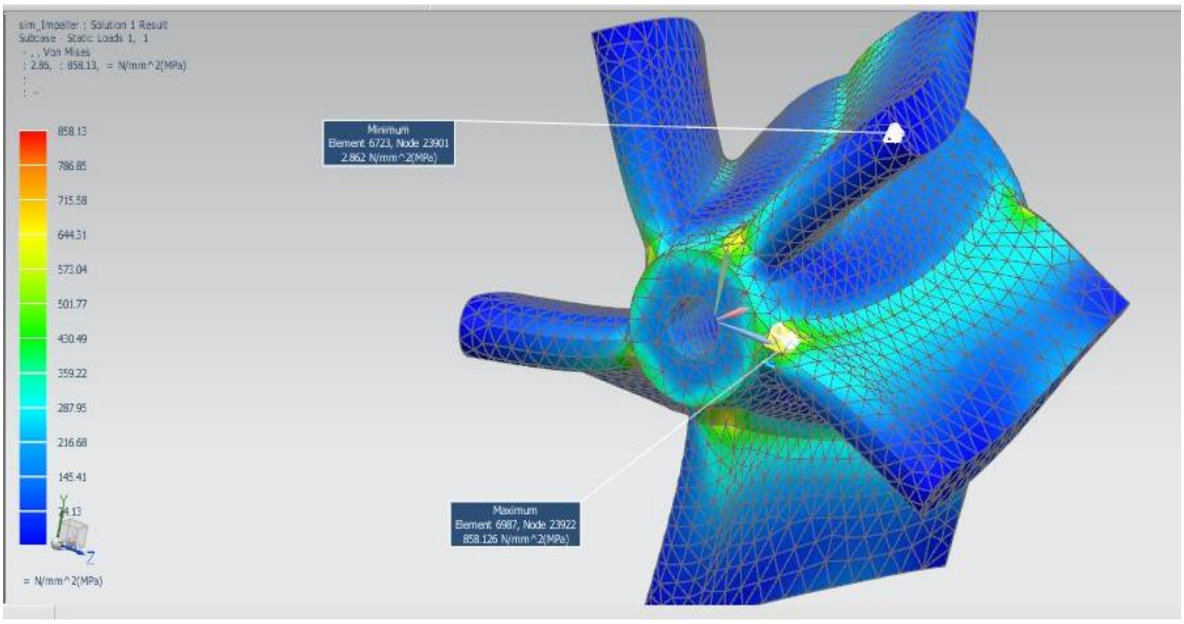

Fig. 3 Stress reprogram

Fig. 4 provides a strain reprogram of the turbine blade. It can be seen from the diagram that the maximum strain occurs at the intersection of the blade and the body, the strain value is 0.004mm. The minimum strain occurs at the edge of the blade.

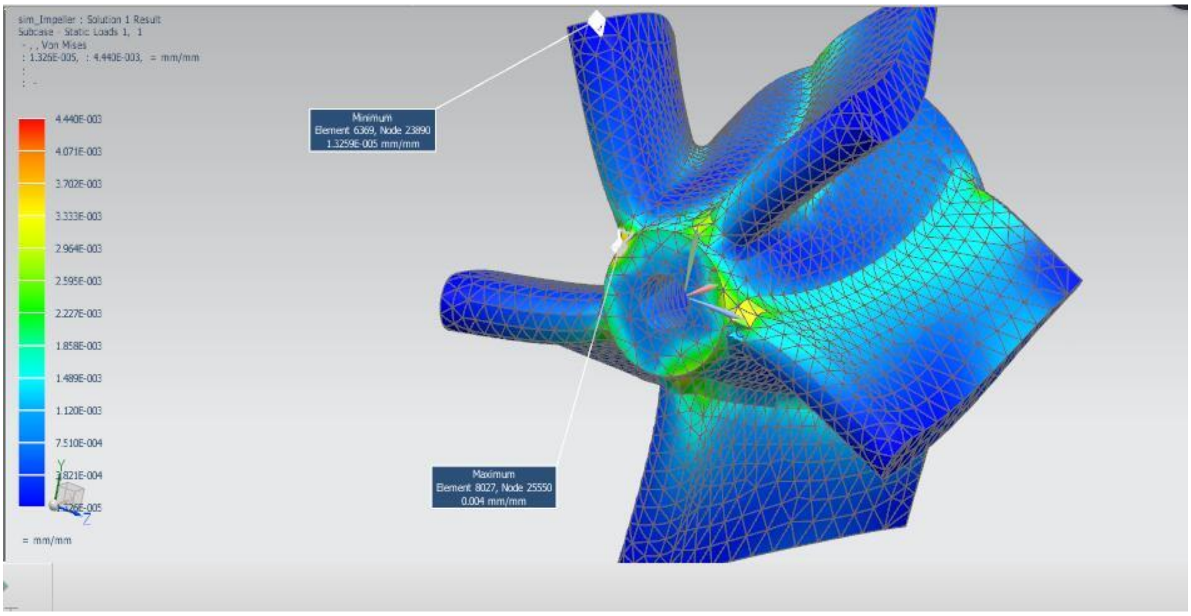

Fig.4 Strain reprogram

4. Conclusion

Through the analysis we can know that under the condition of high-speed rotation of centrifugal load, the blade root of turbine blade will have a greater stress concentration and generate a small range of yield force. The finite element analysis of the three-dimensional model of turbine blade can help beginners familiar with the work process, master the basic skills of using finite element analysis method to solve practical engineering problems, and gradually master the theory of finite element analysis, the main command and its parameters, the calculating functions of other types on this basis [6].

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